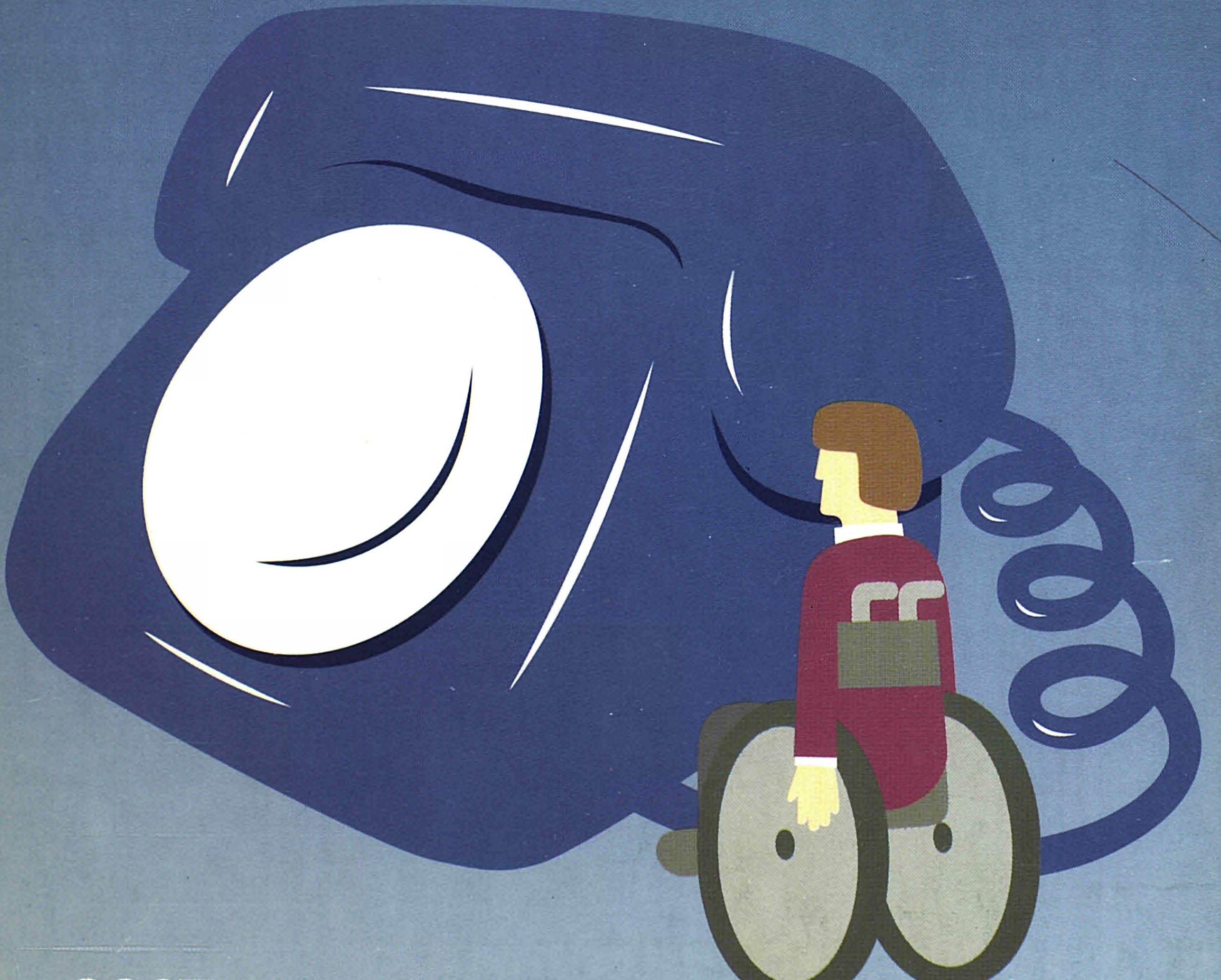
Commission of the European Communities

Issues in Telecommunication and Disability

Edited by Stephen von Tetzchner



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Issues in Telecommunication and Disability

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Foreword

In the field of telecommunications and informatics, new services and facilities are being established at a rapid rate. This rapid development has often taken place with little or no awareness of the needs of a significant group of consumers; those people who have disabilities that prevent or make difficult the use of the telephone.

In order to ensure that the needs of disabled people were properly formulated and made aware to the European telecommunications industry, regulatory authorities and others, the COST 219 project was set up.

COST is the European organisation for Cooperation in the Field of Scientific and Technical Research and has a significant interest in telecommunications as well as other areas, such as transport, new materials, forestry and social technology.

The COST 219 project is entitled: 'Future Telecommunication and Teleinformatics Facilities for Disabled People'. The signatories to this project agreed to co-operate in order to promote research into the field of telecommunications and teleinformatics with the aim of proposing solutions to problems related to the needs of disabled people in gaining access to telecommunication and teleinformatics services.

The project started in September 1986 and was terminated in September 1991. By March 1991, the signatories of Cost 219 were: Czechoslovakia, Denmark, Finland, France, (the Federal republic of) Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. In addition, there has been active participation from Belgium, Greece and Yugoslavia.

A request for a five year continuation of the activity after this date has already been granted by the COST Senior Officials Committee.

COST 219 has exchanged information and influenced different research bodies, such as the European Community projects 'Research into Advanced Communication Equipment in Europe' (RACE) and 'Technology for the Socio-Economic Integration of Disabled and Elderly People' (TIDE), and the standardisation body, European Telecommunication Standards Institute (ETSI). Close relations and involvement with user organisations have been central to the work, both on the international and national level, often through national COST 219 reference committees.

Results of the project's five years of work have been presented at various conferences and publications. This book, however, gives a coherent presentation of the most relevant issues that have been discussed during the project period.

It is the hope of the Management Committee of COST 219 that this book will stimulate further developments and improvements in telecommunications and teleinformatics for people with disabilities, as well as being a practical reference to the work carried out in this field over the last five years.

I would like to add to that my personal thanks to our editor, Stephen von Tetzchner, as well as to all authors who have made it possible to produce this book.

Jan Ekberg
Chairman of COST 219 Managment Committee

Contents

1

Introduction

Stephen von Tetzchner

> 'We do not use the term "independent" to mean someone who can do everything for himself, but to indicate someone who has taken control of their life and is choosing how that life is led' (Brisenden, 1986, p. 178).

Being a member of a larger society is an integral part of modern life. In everyday life, this usually implies communication with other people for a myriad of purposes: to gossip, to go shopping, to ask for help, to arrange meetings etc. To participate in this form of life, one needs to be able to reach other people, as well as to be reachable. In the organisation of everyday life, telecommunication has an important role, influencing social relations and the communication patterns of society at large (cf. chapter 4).

Human beings are both the creators of the technology, and the users of it. It is man who has brought about the technological and social changes following technological inventions. And although it is a limited number of people who have developed the technology and thereby brought about the changes, the technology has consequences for almost everyone in modern society.

When the use of telecommunication is impossible or difficult, the general reliance on telecommunications may become a hindrance to maintaining a social network that extends beyond relatives, close friends and professional helpers, and therefore also a hindrance to participation in a variety of activities.

Telecommunication technology has the potential to create equality and democracy by overcoming geographical barriers. However, because the use of technology requires new competence (cf. chapter 4), technology also has the potential of creating new barriers and thereby differences between those who are able and those who are not. There is considerable variation between people's abilities for most tasks. For some disabled people, even the simple telephone may difficult to use.

Many people with some form of impairment or disability may have little or no access to telecommunication, or have difficulties using equipment and services. When the problems become severe, the world they live in will differ considerably from the everyday reality of non-disabled users. They may have a restricted choice of activities and be unable to participate in many leisure and cultural activities that involve face-to-face contact; that is, they have less control over their own lives.

The limitations on telecommunication use invoked by an impairment will vary according to the type and degree of the disability (cf. chapters 5, 6 and 20). One of the most pervasive problems with regard to people with disabilities is the category 'the disabled' itself. It is common to hear people talk about 'the disabled' as an abstract entity, with common problems and needs. Within the telecommunications field, the stereotype of a disabled person is a hearing impaired person because it is so evident that a hearing impaired person cannot use the telephone without help. So strong is this stereotype that speech impaired people are forgotten; in the USA, a text telephones is called a 'telecommunication device for the deaf' (TDD), in the UK, the relay service used to be called the 'Telephone Exchange for the Deaf' (TED) (cf. chapter 22). Thus, the disabilities and everyday problems of disabled people vary considerably, including those related to use of telecommunications (cf. chapters 5 and 20).

In line with this, one should also carefully consider the intention behind the often used expression 'people with special needs'. People within this group do not have a special need of communication; but they may have a need for special means, that is, equipment and services, in order to fulfil ordinary communicative needs.

New technology has opened up telecommunications for some disabled people, such as text communication for speech and hearing impaired people who cannot use the ordinary audio telephone (cf. chapters 26–29). For deaf people who use sign language, videotelephones may give them equal opportunities for two-way interaction using their own language mode (cf. chapters 36, 37 and 42). People with intellectual impairment may be able to use videotelephones or picture telephones to supplement speech with non-verbal information, or to use graphic sign systems in telecommunication (cf. chapters 31 and 33).

For some disabled people, new telecommunication technology may increase their range of activities, compensating for some of the consequences of their impairment by facilitating activities that are not usually linked to telecommunication. For example, access to a 'newspaper' database and a terminal with a synthetic speech or Braille display may compensate for some of the lack of access to information experienced by many visually impaired people (cf. chapter 43). People with speech and motor impairment often communicate slowly. For them, electronic mail and computer conferences may offer a way to participate in social interaction without being handicapped by their limited communicative speed (cf. chapter 30), compensating, to some degree, for their lack of opportunities to participate in face-to-face communication.

From a different perspective, telecommunication technology may also create problems and difficulties. When Bell invented the telephone in 1876, a new gap was created between the possibilities of those who can hear and speak and those who are hearing and speech impaired. Before the invention of the audio telephone, both groups had to use manned, text communication services. Today, longer telephone numbers are introduced, making the telephone less user-friendly because more people will have problems remembering the numbers. The increased use of text, graphics and other forms of visual communication, so beneficial for deaf people, may exclude blind people from using many new services (cf. chapter 43).

'Improved' telephones with reduced electromagnetic leakage lead to reduced sound quality for hearing aid users (cf. chapter 21). The general development from manned to self-service facilities may exclude many people from use of services.

It is easy to point to new inventions and the positive effects of new technologies, but the reality for many disabled people is out-of-date technology, old fashioned equipment and a lack of standardisation that would be totally unacceptable in society at large (cf. chapters 26 and 27). The stamp of lesser worth seems hard to avoid. Laws and regulations may be necessary to ensure equal access and opportunity for people with disabilities (cf. chapter 9).

Some of the consequences of limited or no access to telecommunications are obvious, but many consequences are more far reaching and less obvious than one may expect. The consequences for mobility are a case in point.

To be able to get around is almost a prerequisite for full participation in society. Hence, the relationship between telecommunications and transport is of particular relevance for many people with disabilities. It has often been assumed that telecommunications will replace transport, but this may be true only in the sense that it would be impossible to maintain the same amount of communicative interaction without telephones. Contrary to many people's beliefs, telecommunications seem to facilitate face-to-face contact. They are used to maintain the social network, and to monitor and coordinate all kinds of social activities. For example, when telecommunication becomes more widespread, people seem to travel more. Similarly, when travelling increases, people tend to use telecommunication more (cf. chapter 4).

Additionally, many conditions that are handicapping in telecommunication situations also make it difficult to get around (blindness, motor impairment etc.). For people with such impairments, their limited access to telecommunications is particularly severe. It does not only hinder the functions and activities usually performed with a telephone or a telecommunication terminal, but also the possibility of using telecommunications to compensate for lack of mobility. The result of these impairments may be a double handicap, with considerable impact on life quality in general.

Another aspect of life that will be influenced by access to telecommunications is education. The general technological development has given education an increasingly important role in society. Today, in order to qualify for the work force, more education is needed than before. For example, due to shifts in job requirements, people often need continuing education to be able to stay in the same job. Education has become a life-long process.

For people with disabilities, education is even more decisive than for other people. They have to adapt their vocational training to the possibilities and limitations set by their impairment, as well as by society. The educational level required by a more technological society may increase the distance between those who are able and those who are unable. The heightened requirements may also make more people unable to perform a function or a task. On the other hand, recent technology has provided new learning environments that make education accessible or easier to access, for example through distance education and remote collaboration (cf. chapters 31 and 36).

A third major area that will be dependent on access to telecommunications is employment. Work provides an economic basis for support, and meaningful employment contributes significantly to an individual's quality of life. Lack of work may deprive people of the opportunity to fill their roles as equal citizens and contributors to the greater good. To be without work may mean to be outside the mainstream of social life. Technological development has a broad influence on work life in general. Simple jobs have a tendency to disappear, and, although technology can be used to make complex jobs easier to handle, there is little evidence of willingness in industry to do so.

Telecommunication technology has been especially important for industrial organisation and production. Telecommunication leads to increased flexibility, so that today, production and marketing of goods and services are often performed in different places. It may be possible for the employee to do part of the work at home, or at smaller work sites outside the main offices or production facilities. However, even communication over short distances, such as within a house or small town, may have an impact on productivity. The Printing House of the Deaf in Bergen saved considerable time and resources by installing a local video network that allowed use of sign language in telecommunication within their four story building. In the near future, videotelephones will make communication with deaf people outside the printing house equally simple (cf. chapters 35, 36 and 42). For other groups of people with disabilities, data communication may be an important part of their work station (cf. chapters 10–11).

However, in spite of increased flexibility with regard to where and how work can be performed, disabled people still lose in competition. Although there is a need to develop new equipment, many of the existing forms of telecommunication can be relatively easily adapted to the needs of people with disabilities. The most important reason why so many people with disabilities are unemployed is probably that employers are not aware of the possibilities that exist, and therefore do not know how disabled people can contribute to productive work. In addition, many disabled people may not know how and where production networks can be established, nor, most importantly, how to become part of such a network. For both employers and employees, knowledge may also be limited because many possibilities for distributed work are new and generally not well known.

From a different perspective, new media may be used to improve services for people with disabilities. For example, intervention is dependent on access to competence and adequate human resources. At present, a scarcity of specialists, sign interpreters etc. make the work less than optimal; there is a need for both specialisation and collaboration, and for the sharing of experience and ideas through workshops and supervision. Telecommunications may play an important role in this process, both within individual countries, and in the integration of knowledge obtained in different countries in Europe. To increase local competence, distance education can be used to supplement local teaching of professionals, and as a tool for guidance and supervision of the local professionals. Distance education, using telecommunication and multimedia terminals with sound, text, graphics, and live pictures, may increase the distribution of knowledge and ensure optimal use of available resources (cf. chapters 32 and 38–40).

From a technological perspective, the topic of telecommunications and disability is concerned with design and production of equipment and services for disabled people, as well as including the needs of many disabled people in the design of equipment and services for general use (cf. the section on equipment and services). When adapted to the needs of disabled people, new technology can have a strong impact on their functioning in society. One important task is to ensure that the technology is used optimally, that is, in such a way that it matches the needs of individual users, and that at the same time it conserves a sufficient degree of generality to be of use to a relatively large number of users. There is a need to analyze the developing technologies from the point of view of disabled people, and the possible impact technology may have on their lives, as well as needs experienced by disabled users (cf. chapters 12 and 13).

The real impact of telecommunication technology on education, work and social participation among people with disabilities is not well known. In many cases, little is done promote use after a system or a service has become available. The evidence that exists has mainly been gathered from projects that are limited in time and scope. Real life, without economic and moral support from a researcher, may be a very different matter. Because many of the potential benefits are easy to see, it becomes all the more important to monitor the actual effect of new developments (cf. chapter 15).

Research and analysis should also be concerned with the acceptability of the technology, and the development of necessary education and training programs for users to learn to control and use the equipment in the most efficient manner (cf. chapter 13).

For telecommunications to provide people with increased independence and control over their own lives, there is a need for both technological creativity and inventiveness, and knowledge about human functioning in general, including the considerable variation that may be found both among those who are considered non-disabled as well as those who have disabilities. And although it is important for technicians and others to collaborate with potential users, 'asking the user' should not be the only method for gathering empirical evidence. Disregarding disabilities, the user may not have the knowledge that is necessary to be able to answer the posed questions in a meaningful manner. A variety of methods should be used, incorporating the needs of disabled people within the general everyday activities of telecommunications companies (cf. chapter 15).

Today, the goal of telecommunications for everybody still seems far away. Many required services are not available in a majority of European countries, high costs may prohibit widespread use of equipment and services, and only limited resources are allocated to research and development aimed at the needs of people with disabilities. There are, however, also signs of a growing awareness in the population of the importance of providing disabled people with access to telecommunications, which heightens expectations of better utilisation of technological possibilities for disabled people in the future (cf. chapters 47–49). The work presented in this book may contribute both to increase these expectations and to their realisation.

Note to the Reader

The primary intention of this book is to give a coherent picture of the state of the art within the field, and the book contains a variety of topics looking at telecommunications for disabled people from different perspectives, including chapters on telecommunication equipment and services, terminal design, descriptions of impairments and solutions for specific user groups, field trials, demographic studies and user surveys. However, acknowledging the fact that readers will have different interests and priorities and that some may read only part of the book, it has also been an aim that each chapter may be read independently. To achieve the latter goal, a certain amount of overlap between chapters has been unavoidable.

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Disability and Telecommunications

Certain fundamental accomplishments are related to the existence and survival of man as a social being, expected of the individual in virtually every culture. The expected abilities include aspects such as self orientation, physical independence, occupation, social relationships, economic self-sufficiency etc. Nevertheless, the circumstances under which an individual who has a disability is seen as handicapped, that is, disadvantaged in the performance of one or more of the survival roles, can be technology driven: the introduction of new technical tools help people not only to change the physical features of the environments they live in, but also gradually shift disability-related appraisals and produce a growing impact on the attitudes and expectations affecting people with disabilities.

An example of this influence is the progressive incorporation of people with severe physical impairments into the mainstream activities, such as shopping, leisure, working, travelling etc., wherever advanced mobility aids become available or the architectural accessibility is improved. Can a similar development be expected in the telecommunications field? The technological advancements in telecommunications may produce considerable changes in the perception of disability; qualifications and potentials to compete are more easily deployed by people with disabilities when barriers to use telecommunications equipment and services are overcome.

The changes of success, however, are not the same for all the issues and in fact the level of development of a new application does not correlate with its availability in the market. A major effort is needed to transfer the criteria for telecommunication accessibility from the research and development field into the market place. There are convincing reasons that can stimulate such a process, some of which address immediate commercial interests and the growing user oriented approach within telecommunication industry, particularly for the next generation of terminals and information systems.

We could even show how some developments initially conceived for customers with disabilities will finally set the basis for equipment and services useful for everybody. The kind of features demanded by some elderly or disabled users may be requirements that telecommunication industries will be obliged to offer to all its customers in the future. The effort to make terminals and services accessible to everybody is something that research and development departments, together with the marketing department, of any telecommunication company should maintain and increase, at the very least in order to benefit their company.

Ramón Puig de la Bellacasa

2

Recent Advances in Telecommunication Services and Systems

Constantine Stephanidis, Klaus Fellbaum, Gerhard Klause and Mike Whybray

One of the problems caused by a wide geographical spread of people is the demand for faster and more efficient communication systems. The continuous evolution of telecommunications methods and media, from the existing analogue to a future integrated broadband digital network, will help to meet this demand.

Conventional telephony is the simplest form of a telecommunications network which facilitates voice communication. Such telephone networks consist of copper cables, with a bandwidth of approximately 3.1 kHz (300 to 3400 Hz), connecting the subscriber to local switching centres which are in turn connected to larger centres by cable or radio transmission, and so on. As the desired subscriber number is dialled, an end-to-end connection is established between the two communicating partners by progressively closing the appropriate switches in the switching centres (circuit switching). International agreements on standards allow national networks to be connected together so as to create a global telephone network.

In addition to the telephone network described above, various other independent/single-service telecommunications networks have also been developed. An example of these is the telex network, which is very similar in structure to the telephone network. It links up telex machines, which provide printed messages rather than speech communication. Another type of independent network is the cable television system, which differs from the others in that it usually distributes information from a central point outwardly to users, without any switching, and with no backward transmission, so end-to-end connection is not possible.

Additional capabilities have been built on top of the analogue telephone network, for example, fax (facsimile) machines which use modulated tones to transmit black and white copies of documents or drawings. Many other services have also grown up on the ordinary telephone system, for example, those which allow a user remotely to interrogate a computer system via a modem for applications such as videotex.

Channel	Capacity	Transmission capability
B-channel	64 kbit/s	Voice & Data
D-channel	16 kbit/s	Signalling information between the terminal & the network

Table 2.1 The channels of the ISDN.

The second generation of telecommunications use digital telephony (usually Pulse Code Modulation). Direct connection to a computer for data transmission can be achieved, without the need for a modem, as in the case of the analogue telephony, alleviating the noise that is usually introduced in the analogue signal; digital telephony enables the transmission of high quality speech over indefinite distances. Higher speech bandwidth (e.g. 7 kHz) can also be provided.

This growth in the number of different networks and services provided may lead to a loss of the operational efficiency, particularly if dedicated equipment is used for each service. This would mean duplication of equipment, lack of flexibility for users who may find that they need many different terminals for different purposes, and ad-hoc solutions to the growing number of service interworking problems that are expected to arise. In order to address these and other issues, the CCITT (International Consultative Committee for the Telephony and Telegraphy) has published a set of recommendations for the Integrated Services Digital Network (ISDN). As its name suggests, the ISDN aims to integrate all the various networks into one, and also provide the basis for the interworking of the various services that can be provided within such a network (Griffiths, 1990).

The basic service provided by the ISDN is comprised of two independent 'B' channels of 64 kbit/s each, and the 'D' channel of 16 kbit/s (Table 2.1).

The 'D' channel is used for signalling purposes during call set-up, but may subsequently be used as a data channel. The 'B' channels may be used to make two independent calls, or for some purposes linked together to provide a single 128 kbit/s channel. In its simplest use, a 'B' channel provides a digital circuit capable of transmitting high quality speech. The real power of ISDN is that the 'B' channel can also be used to send still or moving images, data and FAX at speeds far greater than the ordinary telephone network, and also provide new services, such as, teletex, textfax, interactive videotex, and others.

The main advantage of the ISDN is the integration aspect. Different services are transmitted and switched by just one network, reducing the cost for control and maintenance. Since the basic ISDN service provides two information channels, two different types of information can be mixed (multimodal communication). For example, the communicating partners may use speech communication and simultaneously exchange text or graphic documents.

Some of the services which can be provided by the ISDN are the following:

- *Teletex* is an extension of the well known telex service. It supports the full character set (telex has only lower case characters) which on an analogue telephone network are transmitted at 2400 bit/s. This transmission speed is about 50 times faster than telex. ISDN teletex will use a whole 64 kbit/s channel and thus the transmission speed is much faster (for example, one page of text is transmitted in less than one second).

- *Textfax* is a new service which combines teletex and fax. Documents with text and graphics information are transmitted in a mixed form (facsimile and character coding) with higher transmission speed and resolution.

- *Interactive videotex* was developed on the basis of the UK Prestel service. Videotex information (text and graphics elements) is transmitted via a telephone line and displayed on a television set. Since the bit rate in its original version is extremely low (1200 bit/s), according to the restrictions of the analogue telephone channel and the demand for a low cost modem, the transmission time is up to one minute, which is obviously not adequate. In an ISDN version a full 64 kbit/s channel can be used and the transmission time will be of the order of seconds.

- *Videotelephony* is a service that is not possible to provide on an existing analogue network, but which the ISDN can. It provides simultaneous speech and video transmission, between two individuals.

The ultimate goal of current research and development efforts in the telecommunications area is the Broadband Integrated Services Digital Network (B–ISDN). It is based on new transmission media (optical fibres etc.) in combination with high speed electronic switching systems. This will extend the integration provided by the narrowband ISDN, to include the switching, signalling, and transfer facilities, minimising the need to build service-specific transmission switching systems to support a broad mix of services.

A new transmission and switching technique termed Asynchronous Transfer Mode (ATM) is proposed as the basis for the realisation of the B–ISDN. The greatest advantage of the ATM is that it can dynamically allocate a capacity much greater than the average required by a specific channel. For example, in the case of a rapid change in picture content, additional video channel capacity can be allocated dynamically. Capacities in the Gbit/s range can also be achieved by multiplexing, using the Synchronous Digital Hierarchy (SDH) (Table 2.2).

Technique	Capacity	Transmission capability
Asynchronous transfer mode (ATM)	150 Mbit/s	Simultaneous video, data and voice transmission
Synchronous digital hierarchy (SDH)	155.2 Mbit/s	ATM channels, local (10–50 Mbit/s) and wide (50–560 Mbit/s) area network channels

Table 2.2 Two transmission modes of B–ISDN.

One of the key aspects related to the B–ISDN is the provision of new telecommunications services with impressive facilities like full motion colour video transmission, high quality digital television, advanced radio with digital transmission and signal processing in addition to the narrowband ISDN provided services. As B–ISDN is intended to cover a wide range of services varying in bandwidth, burstiness and session length, particularly attention is being paid during the current design phase of the network to provide built in flexibility in order to meet these diverse requirements.

Four broad categories of services can be identified.

Conversational services refer to end-to-end real time exchange of information between users or between the user and the server at times determined by the user. The information is generated by the sending user or the server and is directed toward one or more individual communicating partners at the receiving end. Representative conversational services are the audio telephone, the videotelephone, multimedia telephone, multimedia conference etc.

Messaging services provide user-to-user communication via storage units. Examples of functions included are store & forward, mailbox and/or message handling (e.g. information editing, processing and conversion). Some typical messaging services are text mail, multimedia mail etc.

Retrieval services offer users the possibility of retrieving and manipulating information stored in information centres (data bases, film libraries etc.).

Distribution (or broadcast) services provide a continuous flow of information, which is distributed from a central source to a large number of users. Typical examples of distribution services are the Television Broadcast Service, Document Broadcast, etc.

By using one or a combination of these services a variety of applications can be implemented. Applications are foreseen in the following broad areas:

- commercial (e.g. teleshopping, publishing, translation and ticket reservation);
- education (e.g. tele-university, computer assisted education and film library);
- entertainment (e.g. tele-bingo, participative radio and television);
- financial (e.g. cash transactions and home banking);
- government/general public communication (e.g. general public poll and government information); and,
- automation (e.g. CAD/CAM, telemetry and alarms, telecontrol, surveillance and medical care).

An important aspect that should be considered in service design and implementation related to the available capabilities, quality and cost, is the environment in which it is to be applied. Four environments have been considered as representative.

Home or residential including services/applications relevant to personal communication (digital telephone, videophone etc.), entertainment (High Definition Television, video etc.), health supervision (telesurveillance, telemedicine etc.), education (tele-university, computer assisted education etc.) as well as domestic tasks (teleshopping, payments etc.).

Office or business covering premises where business activities are carried out requiring high quality services such as, multimedia data base access and archiving, multimedia mail, multimedia document handling, multimedia conference etc.

Industrial, concerned with all aspects related to the creation of 'products' including research, design and engineering, production, testing and packaging. It is obvious that special purpose services and applications are needed in these environments such as, CAD/CAM, telemetry, telecontrol etc., which require accuracy, speed, reliability and are costly due to their restricted use.

Public, addressing daily life needs through the provision of services/applications such as public communications, government information retrieval, ticket reservation, cash transactions etc.

Another sector of interest for the B–ISDN is mobile communication which allows people to communicate with each other from any location. In addition to mobile and cordless telephone currently in use, existing market needs demand more powerful mobile terminals that access services and applications such as videotelephone, video conferencing, group working, information retrieval, vehicle navigation support, remote control and others.

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3

Speech, Hearing and Telecommunication

Klaus Fellbaum

Communication is a fundamental human need. For people who acquire a communication problem, for example because of a severe hearing impairment, social isolation and loneliness may be the most serious problem (cf. Nordeng, von Tetzchner and Martinsen, 1985).

Speech is the most important form of communication. In addition to face-to-face communication, we have accustomed ourselves to the fact that our voice can be transmitted over nearly unlimited distances using electronic telecommunication systems, and the telephone is by far the most used telecommunication service. Today there are about 800 million telephone subscribers worldwide. Summarising all the other telecommunication services (non-voice services like data, fax, telex, teletex) we have about 30 million subscribers, that means, less than 4 per cent of those using a telephone. According to several prognoses, the part of non-voice services will increase. However, prognoses also indicate that the growth will remain under 10 per cent (compared to telephony). This also means that the new networks and services (e.g. narrow-band ISDN and wide-band IBCN) will primarily be used for speech transmission.

The use of the standard audio telephone, analogue or digital, depends on the human capacity to produce and hear speech. Nevertheless, the audio telephone is not only used for communication between people. A person can also use the telephone to operate a machine with the help of speech recognition and synthetic speech. Man–machine interaction with speech input and (synthetic) output normally has a very limited and task-oriented goal, but it may still give many people access to new services (audiotex), and make old ones more user friendly because the user utilises the basic skills of speech and hearing.

Thus, understanding of speech and hearing is fundamental for understanding telephone communication. This chapter presents the basic processes of speech production and hearing, the coding of speech in the telephone network, and the production and recognition of speech by computers.

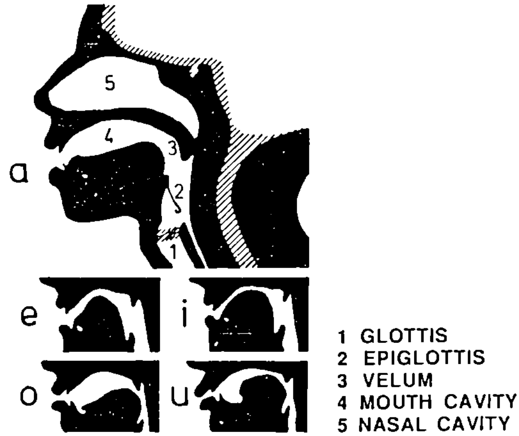

Figure 3.1 The human speech organ.

Human Speech Production and Perception

Speech Production

Speech is produced by a cooperation of lungs, glottis (with vocal cords) and articulation tract (mouth and nose cavity). Figure 3.1 shows a cross section of the human speech organ. For the production of voiced sounds, the lungs press air through the epiglottis, the vocal cords vibrate and interrupt the air stream and produce a quasi-periodic pressure wave. The pressure impulses are commonly called pitch impulses

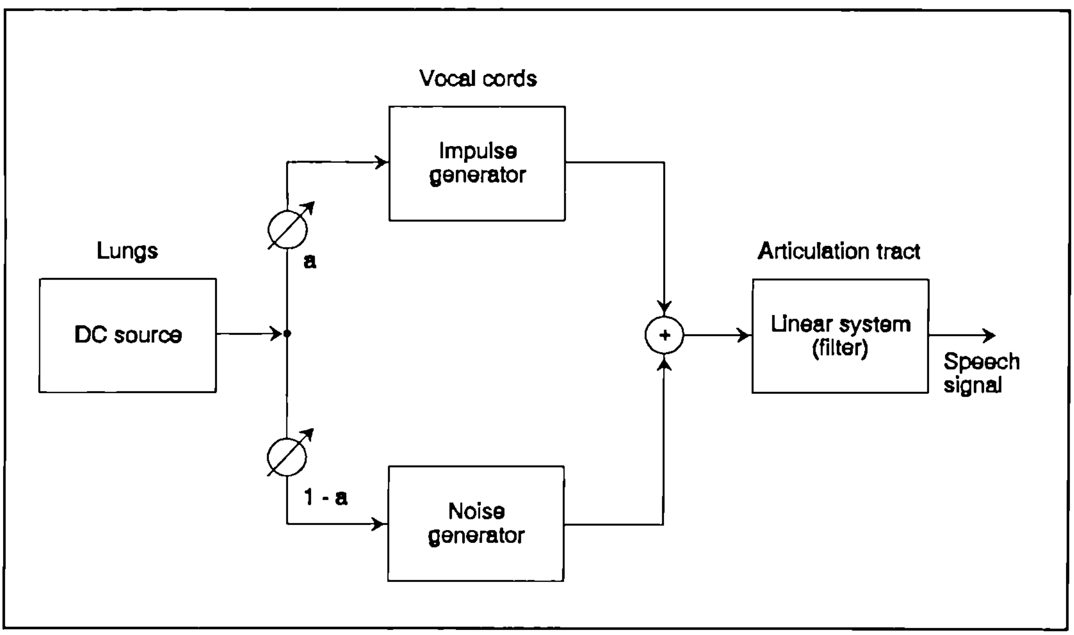

Figure 3.2 A model of speech production.

and the frequency of the pressure signal is the *pitch frequency* or *fundamental frequency*. It is the part of the voice signal that defines the speech melody. When we speak with a constant pitch frequency, the speech sounds monotonous but in normal cases a permanent change of the frequency ensues.

The pitch impulses stimulate the air in the mouth and nasal cavity. When the cavities resonate, they radiate a sound wave which is the speech signal. Both cavities act as resonators with characteristic resonance frequencies, called *formant frequencies*. These formats are numbered so that the lowest frequency is number one, the second lowest number two etc. Since the mouth cavity can be greatly changed, we are able to pronounce very many different sounds.

In the case of unvoiced sounds, the *voice onset time* (VOT) is a little longer, i.e. the vocal cords are open for a longer time, allowing the air stream from the lungs to arrive at the articulation tract directly. Thus the excitation of the vocal tract is more noise-like. This means that the first formant is relatively less intense than the higher ones (second, third etc.).

The speech production may be illustrated by a simple model (Figure 3.2). Here the lungs are replaced by a DC source, the vocal cords by an impulse generator and the articulation tract by a linear filter system. A noise generator takes care of the unvoiced excitation. In practice all sounds being generated have a mixed excitation, which means that the excitation consists of voiced and unvoiced portions. In this model, the portions are adjusted by two potentiometers (Fellbaum, 1984).

Figure 3.3a shows the speech signal of the German word 'löschen' (extinguish). The vowels 'ö' and 'e' can be clearly identified by their high signal amplitude and the quasi-periodic structure, while the unvoiced sound 'sch' has low energy and a random-like structure. Considering the spectrum (Figure 3.3b), the voiced sounds are concentrated to low frequencies, while the unvoiced sound has a much wider spectrum.

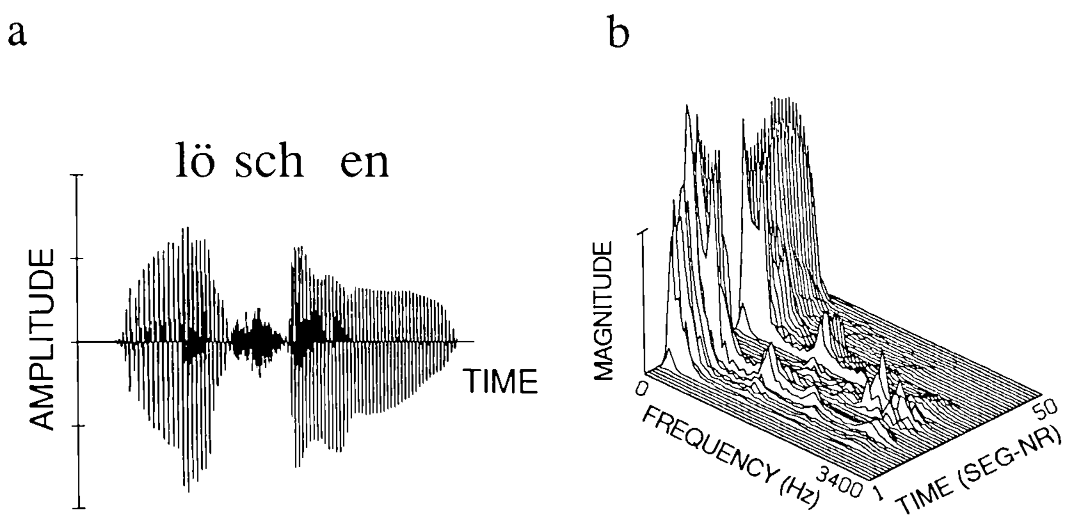

Figure 3.3 The speech signal of 'löschen'.

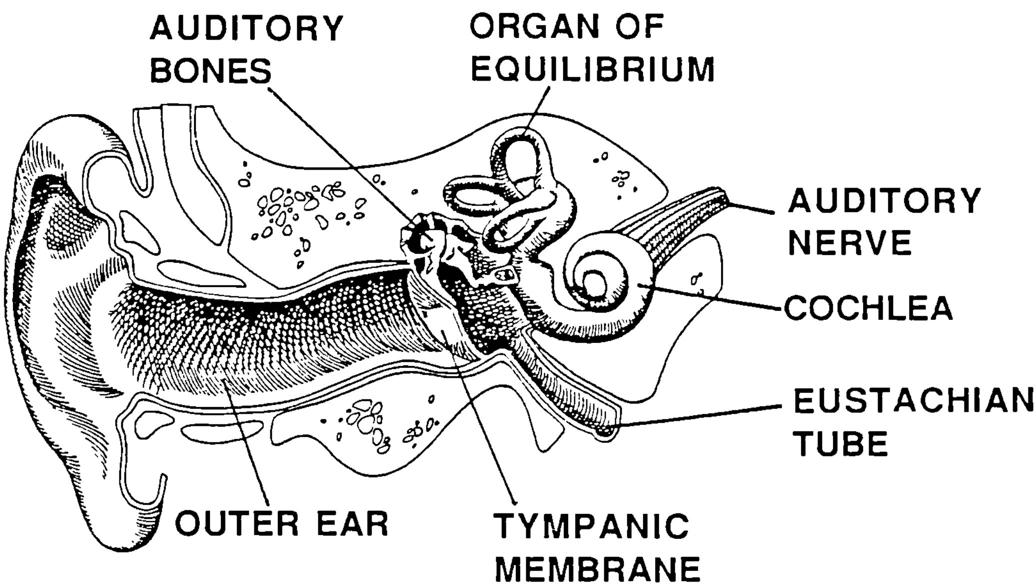

Figure 3.4 The ear.

Hearing

The sense of hearing is a prerequisite for acoustic communication, and in the following, some important facts about hearing will be summarised.

It is customary to distinguish three different parts of the ear: the outer, middle and inner ear (Figure 3.4).

The outer ear comprises the auricle (pinna) and the external auditory canal which ends at the eardrum (tympanic membrane). This acts as resonator, with a resonance frequency of 2–4 KHz. In this frequency range, which is also the main energy range of speech, the ear has its greatest sensitivity.

The air pressure fluctuations result in movements of the tympanic membrane and the amplitude of the movements are extremely small. For normal speech loudness at a frequency of 1 kHz, the amplitude is in the order of 10^{-11} metres. This is less than the diameter of the hydrogen atom and at the limit of the measurability.

The middle ear consists of a small, air filled cave. It has a connection to the nose and mouth cavity (Eustachian tube) which serves to equalise the air pressure on both sides of the tympanic membrane. The middle ear contains three tiny bones (ossicles) called *hammer, anvil* and *stapes*. These bones transmit and amplify the oscillations of the tympanic membrane to the *oval window* of the cochlea. They have three tasks: transformation of the air impedance to the liquid impedance of the cochlea, like an electric transformer, amplification of the tympanic membrane oscillations and protection of the inner ear (by movement blocking) in the case of too high sound pressures.

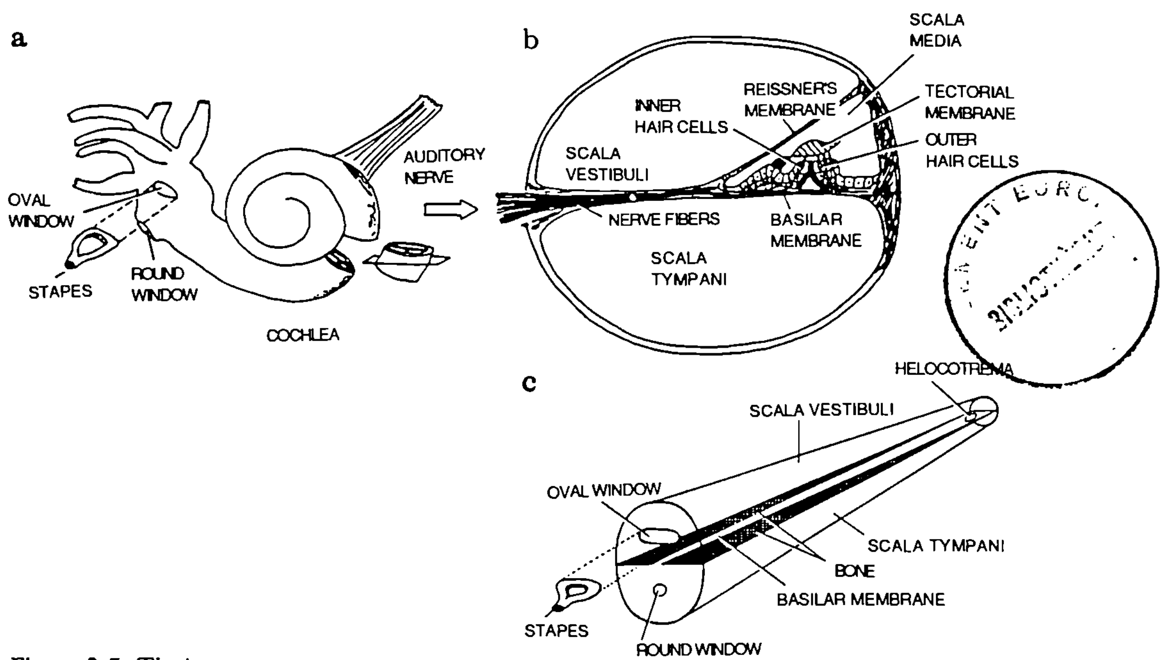

Figure 3.5 The inner ear.

It is important to state that the 'blocking mechanism' needs a certain reaction time (60 to 100 ms.). For very rapidly developing high sound pressures (explosions etc.) the system is not fast enough and there is a serious danger for inner ear damage.

The inner ear is the cochlea (Figure 3.5a). Figure 3.5b is a magnified cross section of the cochlea. On the right side is the *basilar membrane* with the *Corti organ.* With the aid of hair cells, it transforms membrane movements into nerve potentials which are transmitted to the brain.

The cochlea contains three liquid-filled tubes: *scala vestibuli, scala media* and *scala tympani.* The scala media is a separate closed system, while scala vestibuli and scala tympani have a connection through a small hole at the distant end of the cochlea, the *helicotrema.* This is shown in Figure 3.5c, which is a view of the unrolled cochlea. When sound waves impinge, the oscillations of the tympanic membrane are transmitted via three ossicles to the oval window. Due to the oscillations of the oval window, a travelling wave is set up along the basilar membrane through the cochlea. Somewhere along the basilar membrane, the wave reaches a maximum, depending on the frequency of the oscillations. At the maximum, the basilar membrane is bent and straightened and with it the hair cells, which are arranged along the whole membrane. The cells stimulate the nerve fibres and the stimulus information is transmitted to the brain. We thus have a frequency-locus-neural transformation of the sound. Since at the beginning (near the oval window) the basilar membrane is tense and narrow and at the end (near the helicotrema) limper and wider, it has been shown that high frequencies are analysed at the proximal end and low frequencies at the distal end of the basilar membrane (von Bekesy, 1960).

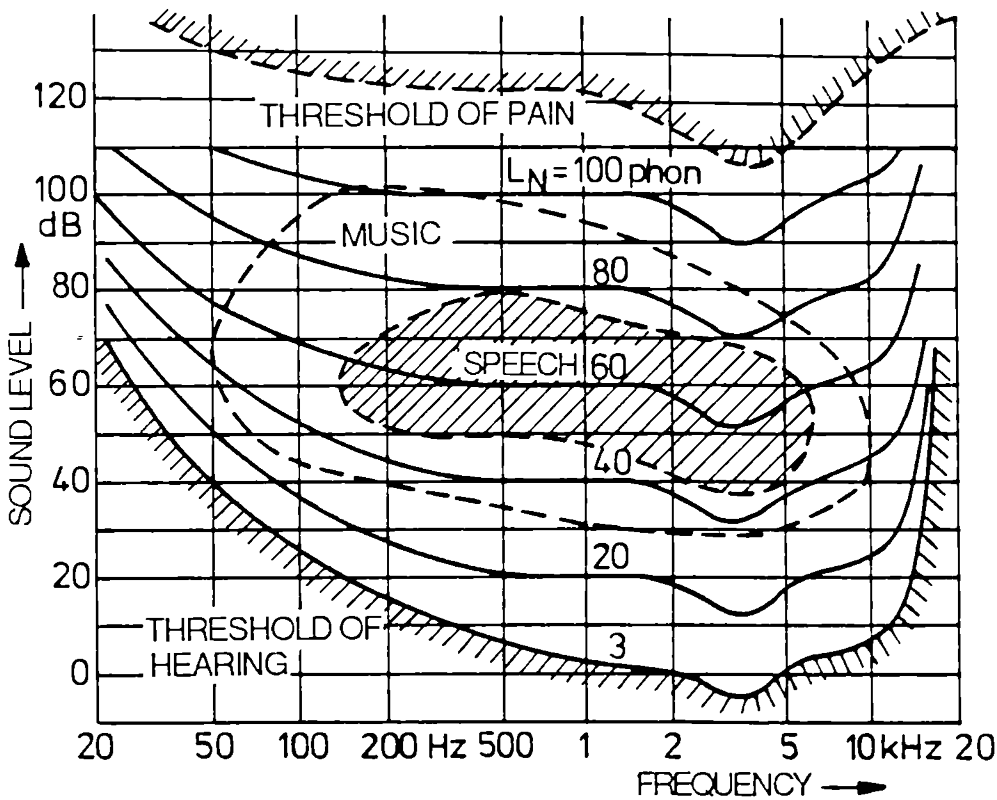

Figure 3.6 The audibility area.

The human ear can perceive acoustic frequencies between about 16 Hz and 16 kHz. This range diminishes with age. The dynamic range is about 130 dB between a sound which is just audible (threshold of hearing) and one which is at the pain level (threshold of pain). The range of 130 dB is immense and exceeds by far the dynamic range of acoustic devices like microphones etc.

Figure 3.6 shows the 'audibility area' in frequency and amplitude coordinates. The sensitivity of the ear is dependent on both amplitude and frequency. The most sensitive area is between 500 and 5000 Hz; for lower or higher frequencies the sensitivity decreases rapidly. This is also the area where acoustic speech signals have the most relevant information. The dynamic range of speech (between 50 and 80 dB) is located in the middle of the hearing area. We may assume that this is not accidental but an evolutionary development in which speech and hearing functions have been adapted to each other.

Digital Speech Transmission and Coding

Although analogue telephony is the most widely used form today, digital speech coding is gradually taking over. Digital coding has advantages over analogue transmission:

- a transmitted or stored digital signal can always be regenerated without any error. Thus, the transmission quality is independent of the communication distance. In analogue transmission the noise portion grows with increasing distance;
- processing of signals is more reliable in the digital format; it also becomes cheaper because the cost of digital circuits is rapidly decreasing;
- speech, data and text can be transmitted, stored and switched in the same network (e.g. ISDN);
- digital signals can be encrypted more easily; and,
- speech processing by computers (recognition, synthesis etc.) requires a digital form.

On the other hand, there are also disadvantages:
- the bandwidth needed for digital transmission is more than a factor of 10 higher than that needed for analogue transmission; and,
- the analogue technique is widely implemented and is known to work satisfactorily. A large amount of money has been invested in analogue networks and systems, which has to be amortized.

Since the advantages are clearly predominant over the disadvantages, there is no doubt that there will be a rapid implementation of the wholly digitised telecommunication network.

With regard to the high transmission and storing capacity needed for digitization, effective coding schemes for high bit rate compression have been developed. On the other hand, the introduction of high capacity telecommunication channels (e.g. fibre optics) and low cost memory storage capacity, may diminish the problem of the extended bandwidth that is needed.

The basic digital coding technique is the so-called 'Pulse Code Modulation' (PCM). Figure 3.7 shows the processing procedure divided into six steps.

Step 1
The starting point is the analogue speech signal. Speech produced by the human vocal tract has no sharp frequency limits. This makes it necessary to use a filter to limit the speech signal to the frequency range of 300–3400 Hz.

Step 2
Sampling of the analogue signal. According to the sampling theorem, the sampling frequency has to be more than twice the maximum frequency of the analogue signal (i.e. 2 x 3400 Hz). A frequency sampling of 8 kHz has been standardized.

Step 3
Quantizing and coding of the sampled signal is a procedure that converts the sampled signal into a sequence of binary digits. For this reason the amplitude range of the signal has to be divided into equally spaced intervals. Each suc-

cessive sampled signal value is replaced by the mean value of the interval which it belongs to. The difference between the true value and the mean interval value yields an error known as *quantization error.* This error decreases if the number of intervals (for the same amplitude range) is increased, because the intervals will then be narrower. Each interval is represented by a binary number. The assignment of intervals to numbers is called *coding* and the numbers being used are the *code words.*

Step 4

Code words are transformed into digital voltage signals, in our case a PCM signal. As shown in Figure 3.7, a voltage impulse appears when the binary digit is '1', '0' means 'no impulse'. For example, the digits '10' (fourth value) are formed by the sequence of an impulse and a non-impulse.

Step 5

After transmission, the PCM signal must be decoded. Since there is a one-to-one relation between the PCM pulse and the code number, and between the code number and the assigned interval mean amplitude value, the quantized signal samples can be transformed back to a set of amplitudes.

Step 6

A filtering process produces the analogue spech signal from the sampled digital sequence.

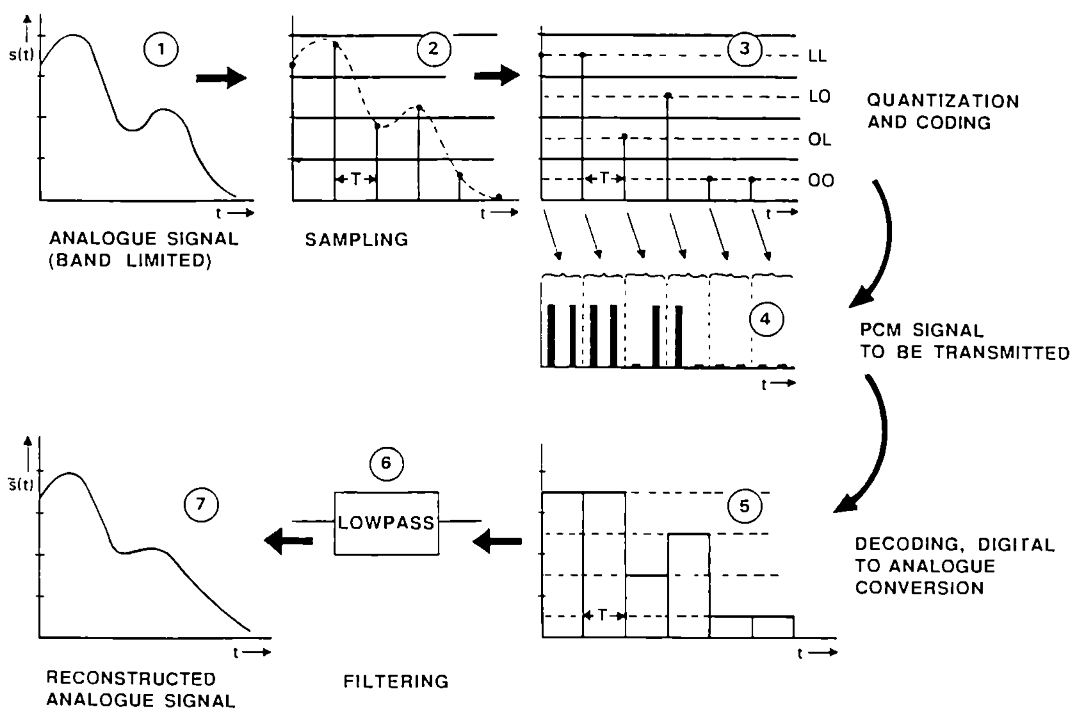

Figure 3.7 Pulse Code Modulation.

The reconstructed analogue signal deviates from the original signal because of the quantization error. This error appears as a noise signal superimposed on the received speech signal. The disturbing effect may be reduced by increasing the number of mean amplitude intervals. An increase in numbers, however, means longer code words and a higher bit rate.

The disturbing effect of the quantization noise depends on the level of the speech signal. If the signal amplitude is high, it suppresses or masks the noise. For low amplitudes, the noise is clearly audible and for very low amplitudes, the speech is completely masked.

Consequently, the relevant measure of speech quality is not the value of the noise level, but the ratio of signal and noise level, called the *signal-to-noise ratio.* High quality means a signal-to-noise ratio with a constant and high value. In order to keep it constant, the noise level has to be small if the amplitude of the speech signal is small. This leads directly to a modified quantization sceme, where the interval width depends on the speech signal level. This sceme is called *non-uniform quantization.* The law behind it is logarithmic; it has been internationally standardized (A-law or u-law) and has resulted in the number of 256 amplitude intervals, which may be expressed as 8-bit digits. Based on an 8 kHz sampling frequency, the final result is a bit rate of 64 kbit/s.

These considerations, made for digital speech transmission, are also valid for *storage* of speech. Thus, with PCM, the storage of one second of speech requires 64 kbit.

Man–Machine Interaction with voice input and output

Man–machine interaction has two directions: when the machine speaks, it is called *speech output,* when the machine is operated by speech, it is called *speech input.*

Speech Output

For most technical applications, only a limited vocabulary is needed. The system has to articulate various error, alarm or confirmation messages, control instructions, standardized question phrases, help functions etc. An important application in the field of rehabilitation is the acoustic keyboard for blind people, where speech sounds corresponding to one or more keys may be articulated, allowing the person to control what key he or she has pressed and possibly to learn to type (Fellbaum, 1986; 1987).

A limited vocabulary is usually made from natural speech which has been stored in a memory. This is called *digitised speech.* It can be replayed at will and is therefore called *replay system.* Another term, usually applied in the American literature, is *voice store and forward system.*

Digitised speech sounds natural and its quality depends on the coding technique and the bit rate. On the other hand, the bit rate influences the required

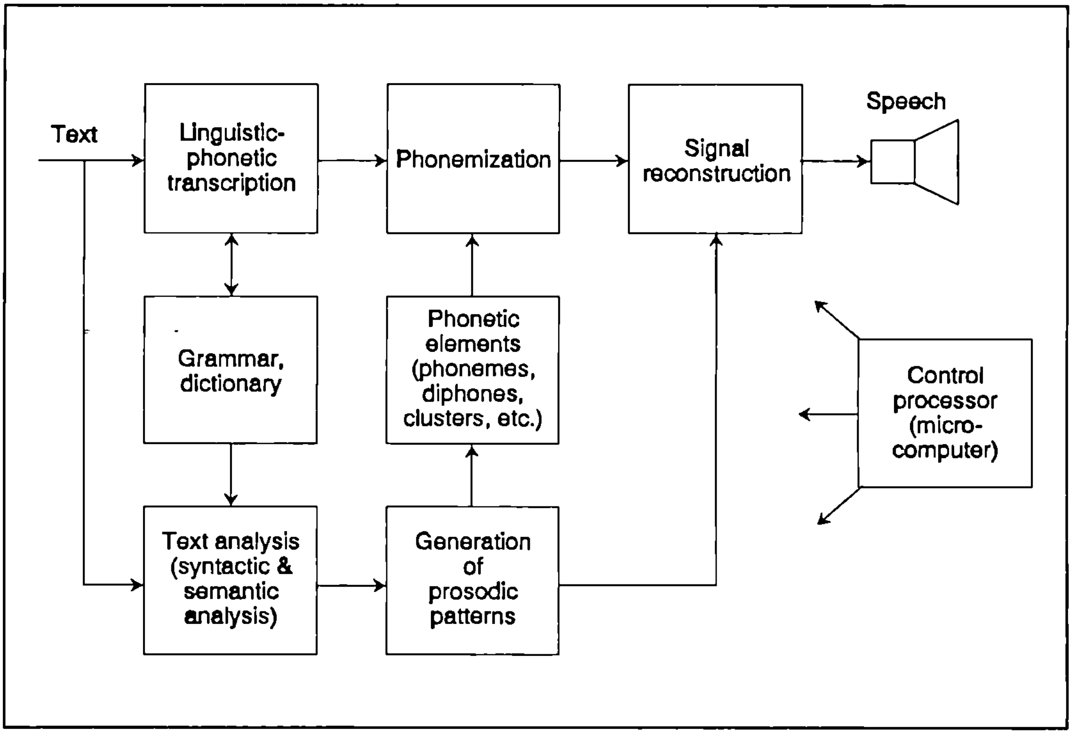

Figure 3.8 Speech synthesis.

storage capacity. To give an idea of what is possible today; on a standard computer board we can store about one minute of high quality PCM speech. With a little degradation of the speech quality, it can be doubled to about two minutes. Finally, with the aid of a special speech compression technique, called *linear predictive coding* (LPC), it is possible to store about half an hour of speech with a moderate, but still acceptable quality.

In some cases, an unlimited speech vocabulary is needed. This is the case, for example, with reading machines for blind people which transform written text into speech. Since these machines should be able to read any text, it would be impossible to record the vocabulary in advance. Hence another technique is used, called *speech synthesis* (Figure 3.8). Its principle will be shortly explained here.

Speech comprises short phonetic elements like phones, diphones (double phones) and others that are joined to form continuous speech. It has been shown that a restricted number of phonetic elements are sufficient for generating an unlimited speech vocabulary (O'Shaughnessy, 1987).

Although the phonetic elements are taken from natural speech, the generated speech sounds artificial. There are two reasons for that: firstly, the various sound transitions which are typical for natural speech are replaced by more or less standardized transitions, and secondly, the phonetic elements are neutral, i.e. they have no stress or speech melody. The *prosodic elements* must be added artificially, a task which is still in the state of research.

In speech synthesis, i.e. transforming text into speech, three main stages of processing may be distinguished (cf. Figure 3.8).

Linguistic-phonetic transcription
The first step transforms the ordinary text into phonetic symbols which describe the pronunciation much more precisely than orthographic text.

Phonemization
In the second stage, the symbols are distributed to the related phonetic elements.

Signal reconstruction
In the third step, the phonetic elements are joined to continuous speech.

Speech Input

For the user to be able to use speech input, the machine must be able to recognise patterns of speech sounds. This is a task that is much more complex than producing synthetic speech. One of the reasons is that the listener may be able to understand poor quality speech. If a machine cannot understand the sound pattern properly, it will be of very little use. There are, however, several arguments for developing speech recognition:

- speech is the most natural and easiest form of information input;
- hands and eyes are free for other activities;
- the user is not bound to a fixed place;
- input information may immediately be processed and evaluated by a computer;
- for some disabled people, and particularly for severely motor impaired people, speech may be the only way to access a computer or an advanced telecommunication terminal. For blind people, speech input avoids the problem of searching for switches, keys and other control elements; and,
- speech can be used for remote control via radio and telephone.

The recognition is based on comparisons between patterns which are stored in the computer's memory and utterances spoken by the user operating the machine. For the machine to make these comparisons, it has to 'learn' how the commands are spoken by the user. Thus, it is necessary to distinguish between a *learning* or *training phase*, and the *working phase* when the voice is actually used to operate the machine (Figure 3.9).

In the training phase, each of the words of the relevant vocabulary is spoken by the user, and processed and stored by the machine as a reference pattern in the memory. Simultaneously, each spoken word and its command are typed into the machine by a keyboard and assigned to the corresponding speech pattern. After all

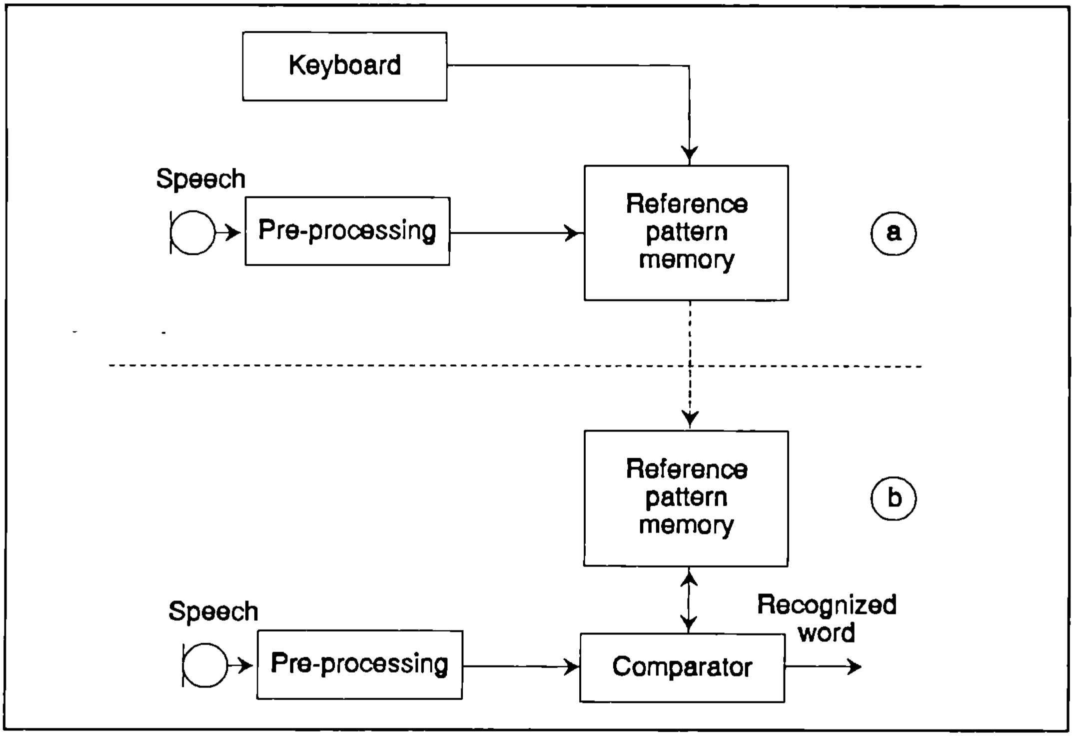

Figure 3.9 Speech recognition.

the command words have been input, the system is ready for the working phase. When a word is spoken by the user, it is first processed in the same way as in the training phase and then stored in a comparator. Then all the reference patterns from the training phase are compared successively with the current speech pattern; the reference pattern with the maximum similarity is selected and the corresponding command is executed.

This procedure is called *speaker dependent* word recognition. More complex forms of speech recognition, such as recognition of continuous speech, meet with considerable problems, and there is still a need for much further research until such systems can appear on the market. On the other hand, a simple form of speech recognition is sufficient for many practical applications.

The vocabulary that must be recognised by a system, depends strongly on the commands that may be used and the number of possible replies. The extreme case would be the two-word vocabulary, for example 'yes' and 'no'. It is likely that there is an optimal number of alternatives: a small vocabulary leads to very long interactions, while too many commands may be difficult for the user to remember. In addition, recognition becomes more complex.

In my opinion, the development of speech recognition should primarily be directed toward systems which are robust (particularly against environmental noise), reliable and cheap, rather than towards sophisticated systems with continuous speech recognition, which may only work satisfactory in a sound sheltered laboratory environment.

Final Comments

Electronic speech processing will play an increasing role in telecommunications and in man–machine interactions, including applications for people with disabilities.

Although speech input and output techniques have been discussed separately, it must be emphasised that they belong together. In a dialogue with humans, we expect a spoken answer when we address somebody, and there is no reason why this should be different in a man–machine interaction.

To optimize man–machine interaction, however, is not easy, and the resources which are allocated to this field leaves much to be desired. This a major reason why technical systems often suffer from a low level of acceptance.

Concerning people with disabilities, modern telecommunication services and speech processing techniques may prove extremely helpful if the needs of these groups of people are taken into consideration. However, speech processing may also become a hindrance to integration if the development is focused exclusively at the needs of non-disabled people.

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4

Telecommunication Behaviour

Stephen von Tetzchner and Knut Nordby

Telecommunications play an indispensable role in forming the patterns of human co-operation and communication in modern society. Telecommunications will change or replace some of the earlier ways of establishing and maintaining social relationships, and may even create completely new forms of social interaction. Knowledge about telecommunications and the demands they make on the users is therefore important for the understanding of the development of society and the role of telecommunications.

In this chapter, changes in communication patterns with increasing use of telecommunications, how telecommunication differs from direct communication, and how individual differences may influence the way people make use of telecommunication media, are discussed.

New Communication Patterns

Social contacts between people are established within time and geographical frames which set conditions for co-operation and communication. The increased accessibility of people provided by telecommunications leads to the faster establishment of new social situations. When the telephone rings, one does not know who it is, and a call may suddenly change one's life situation. It may be sad tidings of death or accidents, but it may also be news of winning money in the lottery or getting a promotion, or it may only be someone who got the wrong number.

The telephone, like the car and other means of transport, has made social interaction less dependent on geographical proximity and has created new social relationships. Mutual knowledge, established and maintained through frequent contacts, is a prerequisite for enduring social relationships. The telephone has decentralised people's lives, since it makes it possible to establish a network of socially close, but geographically scattered, contacts, that is, a 'psychological neighbourhood' (cf. Aronson, 1971). An extended 'electronic' neighbourhood may make communication within the local environment less important, but it is worth noting that the majority of calls are typically made locally, that is, within the city, town or commune (Figure 4.1).

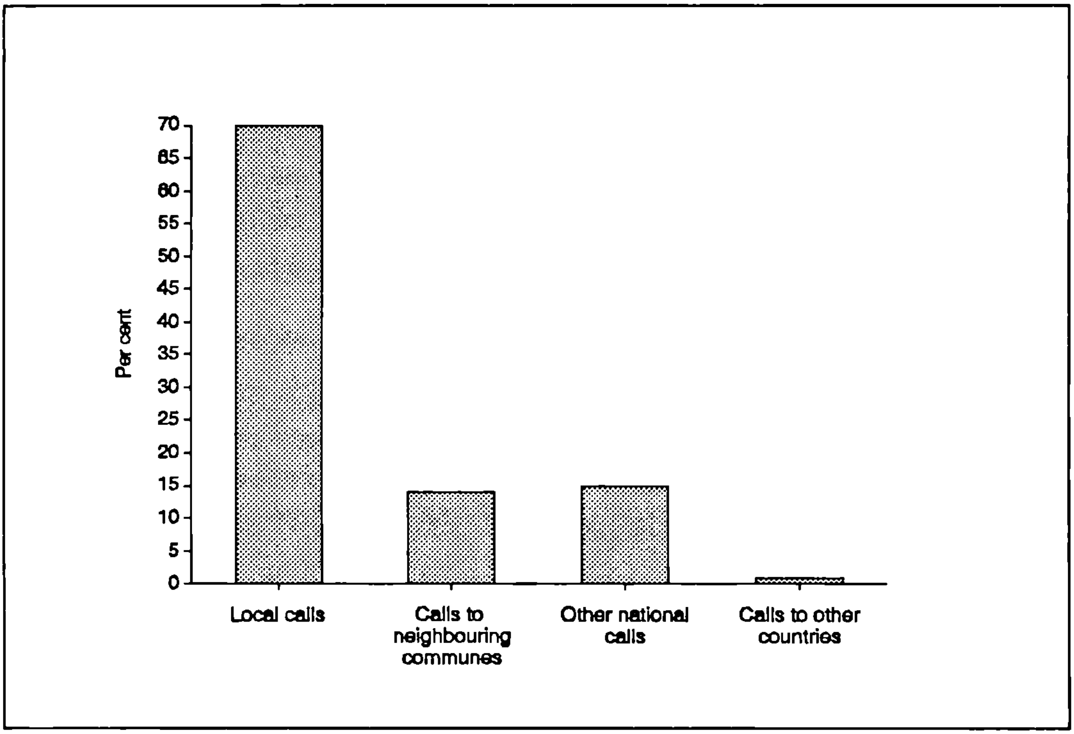

Figure 4.1 Distribution of local and distance calls.

The telephone also makes it easier to intrude upon people's privacy. The caller assumes the power of defining the situation. When the boss calls in the evening, the secretary is suddenly 'back at work'. A ringing telephone is quickly answered and seldom ignored. An American study showed that when people were at home, 96 percent answered the telephone before the end of the fourth ring (Smead and Wilcox, 1980).

The widespread use of the telephone makes people more accessible, provided one knows where they are and that they have a telephone. The radio pager has overcome this obstacle, and people with mobile telephones are in principle reachable wherever they are, also in places where they until now have been shielded from telephone calls.

As in other forms of social interactions, most people follow unwritten social conventions. One does not call early in the morning or late at night, or at times when the person is known to be busy. But it is considered less invasive to telephone than to make an unannounced visit. Many people would telephone someone they do not feel they could visit. For this reason, people sometimes have to shield themselves against such intrusion, e.g. by pulling out the telephone plug. Secretaries and switchboard operators are often instructed to screen incoming calls, for example, to protect management from undesirable calls. Politicians and other publicly known people, who need control over who is allowed to contact them, will usually not be listed in the telephone directory.

It is technically feasible to have the caller's number displayed (calling number identification), or automatically reject calls from specified numbers. These services are not yet available in Europe, but are becoming common in the USA. This has created a need for a service for calling number display blocking, that is, the calls will be anonymous, and the called party will only get a a string of zeroes showing that the caller does not wish to be identified. To ensure a caller's right to anonymity, a law has been proposed in the USA that will oblige operating companies who offer calling number identification service also to offer a calling number display blocking feature (Adler, Springen and Cohen, 1990).

Travel

There are close connections between telecommunications and travel. The frequent contacts that are possible over the telephone would be impossible for most people to have as face-to-face meetings even if they lived near to each other – time would not allow it. On the other hand, it is not probable that the 'saved' trips would have been made if it had not been possible to telephone. Actually, the telephone may be a substitute for only *some* meetings, but it allows 'meetings' that would otherwise not have been held.

Better transport and more face-to-face contacts, however, seem to increase, rather than to decrease, the need for telecommunication.

> When the Severn bridge, connecting Southwest England and South Wales, was opened, there was a dramatic increase in telephone calls between the two areas (Short, Williams and Christie, 1976).
>
> When the Berlin Wall was opened in 1989, the telephone network in East Berlin broke down due to the extreme traffic increase.

More use of telecommunications will also increase the need for travel and transport. If one makes business with people over the telephone, there is also a need to meet. The telephone is useful for making appointments to visit people; there is always the risk that they may not be home if the visit is unannounced, or that the visit is not appropriate. A quick call will usually resolve this.

To sum up, although telecommunications in many instances saves travel, increased use of telecommunications may actually lead to *more* travel, and the net result is an over all increase in travel activity.

Written Communication

It is difficult to know how many letters would have been sent by mail today if there was no telephone. It is not so common to write to people to whom one talks often on the telephone. The long, personal letters of yesterday seem to have disappeared, and, to a large extent, replaced by long telephone conversations and short greetings on postcards and Christmas cards. Letters are still used in formal business transactions and for short ritual greetings in connection with birthdays, holidays and special occasions.

Still, *written telecommunication* is increasing. *Telefax* has had an explosive growth over the last few years, but also *electronic mail* (cf. chapter 30) and other forms of text communication between personal computers and work station terminals are growing, including text communication devices for speech impaired and deaf people.

Telefax makes it possible to copy documents at a distance over the telephone line, and it offers the same availability of people as the telephone. The message is transmitted instantly and, even when the addressee is not present, the message will be received. This also applies to electronic mail, but this service is mainly used by small specialised groups and it has not yet been as widely adopted as telefax. Another advantage of telefax and electronic mail is that it is not necessary to talk to and disturb the addressee when one only wants to give a message, making such communication quicker and more efficient than the telephone.

Telefax and electronic mail make greater demands on the users' abilities to operate complex terminals and on their communication abilities than the ordinary telephone. Electronic mail presupposes that the users can operate a computer and master the special command set that is used to navigate through the 'electronic jungle' in which they move about.

Group Media

The vast majority of telephone conversations are made between two persons. However, it is also possible, via a conference telephone service, to connect several people in different places. Until now, this possibility has been used mostly in professional situations, but as the service becomes more user friendly and more people get to know about it, it will probably also be used for group contacts between family and friends.

The 'Chat line' (i.e. group bridging) is a new kind of telephone service that recently has become very popular. This service allows a small number of people (typically 6–10) who dial a special number to be interconnected so that they can all speak and listen to each other. The 'Chat line' is a very special kind of social interaction. One may take part in the discussions or only listen to people who are unknown without revealing one's identity. It is possible to discuss topics or express views which people would normally not dare to speak about. The 'Chat line' provides an instant source of social contact or opportunities to listen to other people's conversations. According to a Dutch survey, 60 per cent of the people who telephoned the 'Chat lines' listened without saying anything, and only 40 per cent took active part in the conversations (Erdal, 1990).

With a personal computer and a modem, it is possible to participate in computer conferences and access 'bulletin boards'. The electronic conferences may be regarded as continuations of the concept of pen friends, except that the communication exchange is much faster and it is possible to reach many people simultaneously. Many computer conferences are 'open', allowing anyone to read and write to the bulletin boards. Other conferences are 'closed', i.e. only registered subscribers may participate. Most computer conferences deal with a particular theme or topic, bringing together people with common interests.

'Chat lines' and computer conferences represent new ways to establish social contacts. Common interests or the need for someone to 'talk' to, rather than maintaining an established acquaintance, seems to be the basis for this form of communication. In Finland there is now a special club for people who have first talked on the 'Chat line', but who later wished to meet face-to-face, just like pen pals often wish to meet after having corresponded for some time.

Both 'Chat line' and computer conference services have had an enormous increase, which means that people to a greater extent than before communicate with people they have never met and know almost nothing about. Such relationships are, however, still rare compared with ordinary face-to-face relationships.

Conversations and Telecommunications

Language competence is a prerequisite in nearly all communication. However, communication is not only verbal. Emotions may be divulged through the loudness and tone of voice, through pauses and speed of speech or signing. Gestures, body posture, glances and facial expressions are other examples of non-verbal communication that accompany and complement the verbal expression.

In verbal communication, the dialogue is basic. To understand a conversation and its course, it is not enough to monitor the verbal and non-verbal expressions; the setting or context of the conversation and its function should also be taken into account. A conversation may have a practical aim, such as planning a trip with another person, or it may be unpretentious chatting. The interaction in a conversation is based on knowledge about the situation in which the conversation takes place and about the participants, the cultural background and expectations about the discourse. A debate in a formal forum proceeds differently from a lunch hour discussion; one may interrupt a colleague but not the speaker on the rostrum.

The quality of a telephone conversation is not the same as that of a face-to-face conversation. Telecommunications are characterised by the fewer common *situational cues*, as compared with face-to-face conversations and other situations where the parties can see each other. This leads to a lower degree of what Short et al. (1976) call 'social presence'. These distinctions are not due to differences in physical stimuli, but to the kind of relations the various forms of telecommunications may create between the communicating parties (cf. Moscovici, 1967).

Telecommunications, as opposed to face-to-face dealings, offer anonymity, which can sometimes be vital. The idea behind the 'SOS telephone' or 'hot lines', for example, for battered women, abused children and suicidal people, is based on those people who telephone staying anonymous until they decide to identify themselves. Many people may find it easier to talk about personal problems to a sympathetic listener they do not know and who knows nothing about them than speaking to a person face to face. The intimacy and nearness created when speaking about personal matters with someone they know well may be too stressful for many people. In such cases the anonymity and lack of situational cues in telephony may actually enhance closeness rather than distance. This may partially explain the openness and frankness that often characterises communication on 'Chat lines' and computer conferences (see Ball-Rockeach and Reardon, 1988).

But anonymity may also be abused, as in harassing or obscene calls, where the identity of the caller is protected. Calling number identification may, to some extent, reduce this problem, but the possibility of a calling number display blocking will still maintain anonymity in this very undesirable telephone behaviour.

Telecommunication costs money, and considerations for cost have always played an important role in how telecommunications are used. The awareness of the fact that it costs money to talk may contribute in making telephone conversations shorter and more efficient than they would otherwise have been. In telecommunications, distance is not measured in kilometres but in tariff time units, which may not always reflect the actual geographic distance; i.e. the tariff time unit may be the same for all calls from 10 to 1000 kilometres (in the post, weight may be more important than distance; it costs the same to mail a letter across the street and across the country).

It may also be noted that one reason for the telephone's efficiency is that it is often easier to *terminate* a conversation over the telephone than it is in a face-to-face meeting. Cultural conventions necessitate more social rituals when visiting than when making a telephone call; for example, after a telephone call one need not see the caller to the door. It is accepted that the caller, who is paying for the call, may end it quickly and hang up.

Speech

In telecommunication the partners can only act on what they can hear and this determines the form and contents of the conversations. What is special about telecommunications may be illustrated by how telephone conversation typically start (cf. Schleglof, 1972; 1979).

> When calling, the caller cannot always count on being immediately recognised as in face-to-face meetings, even when the callers are known to each other. Thus, it is usual for the caller to identify himself or herself when the call is answered.
>
> J: *Johnson speaking*
> R: *Hi, this is Robert*
> J: *Hi, Robert!*
>
> Not everyone makes a presentation, and sometimes this is not necessary with people who know each other very well.
>
> P: *Hello?*
> D: *Hi!*
> P: *Oh, hi David!*

But sometimes lack of introduction leads to uncertainty.

H: *Hello?*
(pause)
H: *Who is speaking?*
M: *This is Michael*
H: *Oh, hi Michael!*

It is easier for the caller to know who will answer than for the called party to know who is calling. However, it is not always the case that the caller recognises the voice of the person who answers the telephone, and may wish not to identify himself or herself until he or she knows who has answered the call.

J: *Hello?*
A: *May I speak to John, please?*
J: *Speaking*
A: *Hi John, this is Albert*

The *visual* parts of the non-verbal communication in face-to-face conversations, such as direction of gaze, eye contact, gestures, body posture and facial expressions, serve as cues for regulating the discourse, taking turns in speaking etc. Such cues are important for organising the conversation because it is difficult to listen and speak simultaneously. Nevertheless, the regulation of the discourse does not break down even when the parties rely only on hearing. In ear-to-ear conversations, sentences are usually shorter, there are fewer interruptions and there is less overlap, i.e. both parties speaking at the same time. Nor are there as many pauses, since the pauses are filled by the other party who may take them as opportunities for speaking (see Butterworth, Hine and Brady, 1977). There is reason to believe that this determines the way the telephone is utilised and what communicative functions are best served by the telephone.

Fewer situational cues may lead to a feeling of distance, which may give conversations a more practical and less personal character (Rutter, 1987). The significance of the lack of visual cues in telephone communication has been emphasised by Short et al. (1976). However, a person's telecommunication behaviour may have been formed through the use of one particular form of telecommunication equipment, and this behaviour may not be appropriate with other forms of telecommunications.

In a study of videotelephone communication, a voice-switched, loudspeaking telephone was used. In voice-switched telephony it is essential not to interrupt the speaker, because this may make parts of the speech be lost. Since this was also a video transmission, it was possible to use visual cues instead of acoustic ones, that is, to nod or smile to show attention, agreement or appreciation, similar to when listening to someone one should not interrupt. However, the participants found it difficult not to make various assertive sounds (i.e. acoustic nodding), even though a nod with the head would have sufficed. Well adapted telephone behaviour actually prevented optimal utilisation of the new communication medium (cf. chapter 39).

Relatively few comparisons between face-to-face and ear-to-ear (i.e. telephone) conversations, where the participants are not aware that they are being observed, have been made. Following the Watergate scandal, some of president Nixon's taped telephone conversations were compared to his face-to-face conversations with the same people. The analysis of the tapes showed that, on average, the telephone conversations were shorter, contained fewer social rituals, had more disagreements and were, on the whole, less pleasant and less personal than the face-to-face conversations. The study is faulted, however, since the tapes were edited, in particular all expletives and profane language had been deleted (see Wilson and Williams, 1977).

Most comparisons of face-to-face conversations and telephone conversations deal with *instrumental* conversations, that is, conversations with a particular purpose, for instance persuasion, conflict-solving or crisis intervention. Moreover, they do not usually treat real situations, but simulations of conversation situations under controlled conditions. The participants' tasks may for instance be to read a map together, identify a specific light bulb, find profitable and non-profitable factories, draw up a time schedule or find out what to do with a worker who slows down production (Rutter 1987; Williams 1977). The tasks are usually worked out face to face, over the telephone or in writing.

The surveys show that the more cues there are in a conversation, the higher the degree of social interaction, that is, there are more ritual comments and comments without reference to the case. Hence it may be more 'efficient' to persuade people over the telephone than face to face. Morley and Stephenson (1969, 1970) found that the actual state of the case was more vital to the outcome of negotiations on the telephone than when the parties discussed the matter face to face.

Forty students were asked to take the roles of union representatives or employers in a labour dispute. They were thoroughly briefed about the case, which was based on a real situation, but half of the students were given the impression that the union had the stronger case, whereas the others were led to believe that the employers were in the stronger position. Half of each group negotiated face to face. The other half had audio connection only and could not see each other. The results showed that the outcome of the negotiation tended to be more in favour of those who were led to believe that they had the stronger case when there was an audio connection than when the parties negotiated face to face. This effect was strengthened when the negotiating parties were to speak only one at a time without being allowed to interrupt the other, something that obviously reinforced the 'natural' organisation of conversations without visual cues.

Rutter (1987) attributes the results to the absence of the cues which usually contribute to direct the conversation, and to the fact that most people have relatively limited experience in perceiving and reacting to expressions of the other party's personal qualities without support from visual cues. Telephone conversations are therefore less social and personal than face-to-face conversations, in which the personal qualities of the partner are more important.

Comparisons of telephone conversations of blind and sighted people show the significance of being accustomed to communicating without relying on visual cues. For blind people, acoustic cues are normally the main source of social information. In surveys where one or both of the conversing parties were blind, the conversation was less purposeful than when both parties were sighted, and there was more chatting and small talk (Rutter, Stephenson and Dewey, 1981). This shows that the lack of visual cues as such is not decisive, but for sighted people they are important parts of the context in which the conversation takes place. For those who are used to relying on such cues, the conversation is likely to be influenced by their absence. The way in which blind people communicate on the telephone shows that there are sufficient cues in that situation to give the conversation a personal character. Blind people have experience in using auditory cues, hence they have an advantage when using this medium.

In such comparisons, instrumental conversations are used. It may be the case that more social conversations, like calling relatives and friends to hear how they are, would generate fewer differences. Nevertheless, the medium itself appears to set certain limits to the nature of the conversation. Argyle, Lalljee and Cook (1968) let students get to know each other face to face and on the telephone. They, too, found shorter sentences and less overlapping in telephone conversations than in face-to-face situations.

How the conversational frame influences the outcome of telephone conversations between people who know each other is not known. In a modern society, a great deal of the negotiations that form the basis of decision making, both private and public, are carried out on the telephone, and the form typical telephone conversations take is likely to be of some significance. This may be the reason for statements like 'this cannot be decided on the telephone' or 'this will have to be discussed when we meet'.

The use of the telephone is ever-increasing, and it is possible that this will entail that the distinctive features of telephone conversations will become less apparent. It is particularly elderly people who tend not to feel at ease with this medium. They have had little experience in creating nearness over the telephone. People who are young today, however, have grown up with the telephone as an everyday communication tool. In time, this may lead to less difference between face-to-face conversations and telephone conversations than have been found in previous research.

Written Communication

To an even higher degree than telephone communication, written communication lacks ordinary non-verbal conversational cues, and gives little 'social presence' (Short et al., 1976). Written communication differs substantially from spoken language. It is more formal and detailed. Compared with speech, written conversation is slower because writing takes more time than speaking. It is true that most people read faster than it normally takes to speak, but it is the time it takes to write that decides the speed of the interaction. Experimental negotiatory situations have shown that the number of utterances made in face-to-face and telephone conversations is many times larger than the number made in written communication (Weeks and Chapanis, 1976). Thus, writing is normally not an efficient tool for conversations.

Many of the new telecommunication services are based on writing, supported by charts, graphs and diagrams, either by means of a personal computer or an exclusive videotex terminal. In the French videotex system, Minitel, the most frequently used service (apart from the telephone directory) is 'electronic messages', including electronic conferences and electronic mail (Ball-Rokeach and Reardon, 1988).

The communicative skills required by the user are mainly the same for electronic mail as for ordinary mail. In addition, the user has to be able to operate the terminal equipment. Hence electronic mail is more complicated to use than the telephone. Still, it may, to a certain extent, replace telephone conversations. A written message is an advantage for the receiver, because it takes less time, for most people, to read a written message than to listen to a tape. For the sender it may be an advantage not having to disturb the receiver. Usually it will take more time to write a message than it takes to say it, but electronic mail may still be faster because it will not be necessary to go through the social rituals associated with a telephone conversation.

The possibility offered by electronic mail and message handling may lead to a change in the expectations of telephone conversations. Today, it is acceptable to make a telephone call in order to deliver a message, but in the future, frequent use of electronic mail may mean that the telephone will entail a more social function or a need to *exchange* views and discuss something.

In general, written communication is not much used for dialogues and other types of conversation, except by people who use a *text telephone* because of hearing or speech impairment. This is a form of telecommunication where the dialogue is carried on by means of a text telephone terminal, a computer with a suitable communication program or, like in France, by means of videotex (cf. chapters 26–29).

Electronic conferences consist of written contributions, but to a certain degree they can be compared to 'Chat lines' and the 'theme lines' of the telephone service. When using these services, however, words disappear as soon as they are spoken. The advantages of electronic conferences are the possibilities to continue a discussion for days, weeks and months, and to read messages long after they have been written. Thus, the messages communicated through electronic conferences may be accessible for a larger number of people over an extended period of time, contributing to a wider distribution of both formal and informal knowledge. The participants do not have to be present simultaneously, but since the contributions are responses to other contributions, the electronic conference may still be reminiscent of a group conversation.

A conversational form which does not have to take place within a certain period of time is well suited for people with severe motor impairments and speech disorders because they tend to communicate very slowly. As participants in electronic conferences they can read what others have written, as well as write their own contributions when it is convenient for them. They do not have do communicate quickly on-line in real time. They can read and write at their own speed, and they are not dependent on others in order to communicate (Lundmann, 1991; Magnusson, 1989).

Both text telephones and electronic conferences are examples of changes in the conditions for distance communication. Those changes are particularly positive for certain groups of people who have now gained access to telecommunication services, even if the required technical and communicative competence is more advanced. But also for people with ordinary communication skills, written communication may contribute to a wider communication repertoire.

Video Communication

While written communication requires more than just the basic communication skills, the videotelephone seems to make telecommunication more 'natural'. With a videotelephone, live pictures and speech are transmitted together. This entails more visual cues, though still not all the cues that are present in face-to-face-conversations. Research shows that the transmission of live pictures creates communication which falls somewhere between ordinary telephone conversations and face-to-face conversations. Some of the participants in the early videotelephone trials, however, voiced the opinion that seeing the other person is of secondary importance. They said that they felt a higher degree of nearness with the videotelephone than with the telephone, but that the actual *use* of the picture may be limited (cf. Dicksom and Bowers, 1973; Rutter, Stephenson and Dewey, 1981).

In these short-term trials, the picture was mainly used to show the face of the conversation partners, and the possibilities of the medium were not fully exploited. The visual information was never *critical*, that is, the picture was never a prerequisite for communication and understanding of the message. However, in videotelephony field trials of distance supervision for example (see chapters 39 and 40), the visual information was crucial. Such supervision sessions would not have been possible without the picture. It would have made impossible demands on the descriptive abilities of those who were supervised, which in fact would have required that they already knew what they were doing wrong.

Another example of critical visual information is the sign language used by deaf people. In order for those who communicate by sign language to be able to use their language over the telecommunication network, they are dependent on the visual information that is transmitted on a videotelephone. Therefore, the videotelephone will be of great importance for this group (cf. chapters 36, 37 and 42).

The videotelephone may also give people with partial hearing lip-reading support when they communicate in the spoken language (cf. chapter 35).

Many of the visual cues that are absent in ordinary telephone conversations are present in videotelephone conversations. Through the transition from letters and telegrams to telephone conversations, people were enabled to use more of their communicative competence, thereby improving communication. Similarly, there is reason to believe that the videotelephone will facilitate improved communication and therefore be easier to use as a means of communication than the telephone. This is particularly important for people who are dependent on visual cues because of hearing impairment and for those who have problems understanding an ordinary telephone conversation with limited cues because of, for instance, mental retardation or aphasia (cf. chapters 31–33). Deaf people, for example, are presently dependent on written communication, but many of those who became deaf at an early age have limited oral and written language skills, hence their benefit from the text telephone is limited.

The videotelephone removes some of the previous limitations of telecommunication, and may create situations that are similar to face-to-face conversations. This may imply an expansion of the communicative situation, and thereby extend the areas in which telecommunications may be applied. Because the situation is moving closer to 'natural' social interaction, there is reason to believe that the number of functions which can be filled through telecommunications will also increase. The videotelephone will soon be generally available. It remains to be seen how this will influence the 'electronic neighbourhood'.

Sound, Text and Picture

The current development of new telecommunication terminals is focused on *multi-media terminals* which can transmit data, pictures and sound at the same time. Modern computer technology has resulted in an increased use of pictures and graphics in reports and other written documents. When this is applied in communication, the receives gets other cues, and more cues, than those normally present in face-to-face conversations. This development may improve communications in general, and in addition it may be vital for people who can make little use of communication with speech alone.

Although it is usual to supplement ordinary conversations with pictorial aspects, for instance by doodling on a piece of paper or drawing figures in the air, real multi-media communication forms are used mainly in particular contexts, such as in connection with speeches and lectures, where slides and transparencies are frequently used. Not many people, however, have the experience that is necessary in order to utilise fully the possibilities pictures and graphics may provide. To carry on a dialogue consisting of speech, pictures and graphics in such a way that the visual aspects supplement and extend what is being said, requires a special competence, as well as ingenuity and creativity. But therein lies also the opportunity to create new forms of telecommunications and to develop a new type of communicative competence (Mathisen, 1990).

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5

Impairment, Disability, and Handicap

John Frederiksen, Mike Martin, Leonor Moniz Pereira, Ramón Puig de la Bellacasa and Stephen von Tetzchner

> 'Although there is clearly a biological difference between the disabled and the able-bodied, this is not the decisive difference between the two groups. Handicap is a social construct. There is a biological sub-stratum, but what it means to be handicapped to others and to oneself is overwhelmingly social and decisively political' (Roth, 1983, p. 56).

Many different types of impairments and disabilities may have an impact on the use of telecommunications. Knowledge about impairments and disabilities is important to understand possible consequences for the use of telecommunications. It is also a prerequisite for designing and producing standard telecommunications equipment and services that can be used by as many people as possible, and for developing specialised equipment designed to alleviate the negative consequences of a disability. The present chapter reviews some common impairments and disabilities. (Chapter 20 reviews some specific consequences of impairments and disabilities for telecommunication use in relation to standardisation activities).

The World Health Organization (WHO) suggested the following definitions in 1980:

> *Impairment* – a loss or abnormality of psychological, physiological, or anatomical structure or function.

> *Disability* – any restriction or lack (resulting from an impairment) of the ability to perform an activity in the manner or within the range considered normal for a human being.

> *Handicap* – a disadvantage for a given individual, resulting from an impairment or a disability, that limits or prevents the fulfilment of a role that is normal (depending on age, sex, and social and culture factors) for that individual.

Impairments and disabilities may be temporary or permanent, reversible or irreversible, and progressive or regressive. The situation people find themselves in may determine to what degree a disability is handicapping for them. It is evident from the definitions above that a handicap is the result both of an impairment *and* of environmental conditions (cf. Figure 5.1). If environmental barriers are taken away, the person will still be impaired, but not necessarily handicapped. It should also be noted that the definition of disability as distinct from handicap is not without problems, in particular the formulation 'considered normal for a human being', and many people with disabilities do not distinguish their use.

The functional ability of people who are diagnosed as having the same impairment or disability may vary widely. For example, some people who are legally blind may be able to utilise differences in light intensity, while others are unable to perceive such differences. People who have clinically similar hearing impairments, as shown on audiograms, may use quite different aspects of the acoustic information available to them. The degree of handicap may vary significantly and may be specific to certain situations.

In this brief review of impairment and disability, differences in degree are dealt with only in a very general manner. The emphasis is on typical features rather than

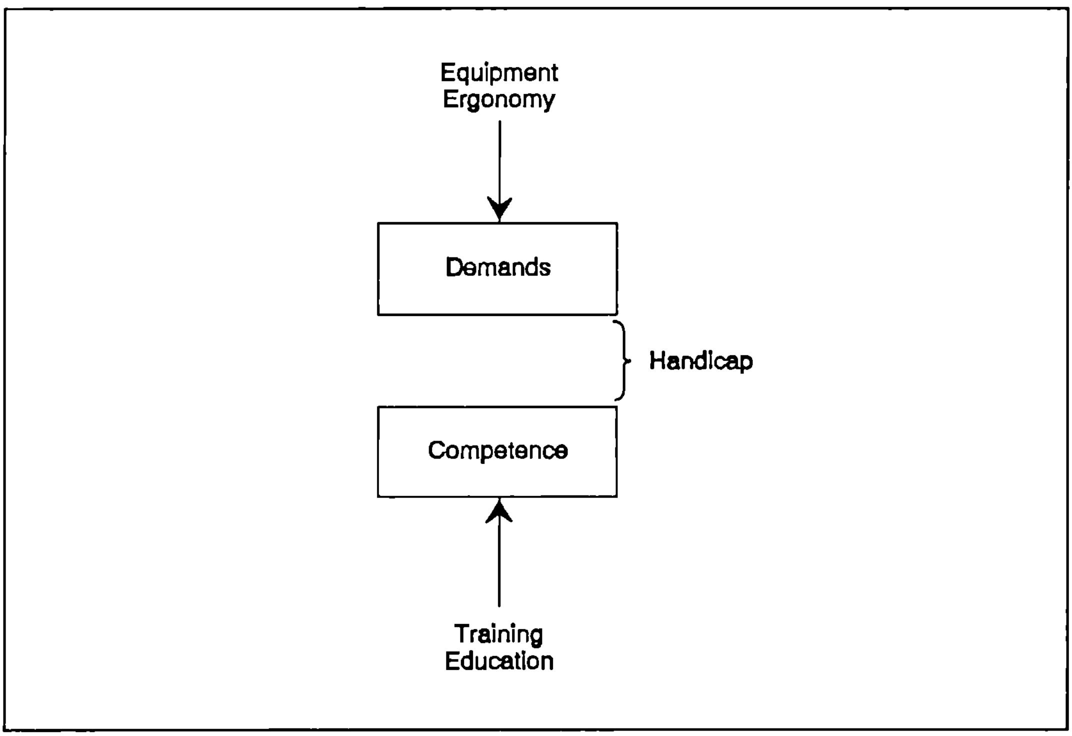

Figure 5.1 *A handicap is the difference between the demands of society and the competence of the individual. The demands can be decreased through ergonomy and physical adaptations. Competence can be increased through education and training. An increase of competence and/or a decrease of demands will make the handicap smaller.*

variations. However, when assessing the needs of a single individual, variation that may influence the handicapping effects of the condition must be taken into account.

Visual Impairment

In medical terms, visual impairment can be defined as a total loss of sight, or reduced ability to perceive light and colour. The classic definition of blindness is a visual acuity of 6/60 or less in the better eye with optimum correction, or visual acuity of better than 6/60 if the widest diameter of field of vision subtends an angle no larger than 20 degrees. This means that a blind person must be at 6 metres in order to see something that a person with normal sight can see at 60 metres, or that the field of vision is so restricted that only a very limited area can be seen at one time. Within this legal definition, a wide variety of visual impairments can be found. Bauman (1969) distinguishes between a visual impairment where vision is of no practical use in a testing or working situation; a visual impairment where vision is of some help in a testing or working situation, but where effective reading of even moderately enlarged print is not possible, and a visual impairment where print may be used effectively, although it may have to be large type, held very close to the eyes, or used with special visual aids and under special lighting conditions.

Blindness implies a total or near total loss of the ability to perceive form. Partial sight implies an ability to utilise some aspects of visual perception, but with a great dependency on information from other modalities, in particular touch and hearing. Reduced vision may handicap a person in situations which put great demands on the use of vision, but in most situations the person will not be handicapped by the visual impairment; they will, for example, be able to read large type print with glasses.

The incidence of all kind of visual impairment increases considerably with age. Less than 10 percent of blind people are under 20 years of age while nearly 50 percent are 65 years or older (Bauman, 1969). In addition, people older than 40 need higher light intensity and contrast than 20-year-olds, and the difference increases dramatically between age 40 and 60.

Problems with orientation and mobility are one consequence of failing sight. In the case of elderly people, difficulties in orientation and mobility may be intensified by other cognitive impairments.

Hearing Impairment

Hearing impairment implies a total or partial loss of the ability to perceive acoustic information. The impairment may affect the full range of hearing, or be limited to only parts of the auditory spectrum, which for speech perception is the region between 250 and 4000 Hz (see Figure 3.6 in chapter 3).

The term *deaf* is used to describe people with profound hearing losses while *hard of hearing* is used for those with mild to severe hearing losses. Hearing loss is expressed in decibel (dB) relative to an audiometric cero which is a standardised normal threshold of hearing. Deafness is usually defined as an average hearing loss of more than 92 dB in the speech area. A person with a hearing loss of 70–90 dB is severely hard of hearing. A person with a hearing loss of 50–60 dB is considered moderately hard of hearing (Davis, 1970). Measured losses of less than 20 dB is considered normal acuity.

The onset of the hearing impairment is important for language development and for identification with the deaf community. A person who was born profoundly deaf or has become deaf at a very early age, i.e. prelingual deafness, is dependent mainly on visual communication for speech and language development, and often uses sign language. A person who becomes deaf later in life usually has a good mastery of both spoken and written language before the onset of deafness. Some deaf people may fall between these two groups. For example, they may become deaf at an early age, but after they have learned to speak, say at 3–4 years of age, and therefore may not have a full mastery of spoken or written language.

For a discussion of telecommunication devices, it is useful to distinguish between deaf people with and without intelligible speech; and between those who can and cannot understand speech with amplification. Although some people with prelingual deafness have intelligible speech, this is more typical of those deaf people who acquired speech and language skills before the onset of the hearing impairment. For people with profound deafness, speech discrimination may be very limited without lip-reading even when they can hear some sound with the help of a hearing aid.

Written text is closely related to spoken language, and the function of writing is to mirror speech (Saussure, 1916). Thus, although mastery of spoken language may not be a prerequisite for learning to read, it greatly facilitates the acquisition of reading and writing. Thus, due to the limited knowledge of spoken language, the written language skills of many prelingually deaf people may often be limited as well (cf. Conrad, 1979).

Post-lingually deafened people usually have intelligible speech, but because they cannot hear their own voice, their control of volume may be erratic, and they may therefore speak too softly or too loudly. While they typically have no special problems in the use of written language for, if their hearing impairment was acquired in childhood, vocabulary and other aspects of both spoken and written language use may be adversly influenced, due to more limited experience with spoken language.

People of any age may have a mild to severe hearing loss, but the majority will be elderly. For people who are hard of hearing, speech and hearing remain the main mode of communication, often with the help of a hearing aid. In the case of a severe hearing impairment, however, the person may be dependent on lip reading in addition to using a hearing aid, and for some types of hearing impairment, a hearing aid is of limited help. Furthermore, although many hard-of-hearing people hear speech with the help of amplification, their ability to understand speech may be hindered due to the effect of hearing loss. The ability to hear is not necessarily equal with the ability to understand what is said.

Impairment of Speech Production

Speech impairment refers to any reduction in a person's ability to use speech in a functional and intelligible way. The impairment may influence speech in a general way, or only certain aspects of it, such as fluency or voice volume. Speech impairment may be due to a number of different factors. It may or may not be linked with difficulties in speech perception or comprehension. Speech impairment may be caused by developmental problems as in the case of moderate to severe developmental language disorder (dysphasia), or by distorted speech due to lack of muscular control (dysarthria). It may be an acquired impairment, for example loss of expressive language skills (expressive aphasia) caused by a stroke or brain tumour, or speech impairment after removal of the larynx (laryngectomy). Acquired disorders are more prevalent with advancing age. When speech impairment is caused by reduced muscular control (apraxia), it is often accompanied by reduced muscular control of the arms. Low volume is often apparent in people who have had laryngectomy and who must speak in a 'whispering' voice.

The intelligibility of speech may be reduced by varying degrees: speech may be lacking totally or it may be unintelligible even to people who are familiar with the speaker. In other cases, the speaker may be intelligible to familiar persons, while difficult to understand for others. There may also be situational variation: for example, people who stutter do so in some situations and not in others, depending upon whom they talk to and the communicative load of the situation.

Impairment of Language Comprehension

This category contains a loss of, or a reduction in, the ability to understand language. The disability may imply only an impairment of language, or it may be associated with a more general intellectual impairment.

Several disorders of the central nervous system may include impairment of language comprehension. In some conditions, like severe developmental language disorder (receptive dysphasia), only the language function is affected, while other conditions may influence most intellectual functions. This may, for example, be the case for people with autism.

Impaired language comprehension may be developmental or acquired. In developmental disorders, the impairment of comprehension will also have consequences for the ability of people to express themselves. In some acquired conditions, it is mainly comprehension that is affected while the people are able to express themselves. Aphasia, a language disorder caused by stroke or trauma, may affect language comprehension and/or use.

Many people with limited comprehension may be able to communicate better through the visual modality than through speech. They may use manual signs or special symbol systems (e.g. Bliss, Rebus), but the vocabulary may be severely limited (cf. Kiernan, Reid & Jones, 1982; von Tetzchner & Martinsen, in press).

In the case of people with intellectual impairment, non-verbal modes of instruction may also be affected. Thus, not only communication in itself, but also instruction in the use of different kinds of equipment may be severely hindered.

People with language disorders and a more general intellectual handicap may have some understanding of language but a limited vocabulary and reduced comprehension of sentence structure. The understanding of language may be strongly related to context, which means that comprehension is very dependent on non-linguistic cues, such as the presence of persons or objects, or limited to a small number of well known situations. Most forms of telecommunication will be hindered because of the limitation in non-linguistic contextual cues.

Intellectual Impairment

People with reduced intellectual ability constitute a very diverse group with a range of sensory, motor and cognitive impairments; most impairments, including visual and auditory impairment, have a higher incidence in the group that is called intellectually impaired. One common trait is that they tend to do things slower than other people, another that they have reduced comprehension of instructions and language in general. For the purpose of adapting telecommunication equipment and services, the best strategy may be to consider intellectual impaired people as having multiple impairments (see below).

Reading Impairment

Dyslexia is a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and socio-cultural opportunity. It is dependent on fundamental cognitive disabilities, which are frequently of constitutional origin (Critchley, 1970). The reading impairment may or may not be associated with other language disorders, such as developmental dysphasia and anarthria due to cerebral palsy. Severe reading disorder may also be an acquired condition similar to aphasia, and is then usually called *alexia*.

A lack of reading skills will be a handicap in a wide range of social and professional situations. In particular, it will influence the person's ability to obtain information.

Reduced Function of Legs and Feet

A reduced function of legs and feet implies dependency on a wheelchair or other mobility aid to help walking (e.g. crutch or stick). People with this disability are usually able to communicate normally on the telephone, but may have problems getting to the equipment.

The mobility of a wheelchair user depends largely on the dimensions of the wheelchair. The length of a wheelchair is usually less than 1.25 meters, including the footboard, and its width is in most cases less than 0.75 meters. This gives a necessary turning radius of 1.4–1.5 meters. Electric wheelchairs may be somewhat wider, but the hands of the user do not extend beyond the arm rests. Thus, the radius of manual and electric wheelchairs will be approximately the same.

In general, a wheelchair user is dependent on an even surface without any significant change of elevation. The maximum abrupt change of level to be managed by somebody driving a manual wheelchair is about 2.5–3 centimetres. Some users may manage an uneven road surface, but it will be most unpleasant, and the wheelchair may break down. For example, it is quite painful for wheelchair users to drive in areas with uneven paving stones. Entering or leaving a pavement may be difficult, and even dangerous. Long-distance travel in a hand propelled wheelchair is tiring and may cause cramp in the hands.

A person in a wheelchair with a normal arm function will usually be able to reach 0.4–1.2 m. Thus, for installations to be within reach, they should be placed at not more than 0.4 m from the nearest place a wheelchair user can access, for example, not more than 0.4 meters from the side of a table.

People who use walking aids, such as crutches and sticks, are mobile over short distances, but will have difficulties moving longer distances. Therefore, it is essential that they do not have to travel long distances and that suitable resting places are provided. Snow and ice are particularly troublesome for people with difficulties in walking. Even rainy weather may cause considerable problems, as many kinds of surface, such as stripes in pedestrian crossings, woodfloors and paving stones, become very slippery when they are wet. In a telephone booth, it may, for example, cause problems to hold the receiver and dial while holding the balance.

Reduced Function of Arms and Hands

Reduced function of arms and hands includes the lack of arms or hands, or reduced ability to use them due to reduced strength or co-ordination. For a person who lacks both arms, or the functional use of both arms, activities related to moving, turning or pressing objects are often impossible, or may have to be replaced by other methods, for example, a mouth stick. This does not influence speech communication itself, but implies great difficulty in using a wide range of technical and non-technical equipment.

A person who lacks one arm or who has lost the ability to use one arm in a functional way, will typically be handicapped in manipulating equipment that demands the simultaneous use of both hands. This includes a large range of equipment, and especially the simultaneous pressing of two or three keys on computer or terminal keyboards.

For people who cannot move their fingers independently, all fine motor skills will be affected. They may not be able to use keyboards or keypads, ticket automats, etc. Turning of pages, and inserting paper into printing devices, may also be difficult.

Lack of strength is a problem in actions that demand strength when lifting, pressing, pushing etc. People with muscular dystrophy, or other conditions that affect the muscles or muscle control, often have reduced strength.

People with severely reduced strength may be unable to use the keyboard of a typewriter or computer, and the keypad of a telephone. They may not be able to press down the handle to open a door, or to lift a book or a telephone receiver.

People with moderate loss of strength may be able to lift and move only very small objects, and to hold them for only a limited time. They may not be able to push open heavy doors, or to open drawers.

Reduced function of arms and hands due to reduced co-ordination is usually a result of neurological damage, e.g. cerebral palsy, or disease, e.g Parkinsonism.

Reduced ability to coordinate the movements of the arms and hands will influence all activities that demand manipulation of objects or equipment. Impaired co-ordination may also increase the probability of hitting and breaking things, and to make errors when operating equipment. For example, a person with cerebral palsy or Parkinson's disease may be unable to drive a car, pour a glass of water, write a message, or dial a telephone number.

Impairment of Growth

Impairment of growth primarily includes adults who are significantly shorter than the population mean. This condition is typically caused by malfunctioning of the hormone system.

In general, shortness adversely influences one's access to equipment. Installations that are positioned high up may be difficult to use unless some form of step is provided. Short people also tend to have short arms, which makes manipulation of some types of equipment awkward or difficult.

It should be noted, however, that also people who are significantly taller than the average of the population may have some problems in using equipment that is mounted at a low level, or where the ceiling, for example of a telephone booth, is too low.

Other Impairments and Disabilities

The above categories cover a wide range of impairments and disabilities. There are, however, individuals who do not readily fit into any of these categories. For instance, people who have to spend most of their time in bed cannot readily be included in the category of wheelchair-dependent users. Their lack of mobility is a significant difference in function, and it is necessary to consider the possible problems this more special situation of being bedridden creates. British studies indicate that at any given time, 0.5 percent of the population are in bed for a limited period, due to disease or accident. This is only one example of a common temporary disability.

Some people have multiple impairments; for example, combined visual and hearing impairment, or hearing impairment and problems in controlling the movement of their arms and hands. People with intellectual impairment typically have several impairments. Within the scope of the present chapter, it has not been possible to discuss such multiple impairments. When assessing the needs of people with multiple impairments, it may be difficult to distinguish the effect that the different impairments have on the use of telecommunication equipment, and the impact of multiple impairments may be greater than the added sum of the individual impairments. For example, most people with reading disorders have no problems with the use of ordinary telephones, although their inability to use the telephone directory may prove an obstacle for them. However, if a person with severe reading disorders acquires a profound hearing loss, text transmission via the telephone network is impossible, and the person is excluded from a form of telecommunications ordinarily used by people with hearing impairment.

The impact of each impairment may also vary according to the situation. For example, for a person with moderate hearing impairment and cerebral palsy, manipulating the equipment may be the most difficult task at home where the telephone has augmented amplification. In a public telephone, the low sound intensity may be a relatively greater problem than handling the equipment.

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6

Statistics

John Frederiksen

The United Nations usually estimate that about ten per cent of the population in various countries may be considered disabled. However, there is great variation in the incidence of disabilities in the statistics from different countries. These differences may be caused by different criteria for reporting, degrees of industrialisation, rate of traffic accidents, participation in wars etc., and some of these differences between countries should be taken into account when considering a probable incidence of various disabilities in individual countries. The differences between available statistical surveys, however, cannot readily be explained only by such differences in conditions of life or diseases.

Sandhu and Wood (1990) describe these problems as follows: 'There are considerable disparities within the European Community as far as legislative and other measures for the handicapped and elderly are concerned. As this project developed, it became increasingly apparent that within the Community, certain governments had devoted considerable effort and money to developing programmes and identifying the categories of disabled people within their borders, whilst others have been much less active in this area. It is an unfortunate fact that most industrialized countries are still not sure exactly who are the disabled nor what the needs of these people are' (p. 29).

One of the reasons why it is difficult to make comparisons between countries, and to evaluate the significance of available figures, is that the existing information often has been gathered for purposes other than to demonstrate the needs of people with disabilities. The statistics may not be based on the presence of the specific impairments of functions, but on more general criteria. The figures may be derived from medical statistics, from social groupings (e.g. number of disabled soldiers, people injured in accidents, or disabled civilians), or from other kinds of official statistics.

The purpose of a survey may also influence the figures. For example, if the obtained estimates are to be used as part of an argument for the implementation of legislation, rules, activities etc. for the benefit of the group in question, there may be a tendency to define a disability in such a way that as many people as possible are included. If, on the other hand, the survey is made by a government as part of a preparation for services, there may be a tendency to define the impairment in such a way that as few people as possible are included, so that less extensive and cheaper services can be planned. For example, people living in institutions are often excluded from these statistics.

Furthermore, even if the statistics are based on the number of people with specific impairments within the individual countries, there may not be clear delineation of the nature and extent of those reduced functions which form the basis of the estimate. This uncertainty within individual countries is even more crucial in comparisons between countries. Thus, comparisons may not be useful, due to the different methods of estimation.

Table 6.1 illustrates the difficulties in comparing statistics from different sources. In 1986, the committee for 'Transport for Disabled People', appointed by the European Conference of Ministers of Transport, made an analysis of information about prevalence of disabilities from the countries participating in COST 219 and a few other countries. The figures were gathered from different official sources, and the percentage of people with disabilities differed widely, both between countries and between estimates within the same country. Switzerland reported the lowest estimates (1.6 %). Spain reported the highest estimate (25 %). Italy reported both one of the lowest and one of the highest (1.7 and 17 % respectively). A study in Spain (Instituto Nacional de Estadistica, 1987) estimated the proportion of people with disabilities to be thirteen per cent while a Norwegian report (Barth, 1987) suggested an estimate of eighteen per cent.

A special problem is linked to the fact that several studies have demonstrated that the number of people with reduced functions, defined by fairly objective criteria, is considerably larger than the number of people who acknowledge that they are disabled when asked about it. This may be explained in several ways. One reason for not acknowledging a disability may be that the person in question, rightly or not, feels that it is socially discriminating to have a disability. It may be related to a quite common depreciation of people with disabilities. Or it may, for example,

Denmark	10.0–12.0
Finland	5.2– 8.3
France	5.0– 8.3
BRD	10.8–13.1
Ireland	3.3– 5.0
Italy	1.7–17.1
Luxemburg	10.0–11.0
The Netherlands	9.5
Norway	12.0
Portugal	7.4
Spain	25.0
Sweden	12.0
Switzerland	1.6
U.K.	7.3
Canada	13.0

Table 6.1 Percentage of population estimated to be disabled in different countries.

be the case that a person with a developmental disability as an adult may feel that the present position is achieved in spite of difficulties and possible resistance from other people, without relating these to the presence of disability.

Furthermore, it should be noted that even the best statistical information of the number of people with a particular handicap may not always be suitable for an estimate of the need for certain products and services. Both availability and information about products and services will determine their use. If services and products are well known and easy to obtain, more people are likely to use them.

Economic aspects usually play an important part. If adapted equipment is not provided free or cheaply by the State, many people will even fail to use equipment that they need for important daily functions because they cannot afford it, or are afraid to spend money on something they are not sure will function. As a group, people with impairments and disabilities have lower than average economic means.

Lastly, the individual's situation with regard to family life and social conditions, as well as the degree of participation in the common social life and expectations about such participation, may to some extent determine whether a disabled person will attempt to obtain useful products and services.

Proposed Estimates

To obtain a realistic estimate of the number of people with disabilities, it seems necessary to make individual estimates of specifically defined impairments and disabilities, where the definitional criteria are clearly related to the purpose of the survey. This will also make it reasonable to compare statistics, and, if necessary to discuss definitional criteria. The present survey is therefore divided into smaller groups.

Table 6.2 is based on the combined inputs from countries participating in COST 219 (Frederiksen et al., 1989). The figures do not include temporarily disabled people.

The above mentioned estimate from Sweden, according to which 12 per cent of the population have limited ability to walk can hardly be compared to the number of people with reduced function of lower limbs. In the Swedish estimate, probably 'everyone' with some difficulty in moving are included.

If the individual estimates are used as a basis for the decisions in connection with planning, one should note that an initial lack of attention to the needs of the groups in question may have led to exclusion from participation in some of the usual activities of the members of the community. Thus, as services become available, estimates may prove too small because people may come to participate in activities they have been excluded from.

If the estimates are used as a basis for adjusting or changing products, one may note that the individual figures may have to be increased to the extent that people with disabilities come to participate more in social life. This increase may vary considerably, and some groups may become significantly larger than they appear to be today.

Reduced function	Percentage	Remarks
Visual impairment		
Blind	0.2	
Partially sighted	2	
Reduced vision		Spanish estimates indicate that 32.5 % of the population need optical correction
Hearing impairment		
Profoundly deaf	0.1– 0.2	
Hard of hearing	10.0–15.0	
Speech impairment		
No speech*		
Cannot speak clearly	0.4	
Low volume*		
Dyslexia	0.5	Estimates of reading disorders are usually higher. The present estimate only include severe cases
Impairment of language comprehension	1.0	
Reduced function of lower limbs		
Wheelchairbound	0.4– 0.6	
Can only walk with aid	6.0– 7.0	In Sweden it is estimated that 12 % of the population have limited walking abilities
Reduced function of upper limbs		
Cannot use arms*		
Cannot use fingers	0.2	
Cannot use one arm	0.2	
Reduced strength		
No ability to lift or push and difficulty in above	3.0– 4.0	
Reduced coordination of movement		
No ability of accurate handling	2.0	
Short people*		

* No estimate available.

Table 6.2 Percentage of people with reduced funtions.

Other Investigations

A study of thirteen European countries shows – as expected – that the categorisation of a person as disabled varies from country to country, for example:

20 per cent of mental capacity (Belgium)
30 per cent physical capacity (Belgium, Luxembourg)
50 per cent of mental or physical capacity (Denmark)

In most countries, categorisation is not dependent solely upon the actual impairment itself, but is assessed along with the consequences for employment and social independence. In Germany, for example, a disability is assessed on the basis of a reduction of 30 per cent or 50 per cent of earning capacity due to physical or mental disorders. Obviously, these percentages are determined by the degree of severity of the impairment and how it is classified, for example slight, medium or severe. Unfortunately, there is no consistent classification of impairment within Europe; classification methods are not standardized and are therefore open to interpretation.

In view of these problems, there is an urgent need for community action which, by establishing provisions applicable to all of the countries in Europe, will eliminate these disparities and present a more united front in the quest for accurate statistical information which is so often used to formulate policies and address political issues.

Type of handicap	Lower limbs	Upper limbs	Visual	Hearing	Mental	Per cent of population
UK	7.9	2.6	3.0	4.7	2.8	11.6
Belgium	3.1	1.03	2.4	2.4	3.4	11.1
Netherlands	5.3	1.8	1.1	2.0	2.3	11.9
Italy	6.9	2.3	4.0	1.7	2.6	12.1
Germany	6.0	2.0	2.3	3.1	2.5	13.1
France	5.1	1.7	1.8	2.4	1.9	10.2
Sweden	7.8	2.6	1.3	5.5	1.9	12.0
Ireland	5.8	1.9	2.0	2.8	2.3	11.6
Greece	5.3	1.8	1.7	2.4	2.0	10.0
Denmark	5.7	1.9	2.0	2.7	2.3	12.0
Portugal	5.7	1.9	2.0	2.7	2.3	11.4
Luxemburg	5.8	1.9	1.9	2.6	2.2	11.0
Spain	5.8	1.9	2.0	2.7	2.3	10.0

Table 6.3 Number of people with visual, hearing, intellectual and mobility impairments in the various examined countries.

According to Table 6.3, the total number of people with reduced functions is estimated to be at approximately the same level in the various countries, in proportion to the size of each population. However, there are differences in connection with the individual kinds of impairments, which cannot be readily explained. The differences are likely to be a result of the uncertainty with regard to definitions (degree of disability) and the collection of data. This concerns, for example, the number of people with reduced function of lower limbs (3.1 per cent of the population in Belgium – 7.8 per cent in Sweden), visual impairment (4 per cent in Italy and 1.1 per cent in the Netherlands) and hearing impairment (1.7 per cent in Italy and 5.5 per cent in Sweden).

The estimated number of people with hearing impairment are considerably lower than in Table 6.2 (the COST 219 estimate). This is not surprising, since COST 219 was focusing only on a reduction of the hearing function. In relation to the figures in Table 6.1 (ECEMT's publication), the numbers appear more homogenous.

In Table 6.1, the number of disabled people varied between 5.0 per cent of the population (Ireland) to 25.0 per cent in Spain. However, it is not corrections of statistical investigations which have changed the figures, but more likely a re-estimate of the existing material. The difference between Tables 6.1 and 6.3 clearly show the need for systematisation and coordination in the field.

Multiple Impairments

A considerable number of disabled people have more than one form of impairments. For example, of 1 000 people who are deaf-blind (Barth, 1987):

120 are totally deaf and blind;
500 have residual sight and hearing;
300 are mobility impaired;
100 have diabetes;
50 have asthma/allergy;
100 are intellectually impaired;
450 have symptoms typical of old age;
650 have to be described as severely handicapped besides being deaf-blind;
750 are more than 66 years old; and,
500 people are over 80 years old.

Table 6.4 gives an overview over the various combinations. The table illustrates that there is a considerable number of people who, in addition to a particular impairment, have other forms of reduced function.

Combined handicap	Mobility impairment Number	Visual impairment Number	Hearing impairment Number
Mobility impairment	1 000	700	530
Visual impairment	150	1 000	160
Hearing impairment	230	380	1 000
Rheumatics	320	220	200
Epileptics	20	30	10
Heart diseases	270	150	170

Table 6.4 Combined impairments.

Conclusions

In this chapter, several statistical surveys have been reviewed in order to obtain the most relevant estimates of the number of disabled people. The material available shows a need for passing of uniform criteria for delineation of the various forms of reduced functions, that is, of the term 'disability'. A uniform understanding will be a requirement for the use of these statistics for national and international plans. Investigations should be based on the criteria put forward, and related to investigations of 'social aspects', for instance, relations between employment, activities etc.

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7

People with Special Needs as a Market

Mike Martin

People with special needs, particularly those with disabilities, are very often thought of by industry as small groups who are in need of some charitable support. Industry may often put quite considerable sums of money aside to provide such charitable financing.

To date industry, with some specialist exceptions, has not seen that there is a market for products, which on a European or international basis is of considerable size. If the market is viewed solely from a national point of view, particularly for small countries, then the prospects for the design, manufacture and marketing of specialist products are often poor.

While the emphasis in the past has been on the design and manufacture of specialist products there has been little or no priority given to marketing. In many respects the design and manufacture of products is a question of money being given to the right people to provide a design that meets the real needs of a particular group of people. However, while marketing requires considerable sums of money to implement successfully, in many cases it also requires a strategy to get the information and then the products to the people concerned. People with disabilities, particularly minor ones, may not always be part of an identifiable group but will be members of the vast general public.

All of us, however, become handicapped in certain environments, for example, in low light levels and noisy environments, and therefore products that are suitable for disabled people will also benefit those handicapped by the environment.

People with special needs may range from those with totally handicapping conditions, such as quadriplegia to the minor, but still handicapping conditions such as being moderately visually or hearing impaired. In general the size of the market decreases with the complexity of the disability.

Marketing Strategies

Visually and hearing impaired people offer a marked contrast in the method of marketing and the general public's attitude to the problem. People who need spectacles are reluctant at first to go for a sight test and to purchase a pair of glasses. However, this action does not carry with it any stigma and the consumer can see people all around wearing glasses. Glasses are optical devices that correct an optical change in the eye and are, therefore, able to restore a function that was deficient; very few prosthetic devices do this so well. Advertising is mainly low key and specialist and today there is a trend for glasses for correcting minor reading problems to be on sale without prescription in a wide variety of shops. In other words, people with sight problems in general have considerable choice and the market is large and well established with very little overt publicity as there are many retail outlets in most towns.

In contrast, the marketing for hearing aids has been aimed at trying to persuade people that their hearing can be corrected by invisible devices and that they should hide their disability. Consequently there appears to be a small market and consumers find it difficult to access the source of supply and when they do they have little choice of products. The effectiveness of hearing aids is also limited due to the nature of the disability.

The visually and hearing impaired groups are numerically very large compared with other impairments and, therefore, market potential is large even within a country, but the relative size of the actual markets reflects the entirely different approach in the two cases.

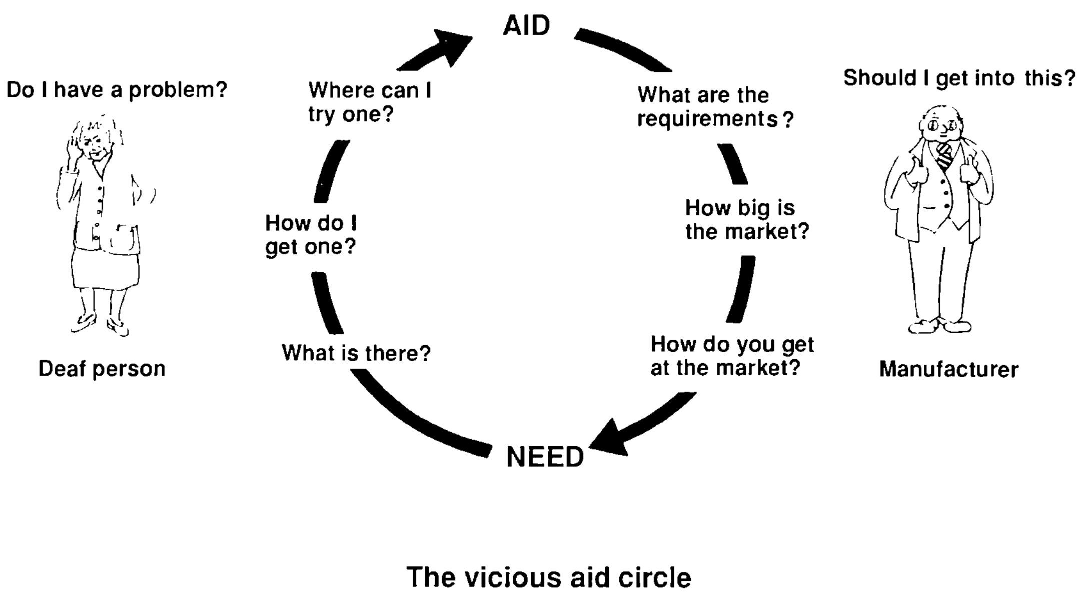

Figure 7.1 The diagram shows the circular problem found by users and manufacturers. The disabled person (deaf in this case) often does not know if something exists to help and the manufacturer does not know if there is a market or how to get at it.

While the optical and hearing aid fields offer a marked contrast in their approach to marketing they both are well publicised and are known to the general public. This is not, however, the case when it comes to knowledge about other aids and there is a great lack of knowledge amongst the general public about what is available and how to obtain it. Figure 7.1 illustrates the circular problem that faces both the disabled person and the manufacturer and has to be resolved for aids to get to the customer.

There has been no apparent move by industry to market those products that are of use to large numbers of people with minor disabilities through the major retail outlets. Consequently simple low cost devices that could be sold in large quantities have to be sold by low profile 'specialist' suppliers. An example of this is that in many shops that sell telephones no publicity is given to the availability of induction couplers, amplifiers, extension bells etc. People who do not consider themselves disabled or handicapped but simply have a difficulty, have to make specific requests for these devices and can only do this if they have somehow gained knowledge of their existence.

Marketing strategies should, therefore, be implemented to correct this current problem which is relatively easily overcome by the right approach. This approach should be much more on the lines of selling domestic products, rather than 'Prosthesis for disabled people'.

A further aspect of the marketing strategy is to take a long term view. Because disabled and elderly people are widely distributed through the general population it takes a considerable time to create an awareness of the availability of products.

General and Special Needs

Due to the perceived difficulty of meeting the needs of disabled people there is a tendency for industry to say they cannot do anything and this is a problem for social services and voluntary organisations. However, what is not fully appreciated is that even people with all their faculties are sometimes in a position where they need additional help in using equipment, for example, when under stress or in poor environmental conditions. Manufacturers, therefore, should view the provision of facilities as a continuum which should aim to take the design of equipment for the general public as far as possible down a path to meet the needs of people with disabilities. An example of this is the telephone that has very large buttons designed as a feature for all to use but enabling people with poor sight to use the telephone easily.

By examining in detail the needs of the majority of people with disabilities and by taking their problems into consideration, it should be possible to provide telephones that are non specialist in design and used by everyone yet still meet the needs of disabled people or can be easily adapted if required.

However, it is not sufficient to make these devices available, the features have to be marketed to a large group of consumers who do not wish to be addressed as 'disabled' but who know they have 'a little difficulty' in undertaking certain functions. It is not unfair to say that people who have highly individualised needs will always have to be dealt with by specialist products and suppliers but in marketing terms they are the minority market.

It should also be appreciated that many people have more than one handicap and that often one of them is seen as a primary problem to the neglect of the other problems.

The Size and Value of the Market

Estimating the market size is made difficult due to problems associated with describing handicap, whether people have to register disabled and whether or not you are looking at the 'handicapped' market or the market for people with 'not too' special needs. An analysis of the demography and market by Sandhu and Wood (1990), provides a considerable insight into the potential size of the population and the market.

Across thirteen European countries there is a consistent figure of between 10 and 13 per cent of the population who have disabilities. These disabilities are broadly grouped in the report across five areas, i.e. lower limbs, upper limbs, visual, hearing and mental disabilities. The size of the disabled population in the thirteen countries is shown in Table 7.1.

Clearly the different disabilities have implications for different types of product but nevertheless show that significant markets exist on a European basis, particularly as it is then estimated that the potential expenditure on communication by disabled people in Europe is 5 144 812 000 ECUs.

Many countries have social service provisions that provide financial aid for specialist devices but it has been recognised that not all the ageing population are financially impoverished and that a large number have a significant disposable income which can be used to purchase devices that will improve their quality of life. For those who are not so fortunate varying degrees of state support are available, this support varying considerably from country to country.

Market research in this area should clearly identify the size and potential for a particular range of products. However, the prognosis for market capture is very difficult to calculate mainly due to the problems of accessing the market set out below.

Disability	**Millions**
Lower limbs	18.7
Hearing	8.7
Mental	7.4
Visual	6.5
Upper limbs	6.1
Verbal communication	3.6
Total	351.0

Table 7.1 The number of people who have disabilities in thirteen European countries (after Sandhu and Wood, 1990)

Accessing the Market

The challenge for manufacturers and suppliers is that the market for products for people with special needs particularly of a minor nature is undeveloped and fragmented. To attack this market for the benefit of both consumers and manufacturers requires a policy decision to invest heavily in creating the market. Currently no major European companies do this but given that a serious effort is made with sufficient investment, publicity and providing a source of a wide range of products, it should be possible to open up the market. This is, however, a long term investment which may deter many commercial companies.

If the market is seen solely as a highly specialised minority market then no large company is going to invest in it. However, if the market is seen as one that is providing a range of products with facilities that enhance the use of the equipment for all users then significant market opportunities may become apparent. This market will not develop if the advantages being offered on the new equipment are not well developed. In general there is little active marketing of products with facilities appropriate to the needs of elderly and disabled people and consequently the market does not develop. The investment in the market must therefore have a significant amount set aside for promoting the products on a wide scale to the general public as well as the specialist market. Devices are very often purchased because of the insistence of a carer rather than the disabled people themselves.

Finally, as the cost of production of devices in small quantities is so high, any marketing strategy should be based on ordering large enough quantities to keep the price down. Too many companies in this specialist area are under capitalised and order just sufficient stock to meet the orders in hand. Without a sufficient investment in stock and strong marketing the area is unlikely to develop.

A list of questions that have to be answered if the marketing is to be successful is set out in the Appendix.

Conclusion

Telephone companies are in a unique position to develop this market as they have direct access to large numbers of people and have both the financial and marketing power to make the market if they so choose. The result of this will be to extend the companies customer base significantly at the same time as bringing considerable benefit to a wide range of people.

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Appendix

A Marketing Check List

- ☐ Who are the likely users of the products?
- ☐ How do the products meet the needs of the consumer?
- ☐ Are the needs of the disabled consumer the same as other consumers?
- ☐ What is the purchasing power of the consumer or the provider of support?
- ☐ Is the retail price likely to be affordable?
- ☐ Is it necessary to provide a specialist fitting after care service?
- ☐ Will the product sell through normal retail outlets and/or through specialist suppliers?
- ☐ What is the cost of development and what volume of sales is required to keep the price right?
- ☐ Is there sufficient capital to produce large enough quantities of products to achieve economic production?
- ☐ What is the potential European and International market for the product?
- ☐ What are the sales of competitors' devices?
- ☐ What form of advertising is appropriate?
- ☐ What agencies will help promote the products to specialist groups?
- ☐ What subsidies or financial support exist to help consumers purchase equipment?

Social Aspects

With the advent and widespread use of telecommunications, the question arises of how different groups of people, and in particular how people with disabilities, are coping with present telecommunications equipment. It also raises the further question of how these people will cope with future technology. This could potentially pose a problem also for other parts of the population, particularly elderly people.

There is little doubt that telecommunications are playing an ever increasing social role in our daily lives. For the majority of us they partially fulfil our fundamental need of reaching out to other people while also helping us organize our social and professional lives. For many other people, they are a lifeline to the outside world offering the opportunity to work and take an active participation in society. In this case they obviously play an even more important role. It will still be some time before we are fully able to realize and appreciate the overall influence of telecommunications on our lives and habits.

Present and future technology hold exciting new perspectives, but also potential dangers for people with special needs. The question is to know whether all this new technology will lead to greater integration or further exclusion and to evaluate the influence these social and human considerations have had on our legislation.

This section looks into these various aspects and yields some preliminary answers and recommendations. It begins with a historical perspective of how people with disabilities have been considered and treated in the past and looks at current trends. The next chapter supplies an overview of current legislation and includes a list of important points to be kept in mind when drawing up new legislation. Practical experience gained through intensive casework and studies conducted in Ireland and Germany give an insight into the problems and benefits of telework for people with disabilities. The last two chapters yield preliminary results and recommendations from several studies on the needs, attitudes and expectations of elderly and disabled people towards telecommunications.

Further research is indeed required, but this section should serve as a useful basis to all those working in this field to ensure that this unique chance of integrating everyone, whatever their needs, is not lost.

Patrick Roe

8

The Disabled Person in Society: a Historical Perspective

Ramón Puig de la Bellacasa and Stephen von Tetzchner

Growing up with a disability is a form of life. Depending on the severity of the disability, it may influence all aspects of life to different degrees. An adult who, due to disease or trauma, acquires a disability, may have to change most habits and everyday functions, including education and work. To understand this life form, it is necessary to acknowledge that 'disability' is a social and cultural construct, which reflects a society's policy and practice towards people with disabilities (cf. Oliver, 1986). Such policies and practices have been created mainly by the able-bodied majority and vary from country to country. They have changed during recent years, typically from segregation of disabled people to non-segregation, and from their dependence towards independence.

> 'We have had people with disabilities, however, throughout recorded history, in all of the world's countries. The problems of these people were dealt with by their families, at the community level. That makes sense, in a profound way that we only recently have begun to appreciate. It is, after all, in the community that these people live and should live' (Bowe, 1990).

The quotation above reflects on the situation that has dominated in rural settings, and highlights the positive elements of the 'community approach' within (re)habilitation practice. (*Habilitation* is concerned with people with developmental disabilities while *rehabilitation* is concerned with people who have acquired disabilities). However, what may be true for rural communities is not necessarily valid in an urban society. In fact, the charity practice and communal solidarity with poor and disabled people found in medieval villages in Europe until the thirteenth century, progressively disappeared with the growth of towns (le Disert, 1987).

Many of the community attitudes with regard to disabled people were based on a general belief that considered them as a part of the world's order and God's will. The traditional notion that poor and disabled people 'will always be with us', is no longer valid when such people are not considered as individuals in a community or identified as members of a family, but looked upon as a 'mass' of underprivileged beings in the streets of the town, a mass that may menace the social organisation.

The development of policy and practice with regard to the position of disabled people in society can be divided into three basic approaches resuming a long history of attitudes and conceptions in relation with disablement. The longest period historically corresponds to a 'traditional approach'. The second approach is the '(re)habilitation model', and the third one is termed the 'independent living model'. The three approaches partly reflect the views of different age periods, but many elements of all three paradigms live together in the attitudes and apprehensions towards disabled people in the European societies of today.

The Traditional Approach

It is a paradox that throughout history, the problem for people with disabilities has not been a lack of integration, but, rather, an unfulfilled form of 'integration', with limited possibilities for education, work and social life. Disabled people have always had a place in society, but a place that the misconceptions of the leaders of the community and the community itself prescribed for them. Mainly, the roles given to disabled people had negative characteristics. In antiquity, for example, deafness was regarded as a kind of disease that made the deaf person unable to develop the skills that were necessary to function as a responsible citizen. Accordingly, the Roman law and derived systems treated deaf people as special cases. Occasionally, a disability was linked to a special ability. For example, blind people have often had special skills attributed to them, particularly with regard to music and poetry, and 'seeing' into the future. Old Greece, Rome and Egypt represented examples, both of rejection (sometimes physical elimination) and sacralization. In one extreme, the person with an impairment could be the expression of Evil, and, in the other extreme, a hierophant (i.e. an instructor in religious duties and sacred mysteries).

With the rise of Christianity, the focus changed. People who were crippled, sick, blind, or deaf, were regarded as objects of charity, and people who were mentally retarded as 'innocent'. It was thought proper that they should beg, in order to give others an opportunity to show charity, or to be taken under the care of the church. The task of the church was not only to provide care, but also to gain the person entrance to Heaven. For example, if the person was not confirmed, he or she could not be saved. This was a reason for the church to undertake to teach deaf people to speak and learn the catechism. These complementary roles of the church and the disabled person may be regarded as a first basis of the later development towards institutional care.

In the fifteenth and sixteenth century, during the constitution of the modern European states, poor and disabled people became subjects of administration as an aspect of the Public Order. The time of enlightment transformed them to subjects of care during the eighteenth century. At the same time, the 'normal' citizens were, step by step, obtaining civil rights through confrontation with the ruling class (the word 'normal' appeared at this time in France [le Disert, 1987]).

The positivism of the nineteenth century led to a new emphasis. The disabled person became a problem subject, and an object of study for psychology, medicine and education. Techniques for the education of blind and deaf people, which started in the previous period, became consolidated (including strong scholastic differences and trends). New categories of impairment were studied at the same time as the differentiation between the asylum and the hospital was reinforced, the former being a centre with socio-scientific functions. For example, the first school for deaf people in the USA, which was founded in 1807, was called 'The Asylum'.

The time had still not come, however, to discuss education for severely disabled children. Thus, the available efforts were directed towards children who posed minor and moderate problems for the teacher. Segregation in education was introduced to provide disabled children with a possibility to learn, and this initial segregation no doubt had positive effects if one disregards the fact that, with the exception of deaf children who are dependent on a signing environment, non-segregated special education probably would have given the same results.

The order of the Church was replaced by the order of the bourgeoisie. The age of enlightment had led to a growing educational focus, but while the general concern of the society was on work and production, disabled people were not yet regarded as able to continue industrial production. They were still, to a large extent, deprived of the role of worker, and thereby also deprived of the possibility of obtaining a reasonable status in society. The function of disabled people was to be the subject of protection by a liberal and progressive society, with the control lying within that society. The first schemes of social protection and social provision appeared, which formed the basis of modern social security and compensation benefits.

The (Re)habilitation Model

In many ways, it was the consequences of the two world wars that led to the creation of a new approach, with an emphasis on repair of functional impairments. According to a (re)habilitation model (Dejong, 1979; 1984), the main problem is the impairment of the individual, and his or her lack of skills. The aim of (re)habilitation is the development or recovery of functional skills (e.g. activities of daily living) and employment (productivity). Because the problem resides in the individual, the key to resolving the problem is professional intervention by physicians, physiotherapists, occupational therapists, rehabilitation counsellors, psychologists, social workers etc. The social role of an individual with a disability is that of patient or client. The focus of control always lies with the professional, typically a physician.

The model of (re)habilitation is a medical-industrial model with a therapeutic and recuperationist technology that transcends the traditional paradigm by seeking to change the prospects of the disabled person. It is a consequent application of the industrialist and positivist ideology, and a result of the approach which takes the disabled person as an object of study. In line with the ideology of the industrialisation of society, people are evaluated within the framework of useful-unuseful, or able-unable.

The ideology of medical rehabilitation, which is the core of this paradigm, was established during the Second World War by Rusk, and is still maintained today. It is a philosophy of medical responsibility, striving towards the goal of individual restoration and an optimal level of self care and functional performance (Kottke, Stilwell and Lehman, 1988). The following quotation from the Spanish legislation is evidence of the emphasis on individual repair: 'All have the right to correct or modify his/her state' (when this is an obstacle to being integrated into society).

From a medical point of view, (re)habilitation represents a third phase of medical care. The first phase is preventative, the second curative and surgical and the third is (re)habilitative. This chain, or – better – assembly line conception, was first introduced by practitioners in the USA in the 1940s, and later adapted by most other Western countries. True to the values of the industrialised society, i.e. productivity and functionality (work), a cost-benefit analysis was the basis for evaluation of the rehabilitation process (Kottke et al., 1988).

In many ways, the (re)habilitation model represented a major step forward, and has led to improved life for many people. It has inspired the invention of many different forms of equipment and techniques, and has thereby contributed to a more active life for people who would otherwise have been institutionalized or would have languished in the old convalescence systems. Still, the focus on production skills and individual repair implied some severe limitations. In recent years, the framework has been altered. Significantly, new and better evaluation approaches have been introduced, including more quality-of-life criteria (Emerson & Pretty, 1987; Fugl-Meyer, 1987). The analyses are not only concerned with the limitations of the individual, but also include the environmental barriers. This focus is also dominant in the World Health Organization's 'International classification of impairments, disabilities and handicaps' (WHO, 1980).

However, it is important to realise that much of the (re)habilitational work is still performed by professionals who 'know best' what the needs of people with disabilities are. These attitudes are typically linked with professional interests that overshadow the interests and preferences of the individual. For example, the interest of special teachers to remain in large institutions has hampered the transition of handicapped people to non-segregated educational institutions, and the learning of skills that are needed in a non-segregated society.

The Individual in Society: the Model for Independent Living

Both the traditional and the (re)habilitational approach place the focus of the problem in the individual. The traditional approach focused on identification and care of disabled people. It had very limited (re)habilitational goals, reflecting the static and deterministic view of human development that has characterized most of historic development. The (re)habilitational approach placed the repair and development processes into focus, but was to a large degree technical and mechanical. Aside from production skills, little attention was given to the person's function in society: it was a personal catastrophe (cf. Oliver, 1986). If segregation was assumed to provide the best restoration of production skills (with education as part of the repair process), there was no hesitation about segregating the person.

The model for independent living is a socio-political model that represents a radical break with both the role as an object of charity, and as a patient. The view incorporates the fundamental willingness to repair or improve an impaired function, but transcends the (re)habilitation by rejecting an evaluation of the individual based on production and self help abilities. The shift in emphasis was to a large degree initiated by the increasing awareness of people with disabilities, with regard to the roles they were allowed to play in society (cf. Abberley, 1987). Thus, the important contribution of the model of independent living is an emphasis on participation in society, strongly rooted in a belief in equality.

The model of independent living and accessibility to society reflects a fundamental change in attitudes, and consequently, of the roles attributed to disabled people. These attitudes both inspired, and were inspired by, the movements of people with disabilities themselves (e.g. 'deaf consciousness' and 'centres for independent living'), which were and still are important tools in the process of desegregation. People with severe physical impairments – and their relatives – have demonstrated in practice that the prognosis of dependency and institutionalization assigned to them could be conquered. Starting in California in the USA in 1972, the movement and its ideology spread to other countries, mainly in Europe (see Heumann, 1986). The movement has been dominated by intellectually well-functioning people with motor disabilities, and has only to a lesser degree been concerned with people who have impaired linguistic and cognitive skills. However, the role of intellectually handicapped people in society is also discussed within this framework today (e.g. Abraham, 1989; Hewitt, 1987; Rock, 1988).

Many of the attitudes toward disability and the trends in society got a foothold first among professionals, and only later appeared in the legal and political world. For example, the normalization principle proposed by Bank-Mikkelsen has significantly influenced the policies on people with mental retardation. It is founded on the right to be considered and treated like anybody else, but initiated in a critique of the concept of 'normality'. The ideas of 'mainstreaming' in USA and 'school integration' in Europe also originated in a critique of the traditional segregated special education, and have been extended to all other domains of life.

The basic notions – mainly elaborated by people with disabilities – expressed in the independent living model both oppose and complement the (re)habilitation approach (Dejong, 1979; 1984). In this model, the main problem (particularly for adolescents and adults, but initiated in early development), is the dependency on professionals and family. The problem resides in the environment and in the characteristics of the (re)habilitation process itself; the keys to its solution are peer orientation, legal action (advocacy), self-help, consumer control, removal of physical and psychological barriers (attitudes of other people) in the environment. The person with a disability is a citizen with equal rights, and should have access to the usual variety of roles that are filled by different members of a society. Significantly, the aim is independent living, and the disabled person should be the controller of the processes.

Although the movement of independent living was named by the members of the movement, the content may be better described by the term 'autonomy'. From the point of view of classical rehabilitation, 'independence' has a functional and physical connotation, which is to improve performance of the activities of daily living. Within the framework of 'independent living', 'independence' expresses the capacity of the person to take his or her own decisions. In this approach, the consequences of disability on the individual's life should be looked at from a social, economical and political perspective, and not exclusively from a reductionistic physical-medical point of view (Zola, 1988). Even a physically extremely dependent person (with a high need of attendant care) could be independent (autonomous) from this point of view, insofar as he or she decides the daily matters and the degree and form of assistance (cf. Brisenden, 1986; Rock, 1988). On the other hand, a 'successfully' (re)habilitated person, for example, who has recovered a high degree of physical autonomy, could still live a dependent and protected life. The lack of autonomy may be caused by fears and misconceptions about the world, which have been formed by professional restrictions and the attitudes relayed by the people in the social environment (family, peers, teachers, etc.).

By defining the problem as residing in the environment, the movement of independent living provided a basis for the notion of 'accessibility'. With regard to the physical environment, accessibility implies a need for awareness in design, so that only a few people will be excluded (cf. Shalinsky, 1989). The current possibilities offered by technological advances, especially in the field of information and communication technology, are increasing the expectations of people with disabilities, that is, the hopes that they will be able to share the services and facilities that modern societies provide for their citizens, such as access to telecommunication. For example, it took about a hundred years from the invention of the telephone before people with profound deafness obtained the means to communicate on the telephone network by means of writing; and in many countries, this possibility still hardly exists. The likelihood that many of the great expectations with regard to access to society will be filled is to a lesser and lesser degree dependent on technological development in general, and to a greater degree dependent on the attitudes of politicians and other members of society, and on their willingness to use legislation and regulations as means for providing a basis for less commercial aspects of technological development in the field of (re)habilitation.

At the same time, it is important that the development does not lead to 'electronic care' and a return to the traditional role of the disabled person. For society to function, different obstacles must be surmounted. Obstacles of communication may be overcome by building roads, bridges, telephone networks, etc. People may experience obstacles of different degrees and types, but still have equal right to have them removed. In a true non-segregated society this is not a matter of charity, but of sharing the resources of the society. And, it is not enough that the physical environment is as accessible as possible. For the expectations of disabled people to be fulfilled, the social environment, that is, contact with people, must also be accessible.

A Synthesis

All three traditions are part of the lives of people with disabilities. Some of the elements are positive, while others lead to increased dependency and oppression of disabled people (cf. Abberley, 1987). The 'problem' approach of the eighteenth and nineteenth century is still apparent in the attempts to understand the development of language and learning disorders, and thereby of human development in general. Today, contributions from cognitive science may lead to new understanding and may change some of the traditional views of cognitive functions, such as memory, language, perception and reasoning. This knowledge is likely to have implications for the design and function of aids for disabled children and adults: for example, in the construction and choice of vocabulary in communication aids. However, the role of charity and the failure of society to understand the disabled person within a wider context are elements of this tradition that should be substituted by the more life quality oriented philosophy of independent living.

Similarly, the medical (re)habilitational model is important in its willingness to repair impaired functions, although the impact may have been greatest for people with acquired impairments; but its focus on the disabled person as a client is too narrow. Both impairment 'as a problem' and 'as something to repair' is supplemental to the independent living model, and for some – for example people with intellectual impairments – is even a prerequisite for optimal adaptation of the environment to the functions of the person. Many people with disabilities need and want help, both technical and manual. However, they do not want to be told how to live and what help to get. They want to devise and control their own life styles within the scope of their own limitations, in the same way as the rest of society (Brisenden, 1986). Not all disabled people are seeking an active life. The differences between disabled people are the same as those within society at large; some may prefer a more passive form of participation. In a typical restaurant conversation there will be people who speak all the time while others hardly say a word, but both kinds may experience social participation in equal degrees. This may not be the perfect analogy, but many well-meaning people make the erroneous assumption that their own frantic life style is the best for everyone. One should not underestimate the factor of time. For many disabled people, most activities take longer time, and more effort. For them, a full and rich life may have fewer or shorter elements.

To sum up, today's societies are moving towards an era in which disabled people will not settle for their traditional role. To accommodate this change, disability must be understood from a comprehensive point of view, in line with the social definition of the concept (cf. Oliver & Zarb, 1989). It is not enough to make technological devices and provide these to the users. The role of these devices in shaping the life of the users must be understood. The influence on work, education and other aspects of personal and social life must be investigated, as well as the role of models for distribution of devices and services, and the funding of research, development and supply to individual users. In this development, it is important that disabled people neither assume nor are given the role of passive consumers. Participation must be equal, not only with regard to matters of concern to people with disabilities, but also in matters of concern to society in general, in the same way that people without disabilities should be concerned with matters for all groups, whether they have disabilities or not.

There may be a long way to go before this era comes. The power of disabled people as a social movement is limited, despite the fact that in recent years the rights of disabled citizens have become an acknowledged political problem. Many disabled adults are still living at home or in settlements that give them limited freedom to choose their own life style (Clark &Hirst, 1989). The passive role they assume is also manifested by the fact that a large proportion of disabled people do not themselves take the initiative by using their right to vote (Oliver & Zarb, 1989).

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9

Policy and Legislation

Guy Cobut, Jan Ekberg, John Frederiksen, Anja Leppo, Knut Nordby and Giorgio Rollandi

One result of increasing urbanisation, of greater mobility and of growing technical sophistication in the workplace, in domestic life and in leisure activities, is that access to telecommunications and teleinformatics has become a necessity for most people to be able to cope with modern society. A consequence of this is that all citizens *must* have the same rights to easy access to telecommunications and teleinformatics. However, although some technical aids, such as text telephones, hearing aids and wheelchairs, are provided free, or almost free, of charge to disabled citizens in some European countries, there are few explicit clauses in European legislation stating the rights of disabled citizens to receive adequate practical technical support to give them:

- full access to telecommunications and teleinformatic services.

Today's legislation typically includes statements about the rights and obligations of the licensed service providers, as well as the rights and obligations of the ordinary users. What is *not* stated is that some users will have difficulties in using the services and equipment provided. All citizens encountering such difficulties will find themselves discriminated against in modern society.

Legislation carried out specifically for disabled people so far includes paragraphs about financial support for, and national and municipal obligations towards, disabled people, but say little or nothing about equal rights to full access to telecommunication services.

Public services should be made available to all disabled people by providing:

- public services and telephones designed so that they are accessible to as many people as possible; and,
- disabled people with special equipment for services that are not otherwise adaptable to their needs.

In some countries a new development can be seen in recent legislation. It is now realised that disabled people must not be discriminated against in any area of life, but rather that they should have the same opportunities as non-disabled people.

General and Specific Legislation

A *national law* should be passed by a country's national assembly. Acts of law, such as, for example Telecommunication Acts, describe general principles for how telecommunication networks and terminals should function, how services should be provided, and which organisational bodies should be in charge of practical regulatory tasks. The contents of such acts may include the following:

- general principles and terms;
- licensing policy and licensing terms;
- users' rights and obligations;
- regulations for building/owning networks;
- regulations for running/providing networks; and,
- control of regulatory bodies.

A *decree* should be approved by a head of state (through the appropriate ministry). Decrees give more specific instructions about administrative matters of applying the basic principles specified by the national laws. Typical contents of a decree would be:

- general principles and terms;
- mandate of national committee for telecommunication affairs; and,
- type approval for terminals, approval of services.

The national *regulatory bodies* supervise the activities in the field and provide the licensed *operating companies* (which are entitled to build networks and implement services) with regulations that describe in detail the technical requirements (e.g. similar to CCITT recommendations) that must be fulfilled.

Laws in such areas as telecommunications, radio, and cable television do not specifically take disabled people into consideration, except by noting that services should be provided to the general public on equal terms.

Legislation Related to Disabled People

Legislation that takes the needs of disabled people into consideration is often broader in scope than the general legislation, typically specifying such matters as financial obligations and reimbursement. Among the activities behind initiatives for new legislation on disabilities, we find the associations and institutes for disabled people and, for example, in the case of Finland, the National Disability Committee, which has representatives from several different disability organisations and from the national agency for social welfare. The normal procedures for creating a new law in this field in Finland are:

> First, a disability organisation or the Disability Committee sends a letter or memorandum to a ministry, to members of parliament, or even to the press, pointing out a need for legislation in some area.

Second, a ministry working-group prepares a first draft act, which is sent to the relevant organisations for comments.

Third, a final draft act is then prepared for passage by the legislative assembly (parliament). Last-minute changes may be proposed by organisations and by individual members of the legislative assembly before the act is passed.

Different examples of disability acts and decrees are discussed below.

Although there are no formal type approval organisation or type approval procedures for technical aids, some checking is performed by social welfare agencies or medical rehabilitation centres etc., since most aids are paid for by the municipal or state agencies. The municipality may listen to users' expressed preferences when acquiring new aids, but often they will not, letting only economic reasons dictate their purchasing policy, since they have the power to decide whether or not to pay for a particular aid.

All technical aids that are connected to the electrical power mains must, of course, meet the local safety regulations or international standards. Technical aids to be connected to the telecommunication network must meet the appropriate national regulations and requirements for terminal interfaces.

Legislation Aspects

Legislation in the United States of America and in some European countries may serve as examples when analysing what is available now and what must be amended in our own legislation.

The legislation in the following countries is only treated to the extent needed to make an informed suggestion about what should be included in future legislation. Missing information does not imply that the particular feature is not available in the country in question. The countries that are mentioned below have been chosen at random.

Individual (Re)habilitation Plan

Services to disabled and elderly people who work in the United States are described in the 1986 Amendments to the Rehabilitation Act (Public Law 99–506). The law establishes that:

- state vocational rehabilitation agencies must include in their plan a description of how assistive technology will be provided to its clients;
- an assistive technology evaluation must be provided as necessary to assess and to develop the capacity for a disabled person to work;
- as appropriate assistive technology must be provided as a vocational rehabilitation service by qualified individuals; and,
- if assistive technology services are needed, they must be identified in the Individual Rehabilitation Plan for the client.

Access to Terminals

In part 603 of the American Rehabilitation Act mentioned above, we find the following paragraph:

Electronic equipment accessibility
Section 508.

(a) (1) The Secretary, through the National Institute of Disability and Rehabilitation Research and the Administration of the General Services, in consultation with the electronics industry, shall develop and establish guidelines for electronic equipment accessibility designed to insure that handicapped individuals may use electronic office equipment with or without special peripherals.

(2) The guide-lines established pursuant to paragraph (1) shall be applicable with respect to electronic equipment, whether purchased or leased.

(3) The initial guide-lines shall be established not later than October 1, 1987, and shall be periodically revised as technologies advance or change.

(b) Beginning after September 30, 1988, the Administrator of General Services shall adopt guide-lines for electronic equipment accessibility established under subsection (a) for Federal procurement of electronic equipment. Each agency shall comply with the guide-lines adopted under this subsection.

(c) For the purpose of this section, the term 'special peripherals' means a special needs aid that provides access to electronic equipment that is otherwise inaccessible to a handicapped individual.

No Discrimination

The United States of America Disability Act (Public Law 101–336 of July 26th 1990), and the Belgian law of 1963 'Relative an reclassement social des Handicapées' and the Resolution AP (84–3) of the Council of Europe 'relative á une politique cohérante en materiére de readaptation des personnes handicapées' which has been adopted on September 17th 1984 by the Councils of Ministers, states that:

> Disabled persons should not be discriminated against in the areas of employment, public accommodations and services, education, transport and telecommunications.

The law clearly and specifically states that all new services etc., should also be accessible to disabled people and that a person cannot be discriminated against because of disability (e.g. when applying for work).

When appropriate, telecommunication providers must provide relay services between ordinary telephones and devices like the Telephone Device for the Deaf and text telephones.

The United States of America Hearing aid Compatibility Act (Public Law 100–394 of August 16th 1988) states that all essential telephones should provide means for effective use with hearing aids. Mobile telephones do not have to comply with this requirement.

The United States of America Telecommunications Accessibility Enhancement Act (Public Law 100–542 of October 28th 1988) states that the Federal governments should ensure that telecommunication systems are accessible to hearing impaired and speech impaired people for communication with and within Federal agencies. This can be accomplished in several ways, for example by using text telephones and videotelephones.

Adaptation and Interaction

The British amended Disabled Persons Act (1986) reinforces some of the provisions of the Disabled Persons Act (1970) and the Housing Act (1974) which allow for carrying out adaptations in the dwelling.

The British Education Act also states conditions for providing the technical equipment necessary for disabled school children to allow them equal participation in education, while local Education authorities will furnish technical aids within the school environment.

Through the British Manpower Services Commission, the Employment and Training Act (1973) assesses disabled people's needs within the work place and provides for giving technical aids, enabling disabled people to be employed.

The British Department for Health and Social Security provides, among other things, various environmental controls. Local Health Authorities provide orthotic devices, hearing aids, surgical appliances and low vision aids.

British Local Housing authorities can fund housing adaptations (10–25 per cent to be carried by the client) and local Social Services will furnish technical aids for disabled people to allow independent living.

Access to Services

In France, more than 10 000 Minitel terminals have been supplied to deaf people, allowing them easy access to public videotex (Minitel) services. Other types of text telephone services, like the push button DTMF (Dual Tone Multiple Frequency) text telephone system, the European Deaf Telephone, the CCITT V21 system, etc., are in use in Europe. The incompatibility between these systems is a barrier to international communication for deaf people.

Various relay services, such as the Minitel videotex based service, Telematic Access Point services and other conversion type services, will help bridge the gap between the closed systems and the outside world, especially the text based services.

The human assisted text-speech-text relay service, implemented in some countries, function as a bridge between the closed text telephone services and the normal telephone service.

An example of a special conversion service is the remote reading service for blind people in Sweden. Here a blind user sends material by telefax to the service centre where it is read back on the telephone to the blind person.

Economy

Reimbursement of Equipment

In the United Kingdom the Chronically Sick and Disabled Persons Act (1970) mentions provisions of technical aid to disabled people.

The Finnish Services and Assistance for the Disabled Act (SADA Section 9) specifies that the disabled shall: '. . . receive full or partial compensation . . . for devices needed for . . . daily affairs'.

The same Finnish act (SADA Section 8) specifies that: '. . . municipality . . . shall provide severely disabled . . . services . . . in order to manage everyday affairs'.

In SADA Section 17, leisure time is explicitly mentioned by the specification: '. . . compensations for . . . devices for mobility and communication to cope at home and in leisure activities'.

The paragraphs in SADA related to telecommunications and teleinformatics are presented more in detail in Appendix 1.

In Denmark, Norway and Sweden support is granted for the procurement of technical aids according to legislation on social assistance. According to the provisions, support is granted for technical aids when these will help people with a handicap to lead a more independent life. The technical aid must, to a greater or lesser extent, compensate for a lost or reduced function.

In a separate declaration, the procedures for granting support are given, whereas a detailed list of all technical aids available with support was included in an earlier version. This change was made to ensure that the compensating or relieving functions of technical aids are duly taken into account when decisions are made – the previous arrangements had left much to be desired in this respect. In some areas, lists of technical aids available with support are still kept, mainly to ensure that users of these aids will continue to be eligible for support. These aids include such equipment as: orthopaedic footwear, video recorders, aids for communication, hearing aids etc.

Despite these increased possibilities for support, because of varying departmental and municipal practices there still are many categories of technical aids that are not yet available with financial support – for instance, mobile telephones – and practice can sometimes be restrictive for very expensive aids.

Normally, financial support for technical aids is granted as loans, while no funds are available for maintenance and operating costs. However, there are possibilities of obtaining financial support for operating some categories of aids; e.g. batteries

Aids for therapy and training	million SEK 190
Orthotics and prostheses	360
Aids for personal hygiene	400
Mobility aids	280
Household aids	5
Aids for adaptation of homes	360
Communication aids	390
Aids for handling other products	10
Aids for play, sport and recreation	1

Table 9.1 The cost of technical aids in Sweden.

for hearing aids, subscriber charges to telephones, storage batteries for electric wheelchairs. Normally, support is given for repair of technical aids.

In Sweden, most of the technical aids are paid for by the social welfare and health care system. A breakdown of costs are given in Table 9.1. These figures include costs for staff and management.

The United States of America Technology Related Assistance for Individuals with Disabilities Act (Public Law 100–407) provides programmatic support to states that establish programs of technology-related assistance for all disabled individuals, including rules for financing and providing the services.

The Belgian law of April 16th 1963 'Relative en Reclassement social des Handicapées' provides also financial assistance for all disabled individuals.

Telecommunication Tariffs for Disabled People

In a French Telecom policy paper (Dondoux, 1990) it is proposed that telecommunication providers should adjust their tariffs to take into account that people with some handicaps may need more time for telecommunications.

2–4 times longer for people with laryngectomies;
2–5 times longer for deaf people;
5–7 times longer for people with no speech using, for example Minitel; and,
2 times longer for blind people using Braille.

Policy

Quota for Disabled Employees

In France, 3.4 per cent of the employees of the French Telecom are handicapped. The policy of hiring disabled people is based on a law from 1975 and 1976 (N. 87-517 July 10) which defines the objective to earmark 6 per cent (1991) of all jobs in administration and industry in the public sector for disabled people.

In the Netherlands, an act on work for disabled people (1986) aims at having a 'reasonable' number of disabled people in the normal work force. The Ministry for Housing takes responsibility for adaptations and reimbursements through the Arrangement for Adaption of Houses Act.

In Germany most organisations employ their quota of disabled people, which is set to 6 per cent of all employees for all organisations employing 20 persons or more (cf. chapter 11).

In Belgium, 3 per cent of the employees of the public sector are handicapped. This obligation is based on the 'Arrête Royal' of 1972 stimulating the employment of handicapped people in the public sector.

The Role of Industry and User Organisations

The coupling between the needs of disabled users, on the one hand, and the industry and standardisation and legislation agencies, on the other, has already been described briefly above. It is important to focus on the following items:

- user organisation(s) or individuals will issue a note about a specific user requirement;
- this requirement is taken into account in the standardisation work by the relevant standardisation agency or agencies;
- any standards and recommendations produced are referred to in new legislation; and,
- the industry has to comply with the requirements set forth in any new legislation and standards, ensuring that companies can compete on equal and fair terms.

The law requiring inductive coils (for inductive coupling to hearing aids) in handsets of all American public telephones is a good example of an improvement achieved to favour hearing disabled people following this scheme.

Any additional costs of taking the needs of disabled people into account from the beginning when designing and manufacturing mass produced communication equipment are negligible, and since every manufacturer and importer has to comply with the regulations, no competitor will be disadvantaged in relation to the others.

Concluding Remarks

In conclusion, we would like to present a list of actions that should be checked in order to ensure that legislation really will include all aspects of habilitation and rehabilitation of disabled people and their integration into society. The legal and social welfare system should ensure:

- competent medical habilitation and rehabilitation;
- assessment of personal abilities and the drawing up of an individual habilitation or rehabilitation plan;

- assistance for independent living (technical and financial aid);
- adaptation of housing and the home environment;
- no discrimination in education, on the job market, in leisure activities, or in selecting a place to live etc.;
- public sector administration and industry to earmark at least 6 per cent of all their jobs for disabled people;
- full accessibility to public telephones, terminals, ticket machines and other self-service automata;
- inductive coupling of hearing aids to *all* telephones and to public address systems in public places such as railway stations, air terminals, cinemas, museums etc.;
- relay services (e.g. speech-to-text and text-to-speech) and adaptation of services in the network to the needs of disabled people;
- provision of security systems, location systems and social alarm systems etc., for elderly and disabled people;
- special low telecommunication tariffs for people who need extra time in using telecommunication services; and,
- a European Disability Act should come into force as a European Community Directive stating that:

> Disabled people should not be discriminated in such areas as employment, public accommodations and services, education, transport and telecommunications.

It should be noted that even legislation as such is not enough; there should also be organisational steps taken in order to ensure that the requirements are fulfilled.

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Appendix 1

An act and a decree taking disabilities into account

Services and assistance for the disabled act (3 April 1987/380)

Section 1
Purpose of the Act
The purpose of this Act is to improve the ability of a disabled person to live and act as a member of society in equality with others and to prevent and eliminate the disadvantages and obstacles caused by disability.

Section 2
The disabled person
A disabled person in this Act means a person who, because of his disability or illness, has special long-term difficulties in managing the normal functions of everyday life.

Section 3
Responsibility for the provision of services and assistance
The municipality shall ensure that services are provided of a content and on a scale that meets the need arising in the municipality.

COUNCIL DIRECTIVE on the approximation of the laws of the Member states concerning telecommunications terminal equipment including mutual recognition of their conformity, 5575/91 25 March 1991

Section 7
The development of services
The municipality shall ensure that the public municipal services are suitable also for the disabled.

In developing the services and assistance to be provided for the disabled the municipality shall take into consideration the needs and views put forward by the disabled themselves.

A disabled person shall be served and the services arranged with consideration for the language he speaks.

Section 8
Services for the disabled
A disabled person shall be provided with rehabilitation counselling, adaptation training and other services required to implement the purpose of this Act. Such services may also be rendered to a close relative of the disabled person, a person caring for him or some other close friend or relative.

The municipality shall provide severely disabled persons with reasonable transport and related escort services, interpretation services and service accommodation if, because of his disability or illness, he must of necessity have assistance in order to manage his everyday affairs. There shall be no special obligation for the municipality to provide service accommodation if the person is in need of continuous institutional care.

Section 9
Financial assistance
A disabled person shall, according to the need dictated by his disability or illness, receive full or partial compensation for the costs incurred by him in having to employ a personal assistant and to purchase devices, machines and equipment needed in order to manage his daily affairs. Compensation shall also be paid for the additional costs of purchasing any clothing and special food necessary because of his disability or illness.

The municipality shall within reason compensate the costs incurred by a severely disabled person in converting his dwelling and in purchasing equipment if, because of his disability or illness, these measures are essential for him to manage his everyday affairs and he is not in need of continuous institutional care.

Support and Assistance for the Disabled Decree (18 Sept 1987/759)

Section 1
Principles of action
The municipality shall prevent and eliminate obstacles and disadvantages restricting the functional possibilities of disabled persons in order for them to function as equal members of society.

The services and support measures needed by disabled persons shall be arranged so that these measures support the self-sufficiency of disabled persons in their daily lives.

Section 7
Interpretation services
Interpretation services comprise all interpretation in sign language or other methods for clarifying communication needed for work, studies, social participation, recreation or any other corresponding purpose.

Section 11
Arrangement of service accommodation
In the arrangement of service accommodation, a person shall be considered severely disabled if, because of his disability or illness, he needs the assistance of another person in coping with daily functions on a continuous basis at different times of the day or otherwise to a particularly large extent and he does not need continuous institutional care.

Section 17
Devices, machines and equipment needed by the disabled person for coping with daily activities
Compensation for the procurement of devices, machines or equipment other than those pertaining to medical rehabilitation shall be paid to a disabled person who, due to disability or illness, requires them for moving, communicating in coping personally at home or in leisure-time activities.

The compensation shall amount to half of the real expenses of the disabled person for the procurement of the devices, machines and equipment mentioned above. However, alternations to standard model devices, machines or devices which are necessary owing to disability shall be compensated in full.

The municipality may also provide devices, machines or equipment for the use of a disabled person free of charge.

10

Telework as an Employment Option for People with Disabilities

Barbara Murray and Sean Kenny

The labour market has been greatly influenced by technological developments in recent years. While many traditional occupations have disappeared, this trend has been matched by the emergence of new opportunities, particularly linked to developments in information technology. One of the developments which is especially significant for people with disabilities is the fact that work can now be carried out at a distance from the conventional workplace in the form of telework, supported by developments in telecommunications. Telework can open up new employment opportunities for people whose disability has excluded them from the workplace (e.g. people whose mobility is restricted) and may also make it possible for people who become disabled in the course of their employment to retain their jobs in a new form.

This paper reports on a recently completed pilot project, in which the feasibility of home-based telework as a form of employment for people with physical disabilities was evaluated. Through this, the extent to which telework might promote their economic and social integration was explored. In addition, broader issues involved in the introduction of telework on a national basis were examined.

Concept of Telework

Telework can be described as work which involves the use of information and telecommunications technologies and which is carried out at a distance from the conventional workplace. It may be carried out on-line or off-line.

Home-based telework was defined in the project as referring to teleworking arrangements where an individual works predominantly from the home, either as an employee of a company or as an entrepreneur, with work being communicated to and from its source in a variety of ways, including use of the various telecommunications facilities now available (on-line) and also of more traditional means of communication (off-line).

On-line telework involves the use of an electronic link (using a modem and telephone) between the worker at his/her remote workstation and the employer or contractor. The electronic link is used for communication and transmission of work.

Off-line telework involves use of conventional transportation (e.g. delivery by car, mail, courier etc.) in either the delivery and/or return of work to source. The work may either be in hard copy form or stored on disk or tape.

While both on-line and off-line forms of telework are currently in use, the off-line form is at present more common than the on-line form. On-line telework is gradually expanding, however, due to the development of telecommunications services.

Methodology

The project was an action-research project in which a number of case-studies were set up and monitored in terms of effectiveness over periods ranging from 6–8 months. The project coordinator acted as a facilitator, in establishing the care-studies and in providing on-going support and assistance to the telework units in the course of the study.

The evaluation of the telework arrangements had both formative and summative dimensions. The formative dimension of the evaluation involved gathering information about the case-studies at regular intervals while they were in operation and feeding this information back to the relevant people to help solve problems which arose, improve the effectiveness of the telework units and enhance their feasibility. This aspect of the evaluation was the responsibility of the project coordinator, who used the information generated to develop and improve the telework units, in consultation with the teleworker, telework employer or service purchaser and other agencies involved.

The summative aspect of the evaluation aimed to answer basic questions about the feasibility of home-based telework as an employment option for people with physical disabilities in the Irish context and about any supports which would be required if this form of employment was to become more widespread. The project evaluator examined the financial, technical, organisational, social and environmental aspects of the telework arrangements by means of interviews with the teleworkers and telework employers at the start and end of the project, and through the information which was generated while the telework arrangements were in operation.

The Telework Arrangements

Eleven telework arrangements were established in the preliminary phase of the project. In setting up the case studies, the aim was to ensure that a variety of work, teleworker characteristics, conditions and locations would be reflected, so that the feasibility of telework could be examined under varying conditions.

Teleworkers

The teleworkers who participated in the pilot project were aged between 22 and 47 years. There included five females and six males. They differed significantly, in terms of both their educational background and their familiarity with computers at the start of the project. Their educational levels ranged from primary to third level. Four of the teleworkers had previously completed computer related courses; three were self-taught in the use of computers and the remaining four teleworkers had not used computers prior to the pilot project.

Each had a physical or sensory disability of some kind, associated with cardiac problems, cerebral palsy, spina bifida, multiple sclerosis, involuntary movement disorder, visual and hearing impairment, arthritis and injuries resulting in paraplegia and quadriplegia. In four cases, the disability had been present since birth or childhood; in the remaining seven cases, the onset of disability was later in life. With two exceptions, the teleworkers were independent of others in terms of mobility.

Seven of the teleworkers had been in employment before the project started, for periods ranging from under a year to over twenty years. Another teleworker had worked as an apprentice for four years. In three of these cases, the telework arrangement was a way of retaining their employment, following the onset of their disability, in a different form than previously. In the remaining cases, the telework arrangements represented new jobs for the people involved, following a period of unemployment. Three of the teleworkers had not worked before starting telework: for them, the telework arrangement was their first experience of paid employment.

A profile of the teleworkers in terms of their age, sex, disability, educational qualifications, computer-related training and previous work experience is given in Table 10.1.

The Telework Employers

Five of the employers who took part in the project were public sector organisations, two were located in the private sector, and the remaining employer was voluntary body. The self employed teleworker carried out work on a contract basis for private sector companies. All of the employing organisations were involved in service provision. The services included educational provision, telecommunications, mass media, local authority services, computer sales and servicing, and advocacy. Most of these organisations had advanced computerisation of activities.

Case no.	Age	Sex	Education	Computer related training	Previous work experience	Disability
1	22	M	Post-primary (junior level) apprenticeship	Computer aided design as part of apprenticeship	None	Quadriplegia
2	36	M	Post-primary (junior level) business studies course	Introduction to computer applications	Technician Policeman	Ankylosing sponylitis (arthritic disease)
3	24	F	3rd level degree Teacher training system analysis at 3rd level	Computer programming System analysis	Trainee system analysis project work	Spina bifida
4	46	M	3rd level degree agency	Self-taught condition	Director-state	Heart
5	26	F	3rd level degree programming and analysis at 3rd level	Computer related	Computer	Paraplegia
6	37	M	Post-primary (senior level)	Self-taught	Technician	Involuntary movement disorder
7	25	F	Post-primary (senior level) business studies course	Introduction to computer applications	None	Cerebral palsy
8	47	F	Primary level and secretarial	Keyboard training	Secretary	Arthritis Impaired growth
9	33	M	Post-primary (junior level)	None	Storeman (navy)	Multiple sclerosis
10	30	F	Post-primary (junior level)	None	None	Hearing and visual impairment
11	33	M	3rd level degree	None	Social work Clerical work	Multiple sclerosis

Table 10.1 Profile of home-based teleworkers.

Telework Conditions of Employment

Two of the case studies involved teleworkers who were self-employed: one carrying out work on a contractual basis and the other working on a piece-rate basis. The other nine telework arrangements were employer/employee arrangements. In four of these cases, the telework jobs were permanent. Three involved retention of previous employment in telework form, the fourth involved permanent employment with an initial probationary period. Two of the employer/employee arrangements involved temporary full-time employment. A further three involved employment on a temporary contractual basis (see Table 10.2).

The work carried out in the telework case studies included 'high status' work such as programming, systems design, computer-aided design and script-writing; and routine jobs such as data entry, work processing and desk-top publishing.

The home-based telework units were located throughout Ireland, in both urban and rural areas. Four of the teleworkers worked on-line, with links spanning physical distances ranging from 8 to 240 kilometres. The other teleworkers worked off-line at distances from their employers or service contractors ranging up to 20 kilometres.

Training Requirements

Seven of the teleworkers had already acquired computer-related skills before the project started. In four of these cases, though, the teleworkers were taking up new jobs and were thus required to undergo a period of induction into company practice before the telework could commence.

Four of the teleworkers had no previous experience of computer usage and required introductory training, which was delivered in the form of computer-based tutorials with the assistance of the project coordinator, before home-based telework could commence.

Telework Equipment and Facilities

Each teleworker worked with a personal computer, a printer and a telephone. The equipment was supplied by the employer in some cases; through the project in other cases; and owned by the teleworker in another case. Specially adapted computer equipment was required by two of the teleworkers.

Four teleworkers had modem connections with the mainframe computer at their employer's headquarters, which were made using ordinary telephone lines, rather than dedicated lines. The data was transferred on-line at times by these teleworkers, using the modem connection, and using floppy disks and hard copy at other times. Where the teleworkers worked off-line (without a modem connection to their employer's mainframe computer), work was transferred using floppy disks and hard copy, by post or by hand. The cost of telephone connections was borne by the employer, in cases where the teleworker worked on-line, and the cost of telephone calls made in connection with work was borne by employers in other cases.

Case no.	Work involved	Training required	Status	Telework facilities	Agency
1	Computer aided design	Self-taught	Self-employed	Stand-alone system	Self-employed
2	Programming and system analysis	In-house induction	Temporary (full-time)	On-line	Telecom
3	Programming and system analysis	In-house training and induction	Temorary (contractual)	On-line	Digital
4	System design	Self-taught	Permanent (retention)	Stand-alone system at present (on-line at future date)	County Dublin vocational education committee
5	Programming and system analysis	In-house training and induction	Permanent (with period of probation)	On-line	Ericssons
6	Word processing and data entry	Self-taughht	Temporary (contractual)	Stand-alone system	Radio Telefis Eireann
7	Programming	In-house induction	Temporary (full-time)	On-line	Telecom
8	Word processing	Self-administered computer-based training	Permanent (retention)	Stand-alone system	Piecework
9	Data entry	Self-administered computer-based training	Permanent (contractual)	Stand-alone system	Navy
10	Word processing	Self-administered computer-based training	Temporary (contractual)	Stand-alone system	Council for the blind
11	Data entry	Self-administered computer-based training	Permanent (retention)	Stand-alone system	Wicklow county council

Table 10.2 Profile of telework arrangements.

Working Arrangements

While all the teleworkers had regular contact with their employers or clients, the extent to which they worked at home varied considerably. Some spent several days working from home, and worked from a conventional work-place for the rest of the week. Others stayed at home for weeks at a stretch, in contact with their employers or clients on-line and by telephone, with occasional face-to-face meetings. The amount of contact with the employing organisations, whether face-to-face or by telephone, was greatly influenced by the nature of the work being carried out, which, in some cases, required considerable consultation. Distance management requirements and personality factors has an impact on the level of contact.

Most of the teleworkers aimed to work 'office hours', while taking a flexible approach to break times. All of them found the flexibility useful in terms of their rhythm and in terms of having to deal with personal business. Many worked to specific deadlines and targets so that from a distance management viewpoint, the effectiveness of the arrangements was not difficult to monitor.

Results

Of the eleven telework arrangements negotiated in the early stages of the pilot project, eight were operational at the end of the project. These included the two self-employment arrangements and six employer/employee arrangements. The work involved in the operational arrangements was programming and systems design combined with general managerial work (including financial and other reporting), computer-aided design, desk-top publishing services, word-processing and data-entry. Each of the employer/employee arrangements was set to continue after the completion of the project, with adjustments in the day-to-day organisation of the telework in some cases to suit the cycle of the work-load or changes in the teleworker's own situation. While one of the self-employed teleworkers was operating a successful computer-aided design service, combined with desk-top publishing at the end of the project, the feasibility of the second self-employed teleworker's arrangement was in doubt. It appeared that a teleworking arrangement in the form in question would be feasible only if the type of work undertaken (word processing on a contract basis) was supplemented with other types of work.

Three of the case-studies were not operational at the end of the project. Two have been delayed for reasons associated with getting sources for special computer adaptations and were likely to commence shortly after completion of the project. One of the arrangements was postponed indefinitely due to a deterioration in the teleworker's health.

Most of the problems arising in the course of the case studies were resolved without having a major impact on the telework arrangement: they were 'teething' problems associated with setting up a new venture, involving work practice and technical aspects of the arrangements. Some of the problems which arose (in connection with the identification and souring of suitable computer adaptation) caused delays in the implementation of the initiatives. In only one case, the telework arrangement could not be implemented: this was due to a significant deterioration in the teleworker's health.

The outcome of the operational telework arrangements was discussed with the teleworkers and in the case of the telework employees with their employers, and at the end of the pilot project.

Six of the eight home-based teleworkers definitely liked working from a home-base, and wished to continue doing so. It should be noted, though, that in most cases the teleworkers combined working at home for several days with working at a conventional workplace for the remainder of the week. The teleworkers liked this and several of them said that they would not like to work entirely at home. One of the teleworkers was glad to have had the experience of home-based telework, but on balance, would prefer a conventional office-based job. She would continue with home-based telework, however, if it was the only employment option open to her. The remaining teleworker said that changes would be needed in the organisation of her telework arrangement (more structuring of the work, setting of clear deadlines) if she was to continue working in this way.

In the teleworkers' opinion, the advantages of home-based telework included the flexibility of working hours; the possibility of working without interruption; the fact that there was no need to rely on public transport, no problems of access to buildings, no worry about the weather; the possibility of working in familiar environment; being his/her own boss. Those who had to travel to a conventional workplace for part of the week reported feeling much less tired on the days when they worked at home.

The disadvantages which the teleworkers associated with home-based teleworking were: the lack of social contact; the lack of work support and the difficulties in consulting others; the lack of structure, giving rise to the need for considerable self-discipline; the need to be highly motivated. Since in most cases the teleworkers combined working at home with working alongside others in the company offices, however, they did not experience isolation but foresaw this as presenting problems should they work at home continually. For most of the teleworkers, the advantages of home-based teleworking outweighed the disadvantages.

For the telework employers, given the experimental nature of their involvement in telework, it was too soon for a policy statement on telework. At the end of the project, though, several of the participating employers were reviewing the telework experience with a view to informing company policy. The advantages which they could already see in having employees working 'off-site' were associated with the retention of valued employees who needed the flexibility of work hours and location which telework could offer. Several employers expressed satisfaction with the high quality of work carried out by the teleworkers at home. While some of them favoured telework for these reasons, they foresaw difficulties in having telework arrangements in operation on a full-time basis, given the nature of the work which they carried out. The need for regular interaction with colleagues and clients, as well as the need at times to use large-scale equipment located in the common offices, meant that a flexible approach to telework would be required. This flexibility was seen both in terms of days of the week and phases of the work cycle.

Discussion

The case study experience indicated that home-based telework is a very flexible form of employment. It may involve working from a home base for part of each week and from a conventional office for the rest of the week; or working from home on specific elements of a broader workload which are suited to the telework format; or working at home for most of the time, with occasional visits to the company offices. It may involve on-line work in which the teleworker is in direct contact with the employer's or service contractor's mainframe computer through a modem link, or off-line work in which work is transferred by post or courier in hard copy or diskette form.

The feasibility of home-based telework for people with physical disabilities in a variety of forms has been demonstrated in the project. A number of conditions need to be met, however: the work to be carried out from a home base should be clearly specified in a way which allows progress to be monitored. It should not require frequent, unplanned consultation with colleagues or clients. A flexible approach is essential: in some cases, the work may be carried out exclusively from a home base; in others, it may be necessary to combine home-based work with attendance at a conventional workplace, either on a regular basis (e.g. for part of each week) or at certain stages in the work cycle. It may constitute a complete job in itself (such as programming) or may be part of a broader range of work duties, only some of which are suited to the telework format (such as general management jobs involving financial analysis and report-writing). It should be possible to carry out the work without the use of equipment or supplies which can only be supplied economically in a central work location (e.g. testing equipment). Where the use of such facilities is necessary at certain stages in the work, attendance at the conventional workplace may be necessary for a block of time, or for part of the working week.

With regard to the management of telework arrangements by the employing organisation, responsibility for maintaining contact with the teleworker and for monitoring the performance of work in this form should be allocated to a specific contact person at managerial level within the employing or contracting organisation. Procedures for distance management should be developed, so that contact with the teleworker is maintained on a regular basis, rather than solely in relation to any crises which may arise. Associated with this is the need for some procedures which help to ensure that the teleworker feels linked to the organisation and its employees and is not isolated.

Finally, telework is suited to some people, but not all. In order for telework to be successful, attention much be given to selection of people who are suited to working at a distance from conventional workplaces. Besides being qualified to do the work in question, the teleworker should be able to work independently, without direct supervision and be a self-starter in relation to the work itself. In addition, she/he should be familiar with computers. A further requirement is that the teleworker should be able to work at home without interruption, making the availability of a suitable 'workplace' in the home an important prerequisite for the success of the arrangement. While teleworkers should be qualified to do the work in question, a period of induction training may be necessary where they are new employees of the employing organisation. This period of induction serves two purposes: besides familiarising the teleworker with the type of service provided by the organisation, it also enables him/her to get to know other employees of the organisation and make links which are essential to prevent feelings of isolation from developing, when the teleworking arrangements becomes operative.

Conclusions

Telework will create new employment opportunities for people with disabilities – especially those with severe mobility restrictions – given the right supports. In some cases, this will involve the creation of jobs which did not exist before; while in others, it will involve the offering of a job which already existed to an unemployed disabled person, although the job may have to be respecified in telework form. The potential for employment creation in entrepreneurial form is also considerable.

In addition to these new opportunities, telework can also make it possible for people who are faced with the onset of a disability to retain their employment. Providing proper attention is paid to the aspirations and skills of the teleworkers, the organisation of work, and to the provision of training required by people who are not familiar with the use of computers and advanced telecommunications, telework will contribute positively to an improvement of the employment opportunities of people with disabilities.

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11

Vocational Training of People with Disabilities in Germany with Regard to Teleworking[1]

Gerhard Klause

There is a general belief held by politicians and labour administrations that 80 per cent of all work places will use computers by the year 2000. This means that manual workplaces, which today represent the workplaces of many people with disabilities, will be drastically reduced. It follows that computer usage will become a crucial part of the work most of the standard professions teach to disabled pupils. Telework may change the black outlook for this group, providing outstanding future possibilities, particularly with regard to severely disabled professionals. Therefore, vocational training should be updated and supplemented with whatever new skills are needed.

The vocational situation of people with disabilities in Germany is mainly dependent on five factors:

- the vocational training and experience of the person;
- the kind and severity of the disability;
- the age of the person;
- the availability of adapted (computer) equipment; and,
- the realiastion of the 'quota regulation' as regulated by legislation.

In Germany, most organisations employ a quota of people with disabilities, which is set at 6 per cent of all employees for organisations employing 20 or more persons (Floyd and North, 1986). Every organisation that does not meet the 6 per cent has to pay a fine.

Although this study is confined to the field of people with severe disabilities, the problems investigated and suggested advantages found in this study may also affect, more or less acutely, non-disabled teleworkers.

Since detailed statistical figures about the overall employment situation of disabled professionals are not available, the figures presented here are inferred from questionnaires and contacts with German vocational training centres for disabled people, and from the local statistics of these centres.

Opportunities of New Technologies: Teleworking

Exploitation of new technologies for vocational training and professional integration of employees with disabilities is at its very beginning. New technologies can provide enhanced opportunities for vocational and social integration, particularly for those severely disabled people who today need specially adapted equipment, or who even cannot easily reach an office or another work place.

In this context, teleworking means using telecommunication facilities for connecting an employee outside a company's or an organisation's location, where interaction with the administration and colleagues at the main location is performed mainly by using a computer. Sometimes, this is called telecommuting (telecommunication + commuting). Telework or telecommuting has been used to a certain extent in distance work for many years, but it has been little used for employees with disabilities. Hence, for this group, use of teleworking is not widespread, either in Germany or in other countries. The results of the few available studies (e.g. Jaeger, 1986; Korte, 1986) cannot be generalised since they are concerned with special applications and specific cases of disability (cf. chapter 10).

Teleworking can be located in different places, such as:

- in 'satellite' office locations of the employer, near to the home of the disabled employee;
- in specific 'disabled professionals (neighbourhood) offices' where different people may be working for different companies and organisations; and,
- at home.

The new opportunities for professionals are strongly related to the use of computer based workplaces, being 'networked' via modern digital telecommunication, where the professionals do, for example, computer programming, data exchange, word processing, computer aided design (CAD), computer aided publication (CAP) and for programming numerically controlled tool machines (NC).

In addition to the functionality and the ergonomic design of terminals and services, and of access and operating procedures, the crucial factor for the acceptance of new technology by users with disabilities in office and teleworking, is the availability of the necessary vocational training on how to operate the equipment.

Some General Results

From different sources, the following statements may be extracted (Klause, 1990):

- technical research for the advantage of disabled users requires industrial partners, who would only be interested in projects which are well supported financially (Kirschenbaum, 1987);
- more than the half of disabled users, that is, those who are less severely disabled, would gain advantage by more ergonomically designed standard equipment (Kerr, 1988);

- developing and marketing equipment must not focus on disabilities but on the remaining individual abilities;
- marketing of (computer) equipment for disabled users is rather poor. Many useful technical aids have been available for many years, yet are unknown by the market;
- the capital investment needed for adapting computers to special needs of disabled users will generally pay back within about one year – taken overall, based on today's solutions. For example, the extra cost for adapting a computer workplace for a disabled user, which in Germany is payed for by the labour administration may be 10 000 ECUs. The decrease in annual social expenses to support the disabled person may be 7 500 ECUs while the income taxes etc. payed by the disabled person may be 2 500 ECUs, totalling 10 000 ECUs, the same as the price of the work station (Cullen and Kenny, 1989); and,
- most disabled employees prefer to work in the normal office environment together with their non-disabled colleagues.

Technical Approaches

The hardware and software required for (tele)informatic usage by people with disabilities is based on two main approaches (Klause, 1990; Marchant, 1987; Sandhu, 1989).

The first approach is based on today's widespread mechano-physical concepts using devices such as special input and output hardware like large or small keyboards, large mouse, touch screen, Braille displays and synthetic speech output, and software interfaces, for example, simplified operation.

The second approach is based upon future (standard) computer concepts, mainly using voice or speech processing techniques as input devices, windowing techniques, optical character recognition (OCR), software interfaces and adaptations and applied artificial intelligence, for example for customizing.

The second approach would realise flexible and optimized solutions for a wide range of applications on the basis of standard hardware and software, whereas the first approach would lead to more individualised solutions of a rather high cost (Klause 1990).

Vocational Training of People with Disabilities

There are a number of different ways people with disabilities are vocationally trained in Germany. Adolescents with disabilities up to about 20 years of age are mainly trained in special classes as part of standard vocational training schools using the 'dual system', that is, joint school and industrial training. Those who are more severely disabled are trained in special vocational training centres, called 'Berufsbildungswerke', which in the western part of Germany (former West Germany) offer about 10 500 places, of which 8 750 have residential facilities.

Impairment of lower limbs	200 000
Impairment of upper limbs	150 000
Impairment of upper and lower limbs	50 000
Non-specified motor impairment (coordination etc.)	165 000
Auditory impairment (loss greater than 75 dB)	190 000
Visual impairment (visus less than 0.2)	125 000
Speech and language impairment	370 000
Learning disorders	1 900 000
Intellectual impairment	880 000
Non-specified impairment	380 000
Total	4 410 000

Table 11.1 Estimate of the severely disabled population in Germany (after Klause, 1990).

Young disabled adults are trained in similar special vocational training centres, called 'Berufsförderungswerke', which in former West Germany offer about 12 800 places, of which 10 400 are residential places.

Table 11.1 shows an estimate of the severely disabled population in Germany; severely being defined as more than 50 per cent reduction the ability to work. Table 11.2 gives an overview of vocational training for disabled people in the western part of Germany in 1988. Table 11.3 shows the number of computers in vocational training centres. The figures in Tables 11.2 and 11.3 are estimated, based on interviews and questionnaires covering more than 50 per cent of the places in special training centres, and on further interviews done in the school administration.

General office work (e.g. clerk, commercial clerk and industrial clerk)	12 800
Application of information technology in the office (e.g. general information technology, graduated on programming, electronic worker and business management)	3 600
Computer graphics applications (e.g. drafting person, designer (CAD = computer aided design), expert on numerical control (NC) and tool machines, technician in construction, design and electronics, engineer in construction, design and electronics and general engineering)	4 400
Total with computer aid	20 800
Metal working (e.g. manual working [sheet metal] and machine tools	18 600
Other standard professions with final examination but without computer usage	56 300
Total	95 700

Table 11.2 Estimated number of disabled people trained for standard professions in the western part of Germany in 1988 (Klause, 1990).

	General office work	Application of information technology	Use of applications with graphics
Impairment of lower limbs	6 100	1 200	1 800
Impairment of upper limbs	600	100	200
Impairment of upper and lower limbs	500	100	100
Non-specified motor impairment (coordination etc.)	4 500	900	1 400
Auditory impairment (loss greater than 75 dB)	1 100	500	700
Visual impairment (visus less than 0.2)	900	100	0
Speech and language impairment	100	100	100
Learning disorders	600	100	000
Intellectual impairment	1 400	300	300
Non-specified impairment	3 600	1 700	1 600
Total	12 800	3 800	4 400

Table 11.3 Estimated number of places using computers in vocational training for people with disabilities in the western part of Germany in 1988 (after Klause, 1990).

There is no difference in vocational requirements between disabled and non-disabled people, except for learning disabled people. They all are trained in standard professions in accordance with standard training plans. Severely learning disabled people are trained in simple professions in special training centres without a final examination.

The majority of disabled students are trained in manual work; only about 22 per cent are trained in the use of computer systems. Since more and more professions are using computer-based tools, vocational education has to change soon in order both to meet the requirements of the future work market and to exploit the new technology to the advantage of employees with disabilities.

Interestingly, no relation between the kind of disability and chosen standard profession was found, although people with some types of disabilities found more places for vocational training than others.

According to the local statistics of the vocational training centres for disabled adolescents and adults, 90–95 per cent of those who were trained in 1988 and 1989 found permanent employment in their standard profession within one year after their examination (Klause, 1990). Similarly to non-disabled people, many of them will need additional training in some years in order to keep up with the development in their field. Some may need additional training due to a progressive impairment.

Finding employment seems mainly to be dependent on intellectual and vocational abilities, and less related to the kind of disability. Only people with severe communication difficulties will have problems in finding employment. People with severe learning disorders get jobs in a 'sheltered workshops', of which there are about 100 000 places in the western part of Germany.

	Adolescents in education	Adults in education	Adults and adolescents in employment
Impairment of lower limbs	4 000	1 000	8 000
Impairment of upper limbs	3 000	1 000	6 000
Impairment of upper and lower limbs	1 000	1 000	2 000
Non-specified motor impairment (coordination etc.)	4 000	1 000	8 000
Auditory impairment (loss greater than 75 dB)	4 000	1 000	8 000
Visual impairment (visus less than 0.2)	3 000	1 000	6 000
Speech and language impairment	8 000	2 900	16 000
Learning disorders	41 000	3 000	82 000
Intellectual impairment	19 000	2 000	38 000
Non-specified impairment	8 000	2 000	16 000
Total	95 000	15 000	190 000

Table 11.4 Projected market of computer workplaces for severely disabled people in Germany in year 2000 (after Klause, 1990).

Future Tele-Workplaces for Disabled Employees

It may be possible to estimate the market figures for equipment based on information and telecommunication technology specific to the requirements of people with disabilities, both with regard to vocational training and for subsequent employment purposes (Klause, 1990).

Since the figures presented only comprise severely disabled people, one may assume that many of them may need some special modules (alternative and additional hardware and software) in their standard computer workplaces, such as:

- voice recognition;
- simple windowing user interface module;
- screen menu of different complexity;
- applied artificial intelligence for customizing the work station to individual needs and applications;
- synthetic speech and/or Braille output;
- special input devices; and,
- adapted furniture.

Such enhanced computer workplaces may generate outstanding possibilities for the users with disabilities in an office, as well as at home, by teleworking, advantages which are not provided with today's 'technical aids technology' and 'technical aids strategy', because of their lack of availability and acceptance, and high cost.

Furthermore, these simple-to-use standard work stations can be operated by non-disabled colleagues as well.

Of the number of disabled people in Germany (Table 11.1), about 15 per cent are young people who need three years vocational training. It follows that the increasing use of computers in office environments, the total number of computer work places in vocational training and employment of young people with disabilities in Germany in year 2000 may be estimated (Table 11.4).

Assuming that an average of 20 per cent of the whole market of information technology equipment for severely disabled employees is to be used in telework locations, this represents a market share of about 60 000 work stations to be used by severely disabled employees in teleworking locations in Germany.

Requirements for Efficient Teleworking

The main personal and environmental preconditions for efficient teleworking have been identified as follows (Cullen and Kenny, 1989):

- personal ability to work independently;
- adequate training with regard to both professional work and to the use of computer-based tools;
- clearly defined job responsibilities;
- one responsible contact and support person in the central office; and,
- an undisturbed workplace at an office or at home.

Another crucial aspect is that all equipment needed (software and hardware) should be available, easy to install and properly marketed. The technological equipment used by disabled employees for telework should, as far as possible, be the same as for disabled people in the main offices. The workplaces for disabled employees should not be too different from the standard workplaces with the same function, since employees with disabilities require the same hardware and software on their 'work station for people with disabilities' as their non-disabled colleagues do. Furthermore, disabled employees need to collaborate with their colleagues, and may sometimes need direct support in using their workplaces. It would not be possible to obtain such help if the work stations were unfamiliar to the colleagues.

Future Trends

In Germany in 1990, an industrial agreement was made with the Trade Union in Baden-Württemberg, which has the character of a law. Home-based telework is now based on certain rules:

- employment contracts for working at home are of the same kind as for normal employment; and,
- mothers or fathers of small children are now guaranteed to be re-employed after up to 5 years of child care.

Telework will probably become more common in the future, especially among young parents and the population in general, and hopefully among people with disabilities too. Exploiting future teleworking possibilities may help to decrease the rather high unemployment rate of professionals with disabilities, which is caused by lack of vocational training and equipment, and, equally important, by the legal situation in Germany, under which an employee with disabilities cannot be dismissed.

Teleworking may become an important aspect of the vocational integration of disabled employees, particularly with regard to severely disabled people. Combining future information and telecommunications techniques and services may help many professionals with disabilities in getting education and employment.

Note

1 The information given in this chapter is based on the study 'Zukünftige Entwicklung von Telekommunikations- und Teleinformatik-Einrichtungen für Behinderte' (Future development of telecommunication and teleinformatic outfit for people with disabilities) funded by Deutsche Bundespost.

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12

Telecommunications Needs as Expressed by Elderly People and People with Disabilities

Sylvie Collins, Leonor Moniz Pereira, Camilla Persson, João Purificação and Gunela Astbrink

Feedback should be obtained from elderly people and people with disabilities on their perceived needs for telecommunications so that the most suitable equipment and services can be developed to meet those needs. There are, of course, difficulties in obtaining feedback from consumers due to the highly technical nature of some of the equipment and services. Partly because of this difficulty, the development of equipment may occur through what is *believed* to be good rather than what may actually be required.

The use of questionnaires is one method by which one makes contact with, and obtain viewpoints from, people with disabilities. The viewpoints obtained are then available for practical follow-up work and can even be used for testing of equipment with small trial groups.

Methodology

A survey was conducted in Portugal, the Netherlands, Sweden and United Kingdom[1], where attitudes to modern technology were gauged by questionnaire. The questionnaire referred to special equipment and requested comments on possible improvements. Personal interviews were conducted with some of the survey participants and these took slightly different forms in Sweden and Portugal. However, in all cases, the same standard questionnaire was used as a basis for the more detailed interviews.

The questionnaire was designed to extract information from elderly and disabled people about themselves and their use of technology, and in particular communications related to technology. It consisted of four sections. The first section asked for personal details about living arrangements, income, social contact and health. The second section focused on the use of telephones. Respondents were asked what type of telephone they had and how long they had had it. They were asked to nominate the principal advantages and disadvantages they associated with their present telephone system, and also about special features on telephones – those that they currently have and those that they would like to have. Finally, they were asked about the number of calls that they make and receive on average. The third section of the questionnaire was similar to the second, but focused on video recorders, rather than telephones.

The last section of the questionnaire concentrated on equipment. First, respondents were asked about various aspects of the telecommunication services, such as printed directories, dialling, cost and line-signalling. Each person was asked how best the facility could be improved to satisfy his or her needs with regard to:

- access to private telephones;
- access to public telephones;
- telephone directory;
- directory assistance;
- methods of dialling the number;
- sound quality;
- cost;
- programming and memory functions;
- telephone signal;
- possibility of altering an incorrectly-dialled number;
- holding the receiver;
- tone signals; and,
- other.

Next, respondents were asked to indicate which of the selection of pieces of equipment they had used, and to judge the ease with which such equipment could be used and the extent to which they would like to own the equipment. Finally, respondents were presented with short descriptions of ten communication facilities which will be widely available in the future, and asked to rate the potential of use of such a facility for themselves, including:

- cordless mobile telephone;
- fax machine;
- shopping and banking using the home computer;
- remote-control panel in the home (smart house);
- electronic mail;
- videotelephone;
- picture telephone;
- access to on-line databases;
- advanced security and warning systems; and,
- telephone conferences.

All the studies were carried out in 1990. In Sweden, the survey was carried out by Camilla Persson based at CERTEC (The Centre of Rehabilitation Technology), Lund Institute of Science and Technology. It dealt specifically with people with disabilities whilst a similar survey was undertaken at Vasa Hospital in Gothenburg by Bertil Steen and Bertil Wärne and dealt with elderly people.

In Portugal, the study was part of work developed by the Faculty of Human Motricity and was undertaken by Leonor Moniz Pereira and M. João Purificação. The last part of the questionnaire was not used in Portugal due to the poor knowledge of equipment mentioned.

The study in the Netherlands was carried out by Jos Brinkmann and Bernard Weerdmeester at the Institute for Applied Social Science Research, PTT Research.

The study in the UK was carried out by Sylvie Collins and Sheron Dexter at Manchester University.

With regard to the Swedish survey of people with disabilities, direct contact could not be made with appropriate interviewees because of the policy of disability organisations in Sweden and thus organisations representing a range of different disabilities were contacted who in turn contacted a proportion of their members. A notice was also placed in an electronic mailbox used by people with disabilities. A total of 575 letters were distributed and 266 people responded of whom 117 were interested in participating in the survey. Of the questionnaires sent out to these 117 people, 108 were completed and returned. There are a number of reasons for the small response rate. Some people can, periodically, be physically unable or lack the energy to complete the survey, or they may have to rely on others' assistance. They could have been ill at the time or have had reading and writing difficulties. As they may already feel themselves to be a victimised group, some people may not have wished to participate in this type of survey.

Even though the response rate was not as high as had been expected, many useful opinions were expressed especially from participants who contacted the interviewer for assistance. This contact consisted either of discussion on the telephone or of personal visits. A total of 10 people were contacted in this way. Table 12.1

Disability	No. of men	No. of women	Age range Men	Women
Aphasia	10	7	44–72	56–90
Deafness	2	5	39–47	36–48
Hard of hearing	11	5	12–83	34–82
Neurological disorders	–	1	–	81
Arthritis	4	11	58–75	37–62
Stammering	9	2	25–63	17–25
Visual impairments	15	11	16–76	15–63
Polio and disabilities resulting from traffic accidents	8	3	43–68	63–68
Others	2	2	37–58	32–62
Total	61	47		

Table 12.1 Description of the disabled people who participated in the Swedish survey.

shows the number of men and women, their age range and their disability who participated in the Swedish survey.

Another Swedish survey dealt solely with elderly people and was conducted in Gothenburg as part of a broader study into elderly peoples' living and health conditions. A certain area of the city called Johanneberg was selected as having a large proportion of elderly residents and all people aged 70 years and over in a couple of blocks in Johanneberg were interviewed. Of 280 people who were approached, 188 answered the questionnaire. There were 121 women and 67 men who participated and they were in the age range of 70 and 94 years. The majority of people received the questionnaire in conjunction with a medical examination, held as part of the wider study, in which they were given information about the aims of the survey as well as instruction on the completion of the questionnaire. Questionnaires together with instructions were posted to those participants who had already attended the medical examination.

In Portugal, an interview was made, based on the questionnaire, which allowed follow-up of the questions of the questionnaire and verification of the difficulties and opinions expressed by disabled and elderly people.

The Portuguese sample consisted of five groups (see Table 12.2). Portugal has approximately two million elderly people of which about 70 per cent are illiterate. About 80 per cent have a monthly pension that is 50 per cent less than the official minimum wage. Elderly people were interviewed from several socio-economic and educational levels and with different levels of dependence. They were aged from 60 to 95 years and were mainly females. In general, this group had difficulties in expressing their requirements. The people with visual impairments and those with physical disabilities mentioned more aspects relating to their needs and what characteristics the different equipment should take.

In the Netherlands, 3935 questionnaires were distributed and 1766 were answered, a response rate of 45 per cent. The minimum participation age was 14 years. Elderly people were categorised as being 55 years and over. People with disabilities were divided into groups who were deaf or hard of hearing, had a visual impairment or had a physical disability. The Netherlands survey contained a special section on alarm systems.

Group	No. of people
Elderly	400
Visual impairments	83
Mental impairments	44
Hard of hearing	72
Physical disabilities	195
Total	794

Table 12.2 Description of the Portuguese sample.

The questionnaire was distributed by mail to 3 500 people aged over 50, living in the UK. These people were members either of the Age and Cognitive Research Centre at Manchester University or the North East Age Research Subjects panels, or of the University of the Third Age. There was a return rate of 78 per cent, with 2 750 completed questionnaires returned. (The high return rate was not altogether surprising since these individuals, by joining these groups, are choosing to be active and involved in research activities of this kind).

Results

During the course of the survey, many viewpoints emerged about the research approach and the questionnaire used. It is important to be aware of these opinions for use during similar studies in the future as well as the basis for comments on the current study.

Some interviewees considered that the questionnaire was too personal and contained some irrelevant questions. Some also felt that it was too encompassing and difficult to complete; in some cases, the questions were unclear and too general.

Some participants answered only some of the questions but many people felt that the work being done was important and that it needed to be developed further.

With regard to the participants' expectations in the usage of telephones, it should to be borne in mind that the results are inevitably influenced by the way the questions are formulated. Also, some types of equipment may not be requested based on the person's disability but rather due to general interest in the product.

Those people who are multiply disabled were categorised under the disability that was considered to be primary. It is also important to consider that as the percentage of people with a certain disability varies considerably, the weighting of some points of view can be quite uneven.

Some specific findings for various disability groups are summarised in the following:

People with aphasia have had brain injuries and have difficulties in expressing themselves in speech and in writing. They said they would like to see the programming of the telephone made simpler and prefer to use the telephone's memory functions to alleviate complications in dialling. respondents expressed the concern that the telephone directory was too complicated and difficult to use.

Deaf people felt it was important that more picture and text telephones should be available in public places. They also felt that, at home, a portable vibrator which indicates that the telephone is ringing is better than a blinking light. The cost of making a text telephone call is decidedly more expensive than that of a spoken call due to the typing required and this should be remedied in some way. Some respondents considered that some text telephones are of poor quality. Text telephone users also expressed a wish to connect a printer to the text telephone. People felt that better information should be made available to the public in the telephone directory about relay services and that automated relay services would be desirable so that calls could become more private.

People who are hard of hearing complained about the poor sound quality in some telephones and maintained that the amplifier in telephones should be improved. This applied to public telephones as well, on the subject of which comments were already made with regard to better sound insulation and the placement of telephone boxes away from noisy places. A desire was also expressed for more loudspeaking telephones.

People with arthritis often have difficulties in using their hands and thus considered that a loudspeaking telephone would be advantageous. A device for holding the telephone whilst it is in use would also be a good alternative. The buttons on the telephone were often too small and this was the case with a variety of technical equipment. The telephone directory was considered too heavy and suggestions were made that it should be divided into more volumes.

The theme of telephone directories was repeated for people who had been in traffic accidents and those with polio. This group principally consisted of people with paraplegia or quadriplegia or some other form of physical disability. Many of the suggestions mentioned by people with arthritis were repeated here. In addition, suggestions were that public telephones needed to be more accessible for a person in a wheelchair and a longer cord was necessary to reach the level of the person sitting in the wheelchair. The cordless telephone was considered a necessity. People felt that the use of push buttons was much better than the rotary dial. The receiver should neither be too heavy nor too large and it should have a support. There should also be more facilities on the telephone such as memory, a key to delete a wrong number, a key to cancel a set of numbers and the ability to see the number that has been dialled. One person mentioned that it would be useful to devise a system whereby the person making a call would know if someone is home and thus wait long enough for the person with a physical disability to answer the telephone in time. This could possibly be solved by an automatic message on the telephone.

Suggestions were made that a credit card could be used in a public telephone so that the amount charged could be debited to the person's individual telephone account. This would alleviate the problem of handling coins which can be difficult for people with a physical disability.

It was felt that there should be financial reductions for people with special needs and that they should be given priority in the acquisition of such equipment.

People who stammer felt that speech-controlled answering machines were stressful and that better sound insulation was necessary in public telephone boxes.

Visually impaired people considered cordless telephones useful so that they did not have to move a long way quickly when the telephone rang. They said that public telephone boxes should be marked in stronger contrasts as they can sometimes be difficult to find; instructions on using the public telephone should be in large lettering and in Braille; the telephone directory should be made accessible to people with visual impairments through the use of larger text, a special section for visually impaired people and the elimination of colour coding. The telephone directory could also be made available on computer disk. As many people in this group can not use the telephone directory at all, the cost of directory assistance should be minimised or be made free of charge. Again, the keys on the telephone should be larger and loudspeaking telephones would be useful. The text telephone could also have larger text than that used today.

In the Gothenburg study with elderly people, it was interesting to note that 99 per cent considered it a necessity to possess a telephone and on average, people had two telephones. Thirty-two per cent expressed a wish to have a security telephone connected whilst 15 per cent wanted memory for storing numbers in their telephone. The telephone directory was considered by 34 per cent of those questioned to need improvement (Wärne & Steen, in press).

The elderly people from Portugal also said that the method of dialling the number should be improved; people preferred pressing keys to dialling. However, some people considered that dialling the number was advantageous because they knew the location of the number on the disk. Another aspect that was pointed out was the possibility of calling the number using only the voice.

Elderly people also mentioned the difficulties in using the telephone directory and felt it needed larger lettering and a better organisation to be able to properly find the required information. It would be easier to turn the pages of the telephone directory if the pages were thicker.

As mentioned by other groups, elderly people feel that there should be more public telephones available and that they should be insulated from external noise. Comments were also made regarding alternatives to using coins and that public telephones should be made more resistant.

Concerning the sound of the telephone, elderly people felt that it should be clearer, should have less interference and could be amplified. The possibility of having the ringing of the telephone as an audio-visual signal was mentioned, as well as the need for an alarm telephone for those elderly people who live alone. This sample of elderly people expressed a desire to see the person with whom they are communicating on the telephone.

Many elderly people in Portugal felt that the telephone was very expensive and that there should be pensioner reductions in fees.

The Netherlands study found that 20 per cent of the respondents possessed an alarm system. This is used by elderly people and people with disabilities living alone who may need emergency assistance in the home and thus by using the alarm can alert relatives, friends or an alarm centre of their need. The most important function of the alarm is to provide elderly people and persons with disabilities with a feeling of safety and security. A problem with portable alarm systems, however, was that more than one-third of the respondents did not carry the device with them when it was needed (Brinkmann and Weerdmeester, in prep.).

Advantages and Disadvantages

The principal advantages of the telephone were seen to be: enabling social contact, being physically convenient to use and enhancing feelings of security. Thus, over half of the sample nominated social contact as the principal advantage. Examples of responses include:

'Direct contact with public services and relatives, as I live alone.'
'Talking to my sister, calling my friend.'

Thirty per cent of the sample made comments about the physical convenience, making comments like:

'Easy to use.'
'Being able to use it in the garden.'

Fifteen per cent of the sample mentioned security as an advantage, making remarks such as:

'Gives a sense of security should there be an emergency.'
'We have an excellent alarm service if necessary.'

One third of the sample mentioned disadvantages of their current telephone systems. These responses fall broadly into three types – comments on cost, physical problems and issues to do with personal privacy. Thirty-six per cent of those that cited disadvantages (330 people) made comments like:

'Rental etc. is very expensive.'
'No concessions for pensioners.'

With regard to physical problems, a further 32 per cent (290 people) mentioned various things like:

'Buttons tend to jam if one number is pushed twice'
'Handsets can be replaced without engaging properly, unlike old handsets.'

Problems related to privacy included:

'Too many wrong or obscene calls.'
'Getting unwelcome calls from sales people.'

The majority of respondents maintained regular contact with family, friends and others, telephoning members of each of these groups, or being telephoned by them, 1–5 times per week on average. Although many respondents reported that they didn't worry at all about paying their telephone bills, 27 per cent did report such concern, 10 per cent saying that they worried very much about being able to pay their telephone bills. However, 81 per cent of respondents said that on the whole they were very or extremely satisfied with their telephone systems.

Improving the Telecommunications Service

Respondents were asked to comment on their satisfaction with twelve specific aspects of the telecommunications service; access to public and private phones, printed telephone directories and the directory enquiry service, dialling, quality of sound, cost, programming facilities, the alerting signal, correction facilities, handling the receiver/handset, and line signalling. People who expressed dissatisfaction were asked to make suggestions for improving the service.

Nineteen per cent of respondents thought that access to public telephones ought to be improved. Suggestions for improvement included ideas about maintenance and servicing of telephone boxes, requests for more telephones in public places, standardised methods of payment and better physical design, improving the siting, lighting and so on. (These ideas have recently been raised as important design concerns by various groups in ETSI and COST 219).

Twenty-three per cent thought that there were problems with printed directories. Issues raised included the need for books to cover larger geographical areas, and the incompatible concern about the weight of the books and the size and quality of print. This sort of conflict could perhaps be resolved by adopting a videotex approach, similar to the French Minitel.

The most vociferous reaction was in response to improving the costing of telecommunications services. Fifty-six per cent of the sample registered dissatisfaction and made suggestions for improvement. About 40 per cent of these responses were simple requests for lower charges across the board. Twenty-five per cent were suggestions that costs for specific items, such as equipment rental or charges for new points, should be lowered. Another 25 per cent suggested that there should be special rates for elderly, disabled or housebound people, or those with low incomes.

Fourteen per cent of the respondents had concerns about the directory enquiry service. Most of the complaints were that the system is slow and expensive. There were very few (less than 8 per cent) concerns expressed about access to private telephones, dialling, quality of sound, programming facilities, alerting signals, correction facilities and line signalling.

The issue of free directory assistance for people with disabilities has been a contentious issue in Sweden for the last couple of years and this was again raised during the survey.

Conclusions

Whilst some suggestions and problems recur within different disability groups and thus seem important for further work, it is also vital to recognise the viewpoints of an individual where additional development could be to the benefit of a larger group.

From the results of the questionnaire and through some personal interviews, it has become clear that there were requests for the development of equipment which is already available on the market. This indicates that there is a lack of information in this area and that there is a need for a technical information booklet.

There are also bureaucratic problems when individuals attempt to find avenues, for example, to have their telephone adapted for their own use and disability. Therefore, it would be useful to produce an administrative information booklet on the methods of obtaining and adapting equipment.

A disability information officer should be employed who could be contacted on a toll-free line where individual assistance could be provided and suggestions as well as technical solutions be registered (Persson, in press).

Note

1 The surveys were part of the RACE project 'Usability Issues for People with Special Needs' (TUDOR). The Swedish Survey was under the auspices of the Telematics and Disability Group within Swedish Telecom.

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13

Attitudes and Acceptance

Sidsel Bjørneby, Sylvie Collins, Knut Nordby, Leonor Moniz Pereira and João Purificação

'So, what do you think it would be like to be able to use a videotelephone, being able to see people when you talk to them, and them being able to see you?'

'Ooh, I don't know about that. It might be awkward mightn't it, if you were in the bath, or if you hadn't done your hair.'

People who are familiar with the concept of the videotelephone may or may not sympathise with the views expressed by the respondent, because they already possess *attitudes* relevant to the idea. At a general level, we all have a rough idea of what attitudes are. If we say that an individual has an attitude towards something or someone, we mean that he or she has certain feelings of like or dislike, approval or disapproval, and so on. A useful definition is: *Attitudes are general evaluations people make about themselves, other persons, objects or issues* (Petty and Cacioppo, 1986). Attitudes are not simply concerned with people's feelings about things; they develop for important reasons and serve a variety of functions. For example, attitudes guide behaviour towards valued goals and away from aversive events, and they help people to process complex information about the world around them. They are, then, an important component of social behaviour and thought, reflecting past experience and shaping behaviour.

Attitudes and Technology

What are the attitudes of elderly and disabled people towards new technology, and in particular, telecommunications facilities? There are many unfounded notions about the response to this question. Various stereotypes exist about elderly and disabled people, that is, there are several commonly held beliefs about old age and disability which are distorted representations of reality. Examples of these include:

- elderly people are a very homogeneous group of people;
- disabled people are a very homogeneous group of people;
- all elderly and disabled people are very poor;

- elderly people are incapable of learning new things;
- elderly and disabled people are very dependent on carers, and are unable to make their own decisions; and,
- elderly people think that 'the old ways are best'

These kinds of beliefs perpetuate the myth that elderly and disabled people are too poor, stupid and set in their ways to have any interest in using advanced technology. Perhaps, one can only address the question of these users attitudes by observing the behaviours of elderly and disabled people, focussing on how much use they make of technology in their daily lives. Presumably, if individuals spend relatively large proportions of time using technology, their attitudes towards it must be fairly positive. Of course, this is based on the false premise that people always have a choice about when to use technology and when to avoid it. This choice may not be available in, for example, the work situation, or in public buildings; some individuals may be technologically quite sophisticated but maintain negative attitudes about technology because of their personal experiences in the technological environment. Some people may regularly use cars, videorecorders and remote control devices, but rarely, if ever, use personal computers, faxes and teletext – what does this pattern of usage tell us about their attitudes?

Even if this kind of observational measurement were feasible, it probably wouldn't give us much useful information. The link between people's behaviour and their attitudes is not a simple one. Firstly, specific attitudes predict behaviour better than general ones (Millar and Tesser, 1989). Thus, if one wishes to examine the attitudes of a user to a particular facility, it is no use asking how important it is to the user that he or she should be able to communicate with people; rather, one must ask the user to describe his or her perceptions and evaluations of the particular system. Secondly, strong attitudes, or ones in which people have a *vested interest*, are more closely related to behaviour than weak or irrelevant ones (Johnson and Eagley, 1989). So, if someone has direct experience of using a system, or if he or she has a good understanding of the benefits of using such a system, there will be a close relationship between the attitudes that individual expresses and the behaviour he or she performs.

More and more often these days we encounter self-service technology in situations where we have been used to receiving personal service. Examples where this is particularly the case include banking, shopping, information-seeking and telephony. It is a common human trait to make choices to do things in the way in which one is used to doing them. It's unsurprising, then, that elderly people who are not used to living in a technological, self-service environment, show most resistance to change. Many will tend, at least initially, to choose personal service when offered the choice between personal and technological alternatives. The material presented in the remainder of this chapter is based on the results of a series of separate studies run in the UK, Norway and Portugal, whose principal objectives were to examine the attitudes and acceptance of new technology among elderly and disabled people.

The Manchester Study – Predicting Interest in New Technology

The first study[1] (Collins and Dexter, 1990) was conducted at the University of Manchester. Initially 80 people, aged between 57 and 90, read short descriptions of four technologies (two currently in use – barcoding and cash dispensers – and two which will be available in the foreseeable future – videotelephones and computerised medical services). The subjects were asked to consider the descriptions carefully and then write down what they thought the main advantages and disadvantages of these facilities are, or might be.

The principal advantages cited for the use of cash dispensers were that they:
- are time saving; and,
- can be used outside banking hours.

The principal disadvantages were that using them makes one more vulnerable to:
- mugging; and,
- overspending,

particularly salient concerns if you are frail and living on a small pension.

The principal advantages associated with barcoding were:
- it saves time;
- it's good for stock control; and,
- you get itemised receipts.

The main disadvantages were that
- it's more difficult to check the price of the goods; and,
- the system is more open to fraud.

With regard to the videotelephone, subjects thought that the advantages were that:
- one could see people and show them things; and,
- it would be a good thing for housebound and disabled people.

The potential disadvantages were that
- it would be expensive; and,
- people would be able to see you.

The main advantages of using a computerised medical service were seen to be that:
- it would save time;
- it would relieve small worries and concerns; and,
- it would be good for housebound and disabled people.

The potential disadvantages were thought to be that:
- there would be a loss of personal contact; and,
- it would be open to misuse by hypochondriacs.

A further 336 people aged between 60 and 94 participated in a questionnaire survey in which they were asked, among other things, to what extent they were satisfied with (barcoding and cash dispensers), or would be keen to use (videotelephone and computerised medical service), these systems. Interestingly the respondents' ages and sex were not strong predictors of satisfaction with, or enthusiasm for, the system.

The strongest predictor of enthusiasm for using a videotelephone was respondents' attitude towards being able to see people when communicating with them. Those people who thought it would be good thing to see the person they were communicating with expressed greater enthusiasm for owning a videotelephone in the future. Other good predictors of interest in owning a videotelephone were the average number of telephonecalls made to friends during a week (more calls = more interest), a positive attitude towards videotelephones being good for housebound and disabled people, and respondents' use of videorecorders. People who owned videorecorders, used them for a variety of purposes and did not experience any problems in operating them all expressed greater interest in owning a videotelephone. So, it appears that there was a cluster of respondents who are currently happy to use technology, and these people were most likely to express an interest in trying out new technologies.

With respect to interest in using a computerised medical service, the strongest predictor was having a positive attitude towards being able to obtain a diagnosis quickly. The more respondents thought that such a system would be good for housebound and disabled people, and the less likely they thought it would be to break down and give wrong advice, the more enthusiastic they were about trying it. Finally, those people who lived with someone other than family or friends showed more interest in trying such a system. Presumably, this is because such respondents can not rely on people who care being in the immediate environment to offer advice, support, lifts to the doctor and so on.

One of the most interesting things to emerge from this study was the importance of psychological variables, as opposed to demographic ones, in predicting use of technology by this sample of elderly people. The respondents' attitudes were more important predictors than age or sex. Of course, age and sex are highly correlated with attitudes but they account for very little variance in using new technologies. Another interesting outcome is the evidence for transfer of interest in, and knowledge of, technology, in as much as those respondents who were already happy to push buttons and have machines work for them expressed stronger interest in using future technologies.

The Norwegian Study – Using Modern Telephones

The second study in this chapter is from the projects 'The elderly and self service technology' and 'Experiments with technology in centres for the elderly', conducted by Human Factors Solutions[2]. The questions central to this work were as follows:

- How do the characteristics of ageing create difficulties when elderly people meet new technology?
- Why should elderly people want to use new technology and why should society want them to do so?
- What conditions must be present if elderly people are to use new self service technology?

The data presented and discussed here were collected from discussion groups with 30 individuals who attended special centres for the elderly, but lived in their own homes. Ten of these people were given practical experience of using new teletechnology and services.

In Norway, when you subscribe to a telephone, you need to go to a tele-centre and choose a telephone from a wide range of models, all at different prices. In the early stages of this project, it was found that most elderly people found it difficult to express their requirements because they were very confused by the variety of possibilities, whose existence was new to them. In order to be able to discuss what elderly people want from a telephone, ten individuals were given experience using different equipment and services. These individuals were mostly quite independent and resourceful. All of them had at least one telephone, but only one of them had special equipment; this was a flashing signal to compensate for hearing loss.

The group tried four modern telephones and the relevant user manuals. They examined the different functions of the telephones; pre-programming, frequently used numbers, volume regulation, automatic redial and the various buttons. They also tried some special equipment for assisting people with visual and hearing impairments.

In general, their reactions to the modern equipments were favourable. They liked the idea of being able to pre-programme, and those who had the relevant feature on their own telephone tried it out at home. They found the lack of a standardised method of programming confusing and the user manuals quite difficult to follow. Since you buy your telephone in a shop it is essential that user manuals are easy to understand when you get home and want to start using the equipment. One of the main problems with the manuals was in the use of jargon, special terms that nobody could understand. The elderly people in this trial would have liked more user-friendly manuals with emphasis on main points, and any additional or specialised information at the end. They also suggested that they might be used as a final test panel for new manuals.

With respect to general design considerations these users emphasised the importance of the following:

- 'normal' design, such that the telephone looks like a telephone;
- large numbers and letters on the buttons;
- clear, preferably standardised text on the function buttons;
- the availability of a wide range of volume control;
- easy to clean surfaces;
- the handset should automatically fall into the correct position when replaced on hook; and,
- one- or two-key dialling of preprogrammed numbers.

The group also tried telecommunication services available in modern exchanges by using the * and # buttons, like programming the transfer of incoming calls to a chosen number, automatic call to a chosen number when leaving the handset off for some seconds and programmed, automatic wake-up calls. Before trying these facilities, the users had no clear ideas about the services they might need; they felt that they had managed well enough with out them and saw no reason to start now. After trying the services a few times, with support of the project staff, the elderly people found the services more familiar and less difficult to use. They expressed the idea that such services would enable them to live longer in their own homes, by contributing to better social communication and security.

In order more fully to understand the impact of technology on elderly people it is useful to differentiate between different groups. In the project, elderly people in general were categorised as being:

1 needing a large amount of care, that is, at least once a day;
2 needing some care, that is, approximately once per week; or,
3 fully independent.

One of the purposes of the project was to investigate whether it is possible to postpone the time when group 3 become group 2, and group 2 become group 1. Being active and independent, and learning to use technology to assist in these respects may make life easier and delay the onset of the need to seek help and carers.

Given current demographic trends, it is clear that people who fall into groups 2 and 3 will be the largest target group of elderly users of modern technology; they should be considered seriously as a substantial market sector. Those people who grow elderly in the next few decades will have had the advantage of living and working in technological environments. However, the development of new systems and products is an ongoing process, so although in the future elderly people will be more familiar with technology in general, they will always be faced with new products and services. People who fall into group 1 will probably only use new technology in connection with home alarms and social communication. However, the earlier they are familiarised with modern technology, the more easily they will be able to maintain a certain level of independence with respect to these procedures. There is no doubt that the technological developments generate many new possibilities for people; it is vital that this development encourages accessibility to a wide range of the population.

It is important that learning situations are tailored to the special needs of elderly people. For example, it is important for there not to be any time pressure or too much noise, and for there to be enough guidance and user support. In the Norwegian project introductions to and learning of technology took place in centres for the elderly, at which about 60 per cent of people aged over 67 are registered. It is possible in these places for elderly individuals who are technologically enthusiastic to offer support to those individuals who are less interested and experienced, in a familiar and friendly environment. The users themselves, in this project, stressed the point that they needed to become familiar with technology early enough for it to be useful and familiar to them later, when they might become less independent.

Another point which emerged from this study is that the elderly people's interest in new technology increased with increasing information. They felt that most information about new products and services has been targeted at other groups, or has not reached elderly people for other reasons. They suggested that presentation of information should be planned in collaboration with elderly users, and that it should be available in various forms (visual, auditory, realistic demonstrations). In addition, the information should explain how new technology can be useful, and how it can benefit elderly people.

Elderly people represent an unused resource in relation to the design of new technology. By establishing a dialogue with elderly users in the design process, many errors can be avoided at an early stage, and elderly people may experience the positive side-effects of feeling, and being seen to be, useful to society at large. It was found through these discussion groups that elderly people think that learning to use modern technology is challenging, rather than threatening, and this is a very positive thing for most people. However, the discussants also felt that they should become users by choice and not by compulsion. This can only be achieved by profiling the technology to their needs, and making it user-friendly. The main conclusions of this project, then, were that given user-friendly and useful equipment or services elderly people's attitudes will be very positive. Those facilities that enhance security and safety in the home, social interaction, independence and access to information were considered most useful and attractive.

The Portuguese Studies

The Portugese studies were conducted by the Faculty of Human Mortricity at the Technical University of Lisboa[3]. One of them reports the results of a questionnaire while the other is a simulated videotelephone trial.

Attitudes to Technology

The first project was based on a questionnaire developed by the University of Manchester (Department of Psychology and Age Research Centre). The questionnaire consisted of 75 items, designed to collect information from elderly and disabled people on their background, use of telephones, videorecorders and other equip-

Visually impaired	10 people
Physically impaired	10 people
Mentally impaired	10 people
Hearing impaired	10 people
Elderly/disabled	44 people

Table 13.1 Subjects of the Portuguese studies.

ment, and comments on current and future telecommunications services. The questionnaire was used as the basis of a semi-structured interview, avoiding the difficulties of having disabled people filling in forms. The interviews enabled the researchers to verify the difficulties encountered in using particular pieces of equipment, and to point out the interesting aspects of the new technologies.

Eighty-four people (46 females, 38 males) aged between 14 and 87 were interviewed. These people were divided into five groups (Table 13.1).

With the exception of the people in the hearing impaired group, all the other participants were representative of the different income groups in the disabled population. Seventy-four percent of the people interviewed owned a telephone; some of those who did not have a telephone at home reported having difficulties using public telephones.

All interviewees were asked about the extent to which they felt that ownership of a telephone was an essential or a luxury. The majority of the sample (82 per cent) thought that the telephone was essential. Only one individual replied that the telephone was a luxury, and this person was a hearing impaired person who was responding to a question about normal telephones, and had never had the opportunity to examine a text telephone.

All interviewees were asked how difficult they thought it would be to use a range of different pieces of equipment, including radio, remote controls, videotex, computers and programmable telephones. Computers, text telephones and videotex were rated as being most difficult to use. However, only 30 per cent of the sample had actually had the opportunity to try out these facilities. Fifty-nine, 61 and 68 per cent of the interviewees had never used a videorecorder, computer or programmable telephone, respectively. Thus people who had not encountered new technologies, or had no direct experience of using them had slightly negative attitudes towards being able to use them. Those interviewees who did have some experience of using technological equipment, e.g. videorecorders, said that they were quite easy to use.

Using the Videotelephone

The second study analysed the attitudes of nine elderly people, who were physically or visually handicapped, while they were using various videotelephone services. Data were collected from videotapes and interviews, which focussed on establishing the call, verbal and nonverbal dialogue during the communication, and the ending of the call. The services provided and chosen scenarios were defined according to the needs of the elderly participants. By contrast, the remote control was not. The participants were aged between 69 and 86. Five of them had mobility problems, two of them had hearing problems, and two had visual problems.

The scenarios for this experiment were:

- an information service concerned with changing diets and confirming medical regimens;
- a counselling service for dealing with financial or emotional problems; and,
- a therapy service related to the need to cure back pain.

After having gained some experience with each service the clients and experts (based at the service centre) were interviewed to find out their feelings about using these services. In general, the results of the interviews may be summarised as follows:

- all participants found it quite straight forward to obtain the correct picture on the screen;
- the experts and three of the clients thought it was very easy to make a videotelephone call; the remaining six clients had some difficulties;
- all thought that it was important not to have to move, nor to wait for a long time in order to obtain information; and,
- all participants thought that the videotelephone call was much more 'real' than a telephone call, because they could see the person with whom they were communicating.

In addition, the experts thought that:

- it was a good way of dealing with several clients and several problems simultaneously; and,
- it was good to be able to detect the emotional state of the client, and to be able to detect more easily those situations which were serious and demanded direct and quick intervention.

It was observed from videos of the clients' behaviour that several of them had problems using the videotelephones, principally because they had to perform several operations. Difficulties arose when clients had to get up from their seats, go to the television set, turn it on and return to their seats. They had problems using the remote control devices because there were so many very small keys (of which only two were needed) with very little space between them. Thus, the same kinds of design problems arose, related to the physical and cognitive changes that develop with increasing age, that were referred to in Chapter 12.

With respect to the services themselves, all the people involved were quite at ease and did not experience some of the difficulties that had been predicted. Instead, they availed themselves of the opportunity to talk about issues that were troubling them, and expressed themselves very easily. They had a very positive attitude towards the provision of such services and equipment, recognising the enormous benefit that would accrue to them. However, they did point out the likelihood that not they but other users of the future would be most likely to benefit.

Conclusion

When taken together the results from these studies help to debunk the myths of the technological incompetence and disinterest of elderly and disabled people. Clearly, when given the opportunity directly to examine and test new equipment and services, elderly and disabled individuals are able to recognise many positive aspects, and develop very positive attitudes towards being able to use such facilities. This is not remarkable: although groups of people are sometimes distinguished or discriminated through the use of labels, the ways in which their lifestyles, behaviour and attitudes are related is essentially the same. What is remarkable is that people with special needs are only relatively recently being recognised as a large and important market sector. The factor that is emerging most strongly from these and other research endeavours in this area is that design considerations are paramount. If people encounter equipment which is physically or cognitively difficult to manipulate or control, the likelihood is that they will develop negative attitudes towards it, and be unwilling to persist in using it. Given the enormous contributions that new technologies can make to the daily lives of elderly and disabled people, this would be a disaster.

Notes

1 The Manchester study as pilot work for a study under the auspices of the RACE initiative (R1088, TUDOR) (cf. chapter 15).
2 The Norwegian study was funded by the Royal Norwegian Ministry of Social Affairs and Norwegian Telecom Research Department.
3 The Portugese studies are part of two RACE projects, – 'Application pilot for people with special needs'; and 'Usability issues for people with special needs'.

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Equipment and Services

Telecommunications technology has led to the development of equipment and services designed to enable people to bridge long distances for spoken communication or for data communications. The analogue telephone, similar to most telecommunication equipment, was developed with the average user in mind, designers disregarding any kind of disability or age-based problems. This has led to problems in adapting standard services and equipment to the needs of people with disabilities. Standardisation that takes the needs of disabled people into consideration is imperative to improve this situation. In some cases existing standards even prevent useful solutions.

During the last decade, a number of devices have been designed to enhance telecommunication for users with disabilities, primarily in the form of supplementary units to standard telephones. 'Telephones for disabled people' have also been designed, for example, including large keys and an automatic dialling facility. Unfortunately, many of these devices suffered from a 'designed for disabled people' look, which in some cases has prevented people from using them.

Access to telecommunications is not only a matter of being able to use a terminal. Equality may also depend on the availability of special services. For example, in many countries, manned relay services have been installed to translate between speech and text in order to enable hearing and speech impaired people using text telephones to communicate with audio telephone users.

The key words for future technology seem to be *modularity* of devices and services, *portability* of terminals and *mobility* of the telecommunication user. Another key issue is the design of the system, services and equipment which must be in accordance with knowledge about human factors, especially relating to the needs of people with disabilities and elderly people.

Technical and behaviourial research, as well as user surveys, are a prerequisite for developing better access to telecommunications, and thereby to society at large, for people with disabilities. National and international research projects are going on, but compared to the number of users who may need better adapted equipment for optimal use of telecommunications, the resources allocated to this field are extremely small. In addition, information about national research is not well distributed, and similar developments may be going on in several places. There is a need for a greater resource allocation to this field, and a comprehensive database to distribute the information that is gathered.

Gerhard Klause

14

Existing Equipment and Services

Kelvin Currie, John Frederiksen and Jan Håvard Skjetne

One of the main objectives of COST 219 is to collect information about existing equipment and services for people with all types of disabilities. In order to achieve this goal, COST 219 has made surveys of existing equipment and services. The purpose of the surveys was twofold:

- to establish which facilities are not being provided to disabled people by comparing the products and services being offered and available to disabled people and non-disabled people; and,
- to provide maintenance of existing facilities as the introduction of new equipment and services takes place.

Survey on Telecommunication Equipment

Forms were distributed in each of the participating countries by a member of the COST 219 Management Committee. Forms were returned by Denmark, Finland, France, Ireland, Italy, Norway, Spain, Sweden and the UK.

A total of 174 forms were received and accepted as relevant. Some devices were reported by more than one country, for example portable inductive couplers. Not all devices recorded were included in the survey, only those designed specifically for disabled people and where the purpose was closely linked to telecommunication. Therefore, information about equipment such as talking calculators, general purpose modems, specialist word-processing systems etc., was not included.

The nature of the equipment that was described can be illustrated by the forms of impairments for which they are supposed to compensate (Table 14.1).

A large number of people have combinations of different types of impairment. This group of people may have special problems related to the combination of impairments, and their needs are often not met by the equipment available today. One example is people with combined visual and hearing impairment (cf. chapters 45 and 46).

Impairment	Number of forms
Blindness	17
Reduced vision	14
Deafness	33
Hearing impairment	46
Speech impairment	20
Mobility impairment	39
Dexterity impairment	30
Intellectual/learning impairment	10
Deaf-blindness	8

Table 14.1 *Impairment and number of forms.*

Table 14.2 and 14.3 list different types of equipment that are available to people with disabilities. Table 14.2 contains equipment which operates alone, while Table 14.3 comprises equipment which is intended to be used in conjunction with other kinds of telecommunication products.

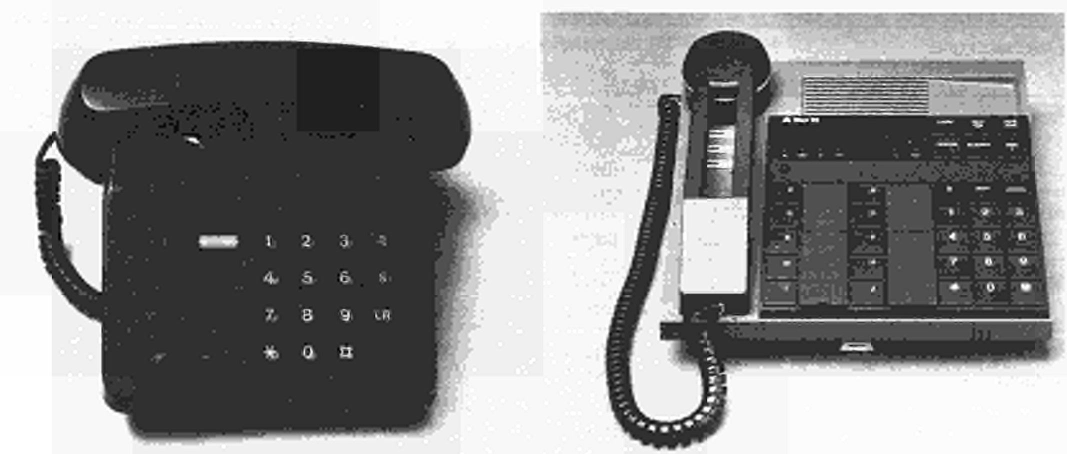

Figure 14.1 *Ordinary telephones.*
Left: Tribune E1 from British Telecom. This telephone has an inductive coupling to the hearing aid and an amplifier to increase the amplification of the incoming speech for people without a hearing aid. The telephone has also a lamp which flashes when the telephone rings.
© British Telecommunications pls 1990.
Right: Bizz from Swedish Telecom. This telephone has big buttons, number memory and is loudspeaking. The telephone has also amplification of the incoming speech and inductive coupling to the hearing aid.

Type of equipment	Impairment	Description
Telephone with extra earpiece	Hearing	An extra earpiece can enhance the user's ability to hear by making use of the hearing in both ears and by reducing the noise from the environment.
Telephone with handset amplifier	Hearing	The incoming speech is amplified and the telephone can be used by hard of hearing people without a hearing aid.
Telephone with inductive coupler in handset	Hearing	The inductive coupling in the handset can help hearing aid users.
Telephone with visual indicator	Hearing	The light can let people with impaired hearing detect ringing and line signals.
Telephone with number memory	Visual Dexterity Intellectual	The number memory can help people who have problems with either dialling or remembering telephone numbers.
Telephone with light weight handset	Dexterity	People with reduced strength in the arms and hands may be able to use these handsets.
Large key telephone	Visual Dexterity	People with poor vision may be able to see the different numbers on the keypad. People with poor coordination of fingers and arms may be able to hit the right key.
Loudspeaking telephone	Dexterity	These telephones have built in loudspeaker and microphone which enable the user to make and receive calls without having to hold the handset.
Text telephone	Hearing Speech	These telephones let people with hearing impairment communicate with text either to another text telephone user or through a relay service to a person using an audio telephone.
Text telephone with tactile output	Hearing Visual	These telephones may let people with combined visual and hearing impairment communicate with other users of text telephones and with people using an audio telephone through a relay service.
Videotelephone	Hearing	The videotelephone may let people with impaired hearing lip read and communicate by signs.
Picture telephone	Intellectual	The picture telephone takes a picture with a camera and sends the picture to the communication partner. That may help people with intellectual impairment to use the telephone.
Vibrating pager	Hearing	The vibration enables the person with a hearing impairment to use a pager.
Writing telephone	Hearing Speech	The telephone user can communicate with hand writing to another user of a writing telephone.
Personal security alarm systems	Mobility	The user activates the alarm with a button and the system calls a specified number(s) and gives a message. The alarm goes either directly to a person or it is routed through to a control centre. The control centre takes charge of the action to the alarm.
Environmental control – voice operated or by touch	Dexterity	The environmental control can let people with dexterity impairment operate a telephone.

Table 14.2 Stand alone telecommunication equipment.

Type of equipment	Impairment	Description
Handset with receiver amplifier	Hearing	Handset with augmented amplification.
Handset with inductive coupling receiver	Hearing	Handset to use with hearing aid.
Inductive coupling receiver inset	Hearing	Upgrade of handset to a handset with inductive coupling.
Handset with microphone amplifier	Speech	People with low volume can have their speech amplified.
Handset holder	Dexterity Strength	Holder for the handset which takes care of the switch-hook function.
Clip-on amplifier – inductive or acoustic pick-up	Hearing	An amplifier to attach to the telephone earpiece. Amplifies the sound either by acoustic or inductive pick-up.
Clip-on inductive coupler	Hearing	An inductive coupler to attach to the telephone earpiece.
Speech synthesizer	Speech	The synthesizer and a computer may enable people without speech to communicate via the telephone.
Pressure sensitive tablet for production of recorded words	Speech	Pre-recorded words can be sent via the telephone to another person.
Large numeral labels for keypad	Visual	Extra large labels with different colours to enhance the contrast.
Large keypad	Visual Dexterity	Extra large keypad with big numbers to be connected to the telephone. The large keypad also makes it easier for people with reduced coordination of hands and arms to hit the right number.
Keyboard/keypad overlay	Dexterity	An overlay may help people with reduced coordination to hit the right key.
Autodialler attachment	Dexterity Intellectual	Autodialler will reduce the number of keystrokes to be performed and the need to remember numbers.
Speech synthesizer card	Visual	Numbers are spoken as they are dialled.
Clip-on visual indicator	Hearing	A visual indicator to attach to the telephone earpiece. Indicates the sound that is being received, for example, line signals.
Relay or acoustic switch for house lighting	Hearing	The light blinks when the telephone is ringing.
Bell	Hearing	Bells with different type of sounds and effects can be connected to the telephone so the ringing can be heard by people with hearing impairment on certain frequencies.
Bell with vibrator	Hearing	When the telephone is ringing, the bell sends signals to a vibrator worn at the body.
Keyboard emulator	Dexterity	With a keyboard emulator and a computer, a person with reduced dexterity may be able to operate a telephone.
Voice recognising switch	Dexterity	With a voice recognition switch and a computer, a person with reduced dexterity may be able to operate a telephone.
Card for switch operation of computers	Dexterity	With switches and a computer, a person with reduced dexterity may be able to operate a telephone.
Phone card with notch	Visual	The phone card has a notch which enables people with impaired vision to orientate the card.

Table 14.3 Equipment intended to be used in conjunction with other kinds of telecommunication products.

Other Sources of Information

Information from the COST 219 survey may be supplemented by information from other sources. One important source is the various information centres with databases containing information about technical aids.

An example of one of these databases is Hyper-Abeldata, supplied by Trace Research and Development Center in the USA. The database is distributed on a CD-ROM and can be accessed with a CD-player and an IBM or Macintosh personal computer.

This database contains 238 entries (May 1991) in the area of telecommunication aids. A review of the database shows examples of some aids of a general nature and some technical aids facilitating regular telephone conversations.

Table 14.4 lists the function areas covered by the subjects in the database. Equipment covering several function areas is included in all the relevant function areas. Hence, the numbers of entries is larger than 238.

The other categories include only a small number of products such as Braille telephones, telephone devices for deaf-blind people and a telephone booth that is accessible by people using a wheelchair.

A problem with these databases, however, is that the information is rarely classified in the same manner. This makes it difficult to evaluate and coordinate information from different databases.

Equipment	Number of subjects
Text telephones	45
Awareness alarm for the ringing signal	40
Loudspeaking telephones	32
Keyboard – large buttons etc.	31
Memory phones	27
Receiver and telephone holders	20
Amplifier	17
Handset amplifier	15
Different types of dialling aids	11
Signal amplifier	9
Telephone headset	8
Cordless telephones	7
Adaptation for hearing impaired people	3
Remote controls	3
Orientational/educational aids	3

Table 14.4 Number of subjects in different categories.

Telecommunications Services for Disabled People

The COST 219 survey shows that there are broadly two types of services. The majority of the responses indicated services which use technology to help disabled people make better use of telecommunications. The second were 'ancillary' services which despite being used for telecommunications, were not primarily technology based. Tables 14.5 and 14.6 contain a break down of the services into these two broad divisions.

Service Type	Impairment	Telecom Medium	Access Method	Protocol
Telephone/text relay	Hearing Speech	Telephony Public network	Text telephone PC	DTMF V21 V22 V23
Text based conference system	Hearing Speech Visual	Telephony Data Public networks	Text telephone* PC	DTMF V21 V22 V23 CEPT
Text access to for general enquiries	Hearing Speech Visual	Telephony Public network	Text telephone* PC	V21 V22 V23
Text users' directory	Hearing	Telephony Public network	Telephone	DTMF
Text based directory enquiries	Hearing Speech Visual	Telephony Public network	Text telephone* PC	DTMF V21 V22 V23
Electronic telephone directory	Hearing Speech Visual	Telephony Public network CD-ROM	Text telephone* PC	V21 V22 V23 CEPT CD-ROM
Talking newspaper	Visual Dexterity	Broadcast radio network	Dedicated receiver	---
Electronic newspaper	Visual Dexterity	Broadcast TV network	PC with synthetic speech or Braille output	Teletext
Electronic mail	Hearing Speech Visual Mobility Dexterity	Telephony Data Public networks	Text telephone* PC	DTMF V21 V22 V23 CEPT
Database(s)	Hearing Speech Visual Mobility Dexterity	Telephony Data Public networks	Text telephone* PC	DTMF V21 V22 V23 CEPT
Videotext	Hearing Visual	Broadcast TV network	Television PC	Teletext
Personal security alarms	Mobility	Telephone Public network	Dedicated telephone	DTMF V21

* Not all text telephones can access databases successfully.

Table 14.5 Telecommunication services used by people with disabilities.
Personal computers for use by visually impaired users require synthetic speech, Braille displays or large character displays. Personal computers for uses with teletext need suitable interfaces.

The most frequent service is the relay service (cf. chapter 22). Another common service is the distribution of information, which can be done in different ways. In several places in Europe, newspapers are distributed by radio or public network to people with visual, dexterity or reading impairment. Databases are used to give information about equipment and services provided, and are accessed through the public network. There is also a growth in using bulletin board systems and other message handling systems to exchange information and make contact (cf. chapter 30).

The ancillary services ensure that people with disabilities are not at a disadvantage when using the telephone. For example, text telephone users can get a discount in view of the fact that text communication takes longer than speech communication, and people who have problems reading the small print on their bills can have them in large print, Braille or even read aloud.

The inclusion of a service does not imply that it is available throughout Europe. There is a wide discrepancy between the services provided in the member countries of COST 219. In some countries, there are private telecommunications companies, and in others state run telecommunication operations, or a mixture of private and public companies. There is no clear correlation between the provisions made by any type of service providers, i.e. neither one is better or worse.

Service type	Disability covered	Description of service
Consultancy	All	Supply of advice to individuals and organisations regarding methods and adaptations to assist in the use of telecommunications by disabled people.
Low user discounts	All*	Low users of the telephone service receive discount on their line rental as long as their calls do not exceed a pre-arranged total.
Discounts for text users	Hearing Speech	Rebate of a percentage of call charges to take account of the extra time required to make text calls.
Large print or Braille bills	Visual	Printing of customer bills in large print or Braille if required.
Priority fault repair	All	Free "fast response" service on 24 hour basis for those living alone and whose life may depend on the telephone.
Text telephone supply	Hearing	Supply of text telephones for hearing impaired users at reduced cost or free.
Bill reading	Visual	Reading of telephone bill for visually impaired user.
Service protection	All*	Nominated person to be contacted in the case of unpaid bill. Nominee not liable for bill but can make arrangements for payment to avoid removal of service.
Special mobile (car) telephone service	Mobility	Provision of low cost car telephone to registered drivers. No rental or call charges, but car phone is limited to calling special assistance number or emergency services. Incoming calls are allowed as normal.

* Particularly intended for elderly people.

Table 14.6 Services to ensure that people with disabilities are not at a disadvantage when using the telephone.

There are differences between the level of support (usually financial) provided by the governments of the member countries. Some administrations provide a high level of support nationally whilst others provide patchy local support.

It is apparent that there are still a number of problem areas for disabled people. In particular, the use of text telephones is not generally catered for when trying to contact emergency services (e.g. Fire, Police, Ambulance). Relay services of various sorts are a growing feature, but the different standards used for text communication will cause problems in the long term. (cf. chapters 22 and 27).

The use of text communication is further hampered by the growing use of voice announcements. These announcements are a big improvement for hearing users, but give no information when using text. Also for hard of hearing people, the increasing use of voice announcements may prove difficult. The recording is often of short duration, at lower than expected volume, and sometimes it is not repeated.

Further work must be carried out to ensure that advances in technology do not cause new problems to disabled and elderly users of the telecommunications system. Services should be designed with the needs of these customers in mind. For example, little or no work appears to be going on to help integrate disabled or elderly people into the mobile communications revolution. This rapidly expanding area of telecommunications could offer huge benefits to mobility impaired people, for example while travelling, and for people living alone who are at risk. However, none of these areas have been addressed in an overall manner, and few services exist to offer help in these areas.

On a more positive note, the growing use of services based on personal computers ties in well with the growing levels of 'computer literacy'. Tomorrow's disabled and elderly people will expect to be allowed to apply the skills they have learned in today's world.

Figure 14.2 Text telephones.
Left: Telescrit 1005 from Genossenschaft Hörgeschädigten-Elektronik. This text telephone is portable with acoustic coupling.
Right: VisiCom from Goedhart Amersfoort. This text telephone can be used as a DTMF text telephone, viewdata terminal and as a terminal connected with the internal modem.

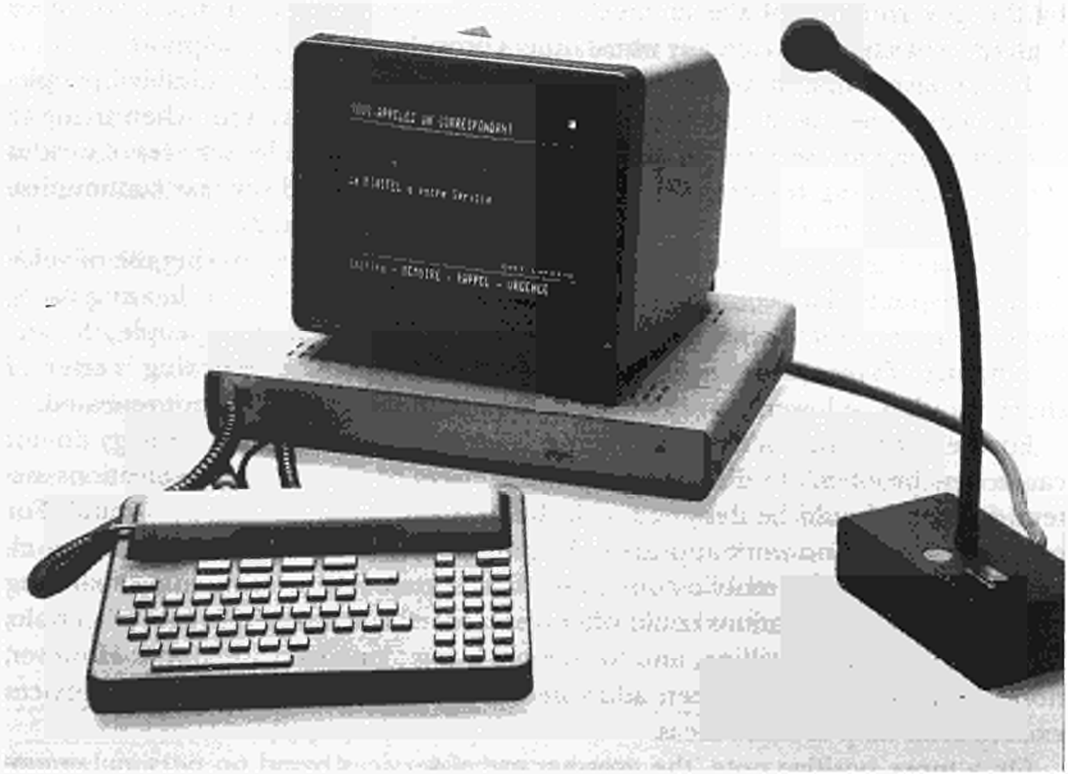

Figure 14.3 Covotel from CNET. This combined telephone and Minitel terminal is operated by voice. The telephone number can be dialled one by one or by choosing from a list of 60 numbers. Minitel commands are also available.

The member countries of COST 219 offer a wide range of services to disabled and elderly people. The provision of these services varies widely and many services are not implemented yet. They are, however, a good starting point for improvement and harmonisation.

Conclusions

The surveys demonstrate that there is a real need for coordinating the knowledge about existing opportunities. Apparently, there are a considerable number of possibilities, but it is often hard to get hold of information about existing equipment and services.

A coordination of knowledge is desirable, both from the consumers' and the producer's point of view. Consumers need information about existing possibilities, and the experience from many countries is that consumers and providers of this type of equipment and services do not know what is available. The producers need dissemination of information in order to make production profitable. Producers and researchers will also be able to make effective use of such knowledge for evaluations of areas where equipment and services are lacking.

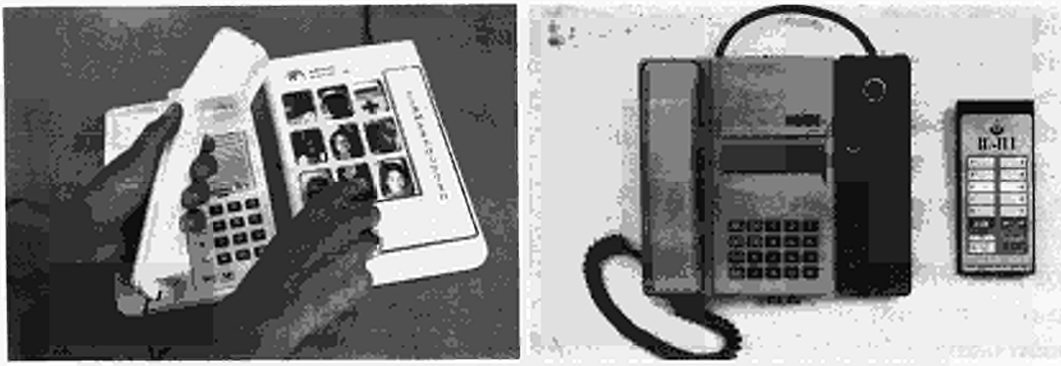

Figure 14.4 Left: Kjempeknotten from Falck Produkter a/s. This number dialler has a 9 number memory. Dialling is performed by pressing one button, and each button has a finger guide. Right: IR-Tel from Swiss Foundation for Electronic Aids. This remote control can enable a person in a wheelchair or a bed to operate the telephone.

The information should be collected and elaborated by centres with comprehensive knowledge of this field. One task for these centres should be to give a clear evaluation of the possibilities and qualities of individual products and services. The information should be easily accessible; it should be prepared to target different users; implying that it should be available in databases, catalogues and other suitable media.

To have easy access to, and better coordination of, this information, there is a need for a detailed set of categories which are based on a common classification system; also with regard to communication and storage of information. The new ISO classification system on technical aids should be used by all information centres and extended to take into account the new types of equipment which are not covered by the classification today. Similar steps should also be taken to make information about services more available.

The wealth of experience and information received from many countries shows that there is considerable variation with regard to the quality of telecommunication equipment and services. This demonstrates the need to incorporate the manner in which telecommunication equipment and services should function with respect to disabled consumers into standards and regulations. Today, there are hardly any standards which take this into account.

15

Research

Jan-Ingvar Lindström and Stephen von Tetzchner

Research is a key issue of technical progress, and all production facilities in industrialised countries devote significant resources to research and development. In an industrial environment it amounts from a few up to thirty per cent and above (medical industries). A typical national telecommunications company invests at least 4–5 per cent of its total budget in research and development activities.

A large fraction of this goes to basic telecommunication structures such as the development of new switching systems and research in fibre optics and data communication. However, significant resources also go to picture communication, videotex systems, speech technology and value added networks, i.e. customer oriented products, which are important for people with disabilities too. Regrettably, despite the fact that disabled and elderly people and other customers with special needs form a large group, often little or none of the research and development resources are used to satisfy their needs. This is also true for most research programs in Europe.

Research Policy

The explicit overall goal of what is called the handicap policy is integration and participation in society. This means that disabled people should be encouraged to lead lives that are as equal to those of other members of society as possible. Ideally, special efforts to reach this goal should not be necessary. Efforts, resource allocation and other means for stimulating progress in societies automatically should include those steps and measures that have to be taken in order to satisfy requirement of groups who need special support. This means, for example, that a reasonable share of the research budget of telecommunications companies should be dedicated to integrating the perspectives of people with special needs in general research and development activities. This should also be the case for European research programs.

At present this is not so. The total share of research activities, both national and international, is almost negligible compared with the total research budgets, and it is normally only as a result of strong political pressure that research activities on behalf of elderly and disabled customers are included in 'ordinary' research programs.

Therefore, for the foreseeable future, it is of paramount importance that resources are made available for research and development projects on behalf of people with special needs. This must be done in order to keep pace with development in general, to demonstrate the benefit of scientific efforts, and to increase awareness among those whose responsibility it is to integrate needs of everybody in the research and development process.

The integration and participation of disabled people is a responsibility of society at large. This means that government offices have an obligation to stimulate research and development where all of the population is included. This may, for example, be done by making government funding dependent on the inclusion of issues related to disabled and elderly people when there may be a theoretical need to take special measures for these groups.

Main Topics

Research on telecommunications and disability covers an array of topics. In addition, many research projects in the field of telecommunications (and other areas) have implications for the lives of disabled people although their needs are not mentioned or taken explicitly into account. If a small fraction of the research resources in those projects were allocated to the perspective of disabled and elderly people, the amount of research for these groups would increase dramatically.

One topic is the development and design of telecommunication terminals and services, which includes both technical and ergonomic research. Terminals entail both ordinary telephones, other domestic terminals and advanced work stations that are interconnected in local and wide area networks. In addition to the technical research that is necessary to develop terminals and other forms of equipment for people who need special adaptations, there is a need for experimental work to assess the importance of different aspects of terminal design for general use.

There is a variety of services, e.g. directory services, relay services, answering services, electronic mail and mobile telephone services. Most of the research on service applications have been field trials, simulations and questionnaires, which seems appropriate to the area. Interview studies may obtain more information although fewer people can be reached because return on many questionnaires has been low. However, there is also a need for experimental work, for instance for finding the optimal way of presenting services to different users, e.g. design of videotex directories and auditory menus in audiotex services.

Another topic is assessment of the needs of different groups of elderly and disabled people. Again questionnaires and interviews are the main methodologies. However, the groups are often not aware of the equipment and services that exist or could be developed, and may not be able to see their possibilities even when told about them. Field trials may be a better approach, particularly if there is an interactive process where the researchers change the terminals and services according to proposals from the users they are working with.

A large share of the research has been oriented toward people with hearing or visual impairment, and there are special concerted actions for both these groups (see below). Other groups of disabled people have received less attention, e.g. mentally retarded people and people with language disorders, and there is a need to focus on the needs of these and other groups which have received less attention as well.

A third research topic may be termed social aspects. The importance of telecommunications in society is constantly growing, but their significance may be larger for some groups than for others. Therefore, differences that appear in society as a result of new developments within telecommunications should be monitored, including the introduction of both general equipment and services, and equipment and services that are designed for people with special needs. This research should comprise changes in communication and interaction patterns, as well as in opportunities for work, education and social participation.

In the area of social aspects, communication skills and strategies should also be included. The communication medium will to a large extent decide the communicative frame and the context of communicative interaction. There has been some research on telephone conversations (cf. chapter 4), but even for people who use a telephone in a normal manner, the available research is limited. For people who are dependent on other media, there is hardly any research at all. There are a number of reports on text telephone devices, mostly from the USA, but little that is concerned with conversational patterns. In the last 5–10 years there has been an increase in the interest of linguistic and conversational aspects of use of communication aids, but a similar interest has not been prominent within telecommunications. This is a notable deficiency.

Ongoing Research and Development in Europe

The total resources for research and development in telecommunications and teleinformatics on behalf of people with special needs are very small. Further, they are not easy fully to identify, since there is no coherent source of information available. International projects are easier to trace than national ones, as they normally are run under the auspices of research bodies within EFTA or EEC, or under some European umbrella organiastion.

National Research

According to inquiries made within COST 219 (see below) and registrations by, for example, the Nordic Council on Disability in Stockholm and the Royal National Institute for the Blind in London, research and development in the field of telecommunications and disability seems to be going on, at least to some extent, in all western European countries and in some of those belonging to the eastern part of Europe. However, since national research is not widely presented and known, no attempt will be made here to provide an overview of it, only to give examples of the research that is going on. It should also be noted that most of the research that is presented in this book is not part of any formal international collaboration, but national projects which have been influenced by contact with other researchers through COST 219.

The research seems seldom to be part of the general activities of the national telecommunications companies, although these companies fund many of the projects wholly or partly. A notable exception is Norwegian Telecom Research Department, where a researcher is allocated full time to research for disabled people and a few other researchers allocate part of their time to this field. Otherwise, most projects concerned with disability are contracted to universities, independent research institutes and private companies. This is unfortunate because the research issues related to disability do not become part of the everyday life of the research departments of the telecommunication companies. It is good to have universities involved in the research since this may have an influence on what the students are taught, but it would be better if the research departments of the national telecommunications companies conducted a proper share of the research as well.

National projects are often linked with certain products and services that are being developed or implemented in a specific community. For example, in France research seems to have focused on the use of the French videotex system, Minitel (e.g. Xech and Mathon, 1987). Also Finland has used resources on the development of videotex, Telesampo, and seems to have made this a major area of national research. In Denmark, national research seem to have centred particularly on the use of text telephones among deaf people, and since the introduction of text telephones in 1986, a longitudinal study has monitored how this has influenced working situation and home life (e.g. Fogelstrøm and Petersen, 1987). In Norway, the development and production of a large telephone keyboard lead to a study of how such keyboards were used (Tyvand and Nilsson, 1989).

Many of the national projects are concerned with the same issues that are apparent in international projects; that is, they are focused on the telecommunication needs of hearing and visually impaired people, and, more recently, on elderly people. There are, however, also research and development work where one or two countries are focusing on equipment, services and user groups that have received little attention in other countries. This research is very important because it widens the scope of the research in general. In Italy, a telecommunication program for speech impaired people who use a graphic communication system, Blissymbols, is being developed (Susini and Tronconi, 1990). Similar work is going on in Norway (cf. chapter 31). In England, there is extensive research on use of narrowband communication for sign language (chapter 37), and a telecommunication device for deaf-blind people based on the English hand alphabet has been developed (Grigson and Giblin, 1989). In Norway, another telecommunication system for this group is being developed (cf. chapters 45 and 46). In France, a voice operated, speaker independent telephone, Covotel, has been developed which allows motor impaired users to dial the number and perform other functions without having to use the hands (Dubois, le Maitre and Rejaud, 1988). Also a cordless telephone with hands-free function for wheel chair users is under development in France. A research project in Sweden has studied the possibilities to provide blind people with daily newspapers via the telecommunication network. In another project in Sweden, still picture telephones are used to support telecommunication for mentally disabled people (Brodin and Björck-Åkesson, 1991). This latter project is of particular interest since the telecommunication needs of this large group until now have been more or less neglected.

International Research

A substantial part of the international research in Europe consists of projects under large research programs. Several of these programs are based in the Commission of the European Communities, but most of the projects have participation from countries outside the European Communities, such as Austria, Finland, Iceland, Norway, Switzerland and Sweden. There are also collaborations between countries in Europe without participation from countries within the European Communities. All these collaborations are *European.*

The major European research programs within the field of telecommunications and disability are listed below. The names of contact persons for these programs are listed in the Appendix.

COST

COST is an acronym for 'European Cooperation in the field of Scientific and Technical Research'. Within this frame a number of projects are run in different scientific fields. The COST projects are not actual research projects, however, since the projects have no budgets, except for arranging their meetings and some conferences. The real research and development work has to be undertaken and financed by other bodies. The COST projects are fora where research and development coordinators from a number of European countries can come together to exchange information, do preparatory work on different topics and promote research and development in their field.

COST 219 started in 1986 and has the title 'Future Telecommunication and Teleinformatics Facilities for Disabled People'. The aim of the project is to promote research and development of telecommunications and teleinformatics equipment and services for people with disabilities. This is done by collecting and analysing information about research, equipment, services, the needs of disabled people and the problems they have to face. The information and results of the analyses are distributed to research bodies as well as to producers, user organisations and politicians. COST 219 cooperates closely with the large European research projects that are mentioned below, and although COST 219 in itself is not a research body, it has inspired many national and international projects.

COST 219 was supposed to terminate in 1991, but has received a five years extension, so that it will run until 1996.

Concerted action

Under the framework of Directorate-General XII (Science, Research and Development) of the Council of the European Communities there are programs which aim to exchange information and stimulate research and development in certain fields. Three projects are concerned with technology and disability: 'Concerted Action on Technology and Blindness', 'Concerted Action on Technology and Hearing Impairment' and 'Concerted Action on Gate Restoration'. However, only the first of these has to some extent included concerns about telecommunications facilities for the group concerned.

'Concerted Action on Technology and Blindness' started in 1988. Several activities are included and more than 50 institutions are involved. Denmark, France, Germany, Italy, The Netherlands and United Kingdom participate. Within the field of telecommunications, the project has been concerned with finding a common European interface for digital newspapers (cf. chapter 44). Another activity is concerned with blind people's access to computers and telecommunication terminals and services. Access to graphics in general, and graphic man–machine interfaces in particular, is one of the most important and challenging problems for visually disabled people. The aim of the activity is to develop approaches for multimedia man–machine interfaces and for adaptation of existing equipment and services.

RACE

RACE is an acronym for 'Research and Development in Advanced Communication Technologies in Europe'. It is a program under Directorate-General XIII (Telecommunications, Information Industries and Innovation) of the Council of the European Communities. It comprises a large number of projects, but only three of these are concerned with telecommunications and disability.

Application Pilot for People with Special Needs (APPSN)

The main objective of this project is to demonstrate to RACE the types of support services and the care sector that would be commercially viable using videotelephony. The activities of the project are:

- home care service provisions for elderly users in Finland, Germany and Portugal;
- home care provision for hard-of-hearing elderly users in the Netherlands:
- home care service provision for deaf users in Italy;
- support service for deaf people in Sweden;
- home care service provision for visually impaired people in Portugal; and,
- home care service provision for mobility impaired people in Finland, Germany and Portugal.

Integration of People with Special Needs by IBC (IPSNI)

Belgium, Finland, Greece, Italy, the Netherlands and United Kingdom are participating. The objective of the project is to come up with specifications for multimedia communication networks on behalf of people with visual, motor, and speech impairment, in order to increase the integration in professional and social environments, to provide better access to culture and to improve autonomy in private life.

The primary emphasis is on personal use of general telecommunication services, and the following functions:

- access to interpersonal communication;
- access to electronic mail services;
- access to multimedia retrieval systems, including services like teleshopping and telebanking; and,
- access to information services, including newspapers and newsletters.

Usability Issues for People with Special Needs (TUDOR)
Germany, the Netherlands, Portugal, Sweden and United Kingdom are participating. The objective of the project is to make RACE aware of the benefits that IBC services can provide for the integration of elderly and disabled people into society and for improving their daily lives. The project includes a survey of 6000 disabled and elderly people in the Netherlands, Portugal, Sweden and United Kingdom, and a database with files on demography, market sectors, telematic hardware and software, relevant human factors and user organisations. In addition, the project will conduct some experimental studies in man–machine interaction.

TIDE
TIDE is an acronym for 'Technology for the socio-economic Integration of Disabled and Elderly people in Europe'. At the time of writing this, the program has not started yet, but since the evaluation committee is currently working on the proposals, the program is included in this overview. The program is the result of a promotion of research and development within this field, and 7.5 million ECU have been made available for a pilot phase from Directorate-General XIII (Telecommunications, Information Industries and Innovation) of the Council of the European Communities.

The money has been allocated to run a few pilot projects in the field of technology and disability from the autumn of 1991 to the end of 1992. The intention is to show what information technology can mean to people with special needs, and to promote further actions in accordance with the policy of the project.

Other Programs
'Handicapped Europeans Living in Open Society' (HELIOS) is a program under Directorate-General V (Employment, Industrial Relations and Social Affairs) of the Council of the European Communities. The aim of HELIOS is to promote development in the field of disabled people's social integration. None of the projects under the program is concerned with communication technology and disability; the reason for mentioning the program here is that one of its projects, HANDYNET, is intended to create a number of information databases, including one about ongoing research and development in the field of disability in Europe. According to the initial plans, the database should also include research and

development on technology and technological applications, and, if implemented, this may prove very useful. It must be added, however, that the work with HANDYNET has been going on for several years without showing much progress.

There are some more programs that include technology and disability, such as some of the projects within the program 'Advanced Information Technology in Medicine' (AIM), but none of them is primarily aimed at solving specific problems for disabled and elderly people with the aid of technology.

The Future

Perhaps the most important task for the future is to ensure, that research and development on behalf of disabled people is integrated in all relevant activities and not, as today, run mostly as separate entities.

Until now, only very limited resources have been spent on research and development for disabled and elderly people. The group of people with special needs is large – of the order of 20 per cent of the European population. This should also be reflected in the share of the research budgets.

People with disabilities make up a very heterogeneous group, and the needs vary. In future research, it will be important to include people with different disabilities.

There is an urgent need for improved distribution of, and access to, information about planned and ongoing research and development work. This need should be satisfied with a comprehensive database – either within HANDYNET or some other institution. The most important conditions are that it should be well designed, have resources for administration and updating, and that it will be available very soon.

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Appendix

Names of contact persons for the international European research projects. Their addresses are listed at the end of the book.

'Future Telecommunication and Teleinformatics Facilities for Disabled People' (COST 219):
Jan Ekberg
Concerted Action on Technology and Blindness:
Pier Luigi Emiliani
RACE: Application pilot for people with special needs (APPSN):
John McEwan
RACE: Integration of People with Special Needs by IBC (IPSNI):
Pier Luigi Emiliani
RACE: Usability Issues for People with Special Needs (TUDOR):
John McEwan
'Technology for the socio-economic Integration of Disabled and Elderly people in Europe' (TIDE):
Egidio Ballabio

16

Towards a Model of Terminal Design

Constantine Stephanidis, Jan Ekberg and Knut Nordby

Since the early 1980's when information technology was beginning to become popular, many professionals in the field of rehabilitation have utilised modern technology to develop devices which may help disabled people improve their quality of life, and a wealth of literature on new technology and disability has become available. Specialists from many different disciplines combined their knowledge and skills in an effort to improve the communication equipment for people with speech and language disorders and other disabilities. Although a number of these developments were ideas which were considered by many to be useful and worthwhile, their popularity has been severely limited and has failed to reach expectations, mainly as a result of the high purchasing cost of the equipment. Much of the cost incurred was due to the fact that many of the ideas and developments took the form of equipment for special, limited purposes. Rarely was there an integrated piece of equipment which had been designed with both disabled and non-disabled users in mind. Whilst it is appreciated that, by the law of supply and demand, costs of customised equipment tend to remain high, it should be noted that the purchasing power of many people with special needs is severely restricted as disabled and elderly people are amongst the poorest in any society. Therefore, any additional expenditure on special purpose add-ons above the normal cost of standard equipment, often proves to be too prohibitive for many people.

Current trends in terminal design are directed towards a multi-media and multi-service terminal which offers the user the capability of accessing, in an integrated manner, a large number of different services through various input and output modes. Advances in this area should lead to progressive replacement of the traditional single service terminals connected to various networks by new powerful terminals connected to a single coherent network. More specifically, four generations of terminals can be identified.

The first generation terminals include mainly products of the domestic environment such as the standard telephone, television, radio and home computer, suitable for the single-media (transference) analogue networks. Because of their incompatibility, internetworking of the above devices was not possible.

The second generation terminals currently in use, can handle digital information (text, data, voice) simultaneously, providing facilities such as interactive videotex, electronic diary etc.

The third generation terminals currently under development, are based on the Integrated Services Digital Network (ISDN) which is capable of carrying different types of information (voice, text, data, images). Compared to the second generation terminals, ISDN terminals provide advanced and extended facilities in digital information, such as digital signal processing, slow motion colour video etc.

The fourth generation terminals are based on fully digital broadband communication in the Integrated Broadband Communications Network (IBCN). ISDN terminals may perform the role of a 'bridge' between narrowband analogue telecommunication and IBCN terminals.

User Interface Aspects on Accessibility of Terminals by People with Special Needs

A Model of User to Terminal Interaction

The process of identification of terminal requirements and its range of functionality is complex and demanding, especially with regard to those aspects of system design that are associated with the accessibility of the various groups of people with special needs. A model of the processes involved in the access and utilisation of services through a terminal may be useful. A proposal for such a model is shown in Figure 16.1.

In order to initiate a contact with a service, the user must have prior knowledge of the existence of the available service (service awareness) and also the desire or need to use a particular service. Beyond these basic requirements, the user must have a strategy for accessing the service, put this strategy into practice and perform the activity necesary to create the appropriate signals in the terminal. The terminal receives the input from the user (signal acquisition), transform it appropriately (signal analysis and interpretation) and propagate information to the service provider. The service provider obtains the information from the user and returns appropriate messages to the user through the terminal. Ultimately, the access phase terminates when the signals and messages generated by the terminal are appropriately perceived and interpreted by the user.

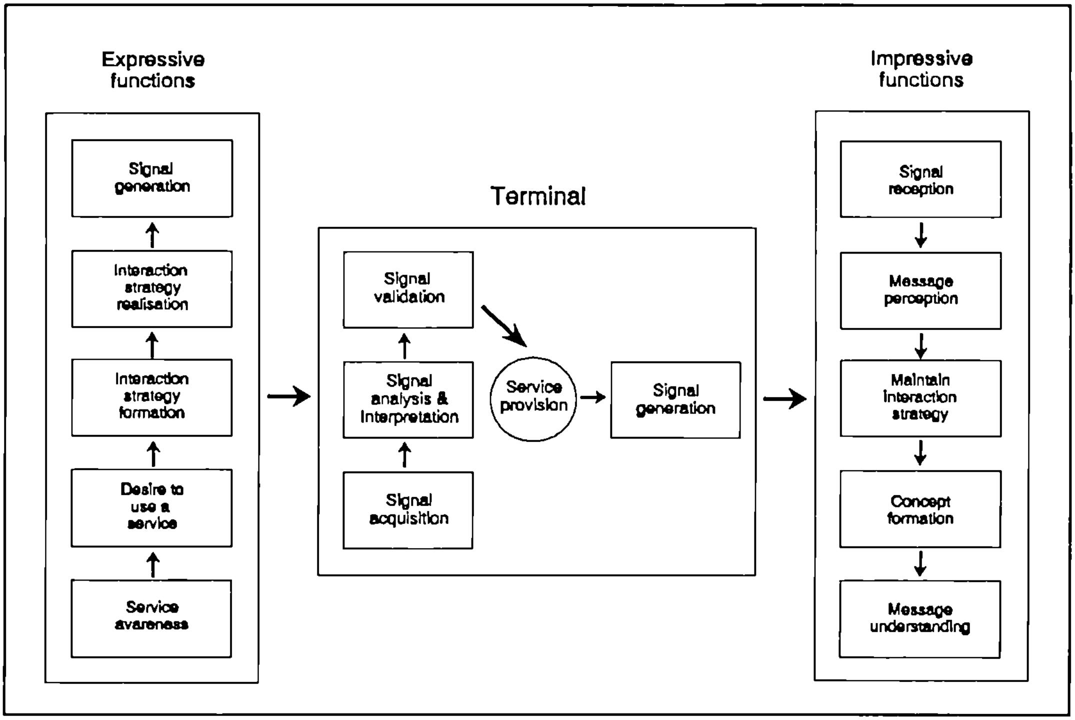

Figure 16.1 Model of service access.

The above model of user to service interaction is based on a three level model of Man–machine interaction by Ziegler (1987).

- *The semantic level*[1] is concerned with the meaning of information conveyed from the user to the system (commands) and from the system to the user (messages, data). Developing interaction strategy and conceptualisation are the actions that correspond to the semantic level of the model.
- *The syntactic level* is concerned with the 'language' applied by the user, and corresponds to the interaction strategy realisation and message perception of the model in Figure 16.1.
- *The physical level*, to which most of the design effort has been directed until now, is concerned with the perceptual (e.g. visual, auditory and kinaesthetic) and motor skills of human beings. The rest of the user's functions (desire to use a service, service awareness, conceptualisation etc.) shown in the service access model, refer to user behaviour and mental processes that take place during user to service interaction.

1 It should be noted that the use of the terms is not comparable to the way the same terms are used in linguistics.

Considerations on Man–Machine Interaction

The aim of the modelling approach is to isolate the points in the interaction where mediation may be most beneficial and maximise accessibility of services provided by networks to the widest possible range of user groups.

The generally recognised division of perception into five senses is a conceptual oversimplification. In fact, the whole human communication process is much more complex. For the purpose of the rest of this section, however, only those perceptual and motor skills that are relevant for interaction via telecommunication terminals will be considered.

- Perception:
  - vision;
  - hearing;
  - touch; and
  - kinaesthetics

  (The two latter ones are often referred to collectively as the haptic sense).
- Motor skills
  - speech;
  - hand movements; and,
  - other motor skills.

Needs of Disabled People

To non-disabled users, the operation of most pieces of microelectronic equipment involves activities that require coordinated use of the arms, hands, fingers, eyes and ears. So, for example, to operate a personal computer, the successful user has to go through a number of operations, which may include switching on the equipment, loading a floppy disc into the drive, selecting from a screen menu, operating a keyboard and mouse, and listening for audible feedback such as error bleeps. The user will mostly do this without significant effort.

However, if the user suffer from some form of impairment, the series of operations which usually require little or no physical effort may suddenly become a major obstacle, making the job almost impossible to complete. A user with upper limb impairment may be restricted, perhaps, to the use of only one hand on the keyboard. This will reduce the speed at which data can be input and may make multiple keystroke entries impossible. If the person has no use of arms and hands, the problems become much more serious. It may not be possible for him or her to even switch the equipment on. The problems facing a user who is blind are very different. Although he or she may be able to use the keyboard to input data quickly, it would not be possible to interpret or manipulate information displayed on the monitor screen. If the user is deaf, a different set of problems have to be faced. Auditory feedback from the machine, such as error bleeps, would be missed.

These examples have been used to highlight the various problems that disabled people may face when using equipment which is designed with only non-disabled users in mind, and which therefore fails to take into account the special needs of people with disabilities. Thus, standard microelectronic technology may be a factor that furthers the social isolation of disabled people. In order to redress the balance of the present situation, engineers should be encouraged to design flexible, alternative access systems to cater for the needs of people with disabilities.

The categories of disablement are wide and varied, and within each category there is a continuum of impairment. Thus, a single ideal or universal configuration for an access system for everybody is simply not viable. Instead, telecommunications systems and terminals need to be designed with disabled users in mind from the beginning and thereby made flexible enough to accept a variety of access modes.

If this is done, the technology may be adapted to the capabilities and limitations of people with specific disabilities. If an access system is inappropriate for the skills of a particular user, it should be replaced by a more suitable alternative. An alternative access system, which uses scanning of a visual keyboard, for example, would then simply be a piece of hardware for a user with a particular disability to gain access to a system which could be used for any application.

Designers of telecommunication equipment are primarily faced with two immediate problems:

- How can new technology help disabled people to achieve their objective in whatever task they wish to perform?
- How can the system be designed with dual facilities for disabled and non-disabled user?

There are, however, vast differences in the perception and application of information technology by the non-disabled and disabled users. Many non-disabled people regard new technology as something which may or may not be useful to them in their employment or social activities. If they cannot afford a piece of microelectronic equipment, or are not fully conversant with a particular operation, the equipment is disregarded in favour of some technically less advanced and more familiar alternative. For a disabled person, however, new technology is often seen as an essential and integral part of everyday life, and not merely as an adjunct to it. Disabled people, in many cases, rely totally upon high technology aids, and live in hope of future technological developments alleviating, still further, problems caused by their impairment. Due to this reliance of disabled people upon information technology, designers should be aware of the importance to disabled people of equipment parameters such as:

- physical size;
- ease of operation;
- portability;
- flexibility; and,
- usefulness in terms of everyday living.

The difficulties that people with disabilities experience when they want to access telecommunication terminals are described in different chapters, and will not be analysed in detail here. The following sections are concerned with the methods that can be applied to terminal design for reducing such difficulties.

Mediation Possibilities of New Terminals

It is possible to make adaptations on terminals, including ISDN and IBC terminals, in a variety of ways in order to ensure their accessibility to users with special needs. Mediation may take place in different parts of the terminal and network, at different levels and with a variety of methods.

Locations of Mediation

Modifications of the interaction process between the user and the service may be accomplished both at the terminal and the service site. A trade-off is possible between procedures for modifying signals and providing special input or output devices in the terminal, and supplying information in an appropriate form or a variety of forms at the point of service supply. This trade-off may be an important design factor, since it affects many performance indicators, such as financial cost, appropriateness of provision and convenience of access.

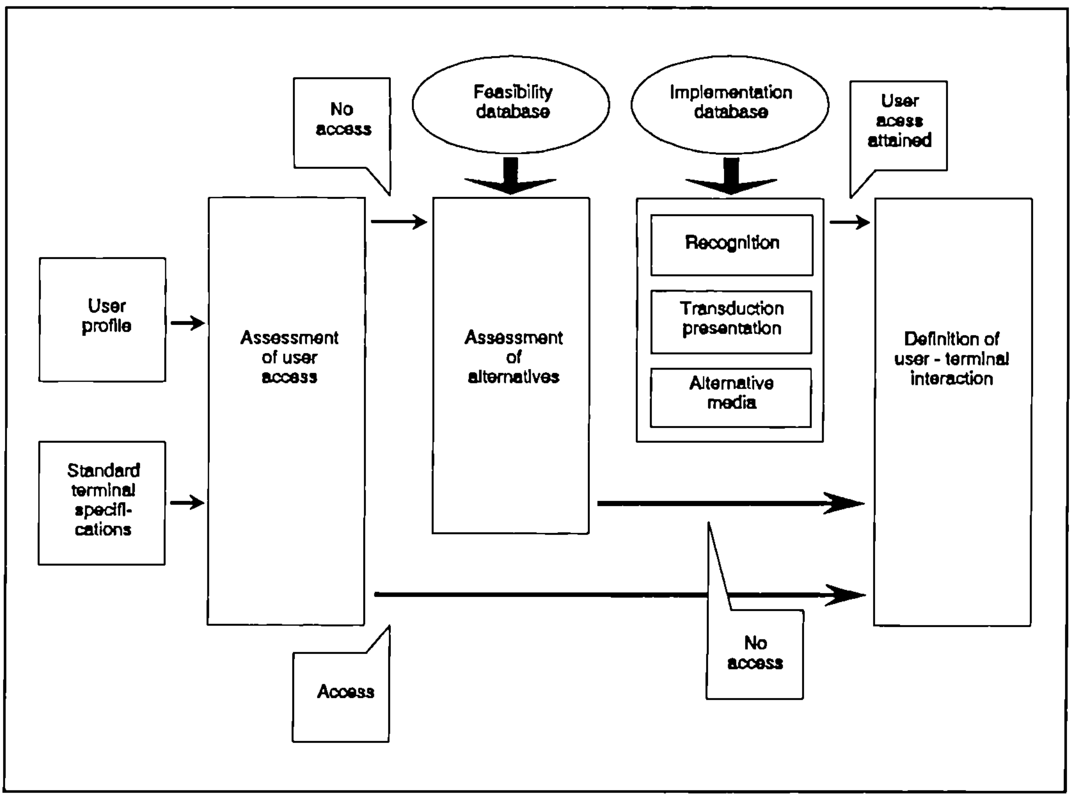

Figure 16.2 Meditation to terminal.

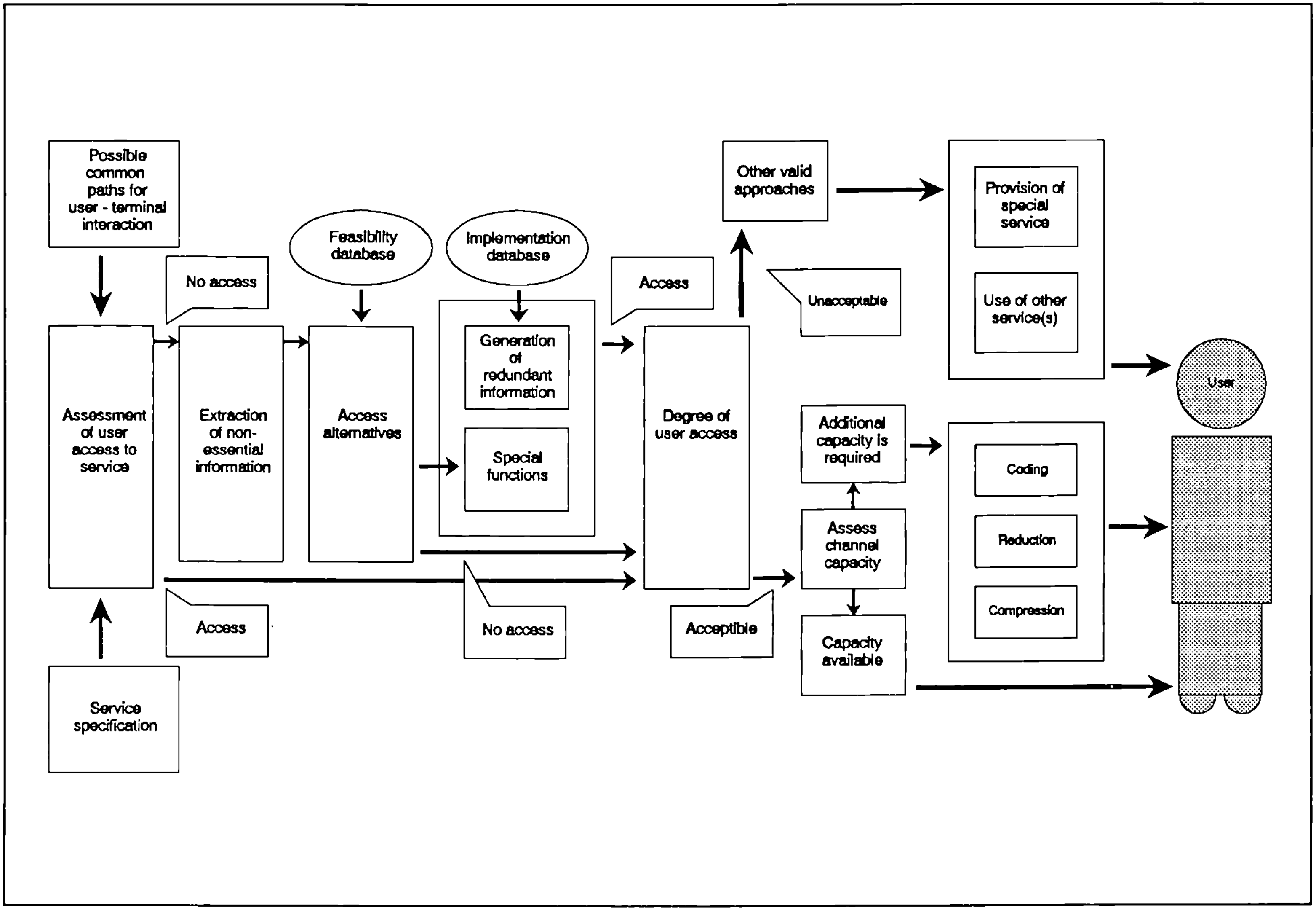

Figure 16.3 Meditation to service.

Two potential approaches are presented schematically in Figures 16.2 and 16.3. In the first approach, a matching process seeks to identify user needs and potential terminal adaptations, using knowledge of the constraints imposed by the user and the terminal specifications. Alternative methods (i.e. using recognition and transduction techniques, or provision of alternative media or modes) for compensating a user's problems are examined next. If sufficient compensation is impossible, the second approach should be followed.

In the second approach, mediations take place exclusively to service provision. In a similar way, an assessment of the user's profile and the service is carried out. The possibilities of using alternative systems in order to achieve access for the user are examined. After any changes have been effected in the interaction, the degree of accessability should be examined. In the event that the service is inaccessible, further effort must be expended in seeking to exploit the possibilities for the provision of the required service (i.e. provision of other services or introduction of new special services for a specific user category). The end result should be that the service is provided to the user in an accessible form.

It should be noted however, that often, the best solution is not obtained with either approach, but rather with a mixed solution, which combines the advantages and diminishes the disadvantages of both approaches.

Levels of Mediation

In accordance with the man–machine interaction model proposed by Ziegler (1987), a three level (physical, syntactic and semantic) intervention approach may be followed. Figure 16.4 shows specific points of the network, where conversions for each level may be realised to obtain accessability and efficiency.

Physical Level

The transformation and conversion (mode changing) facilities needed at this level, may be implemented within the terminal as add on software or hardware modules. It may also be handled in the public services by giving information in multiple modes (e.g. audio, visual, textual) at the same time. In this case, the large capacities of ISDN and IBCN may be used in order to transmit the additional modes to the user. Some conversions, such as text-to-speech and speech-to-text may also be implemented at the point of Special Service Providers or in the Telematic Access Points (TAP), in which case more powerful software modules can be used. The conversions may also be accomplished by having terminals adapt to specific user needs.

Syntactic Level

Adaptation at this level requires 'conversion' or 'translation' modules which match the user's available (restricted) functions to the 'standardised' outside world. Such a module may be a text-to-Blissymbols and Blissymbols-to-text conversion to be used by non-speaking people with reading disorders. This support could be situated within the terminal or in a Telematic Access Point, or be a special service, depending on the memory and processing capacity needed for the conversion.

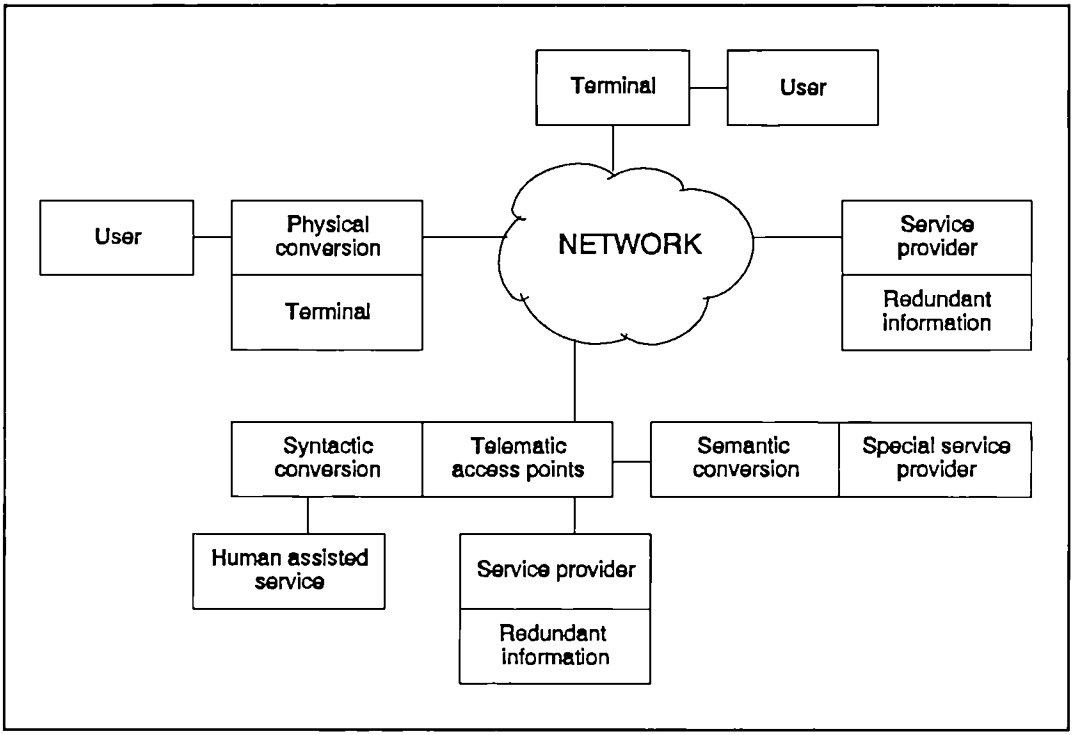

Figure 16.4 Meditation at different levels.

Semantic Level

At the semantic level, interpretation programs based on artificial intelligence (AI) for information reduction and simplification, and for picture recognition and interpretation, are possible examples of this kind of conversions. Because these modules demand large processing and storage capacities, they should reside in a Telematic Access Point or as a special services. Some of these optional information modes may be of interest also to other users, and should be transmitted using the redundant channel capacity of the networks. Some of the programs based on artificial intelligence that may be foreseen for general use in the Telematic Access Points may also be useful for disabled people, for example the natural language dialogue modules which are used in many information services (train timetable information, hotel booking etc).

Methods of Mediation

Future telecommunication terminals based on ISDN, and to a greater extent IBCN, will provide new possibilities of intervention for the benefit of people with special needs. For the purpose of this chapter, only those methods that are relevant to terminals are examined, i.e. redundancy in telecommunication channels and transductions between different types of information.

Redundancy in Telecommunication Channels

Redundancy as a means of providing more information than is strictly necessary may be achieved in the following ways:

- by lengthening the time of transmission, when speed is not important, allowing more information to be sent within a given bandwidth;
- by increasing the speed of transmission to send more information in a given period of time; increased speed may mean either increasing the bandwidth of the transmission channel, or if this is not possible, reducing the quality of transmission;
- by adopting bandwidth compression techniques so that both quality and speed is maintained, but where free bandwidth is created; and,
- by a combination of the above.

The video channel is the channel with the greatest capabilities. For example, some television programmes offer a three window screen – one for the main picture, one for a sign language interpreter and one showing subtitles – in a way that does not reduce the quality of the presentation. Moreover, higher capacity communication links than those that are currently used, will allow transmission of additional information in the audio channel with acceptable reduction in quality, while a high speed data channel may transmit text, graphics and slow scan video information.

When the same information is received by different categories of users, it may be preferable to send the information in different modes instead of running conversions in every terminal. An important implication for terminal design is that it should be equipped, in order to cope with the different media, with the capability of using different information coding schemes. For example, a 48 kbits/s coding scheme (ADPSM) may be used instead of 56 kbits/s speech PCM in order to gain 8 kbits/s for sending text conversions of the speech.

Transduction

The purpose of transduction is to change the form of presentation and/or convert one information type into another, according to the specific requirements and needs of the user group. The following gives some characteristic examples of transduction for different users groups.

- *Blind people*

  In general, pictures are inaccessible to blind people. Nevertheless, the application of two alternative transduction methods may partly overcome this handicap, at least as far as still pictures are concerned. Presentation of picture by a tactile display for graphics is one way, although the complex form of pictures requires a simplification before being presented. Descriptions based on a stored description by a person or on machine interpretation of pictures in the ASCII format (not feasible today with unconstrained pictures) are is the second alternative.

- *Partially sighted people*
  Some of the transduction techniques applicable to this group are:
  – providing the user with 'zoom' capabilities;
  – increasing the contrast with redistribution of grey levels; and,
  – choice of appropriate foreground and background colours.

- *Hearing impaired people*
  Speech recognition technologies may transfer speech information to text or other media that are accessible by this group.

- *Motor impaired people*
  Data is mostly input into a terminal by the hands, using a keyboard, a mouse or another pointing device. For people who cannot use such devices, other input methods should be provided, such as voice control, alternative pointing devices (e.g. eye pointing) and scanning tecniques using switches.

- *Language impaired people*
  Compacting information of complex sentences into small units of graphic signs that represent persons, objects and activities, may facilitate language comprehension for people with impressive language impairments. People with expressive language impairments may for example operate the terminal with the help of a concept keyboard and a graphic sign system.

An important point to pay attention to in the context of transductions, is that information and presentation should be kept apart. Edited text presented as bitmaps, videotex screens with text embedded in graphics, low contrast between text and background, and foreground and background colours, are all examples of outputs where it should be possible to have the original information available in ASCII form. If, for practical reasons, the information must be presented in a specified form, then the original information should also be available in a presentation independent form as an option.

A Functional Block Model of an Accessible Terminal

In this section, a functional block model of an accessible terminal is described[1]. The functions of a terminal may be divided into four major modules: input, process, control and output (Figure 16.5).

Input Function

The input function is the interface of the terminal to external sources, such as active user operation, his or her passive monitoring system, or the environment of the user or the network. Whatever the source, the signal needs to be in the form that is required for the rest of the processing. A number of subfunctions are responsible for filtering the input signal, converting it from analogue to digital if necessary,

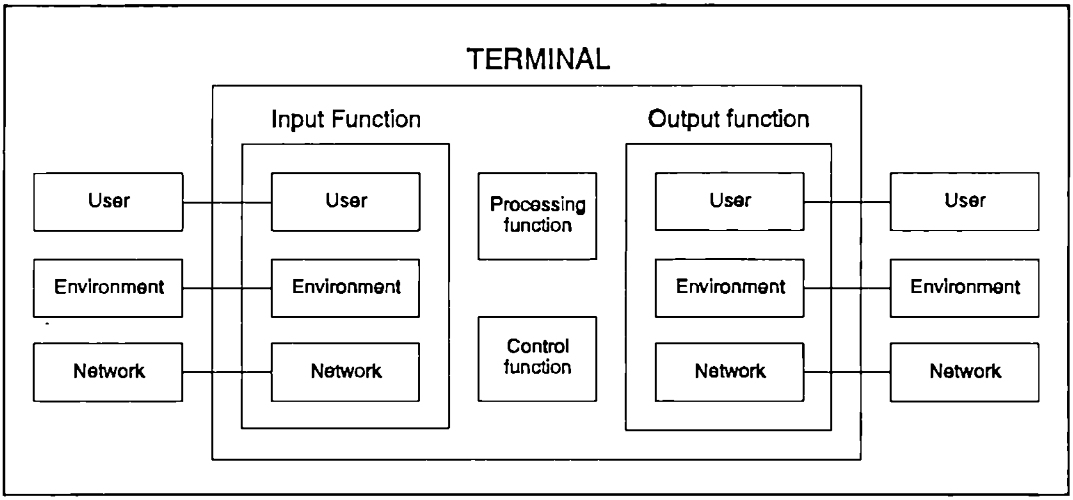

Figure 16.5 Model of an accessible terminal.

and checking for its validity. These subfunctions include: the signal grabbing function (intending to convert the signal received to a digital one), the selection function (checking whether the user commands belong to the set of the ones expected) and the recognition and mapping function (aiming at converting the signal to one such that the terminal can process).

Processing Function

This function provides the user with the tools and facilities necessary to manipulate the multiple media that are handled by the terminal, as well as the working storage function necessary for their manipulation. An example of this function could be to use a word processor to write an electronic letter.

Control Function

This function controls and manages the various functions of the terminal and offers facilities similar to those performed by the operating system in a personal computer. In addition it alters the performance of the system by re-configuring it, in some cases dynamically, depending on the parameters set by the user or on the actual performance of the user in response to system prompts. This may be accomplished by the following subfunctions:

- *The Terminal Management Function*
  This function receives status information of other functional blocks, sends control information, activates and deactivates other functions control error and manages system resources.

- *The Dynamic Configuration Function*
  This function controls and manages the various functions of the terminal relating to configuration of the terminal in a manner suitable for the user.

Output Function

This function provides the necessary interface for data to be transmitted out of the system, and for prompts generated by the system. Its main purpose is to ensure that the data is in a format that is meaningful for the user. In the case where output is directed to the user, the output function consists of three subfunctions: transduction, presentation management and presentation.

- *Transduction*
  This function contains different submodules depending on the information type processed. These are:
  - the *text transduction module* which converts textual information into, for example, synthetic speech, graphic symbols (e.g. Blissymbols and Rebus), animated sign language or Braille;
  - the *sound transduction module* which transforms sounds which are used to indicate the current status of the system (terminal or application) to non-acoustic information which will be more useful to a hearing impaired user;
  - the *speech transduction module* which 'recognises' speech data and converts them into a form that may be comprehensible for, for instance, a hearing impaired user (usually letters) or a language impaired person (e.g. graphic symbols);
  - the *graphics transduction module* which provides a description of computer generated graphical information in alternative non-visual forms, either by line text or other forms of information appropriate for the specific user, that can be derived from text;
  - the *moving graphics transduction module* which describes 'moving graphical objects' using textual information;
  - the *still picture transduction module* which 'recognises' a picture using image analysis and recognation techniques and provides a description of it, or represents the bit mapped pictures in tactile form; and,
  - the *moving picture transduction module* which provides a description of moving pictures (video information) using text.

- *Presentation Management*
  This function structures information for output so as to be suitable for the chosen output mode and the capabilities of the user. It also provides the possibility for the user to control the way information is presented (in terms of mode, structure, speed of presentation etc.). For example, a blind or motor impaired user who relies on synthetic speech output may prefer shorter menus than when they are presented visually, requiring a full restructuring of how a disk directory or a videotex menu is presented. The presentation management function is also responsible for lowering or raising the sound level, illumination and contrast, and changing of colours.

- *Presentation*
  This function transforms an appropriately structured digital signal into a signal which is physically perceptible to the user.

It should be noted that output also may be directed to the passive monitoring system of a user, to the user's environment or to the network.

Technical Implications

The functional requirements and facilities that may be provided in future terminals impose some technical implications to the construction of the terminal's hardware and software. Considering conventional personal computers as a prototypical terminal, some of the implications are discussed below.

Hardware

Modularity and Interchangeability

A terminal should be constructed of a number of different modules which, depending on the environment, may be mandatory or optional. For example, the transduction function is, in general, an optional function, but certain modules, such as speech synthesis and character recognition, may become standard functions. The modular design of the transduction function is considered necessary in order to enable re-use of the transduction modules (optional or standard) in different services and applications, and by various user groups (general purpose transduction modules).

The same may be said for visual, acoustic and tactile input and output modules. For each mode, there could be a set of modules (from standard ones to specific ones with optional features), each of which is directly interchangeable. Optional modules may be added inside the terminal (e.g. expansion cards) or may be connected to the terminal's output ports.

Slots for Optional Boards

Device modules like hard disc controllers, display controllers and network controllers are normally found in personal computers, which means that about 3 or 4 slots are available for additional boards. An expansion card may be used if more boards are needed. Thus, there does not seem to be any significant restrictions on adding hardware modules to a personal computer. Moreover, the memory capacity is sufficient for the auxilliary modules needed by people with disabilities, although the low number of spare interrupt lines on a personal computer may be a problem.

Signals

The signals that control auxiliary input and output devices are defined in the protocol used. The data signal has to be carefully analysed because it may contain different kinds of information (data or presentation) in order to achieve independence of application and presentation.

Software

Data Formats

The data format, which is used to encode the various information types handled by the terminal, determines to a great extent the applicability of the various functions and especially the transduction functions. Consequently, an inappropriate data format may make it impossible to zoom a picture, use redundancy reduction techniques or synchronise optional information modes at the output. An inappropriate data format may also increase the effort that is required to perform a transformation, or completely prevent it.

The most important factor that determines the appropriateness of data formats is the degree to which extraction of the information content from the encoded signals may be achieved. Data formats which encode not only the presentation form but also the content of the information, facilitate the provision of the information content in alternative presentation forms accessible by different disabled users.

Primitives and Commands

The primitives used in the interaction (between user and system or between modules) may be divided into content primitives (text, markers, symbols) or context primitives (set of choices, messages, alarms, prompts and windows). The primitives should be presented in the way most suitable for the output device and the user.

Input Function

In some cases, transduction is provided by a (third party) service provider before the signal is received in the conventional way by the service. An example of this may be a speech recognition service provided as part of a service that enables a speaking person to communicate directly with a hearing impaired person, thereby enabling the hearing impaired person to access telephone services. The signal may pass through a remote speech recognition service (e.g. in a telematic access point) because the function is too demanding to be located within a terminal. Another example may be availability of basic picture recognition in order for a speech and motor impaired person to input eye movement commands.

Control Function

The control function of the terminal should include the means to recognise relevant user needs. This implies that the control function should have the ability to find out from directories where conversion services are situated, or information about this may be given by the user with a smart card. The terminal should also automatically identify the capabilities and options available in the terminal itself. The control function should also be able to allocate special transmission capacities when needed. For example, if a user has indicated that he or she uses sign language, a videotelephone terminal with a flexible bandwidth should automatically receive the channel capacity needed for sign language transmission (unless the user indicates otherwise). A person may indicate that he or she is speech impaired and a text channel subtitles may be added.

Acknowledgement

The authors acknowledge the assistance of Yannis Kasmeridis and Panagiotis Galatis in the production of the manuscript.

Note

1 The model presented in this section has been developed within the framework of the RACE project 'Integration of People with Special Needs in IBC' (cf. chapter 15).

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17

Domestic Telephone Equipment and Services for Disabled and Elderly People

Gerhard Klause and Jim Sandhu

Most people use the simple analogue telephone without any considerable effort. For elderly and disabled people use of the telephone is vital, it enables them to keep in contact with family, friends, and, for example, their doctor. Yet for these groups of people, the 'simple' piece of equipment turns out to be not that simple. In fact, it often forms an insurmountable barrier which prevents him or her from access even to ordinary speech telecommunication.

This book covers a wide range of present and future developments in telecommunications, such as text-telephones, videotelephones and multi-functional terminals. The present chapter focuses on the great family of standard analogue telephones which are in widespread use, and on related services. It will cover especially those telephones and supplementary devices corresponding to the needs of elderly people and people with disabilities.

Despite recent positive developments, it should be noted, that the European telecommunications industry – with rare exceptions, has seldom been amenable to catering to the special needs of elderly people and people with disabilities (Kirschenbaum, 1987). On the whole, the industry seems reluctant to burden common telephone sets with add-on costs, not even for providing simple interfaces to supplementary devices for disabled users. Fortunately, and in spite of this reluctance a number of special devices are available throughout Europe, mainly offered by smaller companies.

Standard Analogue Telephones

Three 'modules', forming part of any ordinary telephone, are crucial to the effectiveness of man–machine interfacing – and therefore, central to the needs of people with disabilities:

- *the dialling device,* which is fast changing from the rotary dial to standard keypads of twelve or sixteen keys. Except for the confusion which results from the two different standard arrangements of the keys (CCITT and ISO are different, see Figure 17.1), these keypad operated telephones do not present problems to visually impaired and blind people. The above mentioned problem could easily be overcome if the number 2 instead of 5 is marked by a dot. Many people with motor impairment will have problems with keypad dialling.
- *the ringing device,* which is changing from the familiar bell ringer to tone ringer. Tone ringers, due to their specific sound characteristics, will make it easier for many hearing impaired people to hear the signal. Blind people in unfamiliar surroundings may have problems finding the location of a ringing telephone because some modern telephone ringing signals have poor acoustics and also poor directionality for auditory localisation.
- *the handset* with receiver and microphone capsules, where the latter has recently changed from carbon to electrodynamic type. The handset now offers better transformation characteristics, thereby enabling better intelligibility. People with reduced strength or dexterity may have problems handling the handset. Blind and partially sighted people generally have no problems lifting a standard handset – and putting it back on the cradle switch – once they have located them, but they may have problems with unorthodox off-hook functions. The line signals are usually given via the receiver capsule in the handset. Severely hearing impaired people may need a visual indication of the line status.

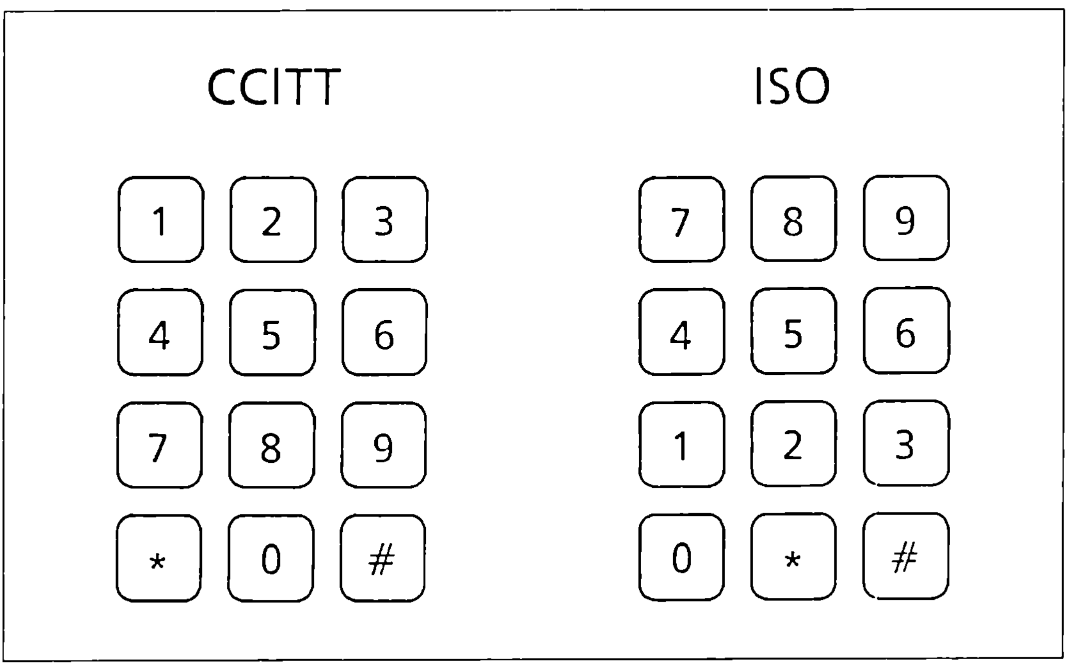

Figure 17.1 CCITT and ISO keyboard standards

In order to meet the manifold requirements of people with disabilities and elderly users, standard telephones have to be adapted with add-on or alternative modules or devices. Frequently this causes technical problems during the installation stage due to inadequate hardware interface points. This often leads to higher cost and sometimes to 'astonishing' results.

It should be noted that the above points are valid for standard digital telephones as well, since they have the same 'modules'.

Services

Use of the telephone is more than telephone conversations. In many countries modern switching systems allow users of standard telephones to have access to a range of services, for example:

- *speech communication* with human partners, the connection being activated by cradle switch and dialling:
- *operator services* offer information (directory, weather, news, time etc.) and special services, such as relaying speech to text and vice versa;
- *automatic call transfer*, which switches incoming calls to another number; and,
- *voice mail messages handling*, i.e. storing a message in the terminal or central, providing output of the message upon request of the user.

Other services may be accessible via terminals often found in the home in addition to the telephone:

- *telefax* (or computer with fax card);
- *text telephones* (or computer with modem and text telephone program); and,
- *videotex terminals* (or computer with modem and terminal emulator).

Telephones with Large Buttons

Quasi-standard telephones with large buttons and corresponding button spacing are available on the market today. Many visually impaired and blind people as well as elderly users find it easier to use telephones with large keys and number memory (the user dials only one or two digits instead of the full number) as long as the number of keys are limited to 20–25 keys, grouped according to different functions and in an order that is known to them. Double functioning keys should be avoided. Large digits on the keys make it easier for visually impaired people to operate the keypad.

Furthermore, many severely visually impaired and blind people prefer having the keypad at eye level, e.g. mounted on the wall.

A rather 'ancient' example of a special telephone with large keys is presented in Figure 17.2 (Klause, 1980). This telephone has 10 numbers with direct dialling and a redialling memory. People with muscular dystrophy or tetraplegia may have reduced strength of finger movements. For them, the low operating pressure (about 0.3 Newton) may be an advantage. These buttons may even be operated with a mouth stick, as demonstrated in Figure 17.2. In this case, the handset was

Figure 17.2 Telephone with large buttons operated by mouth stick.

fixed in a stand near the ear, and the cradle switch function was activated with a pushbutton switch (L = line). The round desk can be turned to three different positions with an electric motor operated by buttons on the telephone via an environmental control unit.

Similar telephones are available in other countries. For example, British Telecom offers a telephone with a dialling keypad of 12 large buttons and a 10 number memory (British Telecom, 1991).

Optional Built-in Features in Analogue Telephones

Number memory and redialling are common useful features. People with intellectual impairment do not have to remember the full telephone number. Generally, it is necessary to finish dialling within a limited time span. For elderly people, the time span allowed for dialling may be too short and in this case the number memory facilitates the dialling of frequently used numbers.

A 'hands free' facility may be helpful for people with reduced strength or coordination of the hands, provided an adequate volume control is included. 'Hands free' telephones have a built-in microphone and loudspeaker, and a volume con-

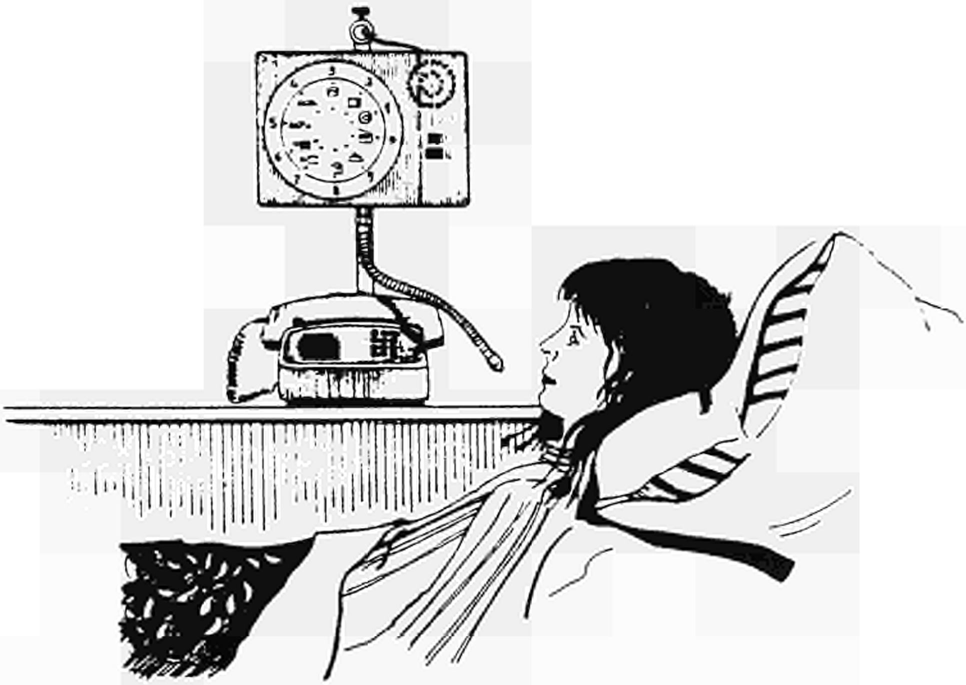

Figure 17.3 Suck and blow control of telephone operation and of the other features.

trol. The transmission characteristics will accommodate automatically to different line conditions, which especially is needed for long distance calls.

Voice-operated telephones offer outstanding usability features for people with severe motor impairment, enabling them to dial and perform other operations by voice commands (cf. chapter 3).

Hearing impaired people may need a handset with enhanced amplification of the received sound (cf. chapter 21). Sound amplification above 10 dB may lead to positive feedback tones, which will create a high steady sound that make voice communication impossible. Hence in Germany, only handsets which contain a 'loud hearing switch' are approved, i.e. the switch reduces the sensitivity of the microphone when the amplification increases.

Amplification of the speaker's voice and the use of special microphones may aid customers who can speak only at a low volume. For example, cordless telephones may allow people in wheelchairs to have the telephone with them all the time. Also other users may appreciate the quick and easy access to the telephone provided by portability. However, people with reduced dexterity or hand coordination may be unable to hold cordless telephones and operate them at the same time.

Mobile telephones are becoming more common. They may extend the opportunities for people with disabilities which today are provided by cordless telephones to usage outside the home area. For people in wheelchairs, for example, mobile telephones may mean increased security while driving on their own, and thereby increased mobility.

Supplementary Equipment for Analogue Telephones

A simple solution for visually impaired people to get large digits on rotary dials is to put a label around the rotary dial.

People with hearing impairment may install an additional ringer – or have the telephone equipped with a tone ringer – in order to enhance awareness of incoming calls.

A simple way of increasing sound perception is to use an extra earpiece. This will shield the user better against environmental noise than when only the handset is used. People with mechanical (outer ear) hearing impairment may improve their telephone sound perception considerably by using an earpiece with controlled volume amplification for bone conduction (Klause, 1981).

A large air-cored coil placed around the receiver capsule (Figure 17.4) can provide a strong magnetic stray field for an efficient inductive coupling to hearing aids, with optional amplification and volume control.

Figure 17.4 Air cored magnetic coil for inductive coupling to hearing aids (Klause, 1985).

Acoustic couplers are available which pick up the sound by a microphone from the receiver capsule and can be attached to the handset like a cap. Acoustic couplers are battery powered portable devices, but they do not fit to all types of handsets, and may sometimes provide a rather poor sound quality. The output may be an amplified sound or a magnetic field as input to a hearing aid (cf. chapter 21).

Mains-powered flashing lights will aid severely hearing impaired and deaf customers to become aware of an incoming call. A relay is connected to the telephone or to the line and is activated by an incoming call for switching the signalling light. It should be noted, however, that many people do not like to be alerted by a very bright flash-type light.

People with spastic cerebral palsy may start their button pressing by searching for and placing their finger on the right button. They may need a key guard, i.e. a plastic cover with holes over the buttons, to avoid pressing one or several wrong keys.

An alternative to key guard may be to insert spiral springs into the buttons, thereby increasing the operating force up to 20 Newton (Figure 17.5). The high operating force may enable a disabled user to locate the right button with his or her hands without pressing any wrong ones.

This searching procedure may require more dialling time than allowed, and the user should therefore have number memory.

People with restricted movement may need to arrange the telephone in different ways, like mounted low on the wall for wheelchair users, small sized keypads, stands for the handset or even for the whole set.

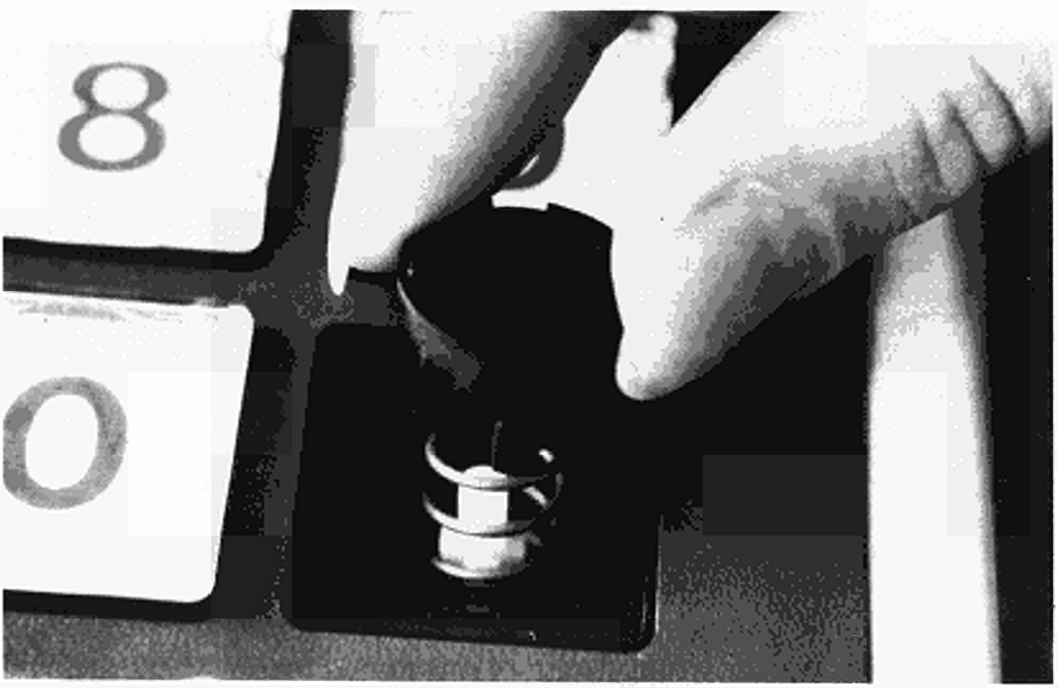

Figure 17.5 Inserting additional spiral springs in large buttons (Klause, 1985).

Conclusions

The well-known simple telephone will keep its dominant role for many years to come. Most of today's special equipment and supplementary devices for analogue telecommunication, require considerable efforts to implement. These solutions therefore tend to be rather costly.

Future technologies will, hopefully, enable quasi-standard simple hardware equipment with well-defined interface points. These should easily become adapted to specific needs by supplementary or alternative software and hardware modules.

As shown in the present chapter, many forms of useful equipment are available without reaching the users. Information is a crucial issue if the equipment is to reach those people who need it. British Telecom have been providing a marketing booklet of all telecommunications equipment for people with disabilities (British Telecom, 1991), which may be taken as an example here. This booklet describes telephones with different characteristics and useful devices that are available in the UK. Similar booklets are available in Sweden, France and some other countries, but in most countries, such easily available comprehensive information is lacking.

Lastly, a word of caution is warranted: futuristic scenarios frequently suggest that people with disabilities are on the brink of a new dawn to be heralded by telematics. Whether or not such views reflect reality is debatable. What is almost certain, however, is that even if solutions are available and become well known, deep rooted attitudes towards disabled people must change before the technological development leads to the possibilities for social change that could be the result.

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18

Modularity and Portability

Jan Ekberg, Jori Paananen and Diamantino Freitas

This chapter analyses modularity of telecommunication services, access points and terminals, from the users' point of view. In order to understand why modularity is needed, it is first of all necessary to understand how terminals are used. One way of modelling user functions is presented in Figure 18.1.

An impairment may influence a disabled person's use of a telecommunication terminal or service in different ways. In the model shown in Figure 18.1, this would mean that the user may have reduced functionality in one or more than one block, that is, each disabled person will have a personal combination of reduced functionalities.

Modular Compensation

To compensate for the various degrees of reduced functionalities in each of the blocks depicted in Figure 18.1, terminals, as well as services, should have a similar modular structure, with modules that may be modified. The modular compensations, conversions and transductions may be performed in different parts of the

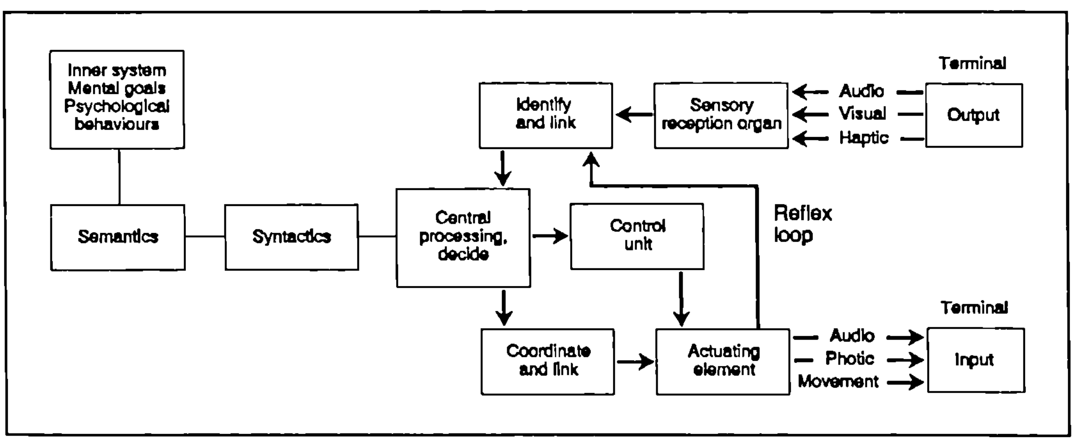

Figure 18.1 A model of user functions (after Klause, 1989).

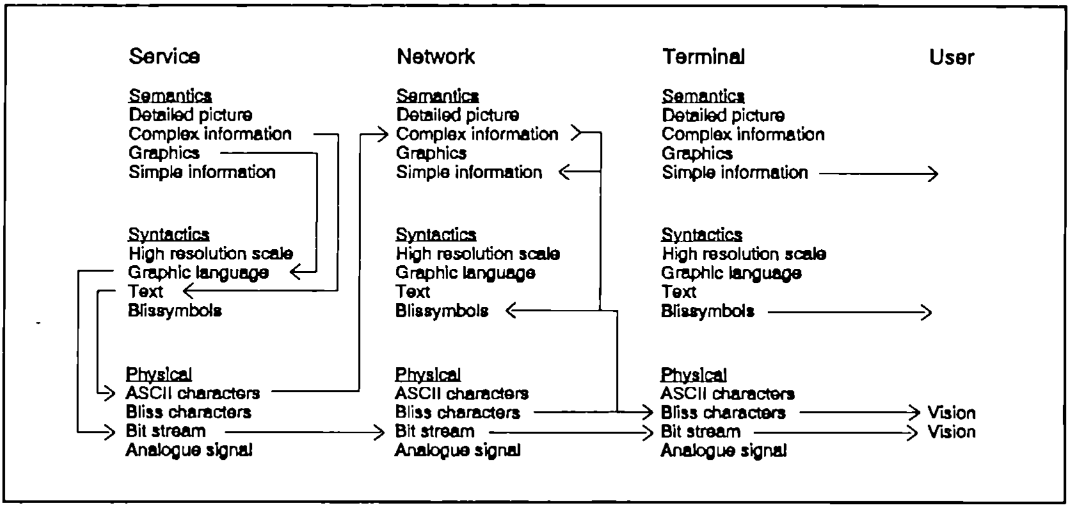

Figure 18.2 An example of information conversion.

communication chain (terminal, network, service access point, service provision site and called terminal) in order to compensate for reduced functionalities encountered at the different levels of the users communication capability. Up to now most conversions have been implemented to compensate for difficulties on the physical level.

In the example shown in Figure 18.2, complex information is converted to a simple form in the network (in the telematic access point service of the network) and transmitted as Blissymbols to the user. The graphical information sent as a bitstream cannot in this case be converted.

Notice that the complex information depicted in Figure 18.2 can be converted in the network because the service has kept the complex information and the graphics separated, sending them respectively as ASCII characters and bitstream, and the service is able to treat the complex information and the graphics as belonging together. By distinguishing information, information types and presentation, conversion may be performed later on at the information or presentation stage.

Modular Terminals

A model of a multimedia and multimodal terminal is presented in Figure 18.3 (Emiliani, 1990). One of the features of a modular terminal is the terminal's ability to adapt itself to the user. This may make the user able to input data or control commands into a terminal using the media most suited to him or her. Similarly, the user may have the output presented in suitable form.

One may consider two levels of adaptive performance:

- detecting and measuring user disabilities. A set-up program could, for example, scan sequentially through the available input and output options, requesting adequate user responses to complete the set-up; and,

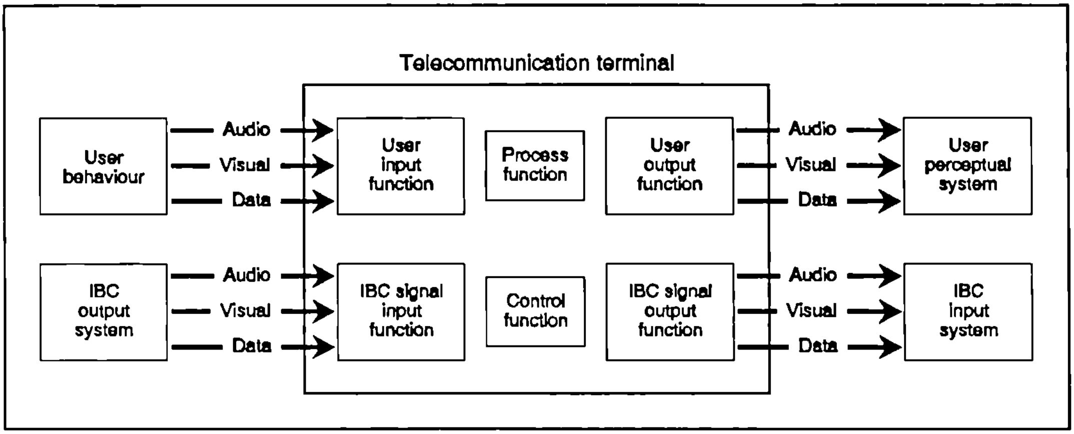

Figure 18.3 A multimedia and multimodal terminal (after Emiliani, 1990).

- configuration of interface use and conversion of information in order to let the user interact with the terminal and communicate in the most efficient manner. This may imply the use of several simultaneous types of input and output.

For instance, the information the user inputs to the terminal may have to be converted from one media to another during the input process, so that the service receives the signal that it is expecting. It may be possible to use functionality already available in the standard terminal, or it may be necessary to add additional functionality to the input stage.

This implies the provision of standard ports or a multipurpose bus to enable additional hardware to be added to the terminal, either internally (e.g. by converting speech to an ASCII text string) or externally (e.g. by providing an alternative input device to produce the same signal as a standard keyboard).

In addition, the software manipulating and acting upon the signal must be well documented, and have clear interfaces, so that additional or optional software modules can be used (cf. chapter 16).

Modularity Means a Family of Terminals

Telecommunication terminals will in the future be based on multimedia, multiservice concepts, using personal computer architectures. There will, of course, also be everything from light weight or simple terminals with only one media (e.g. only voice) to versatile multimedia terminals as well as mobile and cordless telephones. The latter may have suficciant capacity to allow for multimedia communications. What is important is that terminals should follow the same modular principle, or modular architecture, in order to make adaptations easy and facilitate the use of similar conversion modules in different types of terminals.

Transduction is, in general, an optional terminal function, but certain transduction modules, such as speech synthesis and character recognition, may become standard functions of IBC terminals.

The modular design of transduction functions is considered necessary, in order to enable the use of the same transduction module (standard or optional) in different services and applications, and for various user groups (i.e. general purpose transduction modules).

To sum up, terminals should have a modular structure. The modules should be 'universal'. A cheaper terminal should have a reduced set of modules (or simpler modules). The main principle for input and output devices and modules are thus that the terminals should use independent abstract implementation concepts for these building blocks. All specific features should be imbedded in modular drivers, application interface drivers etc.

An Example of Modular Design for Disabled People

In the project 'Modularity in terminals for disabled and elderly people', a multimedia terminal has been developed for experimental and demonstration purposes. The system includes easy-to-use multimedia user interfaces with text, graphics and video output. These are developed, for example, for people with mental retardation and cerebral palsy. A voice output system is also being developed to compensate the disadvantages of a graphical interfaces for visually impaired people.

The basic terminal is an IBM compatible microcomputer with Windows 3 as the application environment. An object-oriented environment with graphical user interface provides many advantages for developing modular multimedia applications. The symbol oriented approach in direct manipulation user interface (with windows, icons, menus and pointing devices) may be easier to use for people with problems in using spoken and written language (e.g. prelingually deaf and mentally retarded people) although it provides some extra difficulties to blind people. Because graphical interfaces are quickly replacing the command language based ones, it is thus justified to find general solutions to these problems in graphical environments (e.g. voice output, tactile displays).

The multitasking environment with simultaneously running applications communicating with each other, makes possible parallel input and output streams of information in different modes, which is an important user requirement for many disabled people. Translation and filtering between different modes of information which is comprehensible to different kinds of disabled users are also easier to do. The applications do not directly manipulate output device drivers, but Windows provides a standard interface (Graphical Device Interface), which virtualizes the output devices, making the applications device independent. Therefore, it is possible to develop highly customized user interface modules which can be fairly easily replaced.

Figure 18.4 presents the modules of the multimedia terminal and connections and interfaces between them. Input and output devices are connected to device drivers (DD) and, through them, to the standard interfaces of Windows. The con-

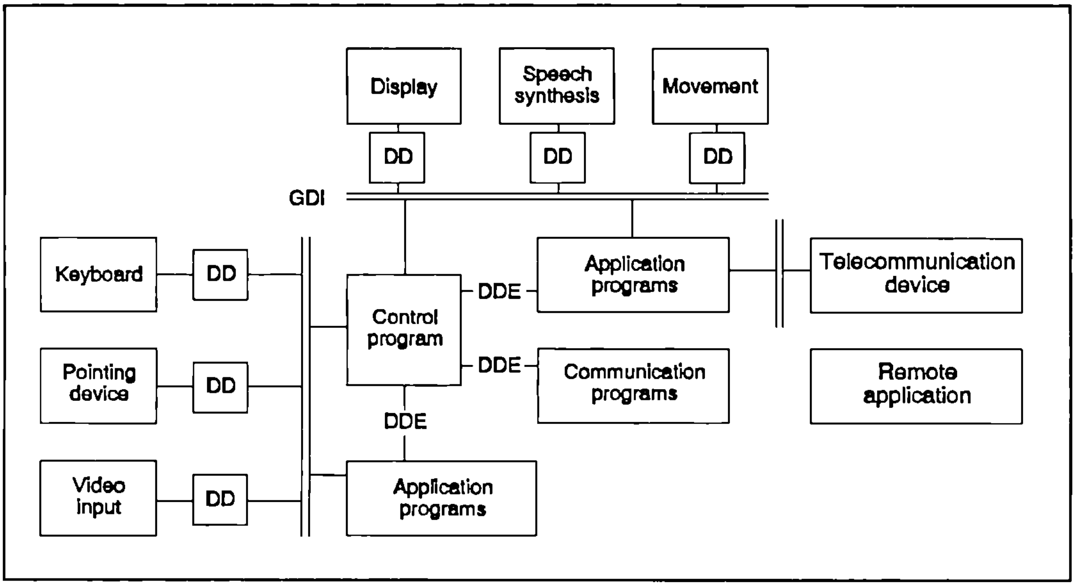

Figure 18.4 Modules, connections and interfaces of a multimedia terminal.

trol program can exchange data and commands with applications provided with the Windows Dynamic Data Exchange (DDE) facility. The control program and the applications are connected through the interfaces to input and output devices and, through the telecommunication facilities, to remote applications (e.g. another terminal, services of the telematic access point etc.).

Expert Systems

The concept of modularity assumes the existence of adequate management and control of the available resources in order to exploit their interaction in an optimal way. The definition of this optimal way includes, in the present case, a man-machine interface problem that could be dealt with using expert systems (in particular, the second generation just emerging, based on the co-operating agents experts paradigm) which pose some significant new challenges and possibilities for man-machine interface design.

A User Interface Agent, part of a global management system, should provide assistance to the user, recognising his or her intention, that is, most probable goals, in order to exhibit co-operative behaviour with regard to the aim that is pursued. A most relevant component of this User Interface Agent is a specific kind of user model, consisting in a number of user characteristics and ratings, which has two main functions:

- to enable the system to exhibit adaptive behaviour to each individual user (the view of the User Interface Agent from the perspective of the user); and,
- to enable other agents to be aware of the capabilities of the User Interface Agent at each instant, related to an individual user (the view of the User Interface Agent from the perspective of other agents).

In these dynamic adaptive systems, the methodology for building up and updating the model for each individual user, is crucial. The simplest strategy could be to ask the user a set of questions. Although this strategy may be important in an initial stage of the man-machine interaction, that is, when the user first starts to use the machine, it has some drawbacks, such as the likely large number of questions required, the probability of inexact replies and decreased functionality of the system.

Another way of accessing information about the user consists in consulting a profile previously made by the system supervisor and recorded in a database, about each individual user, who could be identified, for example, by means of a simple login or voice identification. This methodology should be based on:

- existing stereotypes, i.e. models of groups of users, resulting from the analyses of users' behaviour relevant for efficient and friendly interaction; and,
- triggers, i.e. events that suggest the appropriateness of different stereotypes.

Whenever a trigger is activated, the predictions made by the suggested stereotype are included in the model of the user. The use of stereotypes is a powerful technique to infer many characteristics about a user based only on limited information. Once there is evidence that a user fits a stereotype, the prediction made by that stereotype may be considered default characteristics of that user until any contradictory information appears.

The user modelling component of the User Interface Agent should be able directly to infer information about the user, such as beliefs or goals directly expressed by the user and contributions and adaptations made by the system.

Indirectly, the system should be able to infer global user characteristics from objective facts, using stereotypes; and infer probable plans of the user, using domain dependent inference rules, such as precondition-effect sequences.

In adapting to the individual user, the User Interface Agent should modify and enhance the information passing through it by:

- filtering or focusing on appropriate topics;
- hiding or displaying particular information (e.g. windows);
- providing an a priori explanation to the user; and,
- choosing the level of detail of advice to give to the user.

A complementary perspective that appears at this level is the tutorial performance required of the system in order to interact efficiently with users to which it has not adapted. This topic should be included in the Intelligent Tutor Systems area. Several additional specific system goals, typical of reactive learning environments, may be brought up to serve this purpose:

- allow the user to show his or her problem;
- in the absence of a posed problem, the system tutor should select an appropriate one;
- provide correct answers when requested;
- recognise dubious approaches suggested by the user and produce adequate warning, while allowing continuation;

- make global user performance evaluation, detect user mistakes and choose tasks in this area;
- immediately show comparison between user's strategy and the correct way of solving a problem; and,
- recognise a better strategy produced by the user and incorporate it in the system's data base.

As a global software package, the concept and design of the user interface management system should obey the relevant rules:

- make incremental design possible (important for complex systems by structured growth, horizontal: add more facilities, vertical: make existing facilities more powerful);
- avoid multiple implementation by appropriate modularity;
- use an hierarchial object-oriented approach to enhance portability between different hardware platforms.

Technological possibilities for implementation of such management systems could, for example, be hypermedia based graphical structures.

To sum up, the main principles of man-machine interface system design are early focus on users and tasks, empirical measurement, iterative design and integrate usability design (Gould, Boies, Levy, Richards and Schoonard, 1990).

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19

Standardisation

Jan Ekberg, Björn Lindström and Knut Nordby

Telecommunications have become important to all citizens in daily life, work and leisure time. Despite this there are practically no standards today for telecommunication services or terminals that take the requirements of elderly and disabled people into consideration.

In the past this did not lead to many difficulties since the national telephone companies sometimes provided facilities, subsidised by the state, making it possible, to some extent to provide for users with special needs.

With the current move in Europe towards privatisation and deregulation this situation has changed. Market forces make it more difficult to take the needs of elderly and disabled users into consideration. The costs of manufacturing equipment specifically for these users are higher because the market is more fragmented. However, if equipment for general use is designed with the needs of disabled and elderly people in mind, it can be better used by them at little or no extra cost. On the other hand, the special services for elderly or disabled people are usually labour intensive and hence more costly.

The solution to some of these problems seems to be that we need general international standards or recommended codes of practice to specify the functional requirements that terminals and services should fulfil. We also need new legislation in order to supplement the standards in this area.

The goal in society today is that everyone should have a high quality of life. This means that as far as possible, elderly and disabled people should be given the possibility of living independently in their homes outside closed institutions.

Therefore it is important that the requirements of people with special needs are seriously taken into account when new services are designed and when new standards are made, first and foremost to make basic telecommunication services accessible to as many people as possible. This will reduce the need of having to provide special services and terminals to other than the very special groups of disabled people who cannot be helped in other way.

The term *people with special needs* includes all people who, for any reason such as physical or intellectual impairment or disability, temporary illness or injury, advanced age etc, will encounter barriers against access to, and difficulties in, using the telephone and other telecommunication services.

Standardisation Work

The international telecommunication standards are produced by CCITT (Comité Consultatif International Télégraphique et Téléphonique), which belongs together with its radio technical counterpart to the ITU (International Telecommunication Union), founded in 1865. The European part of the standardisation work is performed by the European Telecommunications Standardisation Institute (ETSI).

One reason why ETSI was set up is that European standards can be produced much faster than comprehensive international standards, and may thus be used as reference standards for the final work in CCITT. Another reason is that ETSI has a larger background, including, for instance, academic institutions, research agencies and industry, thus making the support for the standards (and thereby acceptance) broader from the very beginning. Its Technical Committee 'Human Factors' (TC HF) has a sub technical committee (STC HF 2 'People with Special Needs').

The first report from STC HF 2 has already appeared (see chapter 20). It indicates some solutions to problems encountered by disabled people. As a result of this paper, an interest in disability issues is already spreading to other technical committees in ETSI, making it possible to take the problems of disabled people into consideration from the very beginning in the other standardisation groups within ETSI as well. Thus, the STC HF 2 is not – and should not be – the only group of standardisation where the problems of disabled people are noted. On the contrary, disabled people should be part of all standardisation work, thus starting at level one (cf. CCITT Service Description) with user interfaces, ergonomics etc.

Office and computer technology standards are prepared by ISO (International Standardisation Organisation). The Office Document Architecture (ODA) as well as the Office Document Interchange Format (ODIF) are examples of standards describing how text, graphics, data, and, later on, video information, should be coded. Also for this standardisation work it is important that people with special needs are taken into account.

In most cases, the telecommunications protocols and standards are independent of the user or the application, except for standards describing the user interface of the terminals or the services. The Appendix lists some of the standards which are especially important for users in general and for disabled people in particular.

What Do We Need?

The basic user functionalities which should be specified by the new standards are: *compatibility, non-discrimination* and *quality assurance.*

Compatibility

Compatibility requirements have always been one of the major objectives of telecommunications standardisation work. A telephone conversation across the earth is possible because of standards describing the functioning of the telecommunication networks and terminals. This compatibility is not always found between special devices for disabled people. As an example, the existing text telephone systems for the deaf are not compatible. This is due to historical reasons; different national solutions were introduced without international cooperation and standardisation (cf. chapters 25 and 26).

For a disabled person the use of a current standardised terminal is not always possible. This is why special devices, such as enlarged keyboards for motor impaired people and Braille reading devices for blind people, have been designed. The task of the standardisation work, in this case, is to ensure that communication between standardised and special devices is achieved, preferably without an intermediate conversion service.

Non-Discrimination

Non-discrimination requirements should apply to public telephones and telecommunication terminals, as well as to other self-service equipment, such as automatic banks and ticket machines. An elderly or disabled person should be able to use all such public devices. For this reason these devices should be equipped with optional input and output facilities or standardised interfaces for the connection of special devices. The design of these devices must conform to current trends of style. In particular, the device should not look 'clinical' or 'prosthetic' in any way.

Quality Assurance

All terminals should fulfil a specified minimum level of quality. This means that the technical life span of the terminal must be long enough, the sound or picture quality must be good enough, and parameters like sound level and contrast should be adjustable if necessary. When coils are included for inductive coupling, the electro-magnetic field strength should conform to specified minimum standards.

An inferior quality will increase the size of the group that cannot use the terminal, and thus increase the number of people who become handicapped. Hence, the goal of standardisation is to make terminals usable to as many people as possible.

Standardisation also means larger production series and thereby lower prices. The required quality defined by the standards will not make a product less competitive, because all manufacturers will have to comply with the requirements defined in the standards. But standards as such are not enough, legislation is also needed to ensure that the standards are followed and not only considered wishful thinking.

Today's telephones, mobile telephones, fax machines and video recorders are some examples of equipment that can be difficult to use without a standardised user interface that takes disabled and elderly users' needs into consideration.

A primary consideration for all equipment is that the safety of the user is paramount. Safety is not only covered by electrical safety regulations, but also includes such issues as acoustic shock, reliability in emergency situations etc.

What Do We Have Today?

Today, there are practically no standards for telecommunications terminals or services that take disabled or elderly users requirements into consideration. This has made it possible to flood the market with low quality, bizarre, funny looking and unreliable telecommunication products that may be difficult to recognise as telephones, are difficult to use, will not work with hearing aids etc. Lately there has been a trend in the USA to move back to high-quality telephones as a reaction to the deluge of low quality 'trendy' telephones.

The lack of standards has also made it possible to introduce telecommunication services that almost exclusively serve the well educated young male users. This lack of functional standards has also allowed, for example, videotex services providers to rely on graphical interfaces, making it almost impossible for blind people to read the screen even with the help of, for example, a speech synthesizer.

How Should We Standardise?

Because technology is continually developing, one should not standardise the technical solutions that are possible today, but rather the functional requirements to be met by the terminals and services. For example, the use of a cathode ray tube as a display should not be standardised, but the minimum contrast and legibility that a display must provide should be.

Standardisation Topics

The European Telecommunications Standards Institute (ETSI) Technical Committee for Human Factors (TC HF), Technical Sub-Committee for People with Special Needs (STC HF 2, formerly STC HF 4) set up a project team, 'Telecommunications facilities for people with special needs' (PT 6 V), in 1990 in order to investigate the standardisation situation in Europe and propose a priority list of areas where standards are needed.

Preliminary results show that, with one or two exceptions, no national or international standards in the field of telecommunications for people with special needs exist in Europe. The conclusion must be that international standards are needed in every single area.

A list of recommendations for minimum quality requirements for public telephone terminals was proposed in 1991 by ETSI STC HF 2 in a draft Technical Report, 'Access to Telecommunications for People with Special Needs' (see chapter 20). This report contains recommendations for modifications of public (and other) telephone terminals to obtain access for as many user categories as possible. These recommendations were primarily based on work done by COST 219 and other research bodies, and cover some of the most important areas for standardisation that have so far been identified:

- physical access to public telephones;
- design of telephone booths;
- visual display of line signals;
- improved handling and legibility of telephone directories;
- simple and unified dialling and call set-up procedures for all kinds of telecommunication services;
- improved methods for payment, coins and cards;
- alternative modes of communication;
- amplification;
- special frequency requirements in alarm systems;
- minimum requirements for electromagnetic field strength for inductive coupling between telephones and hearing aids with pick-up coils;
- standards for text telephones protocols;
- minimum requirements for interfacing personal computers with telecommunication services;
- special requirements in telephones for different kinds of disabled people, such as legibility requirements in displays and videotex graphics legibility requirements with Braille reading devices; and,
- remote controls in the home.

This list contains only a selection of important standardisation issues, and no attempt has been made here to set up priorities.

The standardisation work may proceed without a long research phase. It is important that the accumulated knowledge is put to use by the standardisation bodies instead of repeatedly proposing new research, which in many cases amounts to nothing more than 'reinventing the wheel'. In most of the areas mentioned in the list above, the basic information needed to carry out such standardisation work already exists.

The Standardisation Situation in Europe

The ultimate goal is to have fully accepted international standards for minimum quality requirements for public (and, eventually, for all other) telephones. This task can only be dealt with through the international standardisation bodies for telecommunications, such as ETSI, ANSI, CCITT etc., if the standards are to carry the necessary power to have any impact on the situation for people with special needs.

The objection has been raised that the telecommunication industry will not accept, or is very reluctant to accept, any standards related to people with special needs being imposed on telecommunication equipment. They fear that having to comply with such standards will increase expenses and interfere with their competitiveness in the market place.

We know, however, from the automotive industry that various international and national standards for cars are accepted, and because the standards must be adhered to by *all* manufacturers and importers, they do not create any market advantage or disadvantage to any single company.

The alternative to full international standardisation is national legislation. This may lead to different codes of practice being adopted in different countries if care is not taken to co-operate internationally. There is, of course, the danger that national requirements for telecommunication equipment in smaller countries may not be economically interesting enough to be taken into consideration by the large multinational telecommunications companies, which are increasingly dominating the telecommunication markets in the wake of deregulation and privatisation.

If international standards can not be agreed upon in the foreseeable future, national legislation in each country may be the only way to safeguard the interests of people with special needs. In that case, it is important that the international standardisation bodies at least agree upon *common recommendations*, which can serve as models for national legislation in the participating countries and ascertain that the national laws will be as similar as possible. Common requirements in all, or most, countries in a region will increase the size of the potential market for the telecommunication companies and, hence also make it more profitable to take the national standards of smaller countries into consideration.

Ideally, standards should be universal, but this will take an exceedingly long time to achieve. In the meantime, one should create regional (i.e. European, American etc.) standards, produced by regional standardisation bodies (ETSI, ANSI etc.). It is hoped that these standards will then serve as models for world-wide universal standards (i.e. CCITT, ITU, ISO etc.) for the benefit of people with special needs.

Appendix

Examples of Telecommunications Standards

This list is based on the ISO Open Systems Interconnection structure. The aim of the list is not to explain details but only to show that well-established standards should also be checked for compliance with the needs of disabled people. Standards marked with an asterisk are important for disabled people.

General

ISO/DIS 9999	*Technical Aids for Disabled Persons – Classification Gives a comprehensive overview of the classification of all types of technical aids for disabled people.

Virtual Terminal

ISO 9040, 9041	*Virtual Terminal Protocol (Service, protocol)

Message Handling Services

CCITT X 400 F.400	*Message handling systems (ISO 8505 MOTIS, 8883 MOTIS protocol). Describes the electronic mail facility. The user is served by a User Agent, including the dialogue with the user, message transfer as well as reception and storing.

CCITT X 409	*Message Handling Systems Presentation, Transfer Syntax and Notation
CCITT X 500	*Directory services (F.500)
ISO 9594	

Office Document Architecture

CCITT 400	Document Transfer Access and Manipulation (DTAM)
ISO 8613	Office Document Architecture (CCITT T 411–418) Includes document structure, profile, character content architecture, raster as well as geometric content architecture.

Presentation

ISO 8822	*Presentation service
ISO 8823	*Presentation protocol
ISO 9241	*Ergonomic Requirements of Office Work with Visual Display Terminals includes (some parts are not yet ready) Keyboard and Display Requirements, Workstation lay-out Non-Keyboard input devices, Dialogue, Usability, User guidance, Menus and commands, . . . as well as Natural Language dialogues.
ISO 8824 CCITT Rec X409	*Specification of Abstract Syntax Notation One (ASN.1) Describes how the information and data should be structured.
ISO 8825	Basic encoding rules for ASN.1
CCITT T.4, T30	*Telefax
CCITT 503	*Group 4 Faximile ODA compatible
CCITT 501	*Mixed mode (pictures, data)
CCITT S–100 F.300	*Videotex
CCITT T–200 F.200	*Teletex services
CCITT T–60	*Terminal equipment (Teletex)
CCITT T–61	Character coding (Teletex)
CCITT T–62	*Control procedures (Teletex) For Teletex, Facsimile, Videotex, MHS, and Directory Services
F.721	*Basic narrow band videophone service in the ISDN
F.730	*Service oriented requirements for the telewriting applications

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Proposals for Standardisation Activities[1]

Knut Nordby

The scope of this chapter is both to identify some of the main factors that can inhibit the access to and use of telecommunication services for people with special needs, and to propose recommendations for improvements and changes in terminals and services to make basic telecommunication services accessible to as many people as possible.

This survey is in no way a comprehensive treatment of all impairments and disabilities that can occur, nor of all possible problems that people with special needs may encounter in using and accessing telecommunications or the recommendations for solutions to overcome these problems.

It is important that the requirements of people with special needs are seriously taken into consideration when new telecommunication services are designed and when new standards and ETSs are made, first and foremost to make basic telecommunication services accessible to as many people as possible, and secondly, this will reduce the need for having to provide special terminals and services to other people than the most seriously disabled people (e.g. deaf-blind people) who cannot be helped in any other way.

Background

With the continually improving health standards, elderly people not only now tend to live longer, but will, despite the universal lowering of the retirement age, lead much longer active lives. They will also tend to live more independent lives, be economically better off than previous generations and will constitute important new users of telecommunication services.

Because of their age related impairments and disabilities, special considerations should be given to the design of telecommunication equipment and services so as not to exclude them from using the new telecommunication services now being developed.

With the worldwide and accelerating growth in industrialisation and urbanisation, increasing segregation of working and living areas and increased mobility for large population groups, more and more people of all ages will be dependent on telecommunications.

Previous rural populations, with little or no formal education, who are now increasingly urbanised, must learn to cope with modern technology, including telecommunications. Special considerations in the design of simple to use equipment and services are needed.

A more recent trend, which is currently gaining momentum, is the increased recognition for integrating disabled people into society instead of caring for them in specialised institutions. These people will be much more dependent on telecommunications to be able to lead independent lives outside the safety of closed institutions.

These people will have much more diverse and special needs in relation to telecommunications than the above mentioned groups, but taken together all these groups will be a challenge to designers and providers of existing and new telecommunication services.

This chapter is based on Frederiksen, Martin, Puig de la Bellacasa and von Tetzchner (1989).

Solution for Disabled People

Visual Impairment

Physical Access: Private Subscribers

Blind and partially sighted people have relatively few problems in getting access to the telephone in *well known surroundings*, e.g. in their home, at their site of work or in the houses of family and friends, but they may have great difficulties in locating a telephone in less familiar surroundings.

A blind person may often be able to locate a *ringing* telephone by auditory localisation, but in some surroundings it is not always possible to pinpoint the position of a ringing telephone due to bad acoustics. Some modern telephones' ringing signals also have very poor directionality for auditory localisation.

Physical Access: Public Telephones

Blind and partially sighted people are not able to locate telephones in *open* and *strange surroundings*, e.g. public telephones and telephone booths, if the telephone is silent or the site is not marked in a way that is easy to perceive by blind and partially sighted people, e.g. sound signals or specially patterned pavement/floor surfacing.

PROPOSED SOLUTIONS

It is important that telephones are identified so that blind and partially sighted people are able to locate them, e.g. by showing their positions on direction boards or floor plans, or to mark them acoustically or by specially patterned pavement or floor surfacing that is easy to perceive by blind people.

Payment: Coins, Cards

Blind and partially sighted people will normally have few problems in identifying and handling coins of different denominations in their own currency, whereas coins of foreign currencies may constitute great obstacles. Magnetic cards are also easy to handle, but must be identified for correct way to insert, e.g. a notch or cut corner.

Locating and identifying the coin/card insertion slot (or slots when different denominations must be inserted in different slots) can be a major problem. Visual displays, showing either the amount that has been inserted or the amount that remains, and prompts to insert more coins are, of course, impossible to use by blind people.

PROPOSED SOLUTIONS

Slot(s) for inserting coins should be marked with reliefs for easy identification of *where* the coins must be inserted and *what denominations* the terminal will accept.

Terminals that accept magnetic cards, should have the insertion slot marked in a similar way to show where to insert the card and how the card must be inserted or moved through a card reader. Cards should be tactually identifiable for correct way to insert.

There should be some form of acoustic feedback to advise the user about the amount that has to be inserted, the amount that has been accepted by the terminal and, during a call, of prompts to warn the user if more coins must be inserted.

Reading Telephone Directories

Blind and partially sighted people who cannot read ordinary print cannot use the telephone directory or printed signs displaying telephone numbers and directions for making calls. Directories printed in *Braille* are too bulky, expensive and impractical to provide blind people with telephone numbers and other information. Also, relatively few blind people can read Braille.

People with reduced vision, who can read with aid, may have problems with the small print and poor contrast in many directories (a situation which is not improved by the usually low level of lighting at public telephones where the directories have to be read).

PROPOSED SOLUTIONS

A service with prerecorded or synthetic speech, or manned by operators, to give verbal information about telephone numbers and call set-up procedures, should be provided to help blind and partially sighted people and other people who cannot read. Telephone directories should be printed in larger typeface and have better print-to-paper contrast.

Lifting Handset: Going 'Off-Hook'

Once the handset has been located, blind and partially sighted people have no problems in lifting the telephone handset *off-hook* to initiate call set-up or to answer a call. For *hands free* mode and other services that require different procedures for initiating the terminal (e.g. off-hook or en-bloc dialling), blind and partially sighted people may have problems in identifying and operating an unorthodox off-hook function correctly.

PROPOSED SOLUTIONS

Terminals that require other procedures for initiating than lifting the handset off-hook to dial, should have an easily recognisable control, with standardised markings for both tactile and visual identification and simple acoustic prompts.

Dialling the Number: Reading the Keys

Blind and partially sighted people can normally use a standard telephone for dialling ordinary calls, but it is absolutely essential that the number dialling keys, or the digits on the dial, are laid out in the *same* standardised way on *all* telecommunication terminals.

To assist blind and partially sighted people, the 5-key should be identified by a 'dimple' or other tactile marking. Unfortunately, both CCITT and ISO number keypad layouts are currently in use on telephones and other teleinformatics equipment. It is impossible for blind and partially sighted people to determine the actual layout of the numbers on a keypad (or dial), even when the 5-key is tactually identified, since this key is located in the same position in both key layouts. ISO number key layouts should not be used.

Non-standard dialling key layouts and function keys marked only with text, abbreviations, icons, pictograms, symbols etc., are not accessible to blind people. Keys should be marked with reliefs and grouped according to their functions for easy tactile localisation.

If standard and non-standard keypad and dial layouts are mixed (e.g. as in Denmark and Norway), blind and partially sighted people will have problems. They have no way to figure out the layout of a particular keypad or dial by themselves. It is therefore imperative that only standardised keypad and dial layouts are used.

PROPOSED SOLUTIONS

The layout of the number dialling keys on all telephones and telecommunication terminals where telephone numbers has to be dialled should conform to *CCITT Recommendation E.161.*

'2 x 6' or '6 x 2' key layouts are best avoided. If they must be used they should also follow the CCITT recommendation. Novel and unorthodox key layouts should never be used since they will only confuse blind and partially sighted people. Turning dials should also conform to *CCITT Recommendation E.161.*

Keys for auxiliary functions and supplementary features (e.g. redial, store/recall number, hold etc.) should also be standardised and positioned in such a way that they will not be confused with the number dialling keys. They should be marked with reliefs for easy identification. This is also good practice for non-impaired users.

Dialling the Number: Turning or Pressing

For people who must rely only on tactile and haptic information, it is important that the size, spacing and layout of keys and controls follow good ergonomic practice to facilitate the use of the terminal. This is also beneficial for non-impaired users. Small and crowded keypads are very difficult to use for people with visual (and motor) disabilities, and keys and controls located out of context or in unexpected positions may be impossible to find.

Using the traditional telephone turning dial is no problem for blind and partially sighted people, provided it follows the standard layout. They count off the finger holes on the dial until the correct digit is reached, then turn and release the dial in the usual way.

PROPOSED SOLUTIONS

The size and spacing of keys should conform to accepted standards and well established ergonomic practice for keys. Grouping and positioning of keys should be logical and standardised to facilitate their localisation.

Keys should be marked for easy visual identification with large, high contrast numbers and legends for people with reduced vision who can read. Colour coding alone should be avoided because of colour blind people. If used, it should never be the only mode of coding, but an addition to other information.

Visual Alerting Signals

Blind and partially sighted people cannot access visually displayed information, e.g. identify the active line in telephones with line light indicators, or the current status of multimode keys, where mode is indicated by lights, LEDs or LCDs.

PROPOSED SOLUTIONS
Essential, visually displayed information should also be given in parallel, either as acoustic signals or in a tactile form (e.g. buttons that pop up, vibrators, flags etc.) to indicate active line or function mode.

Colours
Many visually disabled people also have reduced or no colour vision. Use of colours as the only means of coding or identification should thus never be used. If colour coding cannot be avoided, it should always be in addition to other information, e.g. to icons, pictograms and symbols, text or abbreviations, inverse contrast, etc., for information redundancy.

If colours are used to identify different groups of keys (e.g. dialling keys vs. function keys), clear, inverse colour contrasts (e.g. white keys with red legends vs. red keys with white legends) can be acceptable for those with some vision. All colours used should transform into clearly discernible grey-tones on the monochrome grey-scale

PROPOSED SOLUTIONS
Colours should never be used alone to indicate vital functions and messages, but always in addition to other modes of information. If colours are used to identify or separate keys and information on displays, the colours should be chosen so that they are easy to separate into distinct grey-tones when transformed to the monochrome grey-scale.

Auditory Impairment

Line Signals
Profoundly deaf people with fully intelligible speech are potential users of ordinary telephony for giving one way spoken messages. However, they cannot hear telephone line signals, i.e. dialling tone, ringing tone, engaged tone etc., and cannot know when to dial, if the other telephone is ringing, if the other party is engaged etc.

PROPOSED SOLUTIONS
Visual displays, showing line status in text or symbols (ISDN), indicators that mimic line signal time cadences, should be provided on telephones to aid profoundly deaf people.

Acoustic Alerting Signals
Even a moderate hearing loss can make it difficult to hear a ringing telephone. Amplification of the ringing signal, combined with remote bells, and alerting lights, on the telephone or remote from it, will aid hearing impaired people. Remote tactile vibrators, carried on the person, may be an interesting new aid.

PROPOSED SOLUTIONS
All public telephones should also have some visual indication of the ringing signal. All telephones should have provisions for adding acoustic, visual or tactile signals, either local or remote, to aid hearing impaired people.

Vocal Communication

Deaf people with poor or unintelligible speech cannot communicate vocally. For these people the text telephone for written communication or the videotelephone for sign language communication and for lip reading would provide the best solutions.

Most post-lingual, profoundly deaf people retain intelligible speech and can use the telephone for vocal messages to hearing people, even though they cannot hear the replies. To aid profoundly deaf people, it is important that all operations to be performed and all signals to react on are also visually displayed.

People who are hard of hearing can use the ordinary telephone if some consideration is given to its design and to its surroundings.

The introduction of piezoelectric earphones in modern telephones has degraded the telephone service for hearing impaired people who use hearing aids. Inductive coupling between the telephone handset and the hearing aid is the most beneficial feature to telephone communication for hearing aid users. Means should be found for obtaining good inductive coupling to hearing aids and a minimum electromagnetic field strength should be specified.

Acoustical amplification, with a loudness control, is of great help to people who are hard of hearing who do not use hearing aids and have no recruitment. To be of help, the amplification should have a gain of at least 20 Db (precautions may then be necessary to avoid acoustic feedback, which may lead to feed-back howling).

Reducing ambient noise at telephone sites will improve intelligibility for all users since noise is very destructive to vocal communication, especially when the hearing is impaired.

PROPOSED SOLUTIONS
All telephones should provide for inductive coupling to hearing aids, e.g. by use of electrodynamic earphones, coils or other means. A standard for a minimum field strength is required. Adjustable, acoustical amplification should be provided for people who are hard of hearing, but do not use a hearing aid.

Operator Controlled Alarm Services

Profoundly deaf people without intelligible speech may only be able to give simple error messages or alarms of errors in the system.

Profoundly deaf people with intelligible speech are usually able to give vocal error messages and alarms, but cannot interact with an operator or the recipient of the message.

People who are hard of hearing can normally communicate with an operator, although communication may be more difficult than for people with normal hearing.

PROPOSED SOLUTIONS
Operators of error and alarm telephones should be trained to deal with various communication disabilities to prepare them for situations where they must communicate with deaf, hard of hearing and speech impaired people.

Impairment of Speech Production

Depending on the type of impairment, the requirements for special services and equipment for telecommunication are different.

Vocal Communication: No Voice Output
People with no voice output or totally unintelligible speech cannot communicate vocally by telephone. For these people an optional keyboard or a text telephone for written communication may offer the best solution. The videotelephone for lip reading support and sign language communication may soon offer good help.

The degree of intelligibility of the speech of people who speak with reduced intelligibility will vary greatly. This will influence vocal communication to different extents. Moderate levels of intelligibility may lead to some misunderstandings and the need for frequent repetitions. Some people with low intelligibility speech may not be able to conduct telephone conversations, although they may be able to communicate vocally in face-to-face situations.

Visual Communication: Lip Reading
People with reduced speech intelligibility who cannot use the telephone, but who can communicate vocally in face-to-face situations, may find that the video telephone may enhance their vocal communication, e.g. by lip reading and gestures.Some people with impaired speech production also lack control of lip movements (e.g. people with cerebral palsy) and these people cannot use the video telephone for lip reading.

Operator Controlled Alarm Services
Reduced intelligibility may make communication with operators or personnel manning alarm telephones difficult, especially over poor quality lines.

PROPOSED SOLUTIONS
Operators of error and alarm telephones should be trained to deal with various communication disabilities to prepare them for situations where they must communicate with speech impaired people.

Reading Difficulties

People with severe reading difficulties will normally be able use the telephone for making ordinary vocal calls.

Instructions and Guidelines

People with reading disorders may encounter problems with tasks that involve reading user instructions and other printed directions. This may inhibit their use of many new services where long and complicated operating instructions and user procedures must be read.

People with insufficient reading education, lingual minority groups, refugees and people visiting a foreign country with a different language from their own and people with different kinds of reading problems will all encounter great problems in dealing with written directions for use and telephone directories.

> PROPOSED SOLUTIONS
> It is important that easy-to-understand directions for use are worked out using pictograms, miniatures, icons, symbols or simple abbreviations to help people with reading difficulties to use telephones. All pictograms, miniatures, icons, symbols and abbreviations used should be designed for easy recognition and understanding, and should be internationally standardised. Electronic coded dialling aids may benefit some of these people.

Reduced Language Comprehension

When referring reduced language comprehension and intellectual impairment it is assumed that the impairment is not so serious that it precludes using a telephone or other form of telecommunication.

Payment

People with reduced language comprehension and intellectual impairment may have problems in following and understanding instructions on user procedures, such as the right order of activities in paying (e.g. to lift the handset off-hook before inserting coins). They may also have difficulties in understanding the use of money and to identify coins of different denominations.

> PROPOSED SOLUTIONS
> Procedures for paying should be very simple and standardised; i.e. the order of actions should always be the same. Instructions should be graphic and extremely simple to comprehend and follow for people with intellectual impairment and impairment of language comprehension, but also for people with little education, people who only speak foreign tongues or people who belong to linguistic or ethnic minority groups.

Access to Telephone Directories: Reading

People with reduced language comprehension and intellectual impairment will typically not have the necessary reading skills for using the ordinary telephone directory or reading other printed instructions for using telephones and other telecommunication equipment. They may, however, recognise simple icons and abbreviations and may comprehend and be able to follow graphic instructions. They should be trained in using the telephone.

PROPOSED SOLUTIONS
Basic user instructions should not demand reading skills or knowledge of the local language. Simple graphic instructions, with miniatures and pictograms showing sequences of procedures, should be standardised to make telephones accessible to people with reduced language comprehension.

Mobility Impairment: Legs and Feet

The main problem for mobility impaired people may be getting to the telephone so that they can use it. For people who are confined to the bed, equipment should be designed in such a way that it can be used from the bed.

Physical Access: Private Subscribers
Physical access to telephones in the homes of mobility impaired people can usually be arranged in such a way that it is no great problem to reach the telephone. In the houses of other people, e.g. family and friends, this can be more difficult. At places of work, in some offices, etc., there may sometimes be problems in placing telephones in such a way that mobility impaired people can have easy access to them. The cordless telephone, or even the mobile telephone, should be of great help to mobility impaired people

A person walking with aids or using a wheelchair may need some time to get to and answer a ringing telephone. It may take so long that the other party gives up and hangs up. Some kind of remote control (e.g. an infrared or radio device) to electronically take the telephone 'off hook' when it rings and give a simple message e.g. 'please wait, I will soon be with you', should be of great help to mobility impaired people.

PROPOSED SOLUTIONS
Provisions for using an electronic 'off hook' remote control device, that gives a short 'wait' message, should be standardised to aid mobility impaired people who need some time to answer a ringing telephone.

Physical Access: Public Telephones
People who use wheelchairs or can only walk with aids can often have considerable difficulties in accessing public telephones, e.g. having to mount stairs to get to it. Also, the design of public telephone booths leaves much to be desired in accessibility for people who use wheelchairs or can only walk with aids.

There are three major types of public telephone booths:

- *Closed telephone booths,* where the with of the entrance, the operation of the doors, the height of the entrance step, insufficient space inside and, not least, the high placing of the telephone makes them impossible or very difficult to be accessed and used by people in wheelchairs or who can only walk with aids.

- *High open booths,* where the high placing of the telephone makes them impossible or difficult to use from a wheelchair, and where the ambient noise level, due to lack of acoustic insulation at the level of the wheelchair user's ears, makes it difficult to carry on a conversation or to keep it private.

- *Open booths with telephones placed low*, where they are easily reached and operated from a wheelchair, but where the level of the wheelchair users' ears, makes it difficult to carry on a conversation or to keep it private.

PROPOSED SOLUTIONS
Public telephones and telephone booths should be designed for full accessibility to people in wheelchairs and people who can only walk with aids; there should be no steps; the width of the booth and its door should allow entry of a standard wheelchair; doors should be easy to open and close by a seated wheelchair user and should not require any strength to operate.

Telephones should either be placed at a height where they can easily be operated by a person in a wheelchair or a standing, short person, or it should be height adjustable; the acoustic conditions in the booth should not adversely affect intelligibility or make it easy for other people to overhear conversations.

There should be some form of fold-away seat or body support for people with little strength in their legs to sit on or to support themselves on while making calls. Telephones should be placed at a height where they can easily be used by seated people, children and people of short stature. There should be a shelf for people with little strength in their legs for supporting themselves and directories and for writing.

Lighting should be sufficient and properly arranged for operating the telephone and for reading operating instructions and telephone directories by wheelchair users.

Payment
People with mobility impairments have few problems in handling coins and cards if they can only reach the insertion slot. Even when the telephone is placed at a low position some parts may still be out of reach to people in wheelchairs; e.g. if the slot for inserting coins or cards are placed on top of the terminal. It is important that all the telephone functions can easily be operated from a seated position or by children and people of short stature.

PROPOSED SOLUTIONS
Public telephones should have all controls, i.e. dialling and function keys, handset, coin/card insertion slots, etc., placed so that they can all be operated from the same seated or low position relative to the telephone terminal.

Telephone Directories
Telephone directories are often fixed or hinged to the desk or the wall in public telephone booths and can be difficult to handle, or totally inaccessible, to people in wheelchairs or to people of short stature.

Lighting is often insufficient where directories are fixed and must be read, and is often arranged in such a way that someone leaning over the directory to read it will put it in a shadow. Lighting should be arranged for good visibility in the booth of all functions and for reading operating instructions and directories without putting them in a shadow.

PROPOSED SOLUTIONS
Telephone directories should be positioned and secured in such a way that they are fully accessible to people in wheelchairs or people who have to get close to read small print. Lighting in telephone booths where directories are read should be sufficient, non-glaring and arranged so that nearsighted readers will not put the text in their shadow.

Reduced Motor Control and Strength

Some people have little or no motor control and/or little strength, or they are restricted by medical equipment or confined to fixed postures (e.g. lying prone or supine). These people will require special solutions.

PROPOSED SOLUTIONS
One-piece, compact or cordless telephones are very useful for most bed confined people. Electronic telephone directories (displayed on a screen), loud speaking or hands-free telephones and remote answering devices should all be helpful to people who have little strength, are restricted in their movements or are in fixed postures. Telephones on trolleys, like the pay-phones used in hospitals, may be used in the home.

Motor Impairment in Arms and Hands, Reduced Strength

People who have lost one or both arms or hands, or have problems using one or both arms or hands due to upper limb motor impairments, are still able to communicate normally via the telephone, but they may encounter great problems in operating a standard telephone terminal.

Access: Private Subscribers
At home, people who cannot use their arms and hands can have special foot-operated devices to lift the handset off-hook and hold the handset in the right position for speaking. Many motor impaired people have become experts in dialling (push buttons and rotary dials) with e.g. mouth-held sticks or other similar devices.

Access: Public and Other Telephones
When people who cannot use their arms and hands have to use telephones outside their homes they meet nearly unsurmountable physical obstacles. They may still be able to use a mouth stick or similar device for dialling, but opening the doors of some telephone booths, or lifting the handset off hook and holding it against the ear during the conversation, may be nearly impossible.

An automatic door opener/closer, operated by a treadle or large touch panel, the hands free (i.e. non-handset) telephone mode and large dialling keys, that require little force to operate, can make it possible for some people who cannot use their arms and hands to access and use a telephone for making ordinary calls when away from their homes.

PROPOSED SOLUTIONS

Public telephones and telephone booths should be designed so that people who cannot use their arms and hands are able to make ordinary telephone calls without enlisting the help of other people.

If doors are fitted to telephone booths, they should be operated from e.g. a treadle or large touch panel or button that requires little force, to make access possible for people with little strength and for people who cannot use their arms and hands.

Telephones should be designed in such a way that they can be operated with e.g. a mouth stick (or similar device) by people who cannot use their arms and hands.

All push buttons and keys should be large enough to receive the end of a mouth stick; keys should require little operating force; keys should have a slightly concave and non-slipping surface, and keys should face the user at an angle that is appropriate for operation by a mouth stick, but they should also be visible to non-impaired users.

Payment

Handling and inserting coins and telephone-cards can be next to impossible for people who cannot use their arms and hands. There are mouth-operated pincers and other special devices that these people can use.

In an emergency situation, some people may have to use their lips and teeth to pick up and insert coins or cards, but most people will find this rather unattractive as a routine operation. It is important that slots for inserting coins and cards are positioned so that it is possible for people who cannot use their arms and hands to be able to insert coins and cards with a mouth operated tool.

PROPOSED SOLUTIONS

All public telephones should be made accessible to people who cannot use their arms and hands for paying with coins or cards by arranging the positions of insertion slots in such a way that coins and cards may be inserted with a personal tool or, in an emergency, directly by mouth. The facility to pre-feed coins, to save having to do this during a call.

Handling Directories

People who cannot use their arms and hands cannot manipulate a telephone directory or turn its pages. They will have to remember telephone numbers or use some special device to store, display and, preferably, also to dial telephone numbers automatically.

People with little strength will also encounter problems in handling telephone directories, but they may well be able to turn the pages in a directory to look up telephone numbers or instructions.

An electronic or manual telephone directory, displaying telephone numbers both visually and acoustically, which can be operated by people who cannot use their arms and hands (e.g. by use of a mouth stick or similar device) and which can also be used by people with little strength, will provide the best solution to this problem.

PROPOSED SOLUTIONS

Public telephones and, eventually, all telephones should be able to access an electronic telephone directory that will display numbers and instructions both in visual and acoustic form, and also provide for automatic dialling. This will be much easier to achieve in the new ISDN systems now being introduced in most European counties.

ISDN will, of course, also allow other services that are not possible in the analogue network, e.g. Bsubscriber debiting, electronic directories and other services that may be beneficial for people with special needs.

Short Stature

People of shorter than average stature and small children may find it difficult or even impossible to use public telephones if these are placed at the normal height. Even when telephones are placed lower than usual, people of short stature may still not be able to access all the functions for successfully completing a call; i.e. they may be able to reach the dialling keys but not the coin insertion slot if this is placed on top of the terminal.

PROPOSED SOLUTIONS

Public telephones should be accessible to and fully operable by people of shorter than average stature and by children from about school age. Telephones can either be height adjustable or folding steps can be provided to suit users of various heights. All controls necessary to operate the telephone should be placed in such a way that they are all accessible from the same operating position.

Tall Stature

People who are much taller than average may find it difficult to get inside some telephone booths with low ceilings or to find a position from which they can operate all controls. Displays should be visible and keys accessible also from a higher than average position.

PROPOSED SOLUTIONS
Public telephone booths should allow access to people who are taller than average by not having low ceilings. Telephones should also be fully accessible when operated by tall people.

Intellectual Impairment

People with intellectual impairment constitute a very diverse group and are not easily categorised. One recurrent trait in many intellectually impaired people is that they tend to be slower than other people and thus require more time to complete some tasks. Their short-term memory is often impaired, i.e. they cannot remember long telephone numbers or long strings of consecutive operating instructions.

Telephony
Intellectual impairments range all the way from not being able to use any telecommunication services at all to being only marginally slower than non-impaired people, so that when given some extra time to complete the task at hand they may have no problems in using the traditional telephone. Some intellectually impaired people may also revert to various compensatory strategies.

PROPOSED SOLUTIONS
Operating instructions should be provided in a form that is easy to comprehend. Terminals should not require long sequences of operations that must be remembered. Time-outs should allow slow users to complete call set-up, or alternative procedures, e.g. off-hook en-bloc dialling, should be allowed.

Dialling
Many people with intellectual impairment do not have adequate comprehension of numbers and cannot understand their use in dialling. A simple automatic dialling device with preprogrammed numbers, using miniatures, pictures or pictograms to identify the numbers, may be a usable solution for some of these people.

People with intellectual impairment who comprehend and can use numbers may still find it difficult to remember and dial ordinary length telephone numbers (6–9 digits), even if they only have to remember and dial one digit at a time. It is important that time-outs in the dialling and call set-up procedures should allow enough time also for slow users to finish dialling a long telephone number.

PROPOSED SOLUTIONS
Time-outs should have sufficient duration to allow slow users to finish dialling long numbers and call set-up.

Line Signals

People with intellectual impairments may not be able to understand or distinguish the acoustic line signals, i.e. dialling tone, ring tone, engaged tone etc., or to understand if an error has been made.

A simple, visual representation of the current line status (similar to that proposed for deaf people above) may be of great help to many intellectually impaired people and to people from other countries where different line signals may be used.

> PROPOSED SOLUTIONS
> Acoustic line signals should also be displayed visually in a simple or graphic format to indicate the current status of the line; i.e. dialling tone, ringing tone, engaged tone, error signal, etc. The number of line signals should be kept to an absolute minimum.

Conclusions and Further Work

The impairments that have been covered here and the proposed solutions are meant to provide topics for recommendations that should lead to new standards and/or legislation. In the future, it is important that new services are dealt with already at the stage when they are being planned.

Sometimes recommendations may be in conflict, e.g. the solutions for people of short and tall stature. It is important to arrive at non-conflicting standards. It may sometimes be necessary to provide more than one type of public telephone to allow users with different requirements to find a suitable terminal.

It is our hope that this Technical Report will provide the point of departure for compiling a fuller and more thorough list of actions that should be taken and point out the most important aspects that should be dealt with in the future standardisation work in STC HF 2 and other ETSI technical committees. Telecommunication services should be accessible to as many people as possible, including people with special needs.

Note

1 This chapter is based on the ETSI Technical Report 'Access to telecommunications for people with special needs'.

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Telephone Amplification for Hearing Impaired People

Mike Martin

People with hearing impairment may have difficulty in using the telephone due to insufficient acoustic output from the handset earphone. It has been shown in studies in Holland (Gleiss, 1980) and the UK that some 6 per cent of the adult population may require amplification on the telephone. This represents a significant proportion of the population and will be relevant to the needs of some 30 million people in Europe, a figure that will increase with the predicted growth in numbers of people over 80 years of age. To overcome this difficulty the level of the output from the earphone has to be increased. This chapter looks at the way in which this amplification may take place and the problems of a technical and administrative nature that might affect the provision of such a facility. The subject matter is divided into four parts: user needs, administrative conditions, amplification and coupling hearing aids to the telephone.

The following should be read keeping in mind that although there will be considerable advances in technology in the coming years, our present systems will be with us for many years to come. Furthermore, the developments in technology do not necessarily alleviate the problems that this paper addresses, indeed it may make the solutions to the problems more difficult.

User Needs

Hearing impairment results in a loss of sensitivity and often a reduction in the ability to discriminate speech. Amplification can restore the loss of sensitivity but cannot restore lost discrimination. The degree of amplification required by most hearing impaired people is not directly related to the degree of loss but approximates to half the hearing loss. Consequently a person with a 50 dB loss will only use something in the order of 25 dB of amplification. This has considerable implications for the effectiveness of amplification on the telephone, as it then becomes possible to provide amplification that is sufficient to meet the needs of people with losses up to 70 dB or so, representing a high proportion of the hearing impaired population. The availability of a volume control on most handsets would allow for level compensation on poor lines etc., even with current handsets without additional amplifiers. When hearing impairment causes a problem which requires amplification as a solution it is likely that the user will not hear the telephone ringing and solutions have to be found to that problem.

Hearing impaired people are often as sensitive to loud sounds as normally hearing people and therefore the levels set for acoustic shock on handsets is also appropriate to the range of hearing impaired people who will use amplification.

Ambient noise is a major problem for people who use hearing aids and is due to the inability of the damaged ear to discriminate speech from noise. Consequently the siting of telephones is important to hearing impaired people and the use of acoustic hoods and other means of noise reduction becomes very important when amplification is used. Due to amplification of the side tone from the handset the use of amplified handsets in noisy situations does not help greatly in overcoming this problem. This is contrary to popular belief that amplification is the best way of resolving this difficulty.

Elderly people form the largest proportion of hearing impaired people and consequently the design of equipment must take this fact into account.

In some countries there is a wide spread use of induction coils on hearing aids (T position on the aid) which facilitates the coupling of the aid to the telephone. For people who have these aids there is a deep sense of frustration in finding very few telephones that can be used with induction coupling.

The problems of hearing impaired people are well established and there should be no argument over the needs. However, this information does not appear to be widely known to designers of telephone equipment, neither are they aware of the relatively large numbers of people who may require such facilities. The purpose of this chapter is to outline the approaches that can be made to resolve some of these problems. The problems of profoundly deaf people are not dealt with in this document and 1 per cent of the hearing impaired population will fall into this category.

Administrative Conditions

In the past, many national telephone companies provided facilities which were effectively subsidised by the state. With the move in Europe towards turning state run companies into independent commercial companies, i.e. deregulation or privatisation, the availability of state subsidies has been removed. In addition, the monopoly of the state run telephone service in providing equipment for the end user has been removed, that is, liberalisation of equipment supply has taken place.

Both privatisation and liberalisation have an effect on the supply of equipment, particularly to a minority group of users, due to market forces dictating the availability of equipment.

It is accepted that the cost of manufacturing equipment specifically for disabled people is higher than that for non-disabled people because of the smaller and more fragmented market. However, if equipment for general use is designed with disabled people in mind, much of it may be used by them at little or no extra cost. Furthermore, specialist telecommunication services for disabled people are usually very labour intensive and hence costly. With the deregulation of telephone companies from state, or semi state owned, to wholly commercial organisations, the question arises as to who is to pay for the specialised equipment and services. Without funding, these technical services will disappear.

The problems concerning the cost and supply of equipment are exemplified by amplified handsets. Amplifier chips are produced which allow 20 dB of amplification to be obtained. However, their higher cost prevents them from being incorporated into telephone handsets which are sold in a highly competitive market. Current line attachment standards also inhibit the use of amplified handsets, and consequently hearing impaired people have very limited access to appropriate equipment. It is therefore important to ensure that future specifications for equipment and measurement standards take note of the requirements for special equipment.

A further effect of deregulation and liberalisation is one that relates to the coupling of hearing aids by magnetic induction to the telephone. Magnetic induction is a very low cost solution to the problem of connecting hearing aids to the telephone if undertaken at the manufacturing stage. It allows the hearing aid user to minimise the effects of ambient background noise and therefore provides a clarity of speech not possible when listening through the microphone of the aid. Developments in transducer design have tended to eliminate stray magnetic fields from earphones which previously provided very satisfactory magnetic fields to be picked up by hearing aids with appropriate built in coils. Manufacturers of telephone handsets have no incentive to reintroduce this magnetic field by providing transmitting coils in handsets and therefore unintentionally deprive all hearing aid users who have the means to benefit from this system from doing so. The technical problems in this area are being identified and CCITT has produced a recommendation for field strength (CCITT, 1984), but without consideration of the negative implications of liberalising telephone equipment there may be no equipment available in the future in which solutions to technical problems can be implemented. In other words, hearing aids able to use induction coupling are readily available now, but in the future there may be no telephones available to provide an appropriate magnetic signal. No alternative solutions to the problem, apart from acoustic coupling, have been identified and if there is an alternative then research has to be undertaken to determine what this is. But who is to pay for this work? It is of particular interest to both consumers and suppliers that the USA federal legislation will require all public telephones and 20 per cent of other telephones to have inductive coupling. If induction coupling is not fitted, the telephone shall be labelled that it does not fulfil all requirements of the FCC. This legislation will require manufacturers to provide this facility and may have a profound affect on the international market for telephone handsets.

Finally, in the development of equipment to be used on the public telephone network there comes a point when line attachment approval has to be obtained. This approval can be very costly and relates only to the version of equipment submitted. Manufacturers of equipment for disabled people are usually small firms with limited financial resources and therefore the high cost of approval prevents, or seriously delays, new equipment from reaching the market. The changes that come about with deregulation are mainly that state owned companies previously could provide services out of government funds, but profit making companies are unwilling to do this out of principle as they say these services should be paid out of taxes. Line attachment approval was one of these services previously provided, but this approval is now often undertaken by independent laboratories who are paid commercial prices for their services.

Amplification

Amplification will be considered in two parts: amplification built into the telephone and add on devices. The use of an additional earphone will also be described.

Built in Amplification

The telephone system is itself an amplifier and consequently many people with small hearing impairments say that they hear well on the telephone without additional help. The effective gain of the telephone system is around 30 dB as compared to the level received at the ear from a person speaking at a distance of 1 metre. The average output from the receiver is around 80 dB sound pressure level (SPL) which is high enough to compensate for smaller losses. However, for those people with greater hearing losses and to encompass the variations in level of signal found on telephone lines, amplification is necessary for comfortable listening.

A number of factors have to be taken into account when considering fitting additional amplification to the telephone.

In the first instance, the reason why amplification is being used has to be asked. A major misunderstanding in this area is that amplification is a way of using the telephone in a noisy situation. This is usually not the case as the signals from the mouthpiece get amplified and put back the level of noise that is trying to be overcome into the receiver. Amplification is not therefore a prime method for overcoming ambient noise problems unless a means of switching off the microphone by either mechanical or electronic means is provided when the user is not speaking into it. It is however an essential facility for hard of hearing people, mainly those who do not have hearing aids.

Side tone is a feature of all telephones and is a determining factor in specifying the degree of amplification. It is essential that the telephone remains stable, i.e. does not oscillate, under all conditions of normal use, and the margin for error in this parameter is very small. The introduction of additional amplification therefore may make it impossible for the telephone to meet normal approval standards. Consequently, new approval standards have to be drawn up which allow for this feature. The possibility of switching the microphone off or reducing the gain by automatic voice switching, will be important in this regard.

The frequency response of a telephone is very similar to that of a hearing aid. A debate exists as to whether or not the additional amplification provided for hard of hearing people should have any form of frequency correction to compensate for particular losses. While this may seem desirable, the problem is which frequency to choose; what is suitable for one person may not be suitable for another. Consequently, for built in amplification it is generally recommended not to provide any specific frequency response shaping. Where the user has a hearing aid, particularly an in-the-ear aid, the frequency compensation will be provided in the aid. This would also be the case for inductive coupling.

Amplification cannot be considered without reference to the distortion that might occur at the higher output levels and also the effect that amplification will have on cross talk. It may be possible, however, to accept somewhat higher levels of distortion than normal at the higher output levels for hearing impaired people who may not be adversely affected by such increases.

The effect of amplification on cross talk is not a problem for hearing impaired people, but may be a problem for normally hearing users. The main problem is likely to be that of hearing conversations on other lines which would reduce the confidentiality of telephone conversations. However, an additional maximum gain of 20 dB is unlikely to create serious problems although it could cause instability. For hearing impaired people the amplification required is positioned at the output of the telephone, i.e. the earphone; consequently, the amplified signal is not fed down the line. Where amplification of the input from the microphone is required, for people with low speech levels, the situation is different and problems with cross talk may occur. The advent of all digital technology will eliminate the risk of cross talk which is currently a limiting factor in providing amplification.

The maximum acoustic output from a handset is controlled to some given limit in order to prevent 'acoustic shock'. This output is often limited to around 120 dB SPL which is approximately the value for the maximum acoustic output of a wide range of medium powered hearing aids. Consequently, in this respect there is not a major problem here in meeting the needs of a very large proportion of hearing impaired people. However, it must be accepted that this will not meet the needs of severely or profoundly deaf people for whom a different solution has to be found.

A further aspect of amplification is that of protecting normally hearing people from using the telephone when it is set to a high level of amplification. Consideration has therefore to be given to means by which the telephone is reset to normal operating conditions after use by a hearing impaired person. Coupled with this is a requirement for the user to be able to preset the amplification so they do not have to find their optimum listening level every time they use the telephone.

Amplification on Public Telephones

The provision of amplification on public telephones is possible and requires the same performance specification as for domestic use but presents a number of practical problems.

The need exists for a reliable method of resetting the telephone to its normal operating condition after being used with amplification. Technically this should not be a difficult problem particularly with digital systems and is incorporated in a number of currently available public telephones.

Amplification must be adjusted to meet the needs of individual users and the means of control has to be simple, robust and vandal proof. The resultant cost of providing amplification and its maintenance should not be great if specified when the design is initiated.

The term public telephones is used to describe telephones in the street but the same principles apply to all pay telephones.

Amplification on Future Equipment

While handsets in their present form will be with us for many years to come, designs are already well advanced for new systems, particularly those involving the transmission of pictures. The need for amplification will, however, still be present for hearing impaired people and consideration must be given to this at the equipment development stage. Projects such as RACE are considering this, but there needs to be a widespread acceptance of the need to allow for additional amplification by all designers.

The problems are no less difficult with videotelephones as for conventional handsets, but are different in certain respects. The main difference is that with a videotelephone the user is likely to be at a distance from the telephone, to view the picture, and may well have a hands free situation. This causes the hearing impaired person problems because it introduces the acoustics of the environment including background noise and the listener looses the 30 dB gain from the telephone referred to earlier. Means of coupling the hearing aid, or providing a remote amplification system have to be provided.

In addition, the removal of the microphone of the telephone from very close to the mouth of the speaker to a distance will also involve the acoustic environment and may cause a loss of speech intelligibility. Means of overcoming these problems are possible but have to be considered at the design stage. Both these problems occur in the hands-free situation but disappear when using a telephone handset.

Add on Amplification

If it is not possible to provide amplification built into the telephone then devices can be produced that fit over the earpiece of the handset. These devices have become quite widely used as they can be fitted to a large number of telephones, providing their shape is not too far from that of the conventional handset. However, they are clumsy to use and some will be extremely difficult, particularly for frail elderly people, to fit over the receiver. They may also prevent the handset being replaced on its holder in the normal manner. Furthermore, the price of the attachment may be more than that of the telephone itself.

One of the most difficult problems to overcome in the design is that of the mechanical construction which should allow the device to be easily fitted to a wide range of handsets and yet maintain a good acoustic seal between the microphone of the device and the handset. The device should be as small as possible to allow it to be carried easily in a pocket or bag. It should also allow the normal distance between the mouth and the mouth-piece of the handset to be maintained.

Amplification is achieved by picking up the acoustic output of the handset with a microphone placed at the acoustic output of the handset. The signal from the microphone is amplified and then feeds an earphone. All transducers, amplifier and battery are housed in a simple unit which is usually attached to the handset with a strap.

Add on devices are also produced which use magnetic induction to pick up the signal from the handset and have an acoustic output. These units will of course only work where there is a sufficient strong magnetic field from the earphone, which is becoming increasingly less likely today.

In addition, devices are made that pick up the signal acoustically from the earphone and produce a magnetic output signal for use with hearing aids with an appropriate pick up coil built into them.

The overall acoustic amplification required from such an add on device is normally around 20 dB. The limit on amplification is that created by acoustic feedback, 20 dB, however, will increase the relatively high output of the handset to a level suitable to meet the needs of a wide range of moderately and even severely hearing impaired people.

The device requires to be battery driven and the current drain should be kept as low as possible to ensure a long battery life. The battery chosen for the device should have a long shelf life as use will be intermittent and should be readily available. An automatic switch is desirable to switch the device off after use. A manual switch must be easy to use and positive in its action (cf. RNID, 1989).

Add on devices do of course add significantly to the price that a hearing impaired user has to pay to obtain access to the telephone.

Use of Additional Earphone

An additional single earphone connected by a suitable lead may be added to some telephones and offers the possibility for the hearing impaired person to use both ears, which in some cases gives an increased loudness to the user.

The separate earphone may also be used to provide the housing for an amplifier and also a coil for induction coupling to a hearing aid.

A further use of the additional earphone is by profoundly deaf people who pass the earphone to a hearing person in order that they may listen to what is said and repeat the conversation as far as is possible word for word. The deaf person then lip reads the hearing person and can reply normally through the handset which they hold in the usual manner. It is of considerable importance that the hearing person does not have the means of speaking back through the telephone as otherwise they will tend to reply for the deaf person.

The design of the additional earphone and in particular its connection to the telephone requires careful consideration to ensure ease of use.

Coupling Hearing Aids to the Telephone

Three alternative ways of coupling a hearing aid to the telephone are currently possible. These are by the hearing aid picking up directly the acoustic output of the telephone, by induction coupling and by direct electrical connection between the telephone and the hearing aid.

Hearing Aid Performance and Specification

International standards, IEC 118 Hearing Aids (1981; 1983a,b; 1986) and others, exist and are widely used to describe methods of testing the electroacoustic performance of hearing aids. In addition, standards are available for such matters as plug sizes, marking of controls and the field strength of induction loops. It should be clearly recognised however that there are no international standards laying down performance criteria for hearing aids. In some countries national organisations, particularly where there is state provision of hearing aids, will specify performance requirements. IEC 118 Part 10 (1986) is a guide to all IEC standards relating to hearing aids.

However, there is a marked similarity amongst the many makes and models of hearing aids produced and if required they can be divided into performance groups primarily on the basis of maximum acoustic output such as given in IEC 118–10.

Induction Coupling from the Telephone

In many countries a wide range of hearing aids are available that have induction pick-up coils fitted. These are used with induction loops in rooms and provide the hearing impaired listener with a connection between the source of sound and the hearing aid minimising the interfering effects of distance and background noise. Induction coupling has the advantage for the hearing aid user of minimising the effect of ambient noise as well as using the listener's own aid as the telephone amplifying device.

Induction coupling between the telephone and a hearing aid has been available since the late 1930s. In the past this possibility has been readily available due to the high magnetic field available from telephone earphones. With developments in earphones, this field has been reduced in many cases and with piezoelectric transducers is not present at all.

In many countries legislation or regulations have made it mandatory for induction coupling to be available on at least all public telephones. In some countries where hearing aids are provided under a state scheme, for example the UK, all standard hearing aids provided from this source have a pick up coil to receive magnetic induction signals.

IEC 118–4 Hearing Aids Part 4 (1981), 'Field strength for audio frequency induction loops', specifies a field strength of 100 Ma/m (–20 dB ref 1 A/m) for the long term average value of speech signals. This value of field strength has been found to be very satisfactory for most general applications.

CCITT Recommendation P37 (1937) gives a wide range of field strengths, –17 to –30 dB ref 1 A/m, for the magnetic signal as well as indicating the methods of measurement. The differences between IEC 118–4 and CCITT P37 are very significant at their extremes and a debate continues as to the viability of providing 100 mA/m from telephones.

Factors that relate to the successful use of induction coupling are the level of ambient magnetic field at the telephone site and the possibility of the magnetic field produced by the handset interfering with electronic equipment within or close to the telephone. The consideration of privacy when making a call and the signals being picked up by an unauthorised listener are not in the main relevant due to the low level of radiated induction signals from the coil in the telephone.

Ambient magnetic noise in practice is one of the major problems facing users, particularly in sites where fluorescent lighting is used. In siting public telephone boxes, a survey of magnetic field strength should be undertaken to prevent such problems occurring.

Induction coils to produce a magnetic field are an additional cost, however small, and in the volume production of telephones this may be significant. However, the possibility of incorporating features at the design stage that will allow for the fitting of a coil at a later date should not be overlooked. In this way the cost of the telephone for non hearing aid users can be kept low and only when required is additional cost involved for those who need the special facility.

In general the reduction of acoustic output signal due to loading by the coil can be kept to 1 or 2 dB with appropriate design and therefore in most cases the presence of a coil will not be apparent to normal users. The level of magnetic field used is that which has been present for many years on telephones and there is no evidence that this has any injurious physical effect on users.

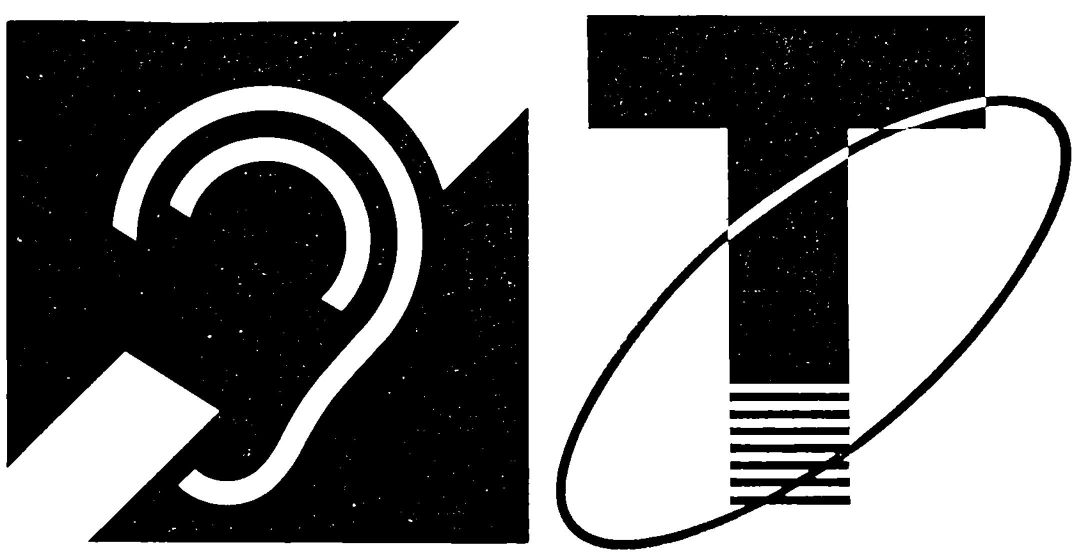

Figure 21.1 Two icons used to mark telephones that allow inductive coupling.

As the presence of an induction coil or strong magnetic field cannot be made visible to the user a symbol should be used to denote the presence of the facility only when it conforms to the recommended field strength. The World Federation for the Deaf (WFD) symbol is recommended by CCITT and used in a number of countries to show the presence of a facility to assist hearing impaired people (Figure 21.1). The addition of a letter or further symbol can make the facility more specific.

Pick-Up Coil Sensitivity

The method of measuring the sensitivity of the pick up coil in a hearing aid is described in IEC Publication 118–1 (1983), hearing aids with induction pick up coil input, and gives a sensitivity of the coil in terms of the output of the aid for an input of 10 mA/m at a maximum gain setting and with the aid orientated to give maximum pick up.

The direction of maximum sensitivity in most hearing aids is when the pick up coil and normally the aid is vertical. This is to meet the requirements for using the aid with an induction loop in a room. Maximum sensitivity for magnetic induction coils occurs when the field cuts the maximum number of turns in the pick up coil, which is usually when the pick up coil is at a right angle to the plane of the radiating coil. Most radiating coils in telephone handsets are wound around the earphone and consequently when used with a hearing aid are parallel to the pick up coil in the aid. Consequently the coil is not positioned in an optimum direction for use with the telephone.

In low or moderate gain hearing aids used by the majority of hearing impaired people there is little problem in fitting a coil into a hearing aid. The exceptions are the smaller in the ear aids and canal aids where their very small size precludes the addition of a coil. However, high gain hearing aids used by severely or profoundly deaf people cause the designers of such aids serious problems in using a high sensitivity coil due to magnetic feedback occurring on the very small circuit boards. Indeed, it has been stated that the induction sensitivity of these high gain aids is at its maximum. However, the use of alternative technology, such as Hall effect devices for picking up magnetic fields, may prove of value.

The above therefore dictates the minimum field for telephones. The recommendation, for the field strength for room loops given in IEC 118–4 is 100 mA/m, which is near the upper value quoted by CCITT in Recommendation P37. The value of 100 mA/m has been found in practice to give very satisfactory results in all circumstances except those of very high ambient magnetic noise. The design criteria for pick up coil sensitivity in hearing aids is based on the figure of 100 mA/m.

If the magnetic field does not exceed by any significant amount, the values given in IEC 118–4 overloading of the input of the aid is not a general problem. Perhaps of more concern is the necessity for the user to alter their volume control significantly when moving from pick up coil position, marked *T*, to the microphone position marked *M* when field strengths are not standardised.

Direct Electrical Connection to the Telephone

Today most manufacturers of hearing aids produce within their range of models aids that can pick up external signals through an induction coil in the aid and/or via a direct electrical connection. The use of a direct electrical connection is however in practice unlikely to be a viable means of connecting a hearing aid to the telephone due to the small size of the hearing aid and its connectors and the problems of standardising plugs on telephones. Induction coupling therefore remains the most practical of methods for connecting a hearing aid to the telephone at the present time.

Acoustic Coupling of Hearing Aids to the Telephone

Whatever the outcome of technical developments with telephones there must always be an audible acoustic output. The obvious solution to the current problems is therefore to couple the hearing aid acoustically to the telephone.

Currently four main problems exist in this area, which are those of increased acoustic leakage from the telephone receiver, acoustic feedback from the hearing aid, the hearing aid overloading and ambient noise being picked up by the hearing aid microphone.

Acoustic Leakage

Telephone receivers are normally designed to be close coupled to the ear and while leakage will always take place, it is greatly increased if a hearing aid is placed between the head and the receiver. Very often the hearing aid user will move the receiver away from the ear to position it better over the hearing aid. Leakage will lead to a significant decrease in low frequency response.

However, the use of receivers with a low acoustic impedance offers a solution to this problem. With low acoustic impedance there is little problem from acoustic leakage and the user has the ability to move the handset away from the ear with only a small effect on the frequency response. This in turn makes it possible to hold the handset in an optimum position for the best acoustic reception by the hearing aid. Currently at least one telephone the Beocom (Bang and Olufsen Ltd) is commercially available with a low acoustic impedance earphone.

Acoustic Feedback from the Hearing Aid

When the telephone handset is brought up to the ear of a user with a hearing aid, the acoustic leakage from around the earmould in the ear is reflected back from the hard surface of the handset. The reflected signals are then picked up by the microphone and depending upon the degree of amplification present and other factors, the hearing aid will acoustically feedback causing oscillation, the well known whistling that comes from hearing aids.

As the acoustic output of the telephone handset is high, that is, around 80 dB SPL, the input to the hearing aid microphone is likely to be some 10 to 20 dB higher than that normally used for conversational purposes. Consequently, one simple way to minimise feedback is by reducing the gain in the hearing aid prior to the volume control either manually or automatically when the telephone is being used.

Overloading of the Hearing Aid

As has been stated above, the output from the telephone handset is higher than that which the hearing aid expects to receive in normal conversational situations. Indeed the output of the handset is sufficient to overload the hearing aid when its volume control is set to a normal listening position. Consequently, there is a need to reduce the gain of the hearing aid for telephone use.

Ambient Noise

When the hearing aid is being used with its microphone input, it will, of course, receive the acoustic output of the telephone handset and also any noise from the environment surrounding the user. In places such as railway stations, hotel lobbies etc. the noise level is likely to be high, thus making listening difficult for normally hearing people and the use of the hearing aid impossible.

Body Worn Aids

The above has largely referred to the use of hearing aids worn behind the ear and has not related to using body worn aids which require an entirely different approach. Furthermore, body worn aids are now used by a very small number of people and while their needs should not be overlooked the predominant need is for users of aids worn behind the ear or in the ear.

In-the-Ear Aids

In-the-ear aids either fill the whole of the bowl of the ear or only the ear canal of the user. These aids are ideally positioned for use with the telephone as they do not alter the natural position of use of the telephone. Acoustic feedback and overloading still occurs and the previous proposals for developments will enhance the use of in-the-ear aids which currently provide effective amplification for some users of these aids.

Recommendations for Acoustic Coupling of Hearing Aids

Hearing aids can be expected to function effectively with acoustic inputs from the telephone if the two following developments are undertaken together:

- to minimise leakage effects, low acoustic impedance telephone earphones (receivers) are used; and,
- hearing aid gain is reduced by some 10 to 20 dB when using the telephone.

Hearing the Telephone Ring

A major difficulty found by hearing impaired people is hearing the telephone ring when they are at any distance from it, for instance in another room. While this chapter is concerned with amplification, it is thought to be appropriate to refer to the problem of hearing the telephone ring as obviously it is a prerequisite to using the telephone.

Solutions to the problem lie in the following directions:

- by making the spectrum of the ringing more appropriate to hearing impaired people whose hearing loss is likely to be greater at higher frequencies;
- making the ringer louder;
- providing facilities for extension ringers to be fitted;
- to replace or have in addition flashing lights to alert the user;
- to have a remote vibratory warning facility, ideally worn on the user; and,
- where a listener uses an induction loop to inject a signal, e.g. mains hum to alert the user.

Summary and Recommendations

The hearing impaired population is predominantly elderly and a significant knowledge base exists on hearing impairment which allows design criteria to be produced for the electro-acoustic characteristics of the amplifying system.

No reasonable alternative to induction coupling for connecting hearing aids to the telephone is likely to be available for many years.

The design of handsets should in all cases be considered with a view to incorporating induction coupling as a basic feature. Means of coupling do not have to be incorporated in all models but the design should allow the fitting of the coupling to be easily undertaken if required.

Amplified telephones should allow at least 20 dB of amplification over the normal listening level in order to meet the needs of a large proportion of hearing impaired people.

Built-in amplification of 20 dB or more will not meet the needs of some severely deaf people and most profoundly deaf people. These people will require to use additional devices.

The maximum capability of digital technology should be used to provide amplification.

The use of low acoustic impedance earphones should be considered as an improved means of coupling hearing aids to telephones acoustically.

Hearing aids should be designed so that the gain of the aid can be reduced by some 10 to 20 dB when using the telephone to prevent overloading.

Hearing aids worn all in the ear would appear to be a better form of coupling to the telephone than aids worn behind the ear. However a significant proportion of people will need to wear hearing aids worn behind the ear as in the ear aids are either not available or are unsuitable for them.

Means of indicating that the telephone is ringing should be made available as a standard item for hearing impaired people.

Additional research problems:

- For service requirements it is essential to know at what level of hearing loss users can no longer manage with the level of sound from the telephone and require amplification.
- The requirements for the level of magnetic field from telephone handsets for induction coupling is largely based on existing practice and experimental work should be conducted to establish if these values are satisfactory and what tolerances are allowable.
- Alternative means of coupling hearing aids to the telephone should be explored, particularly different forms of induction coupling, e.g. the use of Hall effect devices.

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22

Relay Services

Kelvin Currie, Jan-Ingvar Lindström, Kasper G. Olesen and Stephen von Tetzchner

A relay service is a form of 'translation' unit, where language in one mode is transferred into another. The use of text terminals, now widespread throughout the world, enables deaf and speech impaired people, and others who depend on written language, to communicate with each other via the telecommunications network using instruments containing inexpensive modems and displays. However, whilst this opens up telecommunications to people who have access to text communication terminals, it is not possible for this group to communicate with those who have ordinary audio telephones via the telecommunications network without a relay service.

Most of these services relay between text and speech, but other forms of relay are appearing, such as between fax and speech or text, and between sign language, text and speech.

Text and Speech

The relay service was originally set up to allow deaf people to communicate with hearing people over the telecommunications network. However, since text telephones are used also by speech impaired people, the relay service is used by this group as well. For example, in Sweden 20 per cent of the text telephones in use are owned by speech impaired people (Poulsen, 1989). In addition, a small number of deaf-blind people use telecommunication devices with Braille displays which are compatible with text telephones (cf. chapter 45). In Sweden, this group represent 0,5 per cent of the relayed calls (Poulsen, 1989).

The function of a relay service for text and speech is basically simple; it is to act as a real time interpreter between the typed language of the text telephone user and the spoken language of someone using an audio telephone (Figure 22.1). The service operates in the following manner: A text telephone user calls a dedicated number for the relay service and is put into contact with an operator. The calling customer then asks the operator to call the customer he or she wishes to contact. The operator makes a call to the customer, and explains that he or she is being

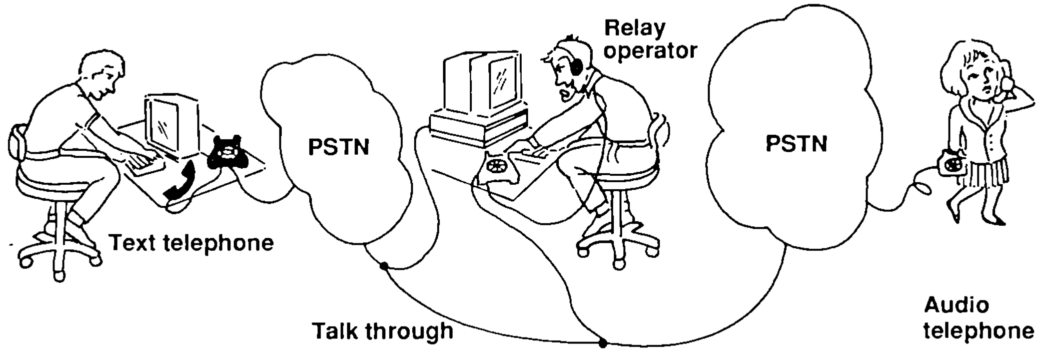

Figure 22.1 Illustration of relay service.

called by a text telephone user. When all the preliminaries are completed, the conversation can commence using the operator as the translator between the two customers.

The same applies when there is an audio telephone user who wishes to contact a text telephone user. In this case the calls are placed in the reverse order.

Text Telephone Standards

In general, the usual international collaboration with regard to standards has not been applied to text telephones; somehow the authorities seem to have been unaware of the fact that deaf people also need to call people outside their own country, and each country has developed its own standard, independently of others. In some countries, like the UK and Germany, no formal decision was made with regard to standards; this was completely left to the market.

A number of problems have resulted from this piecemeal approach by each country. The most apparent of these being the impossibility of many text users in one country calling those in another due to differing data standards. In addition, whilst different standards are used in different countries, some countries have more than one standard. Seven different standards are in use in Europe: EDT, DTMF, CEPT 1, CEPT 2, CEPT 3, V21 and Baudot (cf. chapter 27).

In fact, only two standards have been specified for text telephones, that is, EDT and DTMF. In addition, an industry standard, V21, has become a de facto text telephone standard in many countries, which is also recommended in the CEPT document on DTMF. Unfortunately, both 300 and 110 baud are used with the V21, creating unnecessary incompatibility, although of a type that can be handled at the relay centres. The three CEPT standards are videotex standards which have also been used in equipment for disabled people. Behind the three CEPT standards are Prestel, Bildschirmtext and Minitel. Baudot is an American standard which has been marketed in Europe, especially in Ireland and the UK. This standard is not compatible with any European relay services.

Another problem is that the differing standards also split up the overall market into less economic segments, for example in contrast to the USA where one primary standard has been used (although they have been moving slowly towards ASCII and V21 for several years).

Denmark has recently tried to solve the problems that resulted from the choice of the DTMF standard instead of the more widely used V21. The incompatibility led to complaints from users about not being able to communicate with text telephones with the V21 standard which is used by the other Nordic countries except Iceland, where the American Baudot standard is used. Iceland is currently in the process of changing to V21 using personal computers and the Norwegian text telephone program (cf. chapter 29).

To overcome the problem, an automatic gateway was implemented, allowing communication between DTMF and V21. The system is controlled by a computer and the communication between the user is without any human assistance (Figure 22.2). Thus, for the users, the facilities appear the same as when communicating with a compatible text telephone. The only difference is that they have to dial the gateway number before dialling the subscriber's number. An automatic gateway may be an answer to the problems of incompatibility between, as well as within, different countries, and an alternative to the proposed Telematic Access Points (cf. chapter 27).

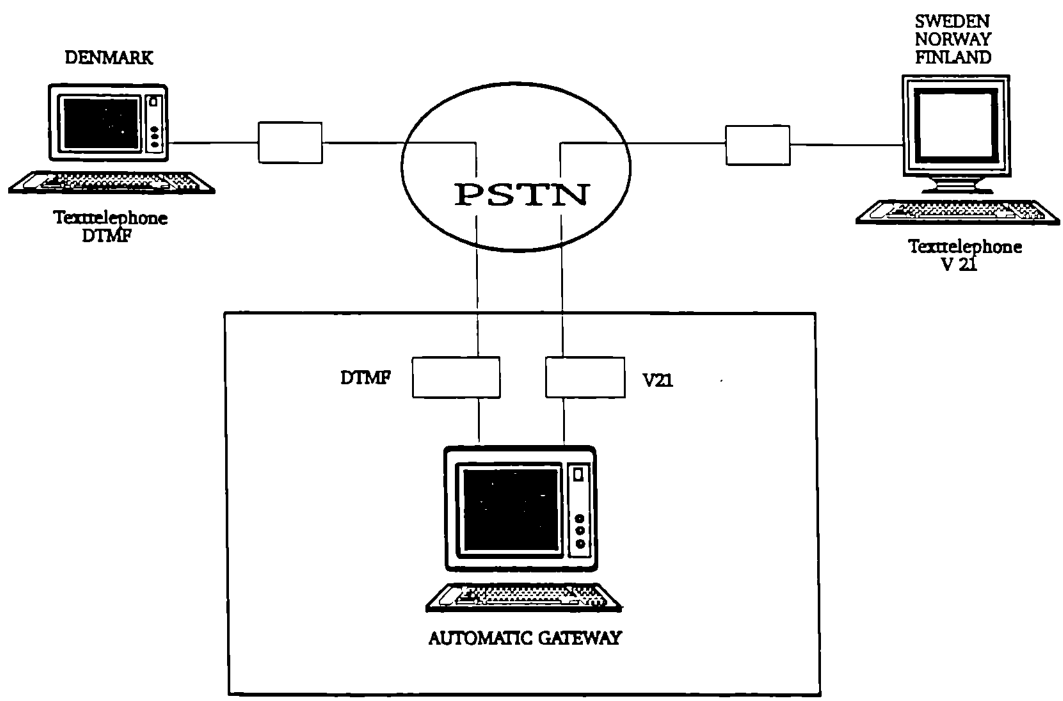

Figure 22.2 Automatic gateway.

Relay Services in Europe

According to a survey performed within the framework of COST 219, only eight countries in Europe have a relay service (Table 22.1). In addition, Austria reported to have an emergency service. Five of the relay services operate on a 24 hour basis, while the others are closed during the night and have shorter opening hours at week-ends. However, these countries have an emergency service that is always open. In the Ireland, there is a commitment from the Telecom Éireann to provide a relay service, but there is no activity on this front at the time of writing.

Nationality	Name of service	Access number	In charge of service	Service opening hours	Language
Austria	None, but emergency service				
Belgium	None				
Czechoslovakia	None				
Denmark	Skrivetelefon Formidlingscenteret	00.32	The Danish Telecom Administrations	Mon–Friday, 7am–9pm Saturday, 8am–9pm Other days, 9am–6pm	Danish
Finland	Tekstipuhelinpalvelu	92028	PTT	Mon–Friday, 7am–10pm Other days, 8am–10pm	Finnish
France	Centre de truchement	146331855 146333694 146339295	French Telecom	Mon–Friday, 9am–7pm	French
Germany	None				
Greece	None				
Iceland	None				
Ireland	None				
Italy	None				
Netherlands	Teleplus	0 68410	PTT-Telecom	24 hours – 7 days a week	Dutch
Norway	Formidlingstjeneste for tekstteleton	0149	Norwegian Telecom	24 hours – 7 days a week	Norwegian English
Portugal	None				
Spain	None				
Sweden	Förmedlingstjänsten för texttelefon (FöC)	00.10	Swedish Telecom	24 hours – 7 days a week	Swedish
Switzerland	Telefon-Vermittlungsdienst für Hörbehinderte French German	 046055100 046056100 046058100 046057100	PROCOM, Stiftung Kommunikationshilfe für Hörgeschädigte, 8636 Wald ZH	24 hours – 7 days a week	Two French German
UK	Typetalk (RNID)	0345515152 (Audio) 0345959598 (Text)	Royal National Institute for the Deaf	24 hours – 7 days a week	English
Yugoslavia	No information				

Table 22.1 Relay services in Europe.

There is no doubt that relay services fill an important need. For example, Norway has a population of 4 million people, and in 1988, there were 1430 registered text telephones. That year, 116 240 calls were relayed. The following year, 1650 text telephones were registered and 139 975 calls were relayed. The average length of the calls was just over 5 minutes (Stensvoll, 1991).

Text telephone users tend to call audio telephone users more often than they are called themselves. For example, 75 per cent of the 480 000 yearly relayed calls in Sweden are from text telephone users. Sweden, by the way, has a population of 8.5 million and 6 000 text telephones.

In France, a great part of the population may be contacted directly via Minitel terminals, and a reduction in the demand for relayed calls is probably a result of more people getting Minitel terminals.

The reason for the high number of relays, is, of course, the need for communication between people who are hearing or speech impaired and people who are not similarly impaired and who do not own a text telephone. For example, people who have become deaf or severely hard of hearing in adolescence or later tend to have hearing relations, friends and colleagues. Although people who are pre-lingually deaf tend to have a social network of deaf people, few of their relatives will be deaf; only 5–10 per cent of deaf children have deaf parents and most couples where one or both of the spouses are deaf, get hearing children. In addition, deaf people have both hearing and deaf friends and colleagues. They also need relay services to obtain information about telephone numbers, call offices and shops, order tickets etc.

Relay Considerations

A conversation is a private matter, and it is important to have it relayed in a correct manner. Thus, education of the operators is an important matter. Many people who use text telephones have been deafened and have good command of written language, while those who are pre-lingually deaf have the local sign language as their primary language, and may be less proficient in writing. Similarly to other people communicating in a foreign language, the structure of their primary language may be apparent in their written language. It is important that the operators are taught about the characteristics of signing, and of typical 'deaf' ways of using written language. In Norway, for example, all relay operators have to go through a course provided by a senior teacher at a school and educational centre for deaf children.

However, it is important that the operators don't interpret or 'improve' on what the user says or writes; that is, they should simply state what appears on the screen in front of them.

There are also ethical considerations, particularly those of relaying messages of a distressing or obscene nature, and those which may relate to criminal activity. There are no formal rules covering such situations, neither nationally or internationally; rules are typically invented as situations occur. Thus, there is a definite need for discussions of how relaying should be performed, and for formulating common rules that may be adopted by new relay services.

Speech-Through

Many users of relay services want to communicate directly, that is, bypassing the operator in one direction. Most adventitiously deaf and many pre-lingually deaf people are able to speak and prefer to do so. Speech impaired people can mostly hear and want the other person to speak. When planning a relay service, it is important to plan for this feature, which is already available in many relay services (e.g. in Denmark, Norway, Sweden and the UK).

Automatic Relay

As far as the future is concerned, there are exciting developments in the voice recognition technology area. It is already quite feasible to convert text to speech using voice synthesis, but it is still beyond our present level of expertise to translate speech into text in real time with a satisfactory level of accuracy. There are considerable difficulties within the same language, given the differences of regional accent, dialect and slang. Great advances are being made on this front, however, and in the future, it may be possible to have a 'relay machine' to do the work of the human operators. This would restore the privacy of those people who rely on text for their telecommunications.

Charges

Text telephony is usually slower than ordinary audio telephony, and several telecommunication administrations and governments provide resources to compensate for this. In spite of this, and the even slower mode of relay services, charges are usually higher than for ordinary calls.

In Sweden and the UK calls are charged at the rate which they would have been charged had the caller been able to dial directly from his or her location to that of the person he wishes to converse. Access is available nationwide, and both incoming and outgoing international calls are permitted. Calls to and from the mobile telephone networks are also allowed.

In other countries, the charges are somewhat higher for relayed calls than for ordinary calls. In Finland, there is an extra charge of 0,08, 0,05 or 0,03 ECU per minute, depending on the time of the day, and in Norway, the charge is 0,12 ECU per two minutes. This is considerable more than ordinary calls, especially off-peak hours. During day-time, one gets 3 minutes for 0,12 ECU, off-peak hours one gets 9 minutes for the same price. In the Netherlands, the price is even higher, about 0,2 ECU per minute.

In Denmark, there is a rather curious schedule. If the call is initiated by a text telephone user, the extra charge is 0,04 or 0,09 ECU per minute, depending on the time of the day. However, if the call is initiated by an audio telephone user, the charge is 0,53 ECU per minute (Johansson, 1989). The rationale behind this schedule is probably that non-disabled users should pay the actual cost of the service while the disabled user is subsidised. This creates, however, an economic barrier toward audio telephone users initiating contact with text telephone users, which is counter to the goal of integration; equal access to telecommunications includes equal availability. One can also easily imagine that the audio telephone user may ask the text telephone user to call back to save money. Thus, a result of the schedule may be that audio telephone users are discouraged from using the relay service to initiate contact with a text telephone user, and, furthermore, produce a tendency for the actual cost to be paid by the text telephone user, that is, the disabled person.

In spite of the large number of calls relayed, one may expect the price of the service to be a barrier to communication between text telephone users and audio telephone users. There is a demand from the users that no extra charge should be connected with relayed calls, and that some general reduction of calling charge should be given because of the slower communication rate when using text telephones.

Funding

The funding of relay services in Europe differs. In some countries, the implementation and operation is paid by the telecommunications administrations, in other countries through government funds, or through the foundation of statutory funds.

The UK may serve as an example. A relay service has recently been introduced on a national basis, following pioneering work carried out by the Royal National Institute for the Deaf at their headquarters in central London. The original Telephone Exchange for the Deaf (TED) was not funded in any straightforward manner and heavily loaded its customers in terms of call charges. Customers of the TED were charged both for the incoming call to the unit and the outgoing call from the unit, thus giving them a disadvantage financially when compared with people using the telephone service in the normal manner.

Following an initial grant from the major telecommunications operator in the United Kingdom (British Telecom), a new unit was set up to handle text communication nationwide. The original TED had only 100–200 customers, and was heavily over-subscribed. The new unit will handle all necessary traffic that is likely to arise from the deaf community within the United Kingdom and is hoping to help integrate pre-lingually deaf and deafened people into the telecommunications community.

The long term financing arrangements for the National Relay Service in Britain have not yet been finalised, but it is likely that the various telecommunications operators within the United Kingdom will have a share in the financial impact of running such a service. The service, being run by Royal National Institute of the Deaf, is independent from all the major national operators.

In Norway and Sweden, the relay service is run as part of the ordinary provision of services, but in Norway, the service is funded by Norwegian Telecom, while the Ministry of Health pays the bill in Sweden.

The matter of funding should be given careful consideration before, for example, an additional tax is imposed on the users' telephone bills, such as has been done in California where a specified surcharge of 0,3 per cent is used to fund the service. Such a specification is not in the interest of disabled people, because it may contribute to segregation instead of integration. It is a matter for government to provide the money that is necessary to establish equal access to telecommunication for all members of society, and this should be done through legislation or as a tax imposed on all telecommunications companies in the country, for example as a percentage of the company turnover. The important matter is that disabled people should not be pointed at as an object of (forced) charity.

Other Services

Sign Language

In the visual communications field, telephones emerging on the new Integrated Services Digital Network (ISDN) will be able to carry a reasonable quality image. This opens the telecommunications network to people who use sign language, thereby also giving rise to a need for a relay service for sign language. The major group of people who use sign language are those who are pre-lingually deaf. Until now, they have had to rely on text telephones and the use of interpreters and audio telephones.

Videotelephones have been used by deaf signers for some time on a trial basis (cf. chapters 36, 37 and 42), but only one of these – 'The Swedish Sign Language Telephone Project', based upon a 2 Mbit/s video communication facility – has included a relay service (cf. chapter 42). The service started in May 1991, and a total of nine videotelephone terminals are connected to a network, enabling about twice as many deaf persons to use them during ordinary office hours. The average number of calls that are relayed is 30, with peaks up to almost 50 calls during a day.

Compared to the small number of terminals and users, this is an amazingly high utilisation, which shows that pre-lingually deaf people have a substantial need to communicate with society in general, and that a relay service with a sign language interpreter is a preferred alternative to other possibilities, including the service of a local interpreter to help with telephone conversations.

Thus, the initial results of the only study of its kind, indicate that relay service with sign language is a highly desired service facility, which should be established as soon as deaf people start to use videotelephones. The Swedish project relayed conversations between sign language an speech, but text relaying is going to be included as well, and future relay services should include all three communication modes.

Fax

Usually, relaying is linked to on-line communication between people who use different forms of telecommunication equipment. However, for some people there is also a need to translate a written text (e.g. a bill or a letter) to spoken language. This may be the case for blind people who do not want their neighbours to read their letters and see their bills, as well as for people with severe reading disorders, making them unable to read the letter or bill themselves. Blind people may actually want hand written and typed text transferred to ASCII characters, which, if they have a computer and a modem, will enable them to read and reread the text independently later. Deaf people may have a need to get a text translated to signs.

One could also imagine other services, such as moderately intellectually impaired people faxing letters for the operator to read and/or explain to them, but in that case, the distinction between a relay service and a service centre becomes blurred. Several services may be useful, but if they need more interpretation as compared to simple relaying, and the organisation of the services and the competency of operators become crucial. Even the step from text-speech to sign-speech is considerable. A number of practical and legal matters should be given careful consideration before such services are initiated.

Conclusions

The importance of relay services is well documented through the huge number of calls that are relayed in countries where this service is available. For countries where relay services are not yet established, this should be given the highest priority and urgency, and the service should be planned large enough for the number of calls that may be expected.

Standardisation of line codes, typefaces and interworking methods should also be a priority, such that a system may be designed around a common terminal or terminals. Certainly the use of the Baudot code should be excluded from future systems, as it is slow and does not lend itself easily for use with automatic databases or other services. European standards, which are rapidly becoming world-wide, such as V21 and above, are the obvious choice for line standards. Screen layout and text styles should be as compatible as possible, given the different needs of languages in different countries.

The funding of telecommunications services should be a matter for discussion at a national level. Whether it be state funded, or funded by communications operators is again a matter for national culture to decide. Standardisation is probably the most important point so that text users can use the telephone in much the same way no matter which country they are in. After all, this is the situation for users of audio telephones.

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23

Directory Services

Olof Dopping

Telephone directory services, where a telephone subscriber can get the telephone number of another subscriber, are of special importance to certain groups of disabled people, who cannot use the ordinary telephone book. This is true for visually impaired people, for some motor impaired people and for some intellectually disabled people.

In some countries, it is possible to obtain the name and address of a subscriber from the directory service by just giving the subscriber's number. For enquiries of this kind, where ordinary telephone books cannot be used, disabled and non-disabled users are roughly on the same footing.

Most directory services are handled by human operators. In some countries there are also data banks with directories that can be consulted by subscribers. This kind of directory service will probably become more widespread in the future.

There is now an international trend towards charging appreciable amounts for telephone directory services, which have in the past generally been cheap or free. For this reason COST 219 sent a questionnaire to the representatives of its member countries in 1989 in order to get an overview of the situation with respect to directory services for disabled people.

This chapter is based on the answers to the questionnaire. The answers have been obtained from the following countries (here ordered according to land codes): Belgium, Switzerland, (Federal Republic of) Germany, Denmark, Spain, France, United Kingdom, Republic of Ireland, Netherlands, Sweden, and Finland.

While all these countries have a number service, only some of them have a name-and-address service. In at least some of the cases where no name-and-address service is provided, this is for privacy protection and/or crime prevention.

Responsibility for Directory Services

As a general rule, the directory information service is run by the organisation providing the overall telephone service, i.e. the organization that in some countries is called either PTT or Telecom. In the UK, however, there are two providers, serving different groups of subscribers.

One of these organizations is British Telecom (BT), and the other is Mercury, a company which uses BT's network but competes with BT. These two providers do not have the same policy with regard to fees for number information, but there are not many private households among Mercury's subscribers, and therefore, BT's policy is the most important one for the majority of disabled people.

Cost Levels

Charges for directory inquiries vary widely from one country to another. In some countries the cost is the same as for a local call. (At the time when the questionnaire was completed, British Telecom charged nothing at all, but they had plans for introducing a fee). Other telecommunication administrations charge either a fixed amount, an amount per minute, or a combination of both.

The typical duration of a call to a directory service is 30 seconds. Therefore, this value has been used for comparisons between fixed and time-dependent fees.

In 1989 – the year of the questionnaire – the cost of a telephone number inquiry made from a home telephone would normally be between 0.15 and 0.60 ECU in most countries. In one country, a call from a telephone booth cost 67 per cent extra, but in another, it was free. A third country had a 27 per cent higher tariff outside office hours, and in a fourth one, a 100 per cent surcharge was made on enquiries for numbers abroad.

In most of the countries where a name-and-address service was available, the tariff was the same as for a number inquiry. However, in one country, where fixed charges were used, a name-and-address inquiry cost four times as much as a domestic number inquiry.

Discounts for Disabled People

In some countries, certain groups of disabled people can get partial compensation for the extra costs caused by high charges for directory information services. However, rebates are seldom tied to the fees for this information service. Instead, they are usually connected to the telephone rental or call charges. And in some countries, free or cheap inquiries can be obtained from special services, quite separate from the directory service operated by the PTT or Telecom.

In Belgium, there are special subscription rates for disabled telephone subscribers. In Denmark, a user of a text telephone can use the directory service via the text telephone relay service without any extra charge. This helps primarily deaf people, who do not generally have difficulties in using the telephone book, but it will be useful for obtaining numbers outside the area that is covered by the local telephone book.

In (the Federal Republic of) Germany, the PTT gives no discounts to disabled people. However, there are some private directory information services which can be of benefit to certain groups of disabled people. One such service covers text telephone subscribers, but – as mentioned before – this group has in general no difficulty with the telephone book.

British Telecom, at the time of the questionnaire, had no reasons for providing specific discounts for disabled people, because directory calls were free. However, BT had plans to introduce a fee for number information and at the same time introduce some sort of discount for disabled people. If the fee were to be based on the duration of the enquiry call, this discount could take the form of longer-than-usual time intervals for the meter. In that case, BT considered issuing PIN numbers – to be used as 'passwords' – to persons entitled to a discount.

However, BT also granted a general telephone rental rebate to low-volume users of the telephone. This rebate was especially intended for elderly people – some of whom are disabled, of course – but it was open to all subscribers who use their telephones very little.

In Sweden, an enquiry fee of 1.16 ECU per minute, i.e. 0,58 ECU for a typical inquiry, was put into effect in April 1989. When the decision was announced, the strongest and most vigorous protests came from blind people, and as a concession to people with disabilities, it was decided that they should get a reduction on the charges for all calls – not only to the directory service – if they submitted an application indicating that their disability prevents them from using the telephone book. Primarily, this affects visually impaired people, but certain groups of motor impaired and mentally retarded people can also apply for such a reduction.

Usually, the reduction in Sweden is about 7 per cent on the meter-unit fee. However, there are also some 'unusual' cases, for example, when a disabled person is very active in an association. He or she can then apply for an additional reduction, which is individually set after negotiations between him or her and a representative of Swedish Telecom. While the number of usual reduction cases is around 5500, additional reduction has been applied for by 150 people (the population of Sweden is around 8.5 million).

Another scheme that is being discussed in certain Swedish municipalities, is to provide a free directory service for certain groups of disabled people on a local basis. The operator in such a service could use for example videotex as a means for obtaining the information.

Computerized Directory Services

In one sense, many of the national information services are computerized in that the telephone operator can access a database. In some countries, the general public can also access databases with telephone directory information directly if they have suitable hardware and software. For a visually impaired user, the equipment may have to include some rather advanced apparatus such as a speech synthesizer, but an increasing number of blind people are getting this kind of equipment.

One example is Denmark, where a do-it-yourself service is available to computer users for 0.44 ECU per minute. But the most advanced system available is the *Teletel* system in France. In this system, a subscriber can make a three-minute directory enquiry free of charge.

Videotex is a database system that provides telephone directory information – as well as many other kinds of information – to the public in many countries. Using a videotex system may be cheaper than using the manned service to get telephone directory information, provided that the subscriber already has acquired a videotex terminal or computer with modem for other purposes.

In December 1989, Swedish Telecom demonstrated a preliminary version of *audiotex,* a system which provides spoken output from videotex databases. Audiotex makes important parts of the videotex databases available to users of ordinary telephones, doing away with the requirement for a videotex terminal or a computer with a modem. The telephone must have pushbuttons producing tone pairs (as opposed to the pulses used by earlier models of telephone exchanges). It must also have keys for asterisk (*) and square (#). Most modern telephones fulfil these requirements.

Audiotex uses speech synthesizers, time-shared by the users. The synthesizers cannot interpret the much used fancy graphics in videotex presentations, but when it comes to telephone directory information, the essential data are words and numbers, which are well taken care of. Visually impaired persons should be the main beneficiaries of audiotex.

While a pushbutton telephone generally has no alphanumeric keyboard, an audiotex subscriber can still enter words as well as numbers. A letter is entered as a digit preceded by an asterisk, a square, or a combination of both, according to a special code. This code is similar to – but not identical to – the code described in CEPT Recommendation T/CS 34–15, 1983, which is used for text telephones in Denmark and the Netherlands.

Plans to introduce an 'electronic telephone book' were also reported in a questionnaire received from one of the countries. Presumably, this system would be somewhat similar to audiotex.

Trends for the Future

The present trend towards introducing or increasing fees for telephone directory services seems to be in harmony with the trend towards a more consistent market economy. This is because the service providers' own costs are higher, generally speaking, than the traditional low charges for this service. Obviously, some disabled people will be disadvantaged by this trend because they cannot use a telephone directory.

An ideal way to compensate for the increased cost would be to give these groups of disabled people a discount, selectively applied to directory calls. Where technical factors make such a directory-selective discount difficult to arrange, however, a more general discount on subscription fees or call charges can serve as a substitute, as it already does in some countries.

In the longer term, direct access to directory information in a data bank will probably take over much of the work of the present manned directory services. If systems like Audiotex come into general use, most of the disabled people who are unable to use a telephone book will be able to use these systems without having to acquire expensive equipment for the purpose.

Even without such systems, many disabled people can use data banks because they have personal computers with data communication facilities and, if required, with such attachments as a speech synthesizer or a Braille display. For example, a deaf-blind person who is using a sufficiently sophisticated text telephone with a Braille display should be able to use a data bank for directory enquiries.

In an era where it is considered natural for a non-disabled person to have a computer, it may be even more natural for a disabled people to have one because its functions may be more important to him or her than to others. Therefore, a computer should be provided for every disabled person who can make use of it, in order to reduce the consequences of their impairment. For people who have one, easy access to computerized telephone directory services will be a valuable by-product.

24

Awareness of Alarm Signals for Hard of Hearing, Deaf, and Deaf-Blind People

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Audible alarm signals are used for many purposes, from national emergencies to actions in daily living, such as door bells and baby alarms. They are ideally suited to hearing people since they attract attention whatever else is being done.

Hard of hearing and deaf people are excluded from receiving this important and potentially urgent information by their disability. However there are technical means by which this problem could be overcome.

The solutions considered must take into account the needs of users in daily living, both at home and at work. Economic considerations and growing European integration suggest that systems should be common across Europe. This will ensure the lowest costs and be of great benefit to people travelling. Finally the systems proposed must also be adaptable to different national requirements, in particular for civil defense, and different applications where alarms are required for people with hearing disabilities.

User Needs

Many alarm signals may be present in daily living or for special circumstances. It is practical to classify them into three groups: personal alarm signals, local area alarm signals and wide area alarm signals.

Personal Alarm Signals

Personal alarm signals are for individual use. They may relate to immediate needs or may simply give information (alerting signals). Typical examples include:

- Warning calls
- Telephone bell

- Door bell
- Alarm clock
- Timer
- Machine needs attention

The signals may be used at home or at work. In the case of warning calls and similar alarm signals, they may also occur in public places (e.g. airport terminals) or outdoors. The common factor is that the alarm signal, intended for either one or several specific users, is generated in the immediate area of the user and that the area of coverage required is small.

Local Area Alarm Signals

Local area alarm signals relate to a generalised danger or warning, intended to reach many people. Examples include:

- Fire/smoke alarms
- Horns of approaching vehicles
- Emergency vehicle sirens

Alarms of this kind are widely used at work places, in hotels and in public places. In the case of vehicle alarms, these are generally intended to cover a small area in the street. Again, a common factor is that these alarms are generated and used locally.

Wide Area Alarm Signals

Wide area alarms are used by national authorities to indicate major incidents. These may relate to incidents at major industrial installations as well as natural disasters and hostile acts. The alarm signal is often given to the general population using high powered sirens, emitting an audible signal heard over a wide area.

There are two important differences between wide area alarms on the one hand and personal and local alarms on the other. Firstly, the wide area alarm must be delivered over a large area. Secondly, the actions required by the person receiving the alarm will be unfamiliar and possibly complex. Further information will be needed, which can be derived from emergency plans and delivered by television, radio, teletext etc. In the case of hard of hearing and deaf users, special help may be needed through support services.

Response to Alarms

For each of the alarms described above, the user will have to react in some way. It is essential to ensure that the alarm signal is reliably delivered to the hard-of-hearing and deaf users, and that the information given achieves the required reaction.

There are three levels of response required to alarm signals. These are:

- Alertness to a situation
- Warning of danger – be ready
- Immediate action required – e.g. get out and stay out

Simple signalling with cadences can differentiate these alarm levels. However the user may have difficulty if more information is to be given, as in the case of wide area alarms. One possibility is that the user interface could include a text display. However this can only contain simple messages, for reasons of logistics. Pre-prepared short messages can convey enough information for a building to be cleared or an area avoided. The user must decide how to do this from the circumstances at the time.

The information can only be provided at the time of danger and must be provided quickly and accurately if it is to be useful. The person providing the information cannot be expected to know the exact location and circumstances of the distant user. Hence we conclude that alarms cannot be specific to a user but can only inform people of the level of response required. Particular circumstances have to be dealt with by training (for example fire drills) and hard of hearing or deaf users may have to rely on the help of others for unknown situations.

Finally, in the case of wide area alarms, a state of readiness must be assumed. These events can often be forecast and a great deal of information delivered to help in actions when the alarm occurs. A practical alarm system cannot be expected to deliver this information but must be supplemented with other information for the hard of hearing or deaf person. Suitable means include written and sign language through the medium of television, teletext, Radio Data System receivers etc. It is not likely to be practical to send messages to an individual in a given situation.

Technical Solutions

Technical solutions are required for the user interface (personal alarm unit) and the alarm broadcast systems, for both wide and local area alarms. The concepts described above will of course need development and refinement. However many practical matters have been considered in reaching our conclusions.

Personal Alarm Unit

The first consideration here is the user interface, i.e. how alarms are to be presented to the user. Hard of hearing or deaf people may have difficulty or be unable to hear the audible alarms often used, so that an alternative sensory input is required.

An alarm signal must attract attention whatever the user is doing. Hence visual alarms such as text displays or even flashing lights can be ineffective since they may be out of the field of vision for much of the time. The user may even be asleep. Of the other senses the only practical possibility is a tactile signal. This could be provided by a body worn device.

Topics for investigation would include:
- Type of stimulation – electro or vibro-tactile stimulation
- Place of stimulation – contact to the skin could either be at the back of a wristwatch, or via a device in the pocket or elsewhere
- Cadence, frequency and duration of stimulation to be given

The personal alarm unit should be cordless. The signalling to the unit will be covered in the next section. The information to be carried will have to include the alarm signal itself as well as possible additional information.

When alarm signals are sent, they are often intended for many people, i.e. applicable to all people in the area. However there are many situations when the alarm will apply to one person only. For example an apartment block with many elderly and hard of hearing people may have several systems for signalling callers at the door. Some coding of this signal will be required to prevent false signals being given to personal alarm units. Hence alarm units should respond to at least two code signals, for individual and wide area alarms.

Local Area Alarms

The issue of the cordless link to the personal alarm unit has been described separately since this needs careful integration of the requirements for local and civil defence alarms. Local area alarms are applicable over a variable area of coverage. They are required in daily living, in a house or work place, as well as in the street for emergency vehicle warnings. The special case of wide area alarms is covered in the section below.

Desirable characteristics of the cordless transmission system are:

- Coverage.
  The area of signal reception should be similar to that of audible alarms in general use.

- User comfort.
  The receiver should be small enough to easily fit the pocket or ideally be wearable as a wristwatch.

- Secure.
  The receiver should reliably operate within the required field of coverage when the user may be moving between rooms etc.

- Personal.
  The receiver should not respond to signals addressed to other users in the vicinity for personal alerting signals. These could occur in the home, in the work place or in the park or playground.

- General.
  The receiver should respond to local area alarms such as emergency vehicle and fire alarms or wide area alarms independent of personal warning.

- Spectrum economy.
  Alarm signals will be relatively short and dispersed in area. The least possible bandwidth and number of frequencies should be specified for this service (users will be greatly assisted by a common system in use throughout at least Europe).
- Ease of integration.
  Transmitters will need to be integrated with all alarm devices. This is more likely to happen if transmitters are cheap and easily connected to or integrated with existing audible alarms.

Wide Area Alarms

Wide area alarms are required for those situations where large numbers of people, including the general population, must be warned in an area. This generally applies for civil defence purposes, although wide area alarms may also be used in large industrial installations.

Many countries use acoustic sirens for civil defence alarms, especially in densely populated regions. However the sirens in the less densely populated regions do not give sufficient coverage to warn everyone.

Alternative systems have been considered to ensure that these were capable of meeting the needs of hard of hearing and deaf people. Distribution through the electricity supply has limited scope. Since signals will not pass sub-stations or consumer motors, only limited areas can be covered. Similarly, distribution through the telephone network is limited by possible network congestion.

The alternative is to use broadcast radio technology. Medium or long wave transmissions would cover an entire country. However the coverage is not well-controlled or defined for use in designating particular regions only.

Paging technology has also been considered, but the function of this is to contact an individual regardless of location. It is not possible to send an alarm code to all users in a specific region. This is because a paging service operator will divide a country into zones on the basis of balancing traffic and tariffs. The zones may not relate to geographic areas and may not cover the entire country in the development of paging services.

A technology which can meet the requirements for wide area alarms is the radio data system, RDS, standardised by EBU.

The needs of people with disabilities have already been anticipated in RDS by the inclusion of the PTY31 code for alarms. Since RDS is delivered by local FM radio transmitters the system is well defined geographically for wide area alarms. Civil defence control stations have only to signal to the required transmitters to activate the PTY 31 code, which in turn activates the user's radio, at which time an alarm logo should be displayed.

Consequently RDS and PTY31 are recommended as a wide area alarm system, especially for sparsely populated regions. However where acoustic sirens are used these may directly activate the personal alarm unit using a high power transmitter in place of the normal local transmitters used. This will extend civil defence warnings to all users of the personal alarm unit independent of any other systems. The system can easily be added to existing sirens.

The merits of RDS versus the local alarm system have been discussed. However these systems are complementary. The user still requires a cordless link from the radio receiver to a personal alarm unit with tactile output. This can easily be integrated with the RDS receiver if an output is provided to signal the PTY31 code. A small local area transmitter will then activate the personal unit in the same way as the local alarm systems.

Security is recognised as a main question to be considered, with special concern for the electrical power supply where power cuts may occur. Measures should be taken to ensure the following:

- the personal alarm unit can be fed with power regularly (e.g. during the night);
- the RDS receiver power supply should not be interrupted because of an electrical supply power cut of specified duration (e.g. less than 5 hours); and,
- the entire civil defence alarm system should rely on a continuously recharged battery system (as in the case of telephone switches, for example).

Practical Implementation

The previous sections have considered the awareness of alarms from a user's and a technical viewpoint. These issues will hopefully become clearer with the following description of how the system is intended to work. Note that this is a conceptual framework only, where many technical details will have to be resolved. The system is illustrated in Figure 23.1.

Users will require a personal alarm unit. This will have a tactile (vibrator) output and may be worn in the pocket, or even on the wrist. The personal unit will warn of alarms at one of three levels differentiated by the cadence and frequency of the output. Ideally a small display will give additional information to confirm the type and source of the alarm.

The personal alarm unit will receive signals from three sources:

- Local alarms, assisting in daily living.
  These will indicate signals from telephone and door bells, babies crying, mother's warning etc. Also covered will be fire alarms etc, at work or at home or even in hotels throughout Europe.

- A combined mode.
  Local alarm signals from transmitters used with civil defence sirens or emergency services vehicles. These will activate a general (not user specific) alarm.

- Civil defence alarms through RDS.
  The RDS receiver will automatically activate the local alarm transmitter on receiving the PTY31 code.

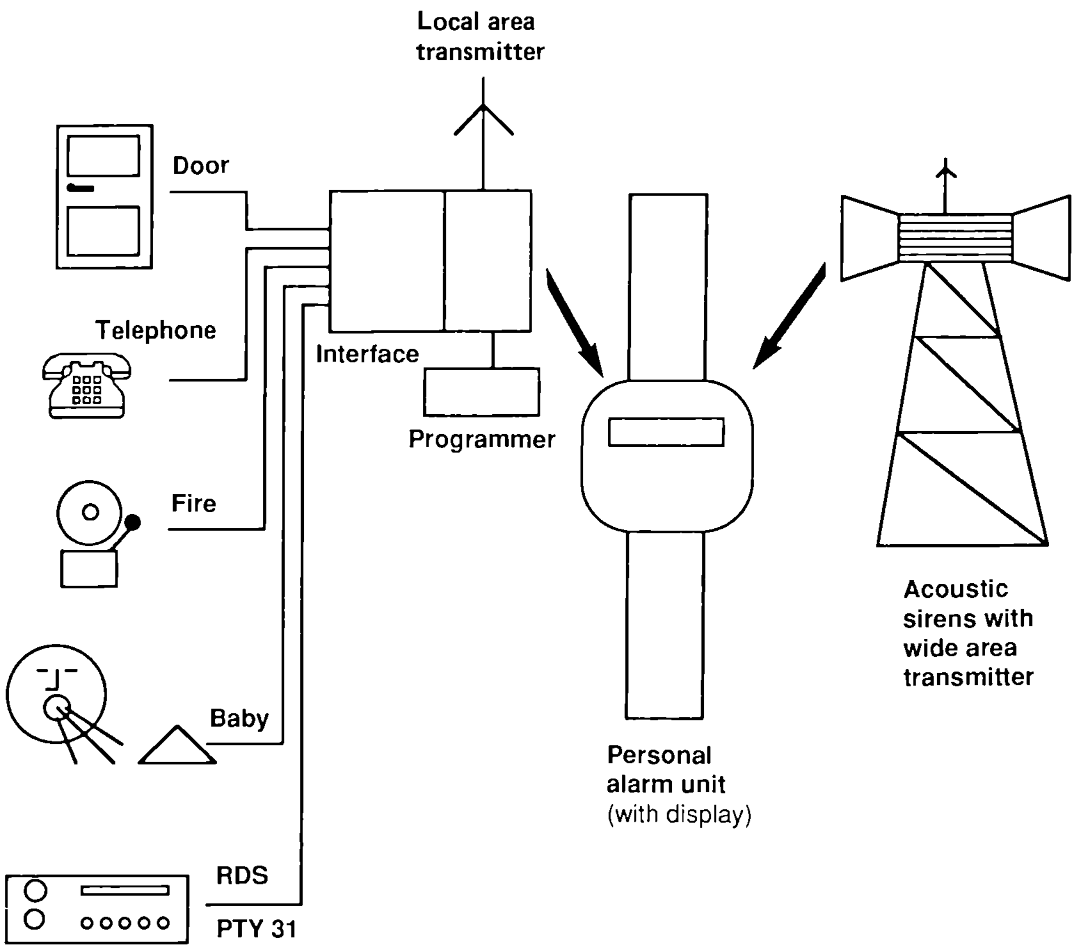

Figure 24.1 Block diagram of the awareness system with wide and local area transmitter. The latter is connected with an interface, to which different alarm sources could be attached.

Hence hearing disabled people will have equal access to alarm and alerting signals. In daily life the use of the personal alarm unit will be of individual benefit. Also the system is constantly in use, so that users are regularly aware of alarm signals and the system is exercised to ensure its continued operation.

In the street, the hearing disabled user can be made aware of emergency vehicles approaching and also civil defence sirens.

At work and when travelling, hearing disabled people will be aware of fire alarms and also audible alarms used with machines.

For civil defence, the inclusion of a relay with RDS receivers will allow these warnings to be relayed to the hearing disabled user even in the countryside (through the car or home radio).

Establishing the system will require:

- Marketing studies to determine user requirements across Europe, design issues and likely market size.

- Technical studies into the technology of the personal alarm unit, local area transmitters, and the radio frequency to be used. Economical factors will be an important consideration, especially since large numbers of (simple low power) transmitters may be required.
- Standards agreements to enable the production of compatible products.
- The allocation of a radio frequency to be used in all areas for local area alarms. A defined allocation is required since the use of local area systems in hotels and large buildings and also in connection with sirens to cover a town, would otherwise interfere with services on the same frequency.
- A strong recommendation for the implementation of a relay function with PTY31 on RDS receivers. Interfaces will be required for home, car, wrist-watch and pocket receivers to allow either direct operation of a vibrator or activation of the local area link to warn hearing impaired users.

Recommendations

Conclusions of the presentation above, result in the following recommendations:

- Technical studies should be initiated to define the local area system and especially the technology of the personal alarm unit for hard of hearing, deaf and deaf-blind people.
- Marketing studies should be initiated to determine likely market size and user requirements of the alarm system.
- Contact should be made with EBU to standardise a relay for RDS and PTY31, to activate a vibrator either directly or via the personal alarm unit.
- Subsequently to the technical studies, proposals should be made to relevant international bodies to secure a standard radio frequency for use with alarm systems for disabled people. A world standard would be very convenient, the proposal should be made by a world deaf institution and an international or European civil defense body.
- Consideration should be given at a political level to the proposals made, especially for the general use of alarm transmitters with audible and other alarms.

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Emergency Telephones

Mike Martin

The telephone has become literally a life line for many people who have found themselves in a situation where help is urgently required, often to save a life.

Motoring accidents, heart attacks etc. are examples where seconds can make the difference between life and death. The ability to get to a telephone and call an emergency service such as the fire brigade, ambulance service or police are taken for granted as the means by which lives are often saved because of the expected rapid communication and response. However, for a considerable minority of the population these emergency services are not accessible due to sensory or physical disability. For people without a disability circumstances can become handicapping, for instance when the light is poor or the stress of the incident reduces the ability to function in a coherent and rational manner.

Types of Emergency Service

In most countries there are two main types of public emergency service which are those provided by the statutory public services, i.e. fire, police and ambulance, and those provided by other domestic service providers such as the gas and electricity authorities.

A third form of emergency service is that provided on motorways for motorists who break down.

There may be considered a fourth level of emergency service which is that provided by counselling and advisory services who provide for those with serious emotional and other needs. However a widely used fifth form of emergency service is a domestic one and is that provided by home alarm services which offer emergency call services particularly for elderly people in sheltered or warden controlled accommodation.

All of these services provide a means of meeting an immediate and unforeseen need and, therefore, require to be used by the whole population with no training except for the ability to use the telephone.

However, the public services are often not integrated through one system and their method of use varies from country to country. Different telephone numbers, which are usually abbreviated codes, e.g. 999, are used in different countries and in some cases one number connects to fire, police and ambulance and in others different numbers have to be dialled for each service.

A further variation is that in some cases the emergency service operator is dialled directly whereas in other cases, such as in the UK, the call first goes to either a local manual exchange or to a central control unit which decides where to route the call. All services will be expected to have targets for response times and quality control methods for assessing their efficiency which take into account those callers who have normal speech, hearing and other abilities. The question has to be asked as to what account is taken of those whose sensory, physical and intellectual abilities are not considered 'normal'.

For domestic services there is often an assumption that although the person is elderly they have full use of speech, hearing and other abilities and little provision appears to have been made for those that do not have full use of these functions. This is somewhat surprising given that all statistics show the predominance of disabilities amongst elderly people.

Problems Faced by People with Disabilities

Depending upon their disability, people are faced with difficulties getting to the telephone, lifting the handset or dialling through visual or physical disability and/or then facing the problem of not being able to hear and/or speak over the telephone. These problems are described in detail elsewhere throughout this book but the implications for emergency services need to be made specific in view of the vital nature of the subject. It has to be remembered that in an emergency situation the caller is under great stress and has to be able to communicate quickly and often has only one chance for the call.

Physical disability requires that the telephone is placed at a height for use by a person in a wheelchair or that a special call button or switch be available for a person whose arm or hand movements are limited or placed within easy reach of a frail elderly person.

For blind or partially sighted people the importance of one format for key-pads or dials is essential as is knowing where to find the telephone. Sufficient light to see the key-pad or call button is important both for visually impaired people and those who wear spectacles and might lose them in a crisis.

For hard of hearing people using hearing aids it is imperative to have induction coupling available. This should ensure a near normal mode of communication and is particularly important in situations where the background noise level is high, e.g. when using motorway telephones. For those that do not have hearing aids, and that may be the majority, the availability of amplification will make the difference between a fast efficient call and a dangerously long and unsatisfactory one. Care must be taken however not to amplify unwanted background noise.

For profoundly deaf or speech impaired people the problems are different again in the fact that the difficulty lies in communicating over the telephone and not in manipulating the instrument itself. The implications for emergency services are, therefore, more complex as the service itself has to provide means of receiving alternative means of communication from those who are profoundly deaf or speech impaired and cannot benefit from amplification.

In part the problem is technical in being able to receive text communication from text telephones but it also requires operator training to recognise the speech of deaf or speech impaired people and not to think that they are hoax calls or from drunks. Furthermore, there should be agreed and publicised procedures for both operators and disabled people to follow. The service operators should ensure full consultation with user organisations in order to produce agreed guidelines. Procedures should take account of where text equipment is being used and also when the person is attempting communication without the use of equipment. The provision of printed instructions on emergency telephones requires very careful consideration for those who are not literate for whatever reason. Pictograms must be understandable even under great stress.

Where text telephones are used, there should be an agreed national protocol for these instruments, there is nothing more dangerous and frustrating than a person who uses a text telephone regularly finding that they cannot make contact in an emergency.

It is also important in cases where the caller cannot hear to be given visual indication on the telephone that the call has been received. This is particularly applicable on motorway telephones where there is often no means of using text.

Service Alternatives

There should be a requirement placed upon all emergency services to provide access for disabled people. The means of providing these services may be considered in at least the following ways:

- an intermediary access service be provided to accept emergency calls from disabled people;
- current services for disabled people, such as a relay telephone service, be given the responsibility for ensuring that the call is routed through to the appropriate service; and,
- the emergency service providing the access directly on an agreed basis.

While the first two alternatives appear to be attractive in not placing additional equipment requirements and staff training problems on the emergency services, they do place an additional link in the communication chain which takes up valuable time and opens opportunities for call failure. Furthermore, as the specialist service is likely to be central and not local, it means that the operator does not have the local knowledge and may not know that the call is a priority one.

The emergency services are, however, trained to deal with the urgent situations and are equipped for recording and tracing calls etc. Furthermore they know when the call is an emergency one and to whom it should be connected locally.

The problem, therefore, is to ensure that additional equipment and training for these services are provided and that the disabled public know how to use the services. When agreed service procedures are available, public education should then be undertaken, particularly in schools so that children grow up knowing how to use the telephone in an emergency situation.

Mobile Telephones

The current growth in the use of mobile telephones and the reduction in their cost offers considerable potential for disabled people to access emergency services. For the motor disabled person, the ability to use the telephone in a public place without having to access a public telephone, which might in any case be impossible, provides an ideal solution. For frail people who can drive or women on their own who break down the ability to phone from the car is of great benefit and provides security.

However, the cost of purchasing and running a mobile phone is still too high for many disabled people with low incomes. Furthermore, their physical design needs consideration for use by certain groups of people with disabilities. The facility of induction coupling for hearing aid users should be available as a standard feature and the layout of key-pads should be such that visually impaired people are able to use them without difficulty.

Future Technology

The availability of new telephone systems such as ISDN and Broadband networks offers a possibility for improved emergency services. The potential for seeing the person at the other end of the line could have very significant benefits as can the possibility to have more than one line working at the same time into where the call is coming from. However, the problems of current technology should be taken note of and dealt with in the design of the new networks. If this is not done at the design stage the same problems that exist today will appear in the new systems with little chance of correcting them for many years to come.

Financial Aspects

The ability to save life or prevent injury and damage represents a very large financial saving to the community as a whole and even more so to individuals.

The cost of providing adequate emergency services for people with disabilities is minimal in most cases as it simply requires the appropriate design and application of equipment which is not only largely applicable to the 'normal' population but will make it easier for them to use the service when they are handicapped by the stressful emergency condition.

For deaf and speech impaired people the cost of the equipment that they require to communicate with is borne by themselves, often supported by national agencies. The cost to the emergency service operator is, however, small in terms of centrally supplying a small amount of equipment and appropriate training for staff. In other words the bulk of the cost is borne by the disabled population.

Conclusions

The provision of means for people with disabilities to access emergency services should ensure that they have the same protection as the rest of the population.

The problems to be resolved in ensuring that this access is available are neither technically or financially difficult.

Often, the main reason for lack of access for people with disabilities is that little or no thought has been given to their problems when the services were set up. All opportunities should be taken to ensure that the facilities required for access are made available now. Below is set out a list of actions that could be implemented in order to achieve the access that is possible.

A List of Actions

- Discuss and agree on the features of telephones used for emergency purposes that can be changed/enhanced easily and at low cost to increase access.
- Determine how public telephones can be situated so as to minimise problems for disabled and elderly people.
- Agree on procedures by which disabled people should be able to use emergency telephones when they require additional devices, i.e. text telephones, voice synthesizers etc.
- Determine how publicity and education in using emergency telephones is best undertaken.
- Investigate the potential for a low cost European alarm that can be used by a disabled person to activate a response from the emergency service either by direct contact with the telephone, i.e. stored digitised speech drive, or remotely by radio to the nearest emergency phone.
- Make available public text telephone emergency services for deaf and speech impaired people.

Communication by Text

The telephone, for most people, is an everyday device that, almost without thinking, you use to speak to someone at a distance, anywhere from a few metres away to around the world, who then speaks back to you and whom you hear usually through an earpiece.

Most of us give no thought to what the effect would be or what we would do if we were not able to go through the simple process above to obtain worldwide communication. Indeed many people express irritation at the demanding interference of the telephone on other activities.

This irritation is nothing compared to the deep frustration experienced by profoundly deaf, deaf-blind and speech impaired people who are locked out of the normal telephone network by their inability to hear and/or speak.

However, technology offers ways to overcome this problem by substituting text for speech or hearing. The following chapters describe the approaches to using text on its own or in combination with speech as the means of overcoming the communication problem.

The availability of technology in itself does not necessarily mean that access is then widespread. Text terminals need to talk to other text terminals and to date the general availability of these devices in public authorities, hotels, doctors' surgeries is minimal in most countries. The handicapped user is therefore further frustrated because the other party is now handicapped by not having a terminal. There is therefore an urgent need to address the problem of universal access for this mode of communication, primarily within a country but ultimately internationally.

Compatibility of equipment is of prime importance, users of conventional telephones do not have to consider what type or model of telephone the person at the other end is using, but users of text telephones may be acutely aware of this as they find they cannot make a connection or simply receive garbled information. National and international standardisation in this area is therefore an urgent and widespread need.

The cost of equipment is important to many handicapped people due to their restricted earning capacity and therefore equipment that is to sell must be at a price that is within the range of low to average wage earners. Communicating through text takes some five times longer than speaking and consequently the cost of calls is much higher and means have to be found to reduce these costs.

Finally equipment must be easy to use. People who use text telephones range from young children to the very elderly and they are largely non technical. Solutions have therefore to be implemented not for engineers or computer buffs but for the average non technical 'person in the street'.

Mike Martin

26

The Short History of Text Telephones

Stephen von Tetzchner

When Bell invented the telephone in 1876, this represented a crucial step in the history of telecommunications; the introduction of the telephone made it possible for the general public to use their own voice to communicate over a distance instead of having to write down messages and ask a telegraph operator to relay them to the other party. For some people, that is, for those who cannot hear or speak, the general development implied a more difficult situation because they were unable to use telecommunication in the same manner as others. They were not able to take part in many new developments in society, because they lacked the possibility of direct communication with people at other geographical locations. While society at large changed, the communication patterns of deaf and speech impaired people remained very much the same.

However, it is not, of course, the development of audio telephones in itself that should be criticised, but the lack of interest for the situation of those who could not use this service. After all, the first telecommunication service, the telegraph, was based on transmission of letters and digits, and from the perspective of speech and hearing impaired people, it seems rather surprising that it should take almost one hundred years before text communication was made available for personal use.

The short history of the text telephone, compared to the history of the audio telephone, started in the USA, where the first text telephone, or a least an approximation of it, was 'invented' in 1964. As has often been the case with new developments for, and movements of, disabled people, Europe was somewhat later on the stage than the USA. But equally typically, Europe has caught up, and today, several European countries have better equipment and services than the USA.

The First Text Communication Devices: The USA

The implementation of personal text communication devices was mainly a result of expensive equipment becoming obsolete, combined with some creative intervention. In the beginning of the 1960s, the teletypewriters (telex machines) developed early in the 1930s for document transmission, were beginning to be replaced with more modern ones. In 1964, Robert Weitbrecht developed an acoustic coupler that allowed two teletypewriters (usually called TTYs) to communicate over the telephone network (Bellefleur, 1976).

The teletype machines were huge, weighed around 25 kilos and were not well suited for a living room. The conversation was written on paper, which is probably the reason why deaf people have got into the habit of demanding prints of conversations. There was also a range of user-hostile features, such as independent carriage return and linefeed, so that when the user forget to do both operations, there would be a black mark at the end, or a new line of text over the previous one (Geoffrion, 1982). But such matters were of minor importance for the users compared to the fact that at last they had obtained access to personal telecommunication without having to use an interpreter.

From 1964 to 1968, only 25 machines were operational, but from 1968 to 1975, the number increased to about 5 000 units. Most of them were of the old type which was designed some 40 years earlier. Little was done to modernise the equipment, and although for the last ten years there has been talk about moving away from the 5-bit Baudot code not used by many others in the world today (cf. Castle, 1981; Pflaum, 1982; Middleton, 1983), it is still this standard that is in common use (there are couple of devices which can communicate with both ASCII and Baudot). There have, of course, been newer models; in the 1970s, new, instead of reconditioned equipment came on the market, and in 1980, there were 10–15 different manufacturers (Castle, 1981). New models are usually called TDDs (telecommunication devices for the deaf). Some of these had hard print, others had small displays, as well as automatic answering facilities, but in general, both functionality and technical standards are the same as the out-of-date units 30 years ago. The typical TDD today has a one or two line display with 32 characters and a transmission rate of 45,5 bit/s.

It has been claimed that more modern equipment would have been more expensive, and that this was the reason why Weitbrecht developed the TTY on out-of-date technology. Deaf people could get reconditioned surplus teletype equipment relatively cheap; that is, initially the average price was $ 2 000, which by 1982 was reduced to $ 1 000 and to $ 500 in 1987 (House document No. 9, 1988; Levitt, 1982). Many deaf people belong to low-income groups, and even at this price, they found the units hard to afford, and for example in the state of Virginia, in 1987, only 27 per cent of potential users had a text telephone. This led to an initiative to provide free text telephones to those who could document a need (House Document No. 9, 1988).

On the other hand, the Baudot standard is extremely slow, and the user may lose on the swing what he or she gains on the roundabout. The use of low cost TTY machines represented a major step forward, but at the same time painted deaf people into a corner by excluding them from communication with other possible text communication devices, that is, in the USA, computers (Middleton, 1982).

A factor that has contributed to conserving the use of old-fashioned technology is probably the fact that in several American states, telecommunication equipment is provided by the telecommunication companies at the same price as ordinary equipment. For example, in 1979, Senate Bill 597 became law in California, requiring telephone companies to provide text telephone devices to certified hearing and speech impaired people free of charge (Pflaum, 1982). While applauding this development, one should consider the risk that telephone companies do not want to develop new equipment if this means higher distribution costs later.

Services

The first services to appear were emergency services where a call could be directed to a hearing volunteer with a TTY who would then relay a message to the police, hospital or fire brigade. In 1980, Bell Telephone Systems installed a special nation-wide toll-free TDD number that allowed TDD users to get assistance from a telephone operator (Castle, 1981).

The first relay service was established in St. Louis in 1969 as part of a private answering and wake-up service, serving 20 deaf families. The service was discontinued after six month because the time it took to relay a conversation was much longer than expected. A new service was started up in 1972 'when a volunteer organization offered services which, even to this day, have been woefully inadequate in meeting the telephone needs of the hearing impaired population in St. Louis' (Taylor, 1989, p. 13).

A number of similar small operations appeared in the 1970s; some larger ones were also established, such as the Hi-Line Relay Service of Rochester, New York, which handled 163 497 calls in 1987. In spite of the large number of relayed calls, with only 4 operators, the blockage rate was 30 per cent (Taylor, 1989). There is no doubt that the lack of nation-wide, or at least state-wide, services have severely hampered the possibilities of deaf and speech impaired people to make full use of telecommunications.

The first state-wide service was opened in California in 1987, followed by Arizona and Washington. In its first month, January 1987, the California relay service handled 87 511 calls, in January 1988, 200 718 calls were relayed, and the number of operators were increased from the expected 60 to 120 persons (Shapiro, 1989). It is worth noting that all of the first three state-wide services were a result of state legislative action, indicating that this sort of major intervention, as relay services represent, must come through legislative action.

With regard to relay services, the USA is still not one country. More than 300 relay services are geographically scattered with different names and telephone numbers (Baquis, 1989). In 1989, 24 states had either established state wide relay services or were in the process of legislation (Taylor, 1989). In 1991, there were 31 states with such relay services and 11 states are planning such services (Currie, 1991).

In addition to relay services, a number of commercial services appeared, some of them very soon after the text telephone had arrived. In some shopping centres, TTY shopping was possible, but it did not work well, and mistakes in the orders were common. The National Railroad was also quick to establish a TTY service. It is notable that this service is not yet available in Europe in 1991, without the help of a relay service. Interestingly, a number of *news centres* for deaf people appeared, that is, TTY users could dial a special number and get a news print. These services preceded later teletext on television as well as today's visions of future newspaper distribution. Additionally, a TTY radio news service was initiated in Philadelphia, where the recipients had a small radio tuner, and the audio signal triggered the TTY which printed out the message (Bellefleur and Bellefleur, 1979).

Development in Europe

While the development in the USA is reasonably well documented, there is a scarcity of available information about the development in Europe. Several countries that have text telephones are not mentioned in this review due to lack of information. The introduction of equipment and services has been almost as piecemeal as in the USA, with the exception that services were usually nation-wide when initiated. There are still, however, many countries without text telephones, and most European countries do not have a relay service (cf. chapter 22).

The first text telephones to be used in Europe were personal imports from the USA, bought during travels abroad. However, the distribution was rather small, and there is no record of any large number of deaf people being interconnected with TDDs (Abbink and de Graaf, 1985).

The first country to manufacture and sell text telephones seem to be Germany in 1976. This happened without any participation from government; the 'Deutsche Schreibtelefon', which used the EDT standard (European Deaf Telephone) was also sold in Austria, and, to some extent, in Switzerland.

Text telephones appeared early also in the UK, although there was never developed a text communication device with deaf and speech impaired people in mind. The British videotex system, Prestel, which was introduced in 1978, allowed direct communication between individual users, and thus this was used for text communication by deaf people. In 1986, a text communication device intended for document transfer in offices based on V21 was adopted as text telephone by deaf and speech impaired people. This system is currently the most widely used, but there is still a considerable degree of incompatibility. The incompatibility has even increased in 1990 and 1991 with the marketing of American TDDs based on the Baudot standard in the UK and Ireland. Those who sold Baudot-based text telephones obviously disregarded the fact that text telephones of more modern standards had already been on the market for several years, and one may assume that not many people would have bought this equipment if they had known of the incompatibility and that the relay service in the UK would not accept the Baudot standard.

Around 1980, several countries started to manufacture text telephones. Sweden began production of Diatext 1, which was based on V21, in 1979, and this text telephone was adopted also in Finland and Norway shortly thereafter.

In France, several 'téléphone par écrir' was commercially available in 1981; the most known is Portatel. However, in 1982 the videotex system 'Minitel' was introduced, and in the following years, the French Telecom gave away four million terminals as electronic telephone directories. In 1986, Minitel Dialogue was introduced to the benefit of deaf and speech impaired people. This model allowed direct communication between two Minitel users if one of them used the Dialogue, and Minitel has to a large extent replaced other text telephone devices (Besson, 1990; Xech and Rimbault, 1987). The large number of terminals given away for free, and the low charges of renting has made text communication widely available in France, which is also reflected in the reduction of relay service use.

In the Netherlands, a trial with four text telephones was initiated in 1981 which was followed by other small-scale trials until, in 1984, a commercial model based on DTMF was presented on the market (Abbink and de Graaf, 1985).

Denmark performed some experimental trials with text telephones in 1979, but they did not appear on the market until 1986, mainly because of funding problems. The Danish text telephone was based on the Commodore +4, for which, due to failing sales, the Danish Telecommunication Administrations got an extremely advantageous offer (Dam, 1987). Somewhat surprisingly, in Denmark, the DTMF was selected instead of the V21 which was already in use in the other Nordic countries, except Iceland where the American text telephones based on the Baudot standard had been in use since 1985. Iceland is presently in the process of changing to computer-based text telephones and ASCII by adopting the Norwegian text telephone program (cf. chapter 29).

Services

With a few noticeable exceptions, relay services in Europe are still in their infancy or not even born (cf. chapter 22). The first European relay service seemed to have started in the UK, where a pilot relay service was set up by the Royal National Institute for the Deaf in London in 1980, but the further development was slow. In 1985, a regular service was launched under the name 'The RNID Telephone Exchange for the Deaf' (TED). That system could, however, only cater for 170 subscribers, which, of course, was vastly inadequate to serve the total population of deaf and speech impaired people in the UK. Deaf and speech impaired people had to wait for more than ten years, until 1991, before a unit was set up to handle text communication nation-wide. This service is also run by The Royal National Institute of the Deaf, and is independent from all the major national operators.

The first nation-wide or state-wide relay services ever, appeared in Finland and Sweden. Finland had a trial service in 1981 that was made permanent in 1982, the same year as Sweden started its service. Norway followed in 1984.

In the Netherlands, a small pilot service, serving a few deaf people, was set up in 1984, and after 2 years, a regular service was initiated. In Denmark, the relay service started simultaneously with the introduction of the Danish text telephones, that is, in 1986.

In Switzerland, the multi-lingual situation seems to create certain problems. A relay service was first initiated in the German-speaking part of the country, in 1988, while a relay service for the French speaking part was opened in 1989.

Learning from History

The lesson from history is that some sort of regulative action may be necessary to ensure that disabled people get the equipment necessary to give them a more equal footing; that is, making society as accessible to them as possible. Both in Europe and America, development has been slow, and there are considerably fewer text telephones than people who need them.

The unfortunate situation in the UK, with three different and wholly incompatible standards, amply demonstrates that commercial interests may be contradictory to the interest of the consumers, and that there is a need to regulate the market in order to establish the degree of telecommunication interchange that is expected in modern society. It is hard to imagine a similar historical development, with lack of interconnections between countries, for the ordinary audio telephone.

The long and frustrating road towards state-wide and nation-wide relay services in the USA and the limited distribution of such services in Europe again demonstrates the necessity of legislative action to obtain private or public funding for a service that is a necessity for hearing and speech impaired people to obtain equal access to telecommunication. In the USA, sufficient relay services have in most cases come only after legislative action, and as Europe is moving towards increased liberalisation, similar development may be expected there.

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27

Text Telephone Protocols[1]

Peter Reefman

This chapter reviews the present situation with regard to text telephones throughout Europe. It highlights the number and variety of systems and protocols currently in use, and the problem of incompatibility presented in communicating with text telephones on a European scale.

Proposals are made to allow cross frontier text telephone communications in the short term and lay the foundations for simplified interworking into the future.

The trends in the development of text telephones are then addressed and some general recommendations are given.

The Present Situation in Europe

A text telephone is a device enabling the exchange of text between two subscribers via the public switched telephone network (PSTN). Some videotex terminals can also be used as text telephones. The term 'dialogue mode' is used here to indicate a direct on-line connection between two videotex terminals via the PSTN. Most videotex centres already allow a 'chat mode' (on-line connection of several videotex terminals via the videotex centre) and electronic mail-box facilities.

Table 27.1 gives a representation of the situation in Europe regarding text telephones. From the table it is clear that at this moment three videotex standards are used in Europe only allowing limited intercommunication.

If we include V.21, Baudot, EDT and DTMF, there are currently at least seven systems in use for text communication in Europe. The locations of the different systems are shown in Figure 27.1. The presence of at least seven different systems makes it very difficult to communicate with text telephones on a European scale.

The liberalisation process that has started encourages manufacturers and distributors to promote new equipment. This is not bad as long as the equipment is

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1 This chapter reports on the work of COST 220 'Communication Protocols for Terminals used by Disabled Person'. Due to the work of COST 219 and 220 being related, and the two projects have cooperated closely, it was decided to include this report on the work of this group.

Country	EDT	DTMF	CEPT 1 / Dialogue	CEPT 2 / Minitel	CEPT 3	V.21	
Austria	X						
Belgium				X			Minitel Dial./CEPT 2
Denmark		X					
FRG	X						
Finland						X	
France				X			Minitel Dial./CEPT 2
Greece							
Ireland						X	Minicom/V.21, Baudot
Italy	X		X	X	X		Videotel/CEPT 1, 2, 3
The Netherlands		X			X		Viditel/CEPT 3
Norway						X	
Portugal							
Spain	X		X				Ibertex/CEPT 1
Sweden						X	
Switzerland	X						
United Kingdom					X	X	Prestel/CEPT 3, V21, Baudot

Table 27.1 EDT = European Deaf Telephone (110 baud, half duplex, V.21)
DTMF = Dual Tone Multi Frequency (T/CS 46-02)
CEPT 1, 2, 3 are European videotex standards.
The system in the EDT and DTMF columns are well defined and compatible. The same holds for the Dialogue systems in CEPT 1 / Dialogue and CEPT 2. The systems in the other columns are not necessarily compatible.

manufactured according to an accepted single standard, but with seven or more standards, there is a receipe for disaster.

Possible Solutions

It has always been the official intention to integrate hearing and speech impaired people in society, and not to split them into a number of closed user groups (the number depending upon the number of incompatible systems in use). From this point of view the DTMF system may be an excellent system if no rigorous changes were expected in the peripheral subscriber equipment. If the whole situation with regard to subscribers' equipment could remain stable, and the only change be that rotary dial telephones be replaced by DTMF telephones, everything would be fine.

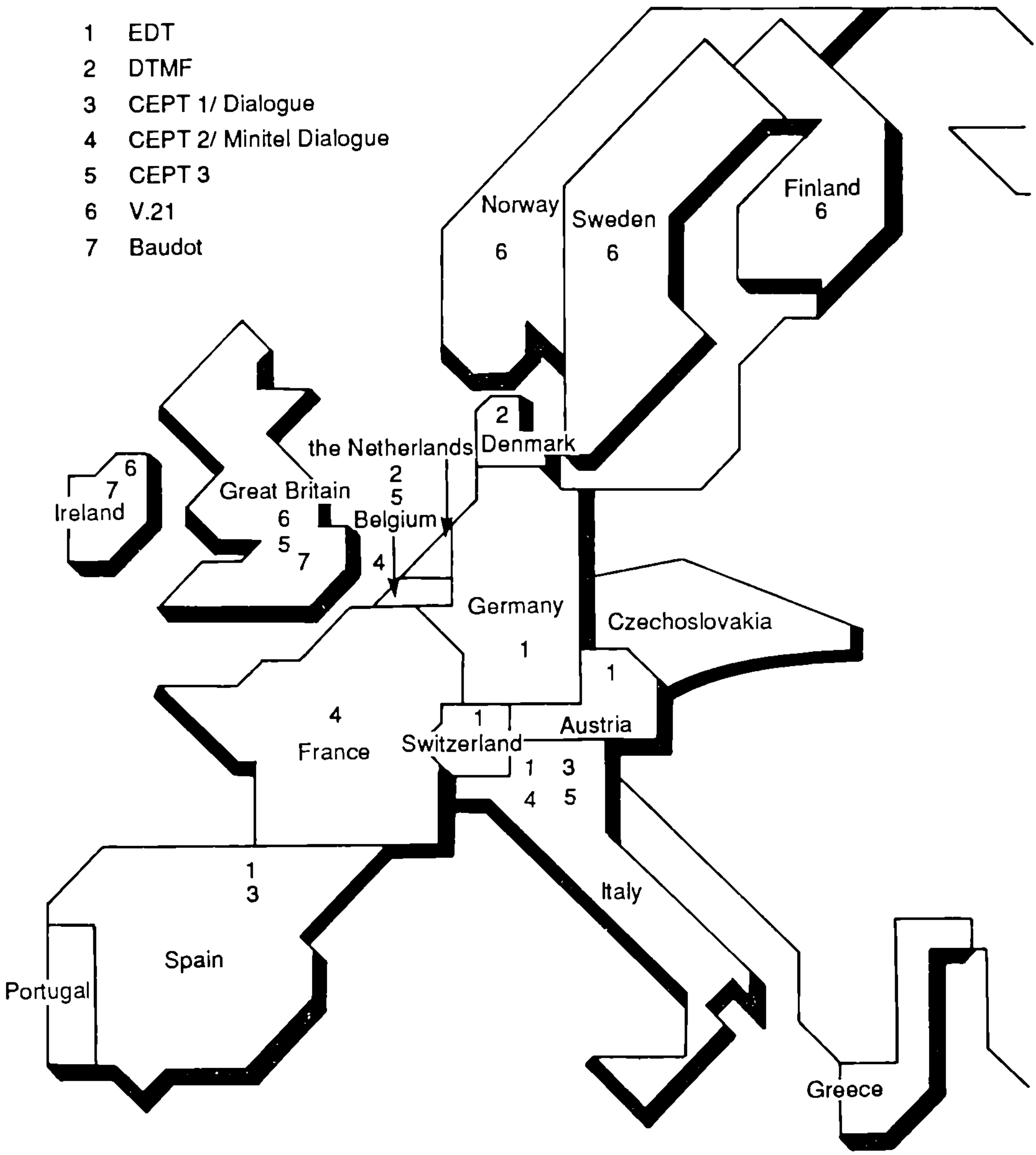

Figure 27.1 Standards used for text telephone communication in Europe..

Today the situation is more complex. The computer can use the public switched telephone network for transmission of text or data, and computers are constantly becoming cheaper. This means that a standard personal computer can be used as a text telephone (cf. chapter 29). This may be a better solution than the development of a dedicated text telephone, which would probably be higher in price, and no better in performance. Another important point is that a computer can also be used for communication with data bases.

All these developments will heavily influence the peripheral subscriber equipment, and it is quite reasonable to assume that in the near future a subscriber's set will look like a multi-functional lap top computer. This point will be emphasised when ISDN is implemented, offering a larger capacity for information transport and a larger variety of services. It follows that in the near future, text communication will be quite normal and not just a special facility for the office and for deaf or speech impaired subscribers. At that point in time, deaf and speech impaired people will not need any special equipment, and will be truly integrated into the community with regard to their subscriber equipment. Moreover, it will always be cheaper to use standard equipment.

From this point of view, it seems logical that the development of multifunctional terminals should be carefully followed, to encourage features that will allow optimal benefits to disabled people. Many facilities (spare memory, extra connectors, spare buttons etc.) have to be included in such a form that they can be implemented easily, when needed. This is indicated by the slogan 'Design for all'. Attention has to be paid to the implementation of special communication modes. For example, the question should be raised if the one channel, mixed mode 'speech–text' be maintained in a modern multi-functional subscriber set, or whether it can be totally replaced by the one channel mode 'text–text'.

In the present situation, the text telephone permits only a one channel mixed mode 'speech–text' and is a rather primitive device, often with a very small LCD-screen (to improve the portability of the equipment). It can be assumed that users will look for equipment that is more in line with modern developments in telematics. The important question is whether it should also give access to telematic services, like interactive videotex and other information systems. In France, the Minitel Dialogue seems to answer this question in a positive way.

Standardisation

At this point in time, it is very difficult to support one single standard as there are already six systems on the market. Moreover, a lot of equipment already sold, is not compatible, but still in use. The main goal however is to ensure communication for disabled people. A good short term solution may be to require the European countries *using* systems for text communication to decide on and stick to one protocol.

This step is an important step, because it opens up the possibility of automatic protocol translation in text communications between countries.

The next step would be that the European countries not using systems for text telephones should choose one of the protocols already in use.

The last step would be to support administrations setting up 'Telematic Access Points' (TAPs) in their networks. Via such TAPs a lot of services could be performed, either automatically or by operators, for example translation of foreign languages into the native language and vice-versa, protocol translation, information services etc.

Automatic central protocol translation is a good way to ensure compatibility between the existing systems. Such a solution will not force disabled people to buy new and expensive equipment unnecessarily.

On the other hand, in the future when disabled people buy their first equipment, they will find multi-standard text telephones on the market. Meanwhile, careful attention can be paid to the development of multi-functional terminals. If this is done from the beginning, it is reasonable to assume that compatible standards can be achieved. This would be the long term approach.

To repeat the steps once more:

- European countries decide upon one system per country for text telephones;
- TAPs are introduced in the European countries; and,
- European discussion about necessary terminal functions, followed by standardization of a multi-functional terminal.

Another approach to ensure compatibility in European text telephone traffic is to encourage a standard for the traffic between European countries. This standard can be implemented as a default in the telephones equipped with the national standard. The difference between this and the standardisation method mentioned earlier is that the later will not solve the compatibility problems for people with old text telephones. The implementation of TAPs is a more universal solution in the interim period.

It is also necessary to recognise the problems posed by the variety of alphabets in use in Europe and the future problems presented by this incompatibility. For the time being the group recommends the use of one alphabet, CCITT No 5. The problem of national character sets may be solved by filtering (see Appendix).

To eliminate the current incompatibility it should be mandatory that Telecom and PTT administrations and RPOA's (Recognised Public Operating Agencies) work to European standards for their videotex networks. Dialogue facilities for terminals have to be considered as an adaptation to the existing videotex standard. This should only require a simple change on most terminals.

Trends in the Development of Text Telephones

Several trends are foreseeable for the future. The use of personal computers will continue to increase as more and more disabled people use them to facilitate their activities. When they need a text telephone, they should be able to implement it on their computers. This leads to a 'software text telephone' functioning directly via the PSTN or via a host computer.

RPOAs, Telecoms and PTTs are promoting the use of multi-functional terminals giving access to telematic services and having text facilities. Thus, multi-functional terminals will also be used as text telephones. An advantage of these devices is that most will allow 64 kbit/s videotelephone connections which would be of great importance to hearing impaired people.

Furthermore, as long as simple telephone sets are in use, people will use simple text telephones. It is clear that the image of the text telephone will be enhanced if hearing people are *taught* to use it, for example during their school period. Another possibility is to market simple text telephones in such a way that they appeal not only to deaf and speech impaired people, but also to others. For example, it could be implemented in such a way that it is possible to receive a message when somebody is not at home. When this is possible, hearing people may be more interested in text telephones, helping to improve the integration of the deaf minority. The same may happen when multi-functional terminals are introduced on a wide scale.

Telematic Access Point

A Telematic Access Point (TAP) is a service that may be implemented on a computer system, coupled to the packet switched data network. The main function is to serve as a bridge between the users and the services by offering access for different types of terminals (telex, VT 100 etc.) and to different kinds of telematic services (videotex, data bases, travel agency booking services etc.).

In addition to offering matching and conversion support, the TAP can also facilitate access to the service in question.

The TAP does not exclude direct contact between terminals and services, it only offers a convenient alternative with additional facilities.

Some of the protocol conversions that are implemented or can be foreseen at the TAP, may in the future be handled in the terminals directly if further technical development leads to still cheaper memory and processing capability.

But there will be new needs, such as:

- conversion between different information presentation modes (speech, text, graphics, pictures, video);
- extraction of information by using redundancy reduction methods;
- implementation of user dependent dialogues and dedicated support for users with special needs; and,
- support services for cheap portable terminals.

From the above, it will be clear that the following protocol conversions in telematic access points are of importance for compatibility in text telephone traffic in Europe:

CEPT 1	↔	CEPT 2
CEPT 2	↔	CEPT 3
CEPT 1	↔	CEPT 3
EDT	↔	ASCII(V.21)
ASCII (V.21)	↔	CEPT 1
ASCII (V.21)	↔	CEPT 2
ASCII (V.21)	↔	CEPT 3
DTMF	↔	ASCII (V.21)
CEPT 1	↔	EDT
DTMF	↔	EDT

For example, in Telesampo, the TAP of the Finnish PTT, several conversions are already implemented. Most of the conversions work in one direction only. For example, it is possible to access the videotex services with different kinds of ASCII-terminals using different link layer protocols including V.21, but not vice versa. In the conversion from videotex to ASCII, however, the graphical information is lost. Only with a CEPT 1 terminal can a nearly complete conversion be carried out. Most of the graphics of Telesampo are in the Prestel (CEPT 3) mode.

The diagram in Figure 27.2 gives an impression of the functions of a telematic access points.

General Recommendations

In the short term compatibility for text telephone traffic can be achieved by installing automatic protocol conversion in the telecommunication networks of the European countries. If each country selects a standard protocol, automatic conversion can be offered as a service by the TAPs. The number of conversions depends upon the protocols chosen as standards by the European countries.

In the development of the text telephone the following steps can be predicted:

- software implementation of the text telephone;
- development of multi-functional terminals for standard use;
- development of small portable text telephones.

In the near future, text telephones will increasingly be implemented on standard personal computers by using software. This will stimulate progress towards an ideal text telephone from a human factors point of view.

RPOAs, Telecoms and PTTs will offer multi-functional terminals for general use giving access to telematic services. On these terminals text telephones will be implemented in software. The terminals will also offer a 64 kbit/s videotelephone mode. They should be based on the 'design for all' principle. Taking into account the situation in Europe today, it is not unreasonable to assume that they will be based on videotex protocols.

There will be a move to compatible standards in this field, which will include suitable dialogue modes for direct connections between terminals. Small portable text telephones may be based on simpler protocols like V.21 or DTMF.

Evolution will also occur from multi-functional terminals to complete workstations which can be used at home. These terminals may provide:

- voice;
- 64 kbit/s video;
- data, text and image processing;
- graphics;
- fax;
- alternative control by, for example, voice and switches; and,
- print output.

For such complex workstations it is essential that again they are based on the 'design for all' principle.

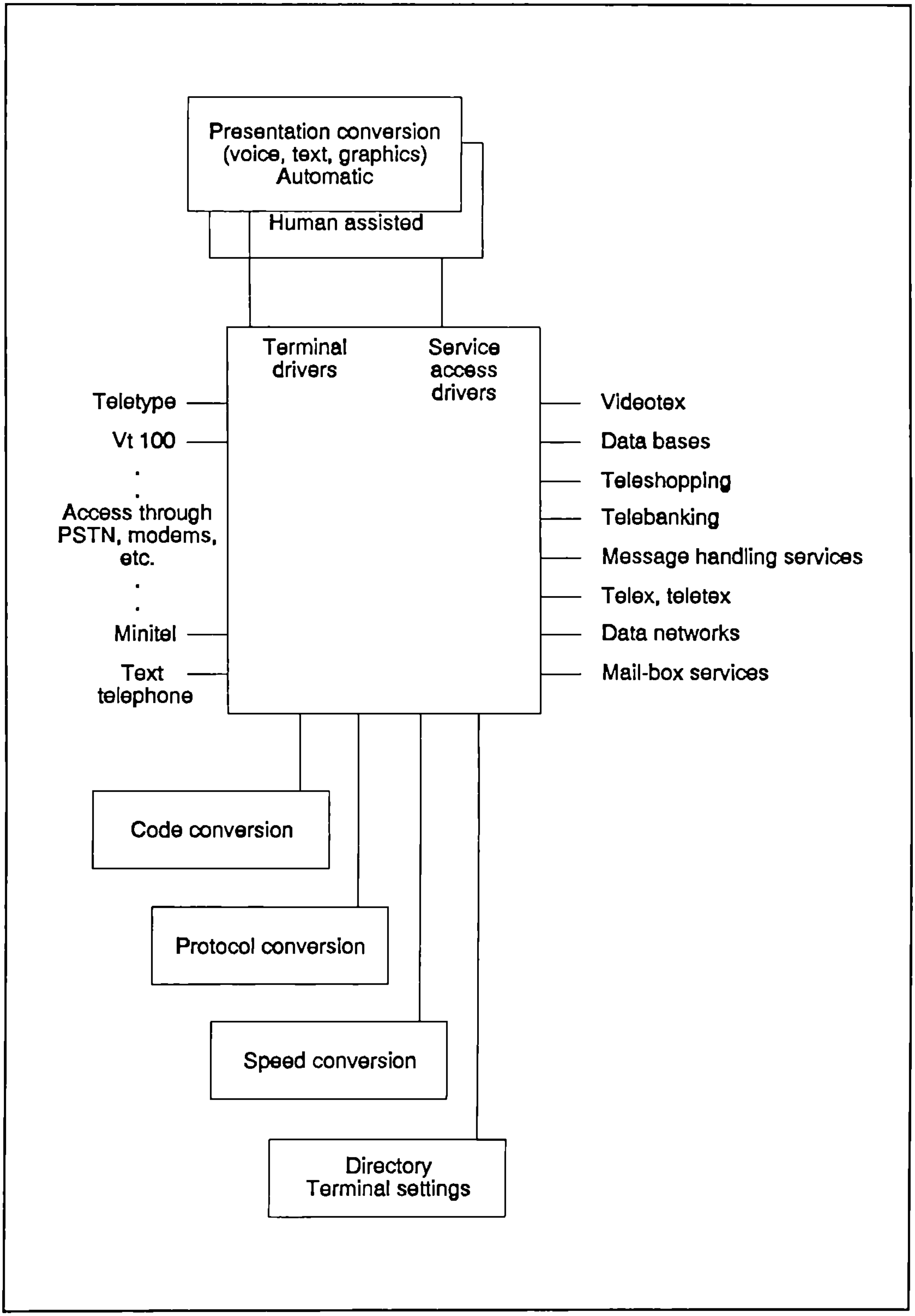

Figure 27.2 Telematic Access Point (TAP)

Appendix

National Character Sets

The problem of representing national character sets may be solved in different ways. One way is to use an 8-bit character set, for example ISO 8859-1, which contains almost all the different Western European national characters. In this case it is possible to make international calls between different text telephones, at least at character set level. But problems arise because nearly all of today's text telephones are implemented around 7-bit character sets with national extensions. The problems with the different protocols will therefore still appear.

Another way is to use a 'filter' that takes away the national characters and maps them into the international character set. For example, Scandinavian *å* translates to *aa*, Swedish ä translates to ae, and Spanish ñ translates to nj. This will at least make the text readable.

The filters can be implemented in the protocol translators (of the TAPs) that are needed for international text telephone traffic.

Protocol conversion can be implemented either through a 'National Translation Service' or a 'European Text Telephone Network'.

National Translation Service

Assume that a person in country A wants to make a call to a person in country B. In case of a national translation service, a call has to be made to that country's TAP. When contact has been established, the code for country B is given. This tells the translator which tables and protocol are to be used. When the called number is given, the translator makes the call directly to the subscriber in country B. The transmitted information is translated in country A's TAP, both as to protocol and national characters.

European Text Telephone Network

The translation from the national character set to the international character set and from the national protocol to X.25 is made in the originating country's translator service (TAP). Only outgoing national characters are translated. In the receiving country's TAP a translation is made to the appropriate national character set and text telephone protocol. In this case voice communication is not possible.

28

Proposals for an Ideal Text Telephone

René Besson

For deaf, deaf-blind or speech impaired people, the normal telephone network is inaccessible as it is designed to be used by those who can speak and hear normally. The introduction of text telephones has now made access possible and in countries such as the USA, their use has been widespread for many years.

A text telephone is basically a keyboard and display to show text and a means of coupling this to the telephone either acoustically or electrically via a modem.

The possibilities for facilities to be made available on the text telephone are quite numerous and the intention of the working group on 'Remote text communication' in COST 219 was to set down facilities that could or should be made available on various types of text telephones. The features and facilities described below are those that are considered by deaf people to be of most importance.

The terms of reference of the working group did not cover the protocols used by text telephones to communicate with each other. An unfortunate situation currently exists in Europe where text telephones cannot communicate with others of a different make, or even model, in either the same or a different country because of differences in protocols. Most users are unaware of these problems and manufactures and retailers are not specific about them, hence creating common concern. This situation requires urgent attention on a European basis both to provide the user with the faculty other telephone users have, i.e. not having to concern themselves with what telephone the other person is using, and to open up the market for manufacturers by having common standards across Europe.

A final consideration is the various modes of use that text telephones may have. The diagram shows that the text telephone may not only be used to communicate with another terminal directly but with electronic mail systems information data buses or be used with a relay service. These various modes of use all require consideration of the facilities that a user might require and are considered in the proposals below.

Preparation of Text

Keyboard

The keyboard shall normally have a QWERTY (or AZERTY) lay out and be of sufficient size to allow an experienced typist to type comfortably. The character set shall include as a minimum all letters and numerals. Upper and lower case text should be available.

For physically disabled, blind or deaf-blind people, it should be possible to substitute alternative input systems for the usual keyboard (keyboard with bigger keys, Braille, control by speech). Alternatively devices may include other methods of access such as scanning (see the paragraph on external devices below).

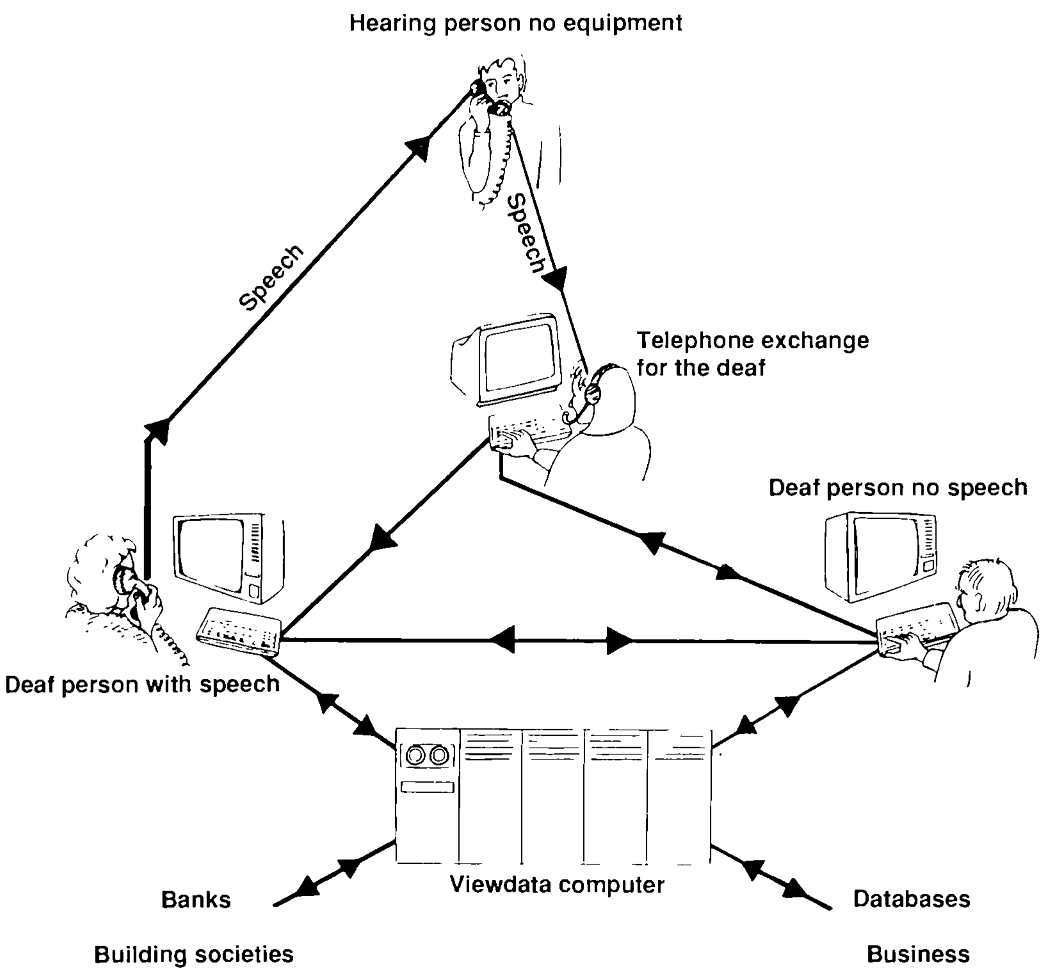

Figure 28.1 The potential for using text telephones. The deaf person may talk with text to another deaf person with compatible equipment, communicate through a host computer via electronic mail or access data bases. Alternatively the deaf person may communicate directly with a hearing person with no text equipment via a relay service (Telephone Exchange for the Deaf).

Off Line Preparation of Text

Before making a telephone call the user may wish to prepare the text off line in order to ensure that the material is correct and to save on the cost of the call by reducing its duration.

The following facilities are required for text preparation:

- basic text editing, i.e. back space, deletion etc.;
- storage of prepared text, one page of A4 minimum; and,
- the ability to receive an incoming call while preparing text off-line without losing the prepared text.

Stored Messages

Stored messages may be used for different purposes, and should include both text messages and spoken messages.

Text Messages

Premade messages may be used to introduce the caller to the person being called. These messages may give the name, telephone number or other information at the discretion of the user.

The messages should be stored so that they can only be erased or changed at the request of the user. The store must not be erased when the power to the terminal is removed (see paragraph on 'Power supply' below).

Other messages: a useful additional facility – but not a basic requirement – is to have the possibility of storing other material, such as phrases often used in conversations, that can be easily retrieved and sent during conversations.

Emergency messages for police, fire, ambulance etc. should be stored and be associated with specific function keys on the terminal. Storage for at least three messages should be available and these should be possible to change by the user.

Spoken Messages

The possibility should exist to store vocal messages. The functions of these messages are to make a hearing person aware that they have contacted a text terminal, and to alert emergency services.

The messages should be pre-recorded in a clear voice at a natural measured rate to ensure good intelligibility.

Sufficient storage should be made available to allow at least the introductory message plus three emergency messages as in 'text messages' above.

Code Number Storage

In order to access some services a code number is required. A store is therefore useful for such numbers to be easily accessed when setting up a call.

Where special call charges, etc. are needed for some services, the terminal should allow a personalised identification number to be sent.

If autodialling is available at least four numbers should be stored.

Recall of the last number dialled should be provided.

Displays

The display used to show the text may vary in form from a single line display to a full page of text on a screen. The choice of display will to a large extent depend upon the intended method of use of the terminal and the visual acuity of the user. The display should be easy to read, even in adverse light conditions.

All displays should take note of accepted good practice with regard to the design of alpha numeric displays and where possible a capability for at least double height characters should be made available.

Tactile displays e.g. Braille outputs or large bright displays should be available for deaf blind people as an add-on facility.

It should be possible to blank the display at the wish of the user if confidential information is being viewed in the presence of another person.

Presentation of Text

Single Line Display

A single line display must contain sufficient characters to ensure that the sense of the material is perceived. A minimum of 20 characters is suggested. The display should flow from right to left.

Multiple Line Display

The text should scroll up from the bottom when the screen is full automatically line by line. To provide empty lines on the screen for text to be written, manual control should be available.

A change from receive to send should result in a new line being started.

Where a large screen is used, the sent and received text must be represented in a clear manner such as the following:

- different colours for send and receive;
- incoming and outgoing text following each other and separated by a code such as GA;
- vertical splitting of the screen. In this case it is important that both persons can write simultaneously using a full duplex system;
- horizontal division of the screen with send in the top half and receive in the bottom half.

Connecting the Terminal to the Line

Connection to the telephone line may be direct, through the line terminal socket, or acoustic by placing the handset of the telephone onto appropriate acoustic coupling devices on the terminal. Direct coupling should be provided on all terminals.

Direct Connection

The terminal should be provided with a lead of sufficient length to allow the terminal to be placed in a comfortable position for the user to sit at a table adjacent to the wall socket.

The cable should be terminated in a plug meeting the national requirements for line connection.

The characteristics of the plug and the terminal should meet national requirements for line connection.

Where a direct connection is used it should be possible to make a connection to the line without lifting the handset of the telephone.

Acoustic Coupling

Where acoustic coupling is provided the following shall apply:

- The correct position of the telephone handset on the terminal shall be clearly indicated on the case.
- The acoustic coupling devices shall accept a reasonable range of telephone handset designs and provide at least 20 dB of attenuation of ambient noise over the frequency range 300 to 3 000 Hz with the most commonly used handset in the country of use.
- The microphone in the terminal associated with the receiving cup shall be mechanically isolated from the case of the instrument so as to reduce vibration borne noise. The associated circuitry shall also reduce the effects of noise on the signal.

Line Signal Indication

Due to the fact that deaf and deaf-blind people are unable to hear the dialling, ringing and engaged tones that indicate the state of the line, it is necessary to provide a means of indicating this information in a visual or tactile form. Furthermore, it is important to know whether data or speech is being received.

The information may be indicated by use of light emitting diodes (LED), words written on the display, and devices that vibrate.

If a single diode is used, it should be of a sufficient brightness and size to be clearly seen and should indicate in an unambiguous manner the temporal pattern of the signal on the line. If more than one diode is used, they should either singularly or in combination indicate a particular state of the line, the temporal pattern of the signal should be retained.

Where the state of the line is indicated on a display, the information displayed must relate exactly to the state of the line. Words such a 'waiting' should not be used to indicate a malfunction or delay. The preferred words to describe the various states are as follows:

- dial tone;
- ringing;
- engaged; and,
- unobtainable.

It is of value to have an LED to indicate the temporal pattern as well as words on a display, particularly if the line is noisy.

On either an incoming or outgoing call, it is important for deaf people to know if they are receiving speech or data. This information may be indicated on a LED by showing the temporal pattern of the signal and/or by a LED connected to a circuit that distinguishes between speech and data.

The information above can be indicated in a tactile form by using a transducer that produces sufficient vibration and follows at least the temporal pattern of the signal.

The above methods can be used in combination.

Operating Procedures

All terminals should have an automatic default condition, whereby the terminal is set to the agreed national code. Additional codes may be available by a simple user operation. All codes should conform to stated CCITT recommendations.

Outgoing Calls

When the connection is made, the caller may be connected to another terminal, to a person speaking or to an answering machine.

- In the case of another terminal, the callers terminal should detect the presence of a carrier tone or data pulses and indicate on the display that the call is connected. The terminal should be capable of receiving the agreed national data codes used by deaf people.

- The caller's terminal should then send a stored identifying message (See 'Text messages' above).

  This message should end with the agreed code requesting the other party to respond.

- In the case of a person speaking at the far end, this should be identified on the display. The users should then have the option of sending a pre-recorded spoken message or using their own voice.
- In the case of an answering machine using speech, the indications of the above paragraph will apply, but the deaf person will need information as to when to speak.
- Emergency messages should be relayed by using an appropriate function key after the call is connected.

Incoming Calls

The caller may be another text terminal, or a person who is speaking.

- The terminal should recognise and respond to the agreed national codes used by deaf people. The terminal should display an identifying set of characters to the caller, e.g. name and telephone number.
- If the user is not present and the terminal has the facilities, incoming messages should be stored for subsequent recall. Stored messages may only be accessed by an authorised user.
- The user should have the option of storing the call for subsequent review or print-out. The material should not be deleted when the power is switched off.
- Automatic connection: The terminal should connect automatically when a carrier frequency is on the line (call from another text telephone terminal or from a videotex service).

Terminating the Call

When the line is disconnected or if the call is finished, the terminal must display this information. At the end of the call, the time the terminal has been connected should be indicated. It should also be indicated if a call is pending (on appropriate networks). This indication should be given by a flashing display on the screen (or by an external light on ISDN).

Call Storage

The terminal should automatically store the characters of the incoming or outgoing call. A marker should indicate the change from caller to sender. A minimum storage of one page of A4 should be available.

External Devices

Input/Output Port

To permit connection of external keyboards or specialised devices such as a Braille terminal, a port, preferably based on the RS232 serial protocol, should be provided.

Alternative Display

A video output port should be available to drive an extra display, e.g. a large screen for visually impaired users.

Alternative Input

An audio input connection, e.g. to connect other devices with speech input, would be useful.

Speak-Through Facility

For deaf people who have intelligible speech over the telephone, it should be possible to speak directly to a hearing person using a terminal at the far end. A function key should be able to switch the line from speech to data and vice versa, without the risk of disconnection of the telephone line. A visual indication must alert the users about the state of the terminal during this procedure.

Power Supply

The different stored messages, spoken messages, codes, call storage, should not be erased when the power to the terminal is removed.

The rating of the power supply should be clearly indicated.

Where batteries are used, their type and correct polarity should be clearly indicated.

An indication of the battery state should be available.

Types of Terminals

The design of a terminal may vary according to the needs of the user. This may be from a very simple portable device to a complex office system.

Terminals can be classified into four types according to the minimum facilities provided.

A Type 1 terminal is the most complete terminal, type 4 terminals are very simple low cost devices (Table 28.1).

Facility	Type 1	Type 2	Type 3	Type 4
Acoustic coupling				x
Direct coupling	x	x	x	
Single line display				x
Multiple line display		x	x	
Full screen	x			
Character choice possible by scanning	x			
Text storage	x	x		
Off-line editing	x	x		
Emergency messages	x	x		
Voice announcer	x	x		
Speak through	x	x	x	
Line status:				
Single LED				x
Multiple LED		x	x	
Text message	x			
Code storage	x			
Auto dial	x			
Last number redial	x	x		
Automatic answer mode	x			
External input port	x	x	x	
External output port	x	x	x	
Battery operated			x	x
Mains operated	x	x		

***Table 28.1** Types of terminals*
The design of a terminal may vary according to the needs of the user. This may be from a very simple portable device to a complex office system.

29

A Conversation-Oriented Text Telephone Program for IBM Compatible Computers

Stephen von Tetzchner and Jan Berntzen

The state of the art of text telephones is a good example of how less advanced technology than that used in ordinary consumer goods, is used in equipment for disabled people. Since the introduction of the first text telephones in the USA in the early sixties, it has always been yesterday's technology that has been used (cf. chapter 26). Today, a personal computer with modem can provide a functionally better and cheaper text telephone than many of those currently on the market.

In the design of telecommunication equipment for hearing and speech impaired people who are dependent on writing for telecommunication, little attention has been paid to how the text is presented to the user. Most text telephones do not present the conversation in such a way as to make it easy for the user to keep track of it. For example, many devices, especially those originating in the USA, only have one or two lines of text, where the letters move from right to left.

In addition, the conversation is often slow, partly because it is impossible for the communication partners to write simultaneously, and therefore difficult for them to interrupt each other. Incoming and outgoing texts are not separated on the screen, and if both communication partners write at the same time, the incoming and outgoing letters become mixed. Therefore, conversational turns are usually terminated with a 'GA' (go ahead) or '*', signalling that the other person may start to write. It is faster to read than to write, but the person who is receiving cannot use this time because his or her full attention is taken up all the time by the small screen.

When designing telecommunication equipment for people with disabilities, the tendency is to consider disabled people as the only potential users. However, many hearing and speech impaired people have a social network that consists of people who are not similarly impaired, and who cannot afford to or do not want to buy a special device for communicating with one particular person. To establish telecommunication between a hearing impaired person and his or her relations, friends and whoever else, may mean that the communication partners have to use a relay service, which makes the communication slower, somewhat awkward and less personal. Although relay services are very important today, it would be ideal if they were to become superfluous, i.e. all telecommunication should be direct. One way to increase the number of text telephone users and form a basis for more direct telecommunication, is to make it easy to use computers as text telephones.

A computer based text telephone consists of a computer, a device for converting the signals generated by the computer to signals that can be transmitted over the telephone line (modem), and a suitable program. The present chapter reports on a program that makes it possible to use an ordinary personal computer as a proper text telephone (standard communication programs can be used for text communication with ASCII characters, but they are often difficult to use and do not have the appearance of a text telephone). The aim of this development was to use available consumer technology to make a better text telephone than the equipment currently available on the market. Another of the major concerns and aims of the program was to ensure that the large number of people with personal computers and modems could have a text telephone at very little or even no extra cost. Furthermore, with the growing number of small and cheap lap top computers with good LCD screens, text telephones have become portable, and even mobile if used with an ordinary mobile telephone.

The program runs on IBM compatible computers. It is compatible with text telephones used, for example, in Norway, Finland and Sweden, as well as ordinary computer communication programs, such as Procomm. Thus, it makes it possible for everybody with an IBM compatible computer with a standard Hayes compatible modem, to have conversations with users of dedicated text telephones.

Description of the Program

The world's most common computers are IBM compatible, and hence a program based on this hardware platform was the preferred choice. With regard to compatibility, the program should work with all reasonably IBM compatible computers, and with all modern versions of MS-DOS (a version for Windows 3.0 and later versions is under development). The program prototype was written in Prolog, with the use of Borland's 'Turbo Prolog 2.0' and 'Turbo Prolog Toolbox'. This software package was primarily chosen because of its excellent selection of communications and interface routines and commands.

During recent years, a modem standard based on the American Hayes modem has emerged. This is not a true standard, but rather an agreement between communication software publishers. The majority of modems manufactured today conform to this standard, and therefore the Hayes command set were chosen as a modem standard.

The program should work with the majority of Hayes compatible modems. Not all Hayes modems behave in the same way, however, and it would probably be impossible to make a program that was compatible with all of them.

A text telephone program should make the user able to communicate with existing national text telephone systems. In Norway, this means ASCII, which is the standard for data communication. Thus, a text telephone program that is compatible with the Norwegian (and several other national text telephone services) will also be compatible with standard data communication programs.

Using the Text Telephone

The program is started from the DOS prompt using FTEL for the colour version and MTEL for the monochrome version. If the program is started from a hard disk, then the user must have selected the appropriate directory. When the program is activated, the 'main menu' appears on the screen (Figure 29.1).

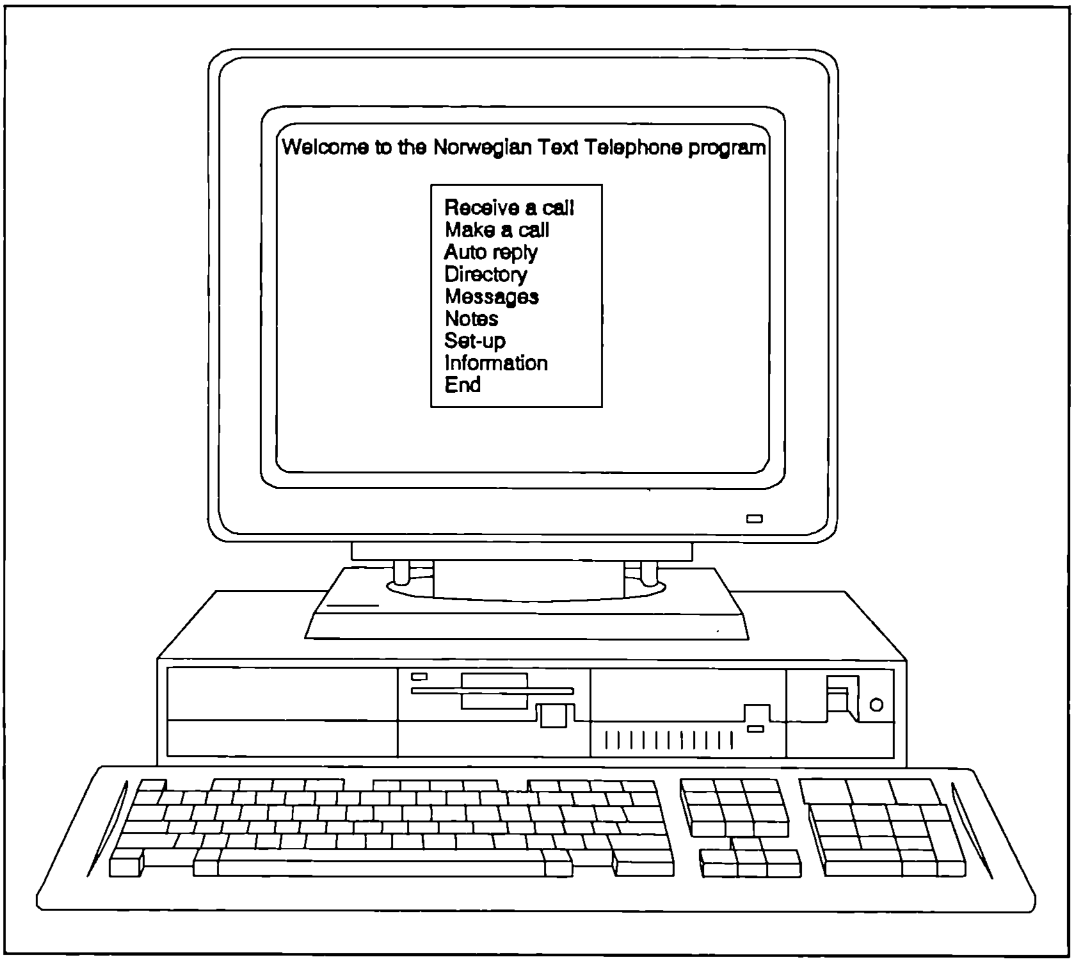

Figure 29.1 The main menu.

Making a Call

To make a call, the user uses the arrow keys to move the highlight to 'Make a call' and presses <enter>. A window appears, where the user keys in the telephone number of the person he or she wants to call (or F1 to repeat the last dialled number), and presses <enter>. If the line is engaged, or if there are other connection problems, messages indicating the status of the line will appear on the screen. If the connection is established, two windows appear on the full screen (Figure 29.2).

Incoming and outgoing texts are presented separately in parallel vertical windows, making it possible to write simultaneously. Thus, the user can give small comments while the other person is writing, similarly to *yes, hm, don't you say* etc. in spoken conversations. Such comments tie the conversational partners closer together and smooth the interaction. This presentation also makes it possible to interrupt without disturbing the other person's text.

Words that are not finished by the end of the line are moved to the next line. The texts of the two partners are linked through the line feed command, so that they are always on the same line. Whenever one of the partners changes line, the other does as well. It is therefore easy to relate the conversational turns on the screen to each other. If the other person has not finished the word he or she is currently writing when the cursor changes line, this word will be moved to the next line.

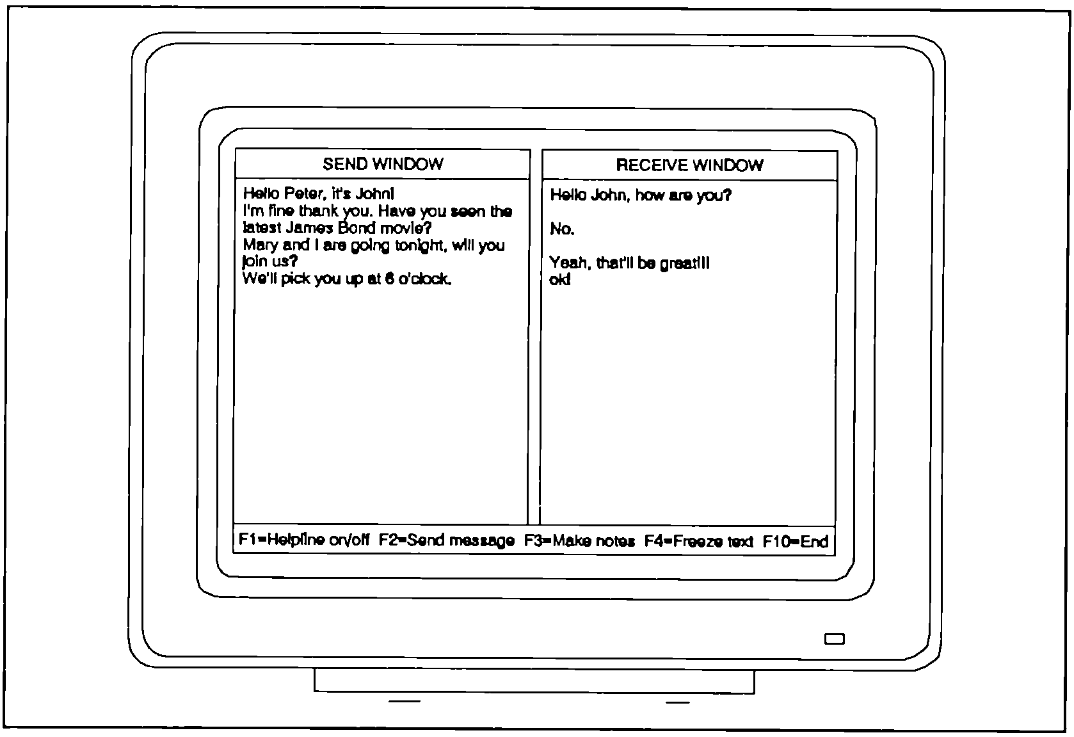

Figure 29.2 The text telephone screen.

During conversations, several function keys may be activated:

F1 turns the help line on and off.
The help line at the bottom of the screen may be turned off to get another line of conversational text.

F2 is used to send pre-composed messages.
It is possible to have several prepared messages. These may be standard openings and closings, or longer messages that are prepared in advance to save time on-line.

F3 is used to pop up a window for writing notes.
This facility makes it possible to write down addresses, telephone numbers etc., without leaving the keyboard. The notes are stored and may later be reviewed or printed. The user can choose (in the set-up) whether or not a message is sent to the other part about his or her note taking (Figure 29.3).

F4 freezes the incoming text.
If the other partner has prepared a long message, the text may come too fast for the user to read it, and he or she may want to freeze it.

F10 is used for terminating the call.

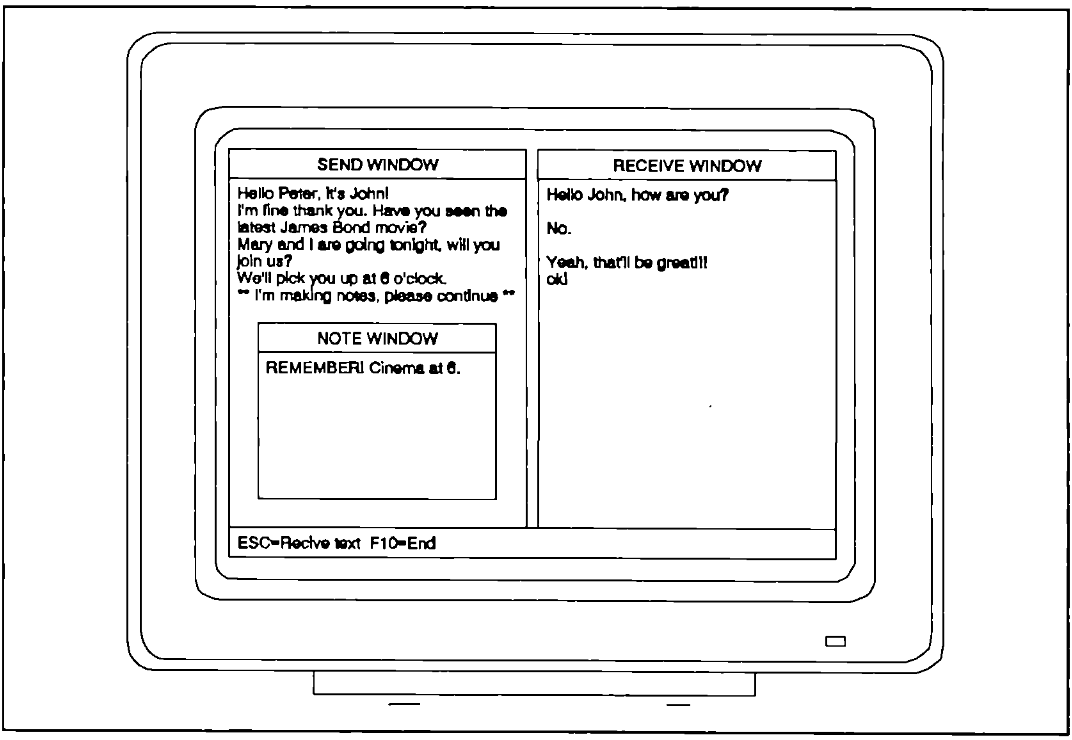

Figure 29.3 The text telephone screen with note window.

Receiving a Call

The program does not have facilities for alternative (e.g. visual or vibratory) 'ringing' signals. Thus, it is assumed that the user has an ordinary telephone with the necessary add-ons for becoming aware of an incoming call.

When the 'ringing' alerts the person, he or she chooses 'Receive a call' on the main menu, and the connection is established.

Other Functions

To make and receive calls are the two essential functions of the program. The other functions on the menu are set-up and communication enhancement functions.

Auto reply

Hearing or speech impaired people who are not able to use an ordinary audio telephone, may not be easy to reach while they are out of their homes or work places unless they have a mobile text telephone. Therefore, an auto reply option should be a standard feature of all text telephones.

The user selects 'Auto reply' for receiving messages when he or she is absent. When the auto reply is on, a message is automatically relayed to anyone calling. This message is editable by the user. The person who is calling can write a message which is automatically saved on disk for the user to look at when he or she returns. The time of the call is also registered with the message.

Directory

Frequently used telephone numbers can be placed in the directory, which contains entries for name, address and telephone number. The list is sorted alphabetically. The user can make a call directly from the directory by selecting an entry with the arrow keys and press <return>, and the telephone number will be dialled automatically.

Messages

It is possible for the user to make and store a large number of messages that can be sent during conversations. Among the messages is also the auto reply message. It is possible to delete old messages, or to edit them if changes are wanted.

Notes

The notes made during conversations can be reviewed, printed and deleted.

Set-up

The set-up menu is used to configure the text telephone. The options are COM-port, pulse/tone signalling, screen colours, modem initialiastion and note signal on/off.

Information

It is possible to read the general and technical manuals as well as obtaining information about installation procedures while using the program. It is also possible to print out the manuals.

Experiences

The prototype program has been distributed for trials in more than ten countries throughout Europe and local versions have been made. The program has been used by both deaf and hearing people over a period of time. It has also been tried out with a Braille display by a deaf-blind person. We have received feedback on the prototype from a large number of users, and their comments are encouraging. No major problems have been encountered and most people find the split screen comfortable to use and express that they prefer this mode of presentation over the traditional ones. The only problems that occurred were related to the function of modems, and in addition to this, several people have asked about a possibility of storing conversations.

Modems

Minor variations in the modem standard caused some problems, but all these difficulties were solved. A problem which causes some complications is the fact that not all modems send the 'calling tone' described in the V.21 standard. This is a tone which the calling modem sends to alert the receiver that data transmission is taking place. Some modems do not send this tone, and this may cause problems when an ordinary audio telephone and a text telephone share the same telephone line, because the receiver is unable to distinguish between a text telephone call an audio telephone call. A possible solution is only to use modems which have this feature when shared lines are used, which is very often the case, and modems with calling tone will be recommended in the manual.

Storage

In many of the modern text telephones, it is possible to store and make a printout of the conversations. This practice is very unfortunate, and reflects the fact that the designers of text telephones have failed to distinguish between written correspondence and conversation by text. A spoken conversation is a transitory event, and an utterance disappears as soon as it is spoken. If a person started to tape audio telephone conversations for later review, he or she would be perceived as rather peculiar. In addition, in many countries it is illegal to tape telephone conversations, at least without the consent of the conversational partner. It may also be illegal to use the recordings for any other purpose than reviewing them personally.

The same formal and informal rules should apply to all kinds of telecommunication terminals that are used for conversations. Thus, neither dedicated text telephones nor text telephone programs should have the option of storing conversations.

It is sometimes claimed by deaf people that they want to store conversations because it is more difficult to make notes during text telephone conversations than it is during audio telephone conversations. This may to some extent be true, although it is quite normal to ask the partner to wait a moment while one writes down something while talking on the telephone. However, the note taking function was introduced to make it easier to make notes without interrupting text telephone conversations. Furthermore, if the partner really wants to send a long message that should be stored, it is possible to use the auto reply function.

Further Developments

A new version of the program is under way, based on the comments on the prototype version. It will be written in C to make it easier to transfer the program to other computers. Not all computers have a Prolog compiler.

The most obvious improvement of the program is to make it memory resident. The prototype version cannot run concurrent with other programs, and if the user is doing something else on the computer, that program has to be terminated and the text telephone program activated before the user can receive the call. No other programs can run concurrently. When the program becomes memory resident, the user may receive incoming telephone calls while using the computer for other applications. A window will pop up, asking the user whether the call should be received, ignored or received by the auto reply.

There will be new procedures for easy switching between audio and text telephone mode, and an option of a larger font. Except for these additions and a few minor adjustments in the menus and commands, the overall lay out and functionality will be kept as it is.

Computers with modems may contain more communication functions than just those of a text telephone. For example, with a standard communication program, databases may be accessed. Most national videotex services provide free terminal emulators. In the next version, the program will start with a master menu (or shell) where the text telephone is only one of several options (the only one that will become memory resident). The users will have to obtain additional programs themselves, but the master menu will make it easy to switch between different communication programs. Thus, a Norwegian user may have PC-Tex to get access to the telephone directory (which deaf people have to access via the relay service) and other Teledata services, for example electronic mail which is available at a small cost. The same user may also have a Minitel emulator to communicate directly with friends living in France.

It is especially important to introduce electronic mail (cf. chapter 30) as an affordable option. In addition to being a practical medium for messages that are intended to be stored, the availability of an electronic mail function will underline the interactive function of text telephones, and thereby reduce the demand for the storage of conversations.

30

Electronic Mail as a Telematic Tool for Disabled People

Jan Engelen

Electronic mail is a network service in which messages are exchanged by computers. In a more restrictive meaning of the word, it is the transfer of electronic messages on a regional, national or global scale. The word 'Electronic mail' (or E-mail) in its strict sense neither includes surface mail transfer of diskettes nor the use of telefax. As a somewhat simplified example one may think of a text written on a computer, preceded by a standardised header, containing key words such as:

From:
To:

This type of messages can be transferred over a network based on the address specified in the 'To:'-field.

Sometimes the messages are stored in a mailbox, i.e. a computer memory that can be consulted by the addressee.

As such, this central computer is a Telematics Access Point (TAP) (Engelen and Reefman, 1991). If the addressee has a permanent line to the TAP or if the TAP can initiate a call to the addressee's computer, the electronic message can be delivered in almost real time.

In many systems however the addressee has to establish a connection to the computer (i.e. to 'log-in') at regular intervals in order to find out if a message has arrived.

In this article details on current and future systems, as well as the practical uses for communication among disabled people and with other groups will be stressed.

The major benefits of E-mail over the use of fax is the immediate availability of the text in electronic form. If one takes some precautions even the formatting can be kept during the transmission to another computer.

The cost of electronic mail is a complex issue depending largely on national regulations. It can be stated however that, if modern modems are used in the network, the telecommunications costs will always be lower than for faxing as the data content (especially for non-formatted ASCII messages) is quite low. Very often though, the cost of subscription to data networks (like those mentioned in note 5) exceeds the actual communication costs if the system is not frequently used.

Local and Wider Area Networks

Computer networks can be divided in general into *Local Area Networks* (LAN) and Wider Area Networks (WAN) although the distinction tends to get confused.

In a local area network, normally the structure and hardware connections are permanent. Sending messages over such a network to colleagues is quite common. In Karlsruhe, there is a field trial, where sighted and blind students in informatics can work together on the same software and send written messages to each other.

Real-time and Stored Systems

Another distinction should be made between *interactive communication* and the use of *Bulletin board systems* (BBS). Real-time interactive communication between two people is uncommon in scientific applications, but the linking of two text terminals is the preferred way of communication between hard of hearing or deaf people (see below).

Although Bulletin Boards (sometimes called *Forums*) and *Mail boxes* do not function in real-time, they are very popular. They stem from the world of the hobby computer users. Mail boxes form a non-interactive system as messages sent in by a person are kept in the computer's memory to be read by the addressee as soon as he/she logs into the same system.

Mail boxes are also one of the most important features of public data communications networks. Generally they are used for person-to-person communication but since the messages are stored, the addressee need not be reachable immediately.

A Bulletin Board is an extension of this system in which one mail box can be written to and read out by a large group of interested people. Such a board can contain timely messages as well as public domain software programs. It is possible to transfer messages to one's own computer (e.g. for printing). Transferring software is called downloading. It is an action that often requires some technical skill and insight because the software is often compressed to speed up the transfer (e.g. ARC, LZH, SIT), then transformed by some scheme (e.g. UU, XX, BOO, HQX) to 7-bit code for transfer over 7-bit serial lines, and finally sent out using non user-friendly protocols, such as Xmodem, Zmodem, Kermit and Teletel.

A bulletin board is called an *open* system if everyone can leave a message on the board. It is a *moderated* system if a person, called editor, can intervene and decide if a message should be kept.

A central computer also can maintain a list of people interested in a certain topic. Sending a message to such a *Namelistserver* results in the duplication and sending out of the message to all the subscribers on the list.

Electronic Digests

Electronic mail also offers the possibility of distributing digests or magazines made by many authors. The procedure is as follows:

- authors electronically send their messages (or questions) to the editor
- this person glues the interesting texts together and sends this digest to a name-listserver
- every subscriber gets his own copy

An example is the 'Handicap Digest' (see below), but also the 'Netnews' system, in which hundreds of topics are available.

Networks

E-mail is a common feature of different computer networks. Unfortunately, this implies also that different protocols are in use. Well known global networks are (Quarterman & Hoskins, 1986; Bell, 1988):

The UUCP/EUNET network
This is a closed network based on dial-up lines and simple modems (e.g. V21, V22, V22b, V23). The protocol used to be a UNIX feature only, but it can now be found on other operating systems too. UUCP addresses can be given to researchers as well as to industrial companies.

The FIDO network
This network has been set up by computer hobbyists and can be considered as an open network of interconnected BBS's. A special protocol is used for the transfer of messages from one node to another over the public telephone network. The participants therefore have to pay communication fees to the node administrator.

The Compuserve and MCI networks
These are commercial networks, axed mainly on the USA and Canada although Compuserve has quite a lot of European subscribers.

The BITNET/EARN
BITNET ('*B*ecause *i*t's *t*ime . . . ') and its European homologue EARN (European Academic Research Network) are research networks. Therefore, the access is, in principle, limited to universities, research groups and other institutions for higher education. It is a fast network as many of the nodes are permanently interconnected using the packet switched international network.

The Internet

Internet is a network grouping several other nets (BITNET and UUCP amongst others). In this network, every node (independent of its original network position) has a numerical address consisting of four groups of digits, and an address formed by three or four mnemonic abbreviations (see below for addressing schemes). These interconnections became possible by the generalised use of the X-400 protocol.

Private Nets

Many large companies (e.g. IBM, APPLE, SWIFT) have their own closed network. Because they are intended for private use, encryption is often used. The European Community also has its own E-mail network, called EUROKOM.

National Networks

Almost all European countries have their own network that is administered by the national Telecom. It is usually part of a public videotex service (e.g. Bildschirmtext, Minitel, Prestel, Teledata), or part of the public packet switched network, known under different national names (e.g. DCS in Belgium, Datapaknettet in Denmark, TRANSPAC in France, IBERPAC in Spain and EIRPACK in Ireland). A few standardised mail protocols (X-400 and X-500) are used.

Interconnection

Interchange of messages and mail with other networks is an essential prerequisite for a world-wide communication system. Fortunately, all the networks (except some of the private and national ones) are interconnected at some of the nodes. These are called *gateways.*

Some of the private nets (e.g. Applelink, Eurokom) can be reached by Internet users. Many of the national systems are interconnected with the telex network or with analogous networks in neighbouring countries.

Addressing

Every network used to have its own addressing scheme. This tended to complicate sending electronic messages. Currently most of the mailers can handle the Internet scheme in which logical and meaningful abbreviations can be used. The examples shown in Table 30.1 give an idea on how to reach the InfoVisie technical advisory centre for visually impaired in Leuven.

BITNET/EARN	FHEDA02 @ BLEKUL11 or
	INFOVISI @ BLEKUL11
UUCP/EUNET	Engelen @ kulesat.uucp
INTERNET	INFOVISI @ CC1.KULEUVEN.AC.BE or
	INFOVISI @ 134.58.10.1
VIDEOTEX (Belgium)	BOX 100518
FIDO	Craig.Werner @ 1:260/10

Table 30.1 Addressing schemes for electronic mail to InfoVisie (except for FIDO: the address given is for the technical editor of the 'Handicap Digest'). BE is the ISO-3166 2 code for Belgium, AC designates the Academic network, KULEUVEN is the Katholic University of Leuven and CC1 is name of the computer within the University that takes care of Internet mail. Blanks to the left and right of the @-sign are for readability only. They should be omitted for real addressing.

Electronic Mail and Disabled People

Electronic mail can be an integrative means of written communication between individuals in which the partners need not know about each others race, sex or disability. As E-mail is text based, this makes it possible to access it through different media (voice, visual, tactile and combinations). Moreover messages can be locally composed at one's own pace before actually sending them. Especially for visually impaired people, E-mail has the advantage of completely eliminating the handling of paper.

Text Telephones for Hearing and Speech Impaired People

Mail boxes and Bulletin Boards are common within this community. Special services for people who need to communicate by text have been set-up, for example in the U.K., France and the Scandinavian countries (cf. chapters 26–29). Due to the large acceptance of the French Minitel system, deaf people in France are using the Minitel frequently. Text-to-speech and speech-to-text TAP's have been built into the Minitel system for communication with non-impaired users. In many other countries, deaf people tend to use fax in stead of electronic mail.

Several national systems (e.g. in Belgium and Norway) offer the possibility of converting E-mail to fax or telex messages.

Electronic Bulletin Boards

There is a special section within Compuserve for disabled users. On the Internet, there is an electronic magazine 'Handicap Digest'. The text is sent in electronically by the authors, edited by Bill McGarry and then distributed to all subscribers. Thanks to the interconnection of the networks, this magazine can be sent out on a private network (Compuserve), a closed network (Bitnet/Earn) and an open one (FIDO). There are also two mail servers called 'Blind-L @ UAFSYSB' and 'Handicap @ Blekul11'. The former is limited in scope to issues relevant for visually impaired people, while the latter is almost uniquely used for distributing news on forthcoming events. Any messages sent to these dummy addresses is distributed to all the subscribers of these mailing lists.

In Sweden, a Bulletin Board for disabled people has been used for conferences for several years. User experiences are very positive (Magnusson, 1989; Lundman, 1991).

Research Institutes

During recent years, many research centres, including some in the field of disability, have been connected to electronic mail. E-mail address is (or will soon become) a standard item in address databases (next to telephone, fax and telex). For example, almost 25 per cent of the participants of the '6th International Workshop on Computer Applications for the Visually Impaired' in Leuven in 1990 gave an electronic mail address.

In several countries, text telephones have not been used very much, except for communication to other disabled people. The advantages of E-mail are clear: rapid communication, texts remain available in electronic form.

The HELIOS/HANDYNET Electronic Mail System

Handynet is the European Community's database (situated within the Helios project) on all aspects related to disabled people. The HANDYNET activities require a rapid information exchange between the participating groups. All data collection centres and the data retrieval centres actually are using an ad-hoc network, using facilities of the European Space Agency's private network.

The VLICHT System

Vlicht is the Flemish Centre for Handicap and Technology. In order to exchange information and personal remarks between (re)habilitation specialists, a computer network has been set up. It is based on standard Bulletin Board software as used in the FIDO system. (Because it is a more or less a private network, no external access is planned).

Conclusions

There are many ways in which disabled people may benefit from electronic mail. So far, only a few applications have been tested out with disabled users, and many new application trials can be expected in the near future. Fax machines are currently used for many of the simple messaging functions that may in fact be better handled with electronic mail. The increasing quantity of electronically available text, and the simplification of the E-mail systems (X-400), should lead to more extensive use in general, and more extensive use by disabled people in particular.

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Graphic Communication

Use of icons and other forms of graphics has become increasingly popular in computer programs in order to construct more user-friendly man-machine interfaces for computers and telecommunications terminals. However, graphic communication may play a much more significant role for many disabled people, such as in those applications discussed in this section. It may function as an alternative communication system for people who are unable to speak or as a supplement to speech for those whose speech is difficult to understand. For these groups of people, availability of telecommunication terminals with graphic sign systems is a necessity for being able to communicate independently via the telecommunication network at all. Use of graphics in telecommunication may also play a role in distance education, for example, improving and supplementing traditional speech therapy methods in distance therapy.

Leonor Moniz Pereira

31

Use of Graphic Communication Systems in Telecommunication

Stephen von Tetzchner

Speech is the best and most common form of communication for people with normal hearing. However, not everyone is able to speak, no matter how much training they are given. For these people, alternative means of communication will have to be used. Others have more limited speech difficulties. They may need alternative communication while learning to speak, or in order to make their speech easier to understand.

A large number of people are dependent on communication aids with non-orthographic writing systems because they are unable to speak and have difficulties in reading and writing. For example, many people with cerebral palsy are unable to speak and may never learn to read, or may do so at a late age. Mentally retarded and autistic people often have poor speech or do not learn to speak at all (cf. von Tetzchner and Martinsen, in press).

Until now, graphic communication systems have been used mainly in face-to-face conversations. In spite of the increased use of graphics in computer and telecommunications interfaces, only recently have initiatives been taken to extend the communicative possibilities of people who depend on communication aids and non-orthographic writing systems to include telecommunictions.

Graphic Signs

Graphic signs include all graphically formed signs (Blissymbols, Rebus, PIC etc.). The term 'sign' is used here as a generic term for linguistic forms that are not speech and includes both manual and graphic signs. In the literature, graphic signs have often been described as 'symbols'. However, in linguistics, speech and manual and graphic signs are all referred to as language symbols. Using the word 'symbol' to describe only one of these groups is therefore imprudent, and 'sign' would seem to be a more neutral concept (cf. Remington and Light, 1983).

Graphic sign systems are often linked to the use of communication aids ranging from simple pointing boards to apparatus based on advanced computer technology. Blissymbols and Rebus were two of the first systems to be used, but quite a number of systems have come into existence in the course of time (cf. Bloomberg and Lloyd, 1986).

Blissymbols

Blissymbols are a form of *logographic* writing, i.e. written signs that are not based on a combination of letters. This means that the word, not the letter, becomes the smallest unit in the written language (Downing, 1973). The system was developed by Charles Bliss (1965), but was first used in Toronto as a system of writing for physically disabled children who were unable to speak, and who also had difficulties in learning to read and write (McNaughton and Kates, 1974).

The Bliss system consists of 100 basic signs that can be combined to form words for which there are no basic signs. A number of these sign combinations are conventional; that is, the Bliss Institute in Toronto and the International Bliss Committee have adopted a fixed English gloss, or 'translation'. This gloss should be adjusted to fit the national language; a specific sign or a given combination will be used slightly differently in different countries, in the same way as a word in the spoken language is not exactly the same when translated into another language. When a conventional combination has not been decided upon, there will be several ways of saying the same word.

Communication boards with Blissymbols usually consist of both basic signs and the sign combinations that the user often needs. For the majority of words in the spoken languages, however, there are no established conventions, and in many cases the user would either not know the accepted form or else not have the necessary basic signs. Thus, it will be up to the user to find a suitable sign combination to express what he or she wishes to say.

The signs that form a sign combination may be regarded as *semantic elements.* The single signs are combined and understood by means of analogy. This gives the sign combination meaning. For example, ELEPHANT usually consists of ANIMAL + LONG + NOSE. HOME is HOUSE + FEELINGS (Figure 31.1). In addition to the signs that correspond to whole words, there are also a number of Blissymbols that constitute grammatical inflections and denote parts of speech, such as PAST TENSE, PLURAL, ACTION, OPPOSITE-MEANING etc. Thus the Bliss system has a fairly complex construction, based on combinations of signs.

The basic signs and sign combinations can also be joined together to form sentences. Bliss (1965) gives information about syntax, but in principle any word order may be used. In most countries the word order will resemble the spoken language as closely as possible.

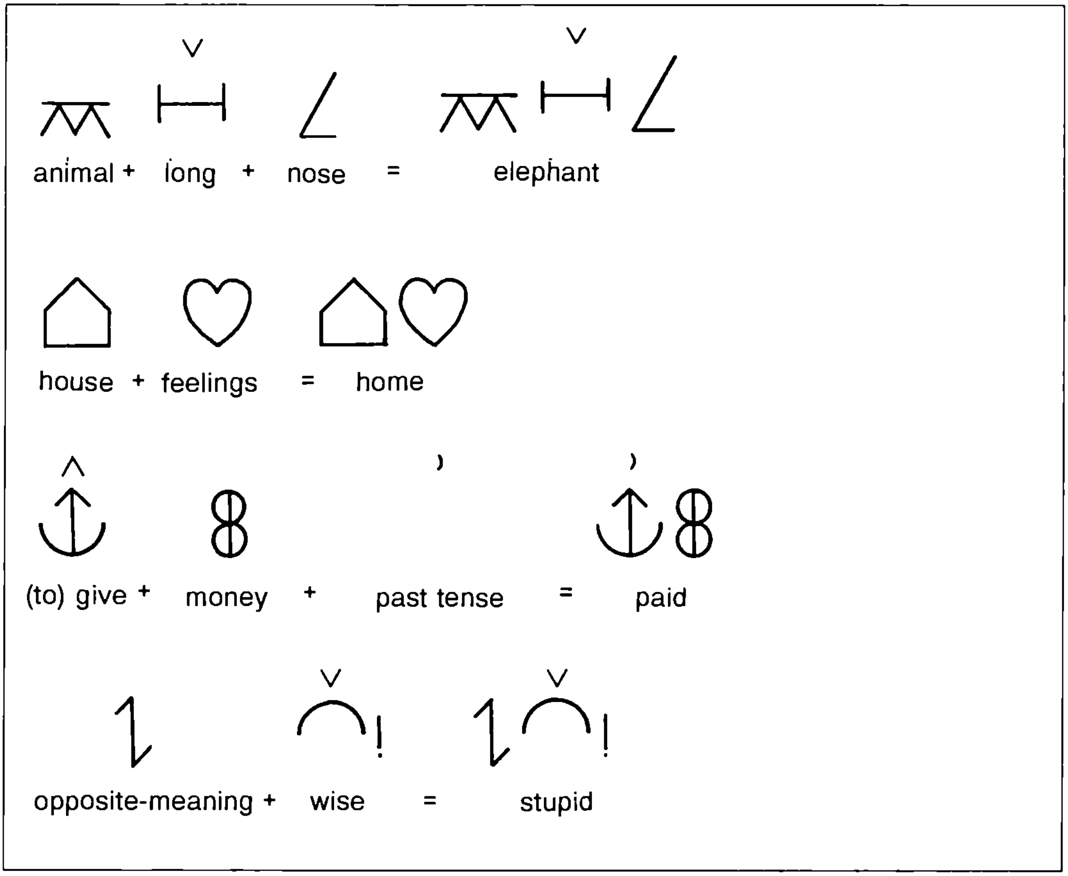

Figure 31.1 Examples of Blissymbols.

PIC

PIC (Picture Ideogram Communication) signs originate from Canada (Maharaj, 1980). They have become very popular in the Nordic countries and have to a great extent replaced the use of Blissymbols among small children and among adolescents and adults with extensive learning disorders. PIC signs consist of stylized drawings which form white silhouettes on a black background. The gloss is always written in white lettering over the drawing itself (Figure 31.2).

Parents and professionals find PIC signs easy to understand, and have taken to them quickly. PIC signs are, however, less versatile, and in some respects more limited than Blissymbols. There are only 563 (Norwegian) PIC signs (1989), and combining them to form new words or sentences is not always easy. When the user needs more opportunities than those given by PIC signs, the signs may be supplemented with signs from other systems which have a more general use.

Figure 31.2 Examples of PIC signs.

Rebus

As with Blissymbols, the Rebus system was devised as a system of logographic writing (Clark, 1984). It was originally made to help people with a lesser degree of mental handicap to learn to read. Later on its use was extended to include communication (Jones, 1979).

The Rebus system is of special interest because to a certain extent it represents a different approach than that of Blissymbols and PIC signs.The system consists of 950 signs, the majority of which are iconic. It is possible to combine these in the usual way; STREET + LIGHT becomes STREETLIGHT (Figure 31.3). In addition to the usual combinations of words, one may also use the pronunciation of the sign's gloss. For example, LIGHT can mean both 'bright' and 'not heavy'. This is especially useful in English speaking countries where there are many homonyms.

In Rebus, letters are combined with the pronunciation of the glosses so that the combinations of signs and letters form new words. When a sign is combined with a letter, it is the pronunciation of these two elements together that expresses the new word. The meaning of the sign plays no part. H + EAT becomes HEAT, P + LIGHT becomes PLIGHT, and C + AT becomes CAT (Figure 31.3).

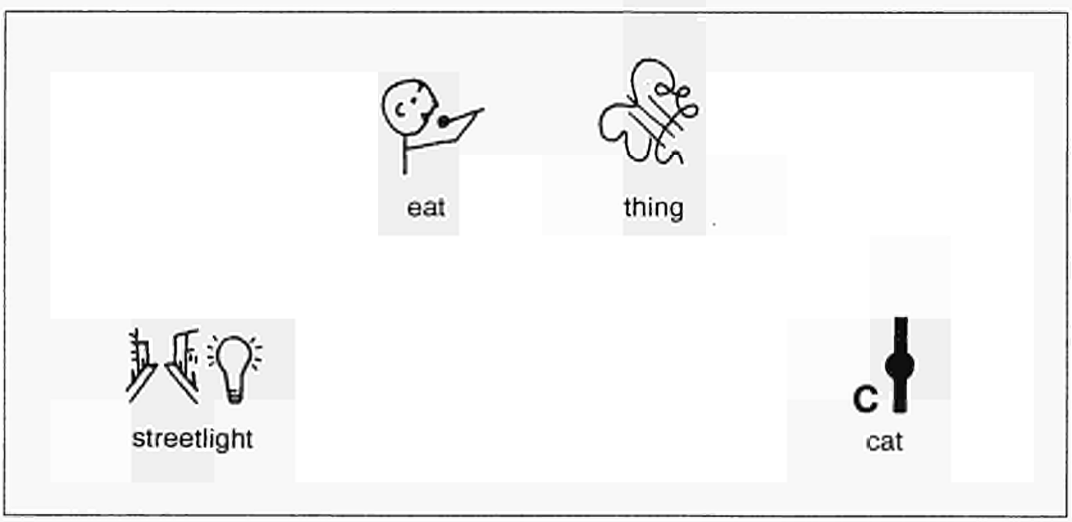

Figure 31.3 Examples of Rebus signs.

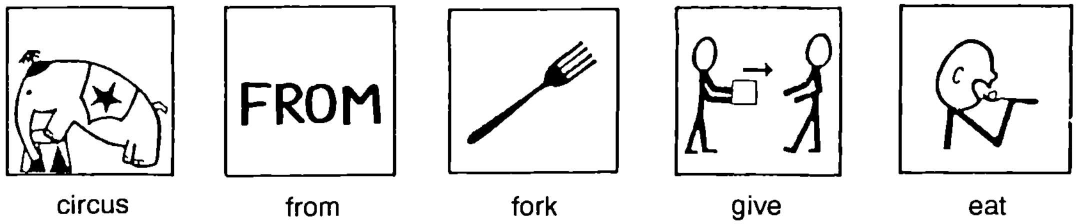

Figure 31.4 Examples of PCS.

PCS

Picture Communication System (Johnson, 1985) consists of approximately 1800 signs. The signs are simple line-drawings with the word written above. In some cases, the written word appears without any line-drawing (Figure 31.4). The signs are easy to draw, and PCS can therefore be easily copied by hand. PCS is common in the United States and Spain.

Sigsym

These signs are based on both iconicity and sign language. The graphic signs that are made from manual signs show characteristics that are typical of the manual sign's execution (Figure 31.5). Since manual signs differ from country to country and between the various systems, it is essential that the Sigsym signs are designed on the basis of the sign language in use in the particular area. There are, for example, Sigsym signs for British sign language (Cregan, 1982) and American sign language (Cregan and Lloyd, 1984). Sigsym would appear to be of interest for people who use both graphic and manual signs, and as a possible written language for people who learn manual signs.

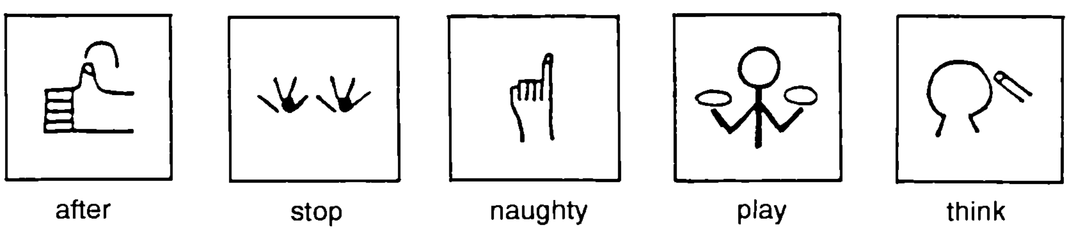

Figure 31.5 Examples of Sigsym signs.

Mixing Systems

There is no reason to be afraid of mixing different graphic sign systems. There is nothing magical about them that requires that one sticks to one system only. PIC signs will, for example, gradually become too limited for many users, and Blissymbols may be placed among the PIC signs as a link in the developmental chain. Blissymbols generally have a wider use than PIC signs, and therefore make a more useful instrument for the user. At the same time, Blissymbols place greater demands on, and build on, the communicative skills which the user has acquired through the use of PIC signs.

The Use of Graphic Sign Systems in Telecommunication

Graphic signs may have several functions in telecommunication. First of all, people who use graphic signs as their main form in face-to-face communication should also be able to use them for distance communication; secondly, graphic signs may be used to support speech by making what is said easier to comprehend or by adding cues to the situation.

Primary Communication

Several projects have recently been intitiated which aim to provide telecommunication for intellectually well-functioning people with severe reading disorders who use Blissymbols. In Italy, Tronconi (1990) has made a prototype version of a computer-based telecommunication program for Blissymbols. Similar developments are found in Canada, where the BlissTel project started in 1988 with the aim being to produce and test a computer-based Blissymbol telecommunication system (Feeley, Brown, McNaughton and Laughton, 1990; Kennedy and Watson, 1991), and in Sweden, where solutions for fulfilling the telecommunication needs of people who use Blissymbols are being investigated (Magnusson, 1990).

The Italian and Canadian communication programs are intended for interaction between users who have the same program. It is, however, also conceivable that the Blissymbol program could be made compatible with standard text telephones and text communication programs for computers, such as the Norwegian text telephone program. Users of Blissymbols have a limited vocabulary, and compatibility would depend on the program's ability to handle this. One way would be to restrict the message *from* the communication partner to the vocabulary of the Blissymbols user, letting the system send a message to the communication partner when a word is not acceptable.

A somewhat more advanced version of such a program may suggest one or more synonyms which can be accepted or rejected by the communication partner. The program may also accept different forms of the same word (with the help of a customised 'thesaurus'), perhaps disregarding inflections which are important in some languages (e.g. Norwegian, Icelandic and German). When the Blissymbols user sends messages to a text telephone, only the gloss of the sign would be transmitted. When a word is received, a Blissymbol, or a combination of Blissymbols known to the user, would be presented on the display.

Similar telecommunication programs may be developed for other graphic communication systems, depending on which systems are used nationally. There are, for example, several computer programs for PIC signs, and these may be extended for telecommunication use. In Norway, an open telecommunication program for personal computers is under development, in which any kind of graphic communication system may be used. This will allow, for example, a deaf and cerebral palsied boy who uses a computer with drawings of manual signs, somewhat similar to Signsyms, to also use his communication system for telecommunications.

Support

People whose speech has reduced intelligibility are often more difficult to understand when speaking on the telephone than face to face. It is a well-known fact that, for example, knowledge about the conversational topic may make poor speech sound more intelligible to the communication partner. When a listener tries to understand speech with reduced intelligibility, this seems to take the form of hypothesis testing. Contextual knowledge appears to direct the user's hypotheses and thereby increase the probability of the listener being right.

Compared to face-to-face conversations, telephone conversations are characterised by a lack of situational cues (cf. chapter 4); the partners have to rely on speech alone, which for a person whose speech has reduced intelligibility is the worst circumstance conceivable, because it is impossible to use situational cues, such as pointing and demonstrating to help explain what he or she wishes to say.

Additional cues may be a help not only for people with articulation disorders. People with moderate and severe intellectual impairment may be able to speak intelligibly but be dependent on situational cues for comprehension. The lack of non-acoustic situational cues in telephone conversations may make telecommunications inaccessible because they have difficulties understanding what the partner is talking about. For some of the members of this group, visual telecommunication may provide sufficient cues to keep a conversation going. A videotelephone may be the best tool, but also graphic signs transmitted via a still-picture telephone may provide enough cues to function as a communicative 'scaffold', as demonstrated by Brodin and Björck-Åkesson (1991). In their study, five adults and three children with intellectual impairment used a still picture telephone which would transmit a picture in six seconds. Four of the adults used graphic signs to support speech in telecommunication, in addition to transmitting pictures of objects and people; the addition of still pictures to the sound transmission led to a more positive attitude towards telecommunication, increased communicative competence and more frequent use of the telephone. According to Brodin and Björck-Åkesson, the four adults showed interest in using PIC signs, but it should be noted that in the description of the project, no distinction is made between the effect of seeing a picture of the other person or an object, and that of using graphic signs.

In the project above, a special still-picture terminal was used. Another method would be to use a computer with a modem and an adequate communication program, or, in the not too distant future, a multimedia terminal with video, still pictures and graphic signs.

When different communicative expressions are used together, which is typically the case for intellectually impaired people using alternative communication systems, the most important thing may be to make as many as possible available in telecommunication. This 'scaffold' may also function the other way around; that is, the person may be dependent on graphic signs for expressive language, and use sounds to support the visual communication system both in face-to-face interactions and when using telecommunications. Thus, whether the person uses speech or graphic signs as the main communication form, both forms should be available at the same time. For example, if a computer program is used for transmission of graphic signs, this should allow for simultaneous sound and picture transmission.

Standardisation

Several computer programs for telecommunication with Blissymbols are under development, seemingly without much collaboration. It seems imperative to avoid a situation similar to that of text telephone protocols. Tronconi (1990) proposes that a standardised communication protocol for Blissymbols be developed, BLISCII. To simplify transmission protocols, only the codes would have to be transmitted instead of the full graphic information. This is a good idea, provided BLISCII is developed through international standardisation work, not by one nation alone.

Because all Blissymbols are made up of 100 basic characters, it is relatively simple to devise a standard. With Rebus, Sigsyms and PIC, the situation is different. Although it is conceivable with REBUSCII, SYGSYMSCII etc., it may be necessary to use a graphic transmission standard. For those who use a combination of systems, more than one transmission form should be included. There is a real danger that telecommunications will be available only for Blissymbols. Furthermore, Blissymbol users may want to include graphic or video information in the communication when communicating with another user of the same program. Whatever standards are chosen, it is important not to exclude any graphic communication system, so that users may get access to telecommunications independently of the system they use.

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32

Use of Graphic Communication in Distance Training of Patients with Aphasia

Unni Holand

In many countries rarely occurring diseases and disorders are normally treated in centralised institutions. So far it has not been possible to provide professional help or treatment for these groups of patients in their local environment. With the help of modern information technology, however the necessary tools and techniques are available for changing this tradition.

There are also centralised institutions for patients with aphasia. Aphasia is a disorder for which no pool of qualified therapists exists. This is especially the case in rural areas such as northern Norway.

This chapter discusses how personal computers and telecommunication technology can be used to offer distant training to people with aphasia. The discussion is based on the results of a project that took place in the north of Norway.

A Short Description of Aphasia

The symptoms of aphasia are a loss of or reduction of one's ability to speak, write and understand the spoken or written word. It is usual to distinguish between *impressive* and *expressive* aphasia. Impressive aphasia is primarily a reduction of the ability to understand the spoken or written word. Expressive aphasia is a reduction of the ability to use language.

Aphasia is mainly caused by stroke or accident. In Norway, the number of people that acquire aphasia has been estimated to be approximately 5000 per year, i.e. 0.12 per cent of the population (Alstad and Bachmann, 1990). Some of these people recover from the disorder without prolonged treatment, but most patients need extensive treatment. Such treatment is usually provided during a limited stay at an institution for rehabilitation. After the treatment period, the patients are usually left to themselves with little or no training or follow-up in their local environment.

Participants

The project was a cooperation between two rehabilitation institutions (Sonjatun Health Centre at Storslett and Lødingen Rehabilitation Centre) and Norwegian Telecom. The two rehabilitation institutions are responsible for diagnoses and initial training of all people in northern Norway suffering from aphasia. During the last 12 years they have been responsible for some 600 patients, but a lack of qualified therapists in this region means it is almost impossible to offer an adequate service to all patients in need of speech training.

In the present project, two speech therapists and six patients were involved. The therapist gave each of the patients a total of four weeks of distance training during a six-month period in 1989. The patients also participated in the normal rehabilitation program, which consisted of a total of two weeks training at the institution. The distance training should therefore be regarded as a supplement to the traditional treatment, both with respect to the amount of training and the methods employed.

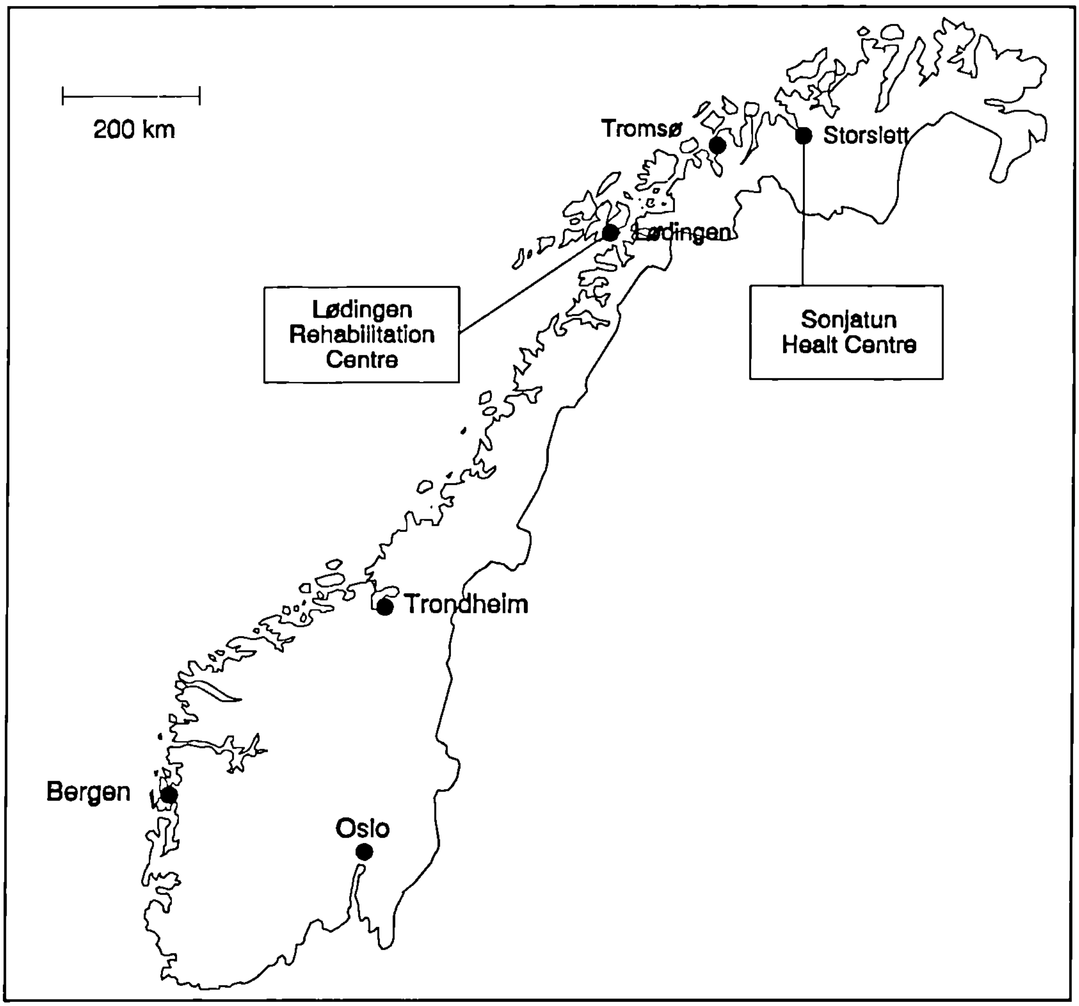

Figure 32.1 Map of Norway with Storslett and Lødingen.

Technical Equipment

A goal of this project was to evaluate any existing technical equipment for distance training that was simple and cheap. The aim was to get available technology to work without too much trouble or any new development work. It was hoped that this approach would result in a technical solution that was readily available to potential users.

Both the speech therapists and the patients used a personal computer with a data/voice modem, ordinary telephone, and an electronic pad called Optel Telewriter (Figure 32.2).

Ordinary telephone lines were used to connect this equipment. Patients and therapists could then either communicate using the telephone, or transfer material between their computers, in the form of handwritten text and drawings made on the electronic pad, or text that was keyed into the computer.

Training was based on real-time, synchronous communication in either of these three modes. The therapists presented the patients with questions related to information displayed on the screen. Answers could be given vocally, by keyboard entry, or by writing with a pen on the electronic pad. Therapists could also transfer prepared exercises from their computers to the patient's computers before training sessions. Both text and graphics were used in these exercises which were solved in the real-time training sessions.

To sum up, by this arrangement, it was possible for both parties in the distant training to exchange ideas vocally, by writing and by drawing. This was achieved using readily available equipment.

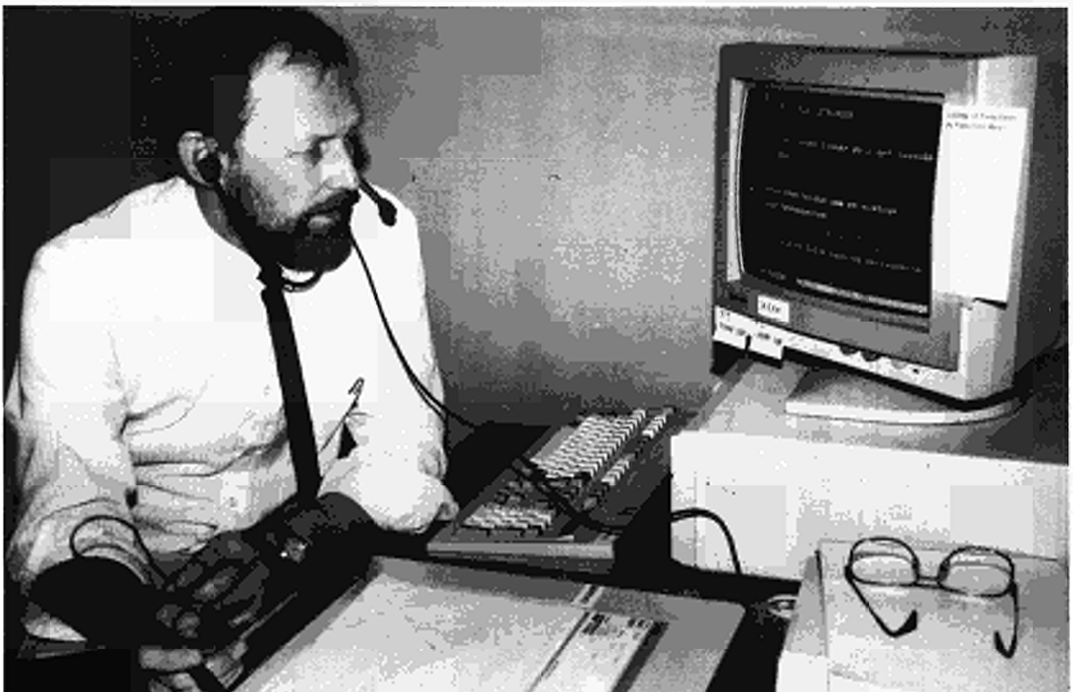

Figure 32.2 Speech therapist using equipment.

Evaluation

The evaluation of the distance training was based on the patients' performance at a standard test of aphasia before and after the training period, their production of sentences based on pictures, and their self evaluation according to a questionnaire. The standard test used was Reinvang and Engvik (1989). The pictures used for sentence construction was developed by the two speech therapists (Alstad and Bachmann, 1990).

The results on the aphasia test showed an improvement in function of 10 points. According to the speech therapists, this may be regarded as a major increase in the linguistic performance of the patients. Such an increase would not be expected without language intervention.

The improved linguistic performance was also evident in the patients' abilities to produce sentences from drawings. They were able to produce longer stories after the distance training than they could before, and there was a noticeable increase for all patients with regard to the number of sentences produced in the first and the second training period (Figure 32.3).

There was also an increase in the number of words per sentence, i.e. the patients constructed longer sentences from the same drawings, as well as a higher proportion of complete sentences (Figure 32.4 and 32.5).

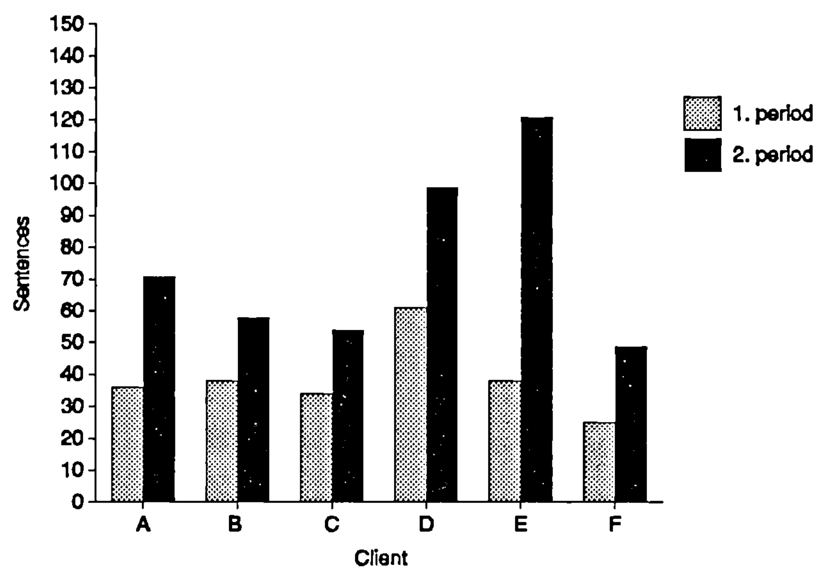

Figure 32.3 Number of sentences.

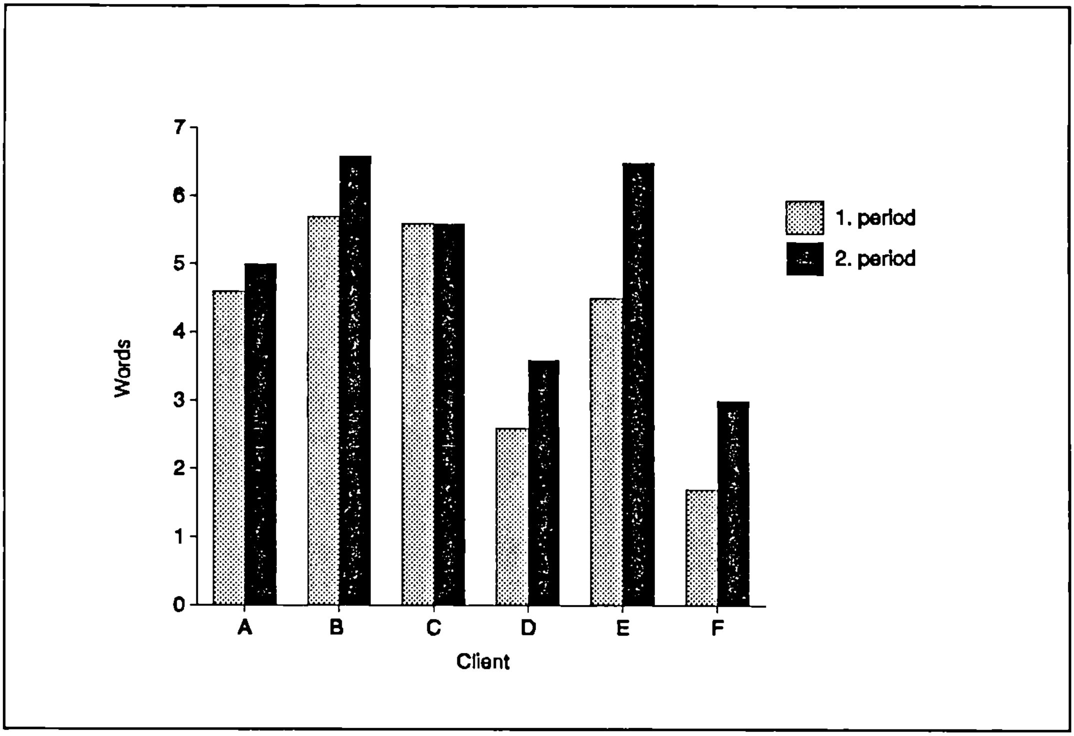

Figure 32.4 *Number of words per sentence.*

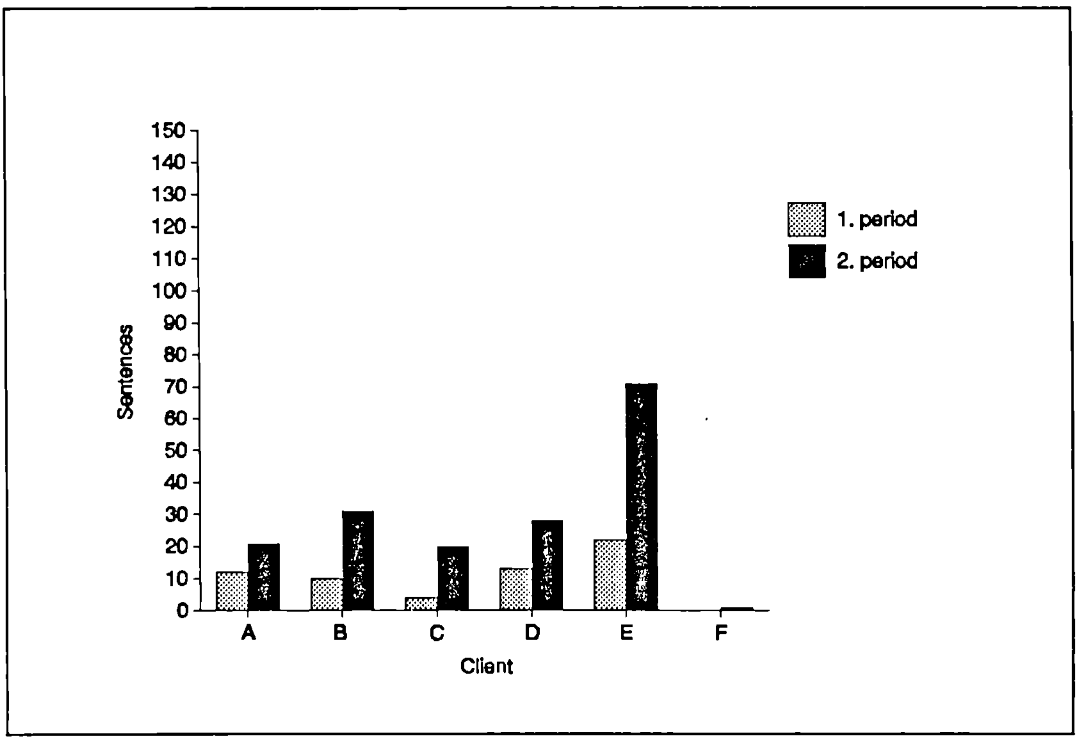

Figure 32.5 *Number of complete sentences.*

In addition to the test results and the linguistic measures, each patient was interviewed about his or her feelings and reflections concerning the distance training. All patients expressed satisfaction with what they had gained through distance education. In the self-reports, they emphasized increased linguistic ability, social competence, and self-confidence.

Discussion

The project may be regarded as a pilot study of distance teaching for patients with aphasia. It was not designed as a controlled experiment, and there was no comparison group. Therefore the possibility that the improvement may be due to, for instance, spontaneous recovery cannot be excluded. The group of patients was rather small. With only six patients involved in the project one should be cautious about drawing generalised conclusions from the results.

Some technical problems appeared during the training period, as a result of which the training procedure could not be completely followed in all cases. Consequently, the training conditions were not identical for all patients.

Despite these drawbacks, the study seems to indicate that it is possible to offer distance teaching to people with aphasia. Furthermore, it has been demonstrated that it is possible to base such teaching on the use of telephone, personal computer and Telewriter. The use of this equipment made it possible to provide training that seemed to have positive effects on the patients' linguistic ability.

The patients had no trouble learning to use the equipment. Their ability to master the technology was a surprise both to the patients and their family and friends, and improved the patients' self-esteem.

A training program implemented in the home environment of the patients might also contribute to making aphasia and its treatment more commonly known. Family and friends could participate in the training, and they might get an understanding of the methods employed, whilst gaining more knowledge and understanding of the problems that the patients face.

One question raised was whether the lack of visual contact would have a negative impact on communication. In traditional speech therapy, gestures and mimicry are often used, thus one may hypothesize that lack of visual contact in the distance training would have negative consequences. However, the speech therapists in the project reported the contrary; the lack of visual contact would seem to put more emphasis on verbal abilities, which forced the patient to access 'hidden' linguistic resources. Thus, the patient and the speech therapists lack of ability to see each other during the training did not seem to have negative effects, and what is usually regarded as a deficiency in remote teaching could under certain circumstances be an advantage.

Issues for future studies

The project presented here is limited in both time and scope. Still, as a pilot it may serve as a basis and inspiration for future studies. In addition to the question of usability of technical equipment and remote intervention, a number of questions may be addressed.

Even if results are positive, one may ask whether this form of training is better suited for some forms of aphasia than others, and how the training may be adapted to the needs of different groups. Also the technology that is applied and the user interface may affect the training in different ways.

Remote training is not a substitute for traditional therapy, and it may be important to investigate how the two forms of training may be combined to produce the best results. This implies a need to investigate and specify the gains from different training methods in general, to compare the results of traditional training with the results of distant training.

The answers to such research issues might lead to a description of requirements for the user interface and the functionality of equipment for distance training.

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Videotelephony

For people with a sensory impairment, the other senses must be used to compensate for it. For this reason, multi-functional terminals or terminals with non-acoustic outputs, may be of great use for people with such impairments. Positive examples are distance communication with sign language, lip reading facilities for hearing impaired people, visual support in telephone conversations for mentally retarded people and distance supervision of intervention by physiotherapists, psychologists, speech therapists and other professionals.

Until now, the cost of videotelephony has been probihitive. For digital transmission of live pictures, a channel capacity of at least 216 Mbit/s is normally required. With new advanced compression techniques, it is possible to use 64 kbit/s – or even lower bit rates – for video transmission in practical applications with two-way communication. This implies that the cost soon may be low enough to create a large market, which in turn will lead to lower prices.

Video codecs (coder–decoder) for 64 kbit/s videotelephony may have different properties, and the choice of terminal will depend upon the application. For example, codecs with a good dynamic performance may be needed for sign language, while codecs with good spatial resolution may be preferred when there is less movement in the picture. In the future, it may be possible for the user to decide on the spatial and temporal resolution, depending on the application.

Videotelephony is likely to change the communication patterns of society in significant ways. One of the effects may be increased social integration of people who have so far had limited access to telecommunication, leading to a greater equality in society.

Peter Reefman

33

The Use of Picture Communication for People with Disabilities

Jan-Ingvar Lindström

History

Remote picture communication is often described as a result of modern electronic development. This is true from some points of view. But as a matter of fact, the first successful picture communication took place in the middle of the nineteenth century with a technique very much like today's telefax machines. The inventor, Arthur Korn from Germany, made use of the discovery of photoelectricity in the beginning of that century. The discovery formed the basis for moving picture transmissions, which after the Second World War resulted in the phenomenal growth of the television industry.

Technical Possibilities

Why is it possible to establish a television network but not introduce picture telephones? – The explanation lies in the limited transmission capacity available. A picture contains a lot of information, and channels for transportation always have a limited capacity. Electric cables in general have a very low information transmission capacity (telephone's 'twisted pairs'), whereas free wave transmission has in principle a large capacity (broadcast radio and television, satellite communication etc).

Much of today's remote communication takes place in digital form. This means, it takes place in the form of very short, electric pulses, independent of whether it is speech, picture or data signals that are being sent. The information is contained in the sequence of pulses, similar to the way morse code communication is performed. The presence or absence of a pulse is also called a 'bit', and the communication speed is measured in bits per second (bit/s). Some examples of bit rates required for various kinds of communication are shown in Table 33.1.

Telex	50 bit/s
Telefax	4 800 bit/s
Telephone conversation	64 000 bit/s
Music of HiFi quality	1 000 000 bit/s
Videoconferencing	2 000 000 bit/s
High quality colour television	200 000 000 bit/s

Table 33.1 Bit rates for various kinds of communication.

As mentioned before, our present telephone networks have a rather low capacity. Most of them have a capacity corresponding to the bit rate of a telephone conversation, but in certain cases and over shorter distances much higher capacities could be achieved.

Still pictures can be transmitted at in principle at any rate, but if an A4 text page or a photo with decent resolution is to be sent within a few seconds, the transmission capacity must be that of a telephone conversation.

Moving pictures usually require very high capacities, i.e. of the order of one or two hundred million bits per second. Now, techniques are being developed which allow picture transmission with very low bit rates. Indeed, rates even lower than those of telephone conversations have been tried. The practical result is that the picture becomes degraded. This may perhaps not be too disturbing in a conventional use of picture telephony, but could be disastrous in systems used for sign language communication for deaf people or lip reading in combination with telephony for people who are hard of hearing.

Possibilities for People with Disabilities

Some applications of the use of picture communication for people with disabilities are reviewed below.

Picture Telephony for Mentally Retarded People

Some mentally retarded people have more or less pronounced problems in using ordinary telephones for the exchange of information. In many cases this depends on difficulties in understanding abstract as well as concrete concepts, but also upon the lack of clues that are present in communication where people can see each other. One way to facilitate their remote communication via ordinary telephones could therefore be to display a picture. This method has been tried out in a still picture telephone project, where commercially available still picture telephones were used. The typical transmission time for a picture was 6–8 seconds using the ordinary telephone network (Figure 33.1).

Figure 33.1 Still picture communication may facilitate mentally retarded people's telephone conversations.

The results, based upon participation by moderately retarded adolescents, have been very encouraging, and further trials will take place with more severely retarded people and with videotelephones, i.e. moving picture telephones.

Speech Impaired People

Very little has been done for this group in terms of picture communication facilities, but it's very likely, that the group could benefit from remote picture communication in training and rehabilitation as well as communication. Transmission of Bliss symbols is one example, but there are also other interesting possibilities.

Hard of Hearing and Deaf People

The most obvious target groups, who could benefit from picture communication are those who are hard of hearing or deaf. Both need a rather high quality bi-directional moving picture communication link. For cost reasons it will not be practical within the next decade to provide them with broadband communication links, so other possibilities are being tested. Projects with capacities between about 10 kbit/s and 2 Mbit/s are running in different European countries, and also some analogue transmission is used. The key issue is to provide a connection with a quality good enough for lip reading or for sign language. Currently it seems that a capacity of about 64 kbit/s is necessary, but cases are reported where deaf people have benefited from connections with much lower communication capacity (cf. chapter 37).

Figure 33.2 Follow-up and providing instructions via videotelephones.

Facilities in (Re)habilitation and Medical Treatment

A very special application concerns people who need special treatment, and then follow-up by specialists who live far away. Pilot studies have been made in Norway, where follow up of treatment of children with cerebral palsy was made via 64 kbit/s videotelephones. By using this facility, a specialist doctor or physiotherapist, for example, can give qualified advice and instructions to a local physiotherapist working with a motor impaired child without having to travel over long distances.

Picture Communication in Home Care

Most people want to live in their own home even in old age. However, the risk of falling, getting ill etc makes many elderly people feel unsafe. Many of them have installed emergency telephones but still feel unsafe. However, if a picture communication link could be established with an emergency or care centre, it is likely that the situation would improve. And if such a videophone facility is made available, a number of minor problems could be solved easily and quickly, like identifying medical pills, getting help with filling in forms, checking movements in the exercises recommended by the physiotherapist etc. This has been done on a trial basis in Finland and Germany with very positive results. In these trials, the cable television system has been used for transmission, which has proved to be very useful. In Figure 33.3 a typical situation is shown.

Visually Impaired People

In general, the increasing use of pictures and graphics in communication causes problems to people with a visual disability. However, the technique could also be advantageous to this group. An interesting application is to make use of still picture transmission as a remote reading facility.

A small minority of blind people could read printed documents with the aid of reading machines of their own, but even those cannot get access to handwritten material, graphics or pictures. The only way to do it is to rely on human assistance. However, it is not self evident that family members or neighbours should volunteer.

Figure 33.3 A home situation with picture communication via the cable television network.

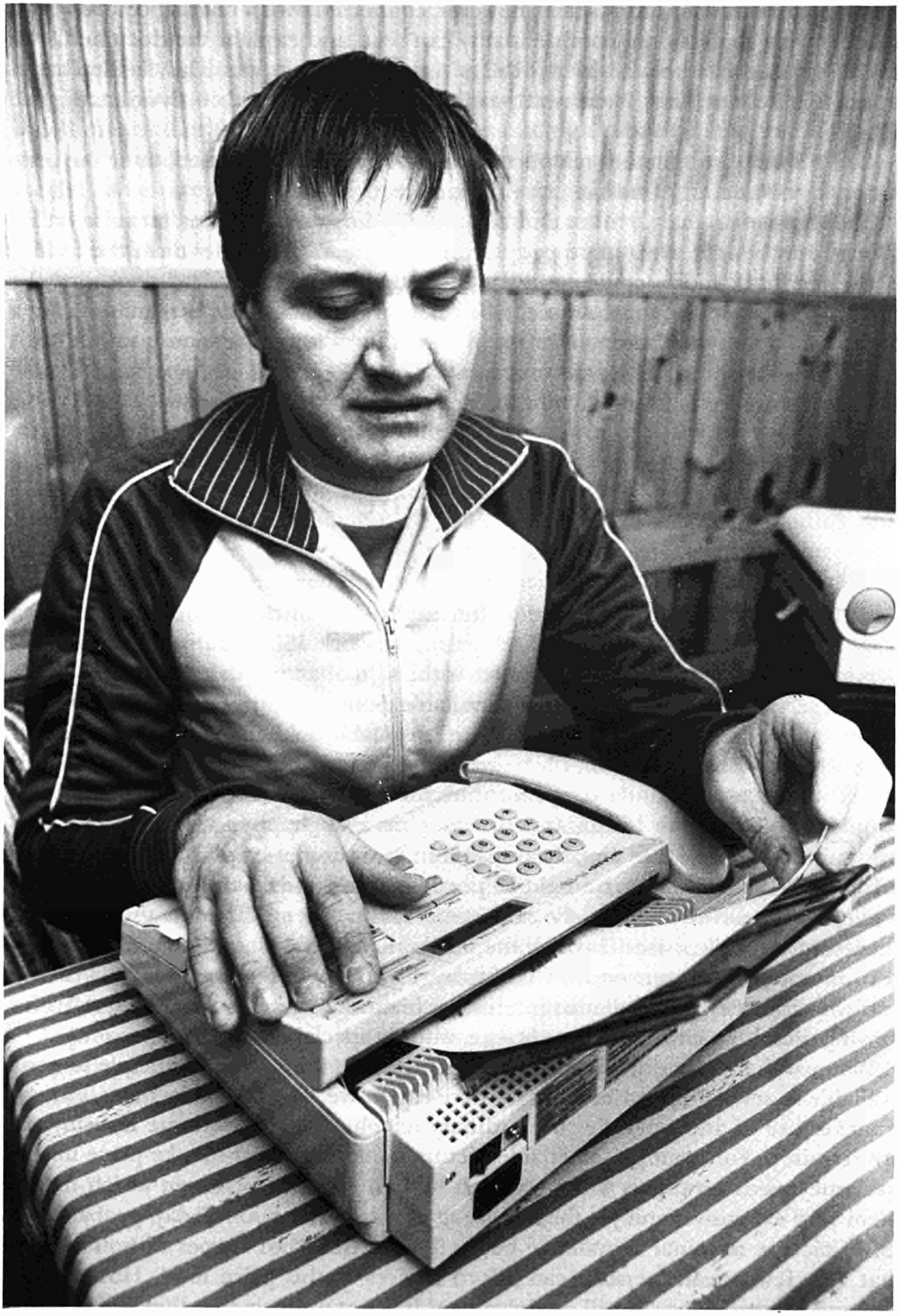

Figure 33.4 A telefax machine is used as input device for a blind person's remote reading service.

A still picture transmission facility, however, connected with a reading centre where readers with professional confidentiality can read and explain the documents via the telephone has been shown to be an interesting solution. This facility, based upon telefax machines is currently being successfully tested in Sweden (Figure 33.4).

Some kind of still picture telephone could of course also be used, once the resolution is good enough and the price acceptable.

The service is mainly intended for visually impaired people, but also other groups may benefit. Deaf-blind people, for example, may be able to use the facility, if the feedback mode could be adapted to their conditions. The person at the reading centre could, for example, type relevant translations or explanations via a keyboard so that the customer gets it in digital form for conversion into Braille. A scanner with optical character recognition (OCR) could also be used at the reading centre for conventially printed documents.

The Future

ISDN

Something that is a target for many industrialized countries in the world today, is what is called an ISDN standard of telephone network. ISDN stands for 'Integrated Services Digital Network'. This acronym is the sign of an upgraded network, where certain services facilities will be made available. Some countries can offer this facility today, but because of the costs, it is reasonable to believe that this kind of network connection will primarily be requested by business users.

According to the standard, every future ISDN subscriber should have access to two 64 Kbit/s and one 16 Kbit/s connection on a single physical telephone line – basically the kind of line already available in most homes or places of work today. With the ISDN technique, it would be possible to use one 64 kbit/s connection for a telephone conversation, at the same time as the other channel is used for data retrieval from a database. Through the third one, the 16 kbit/s channel brief information could be shown on a LCD display, for example that somebody is calling and who it is. Perhaps the most interesting feature is that it is possible to transfer moving pictures within this concept – i.e. without special cables etc.

When will these visions become true? – Indeed, they are in principle already available in several countries – but they are expensive. The reason is, that although it makes use of and upgrades the ordinary telephone network, huge investments are required. For example, to enable picture communication to take place in this way, one needs terminals with very high built-in computing power, which makes them very expensive; and yet the picture quality is rather poor. Today, probably no ISDN picture terminal is available below 9 000 ECUs, and it goes without saying that very few private persons can afford devices at this price level. However, as demand increases, prices will go down, and it is not unlikely that they will reach a reasonable price level during this decade.

IBCN

What next? – According to the experts, the ISDN will be followed by the IBCN, i.e. 'Integrated Broadband Communication Network'. Broadband is a technical term which means that the communication link has a high capacity – the traffic flow of bits have broad avenues to use. Here the ordinary telephone lines are too narrow – special cables are needed. One type of cable, which has a rather high capacity, is called a coaxial cable. It is used in many applications already today, for example for cable television, aerial cables etc. They have a capacity that is sufficient for the transmission of television pictures of high quality.

The next generation of cables, with still higher transmission capacity, are glass fibre cables. As can be understood from the name, such cables are made of glass. The fibre is very thin – like a hair, and does not transmit electric current, but light. The 'bits', consequently, are not electric pulses but light pulses. Communication takes place with the aid of a transmitter in the form of a light source (a small laser), and at the other end is another device, which can transform the light to electricity. The light emitting laser can be operated so as to change between 'on' and 'off' states at an extremely high rate. With the aid of proper coding and decoding techniques, the signals can be converted to music, text or pictures at a very high speed. As the speed is very high, these cables can transfer large amounts of information in short time intervals and thus open up possibilities for multi-modal communication – one single cable could carry moving pictures of high quality, at the same time as several telephone conversations, database accesses etc. are going on.

Now, why doesn't development go directly into the era of IBCN, and skip the ISDN compromise? – Even some experts ask the same question. One answer is, that the investment to replace the whole of the present telephone network with glass fibre is extremely expensive and will take a long time. Currently, the big telephone companies concentrate upon glass fibres on trunk lines, i.e. communication links between main exchanges, but retain the ordinary lines between the telephone exchanges and the individual subscribers. This situation will probably continue for the remainder of this decade. In other words: it will be some time – probably quite some time after the year 2000 before we get glass fibres in our homes and thereby picture communication of high quality at low prices.

At present, prices are high. But there are good reasons to believe, that the prices will go down significantly, not least because glass is based upon the most commonly available material – silicon.

34

The Development of Videotelephony

Bjørn Møllerbråten

The videotelephone has been discussed for decades; prototypes have been developed and many practical trials have been carried out over the years, but nothing has come of it – as yet. Now, however, it seems that the time has come for videotelephones, mainly because of the new opportunities offered by the ISDN. Another important factor is the fact that developments in digital signal processing, along with the development of complex microelectronics (Digital Signal Processors, VLSI circuits), render mathematical algorithms realisable in hardware at a reasonable price. A large number of industrial undertakings around the world are ready to start mass production of videotelephone products for a, hopefully, wide open market in the countries where the ISDN will be introduced. With the progressive introduction of the ISDN, the definition of videotelephone standards and the available terminal units, the last obstacles for videotelephony are now being removed.

History

The first ideas of videotelephones appeared a hundred years ago. The French futurist Albert Robida outlined a so-called Telephonoscope in his book 'Le centieme siecle', and Jules Verne depicted the private use of a videotelephone in his short story 'A day in the life of an American journalist' (Romah, Prussog and Mühlbach, 1987).

About 40 years later, the first demonstration of picture transmission was presented. In 1926 the Scottish inventor John Logie Baird demonstrated a system for television via radio between two rooms of the Royal Institution, and in February 1927 he demonstrated television transmission from London to Glasgow (AT&T, 1978).

Herbert I. Ives of Bell Laboratories was responsible for the first videotelephone conversation between Washington and New York. In April 1927, pictures were transmitted one way with two-way sound via cable from Washington DC to New York State and via radio from Whippany, New Jersey, to New York City. Even if the pictures were transmitted only one-way, this is referred to as the first public experiment between two different geographic locations (McGraw-Hill Encyclopedia of science and technology, 1982).

In those days, there were no broadcasting standards, and the pictures in Ives' experiment were transmitted with a definition which could only just reproduce a human face. The picture had 50 lines, and 18 pictures were transmitted per second. The signal required a bandwidth of 20 kHz. In 1930 Ives demonstrated two-way videotelephony via cables within New York.

The first publicly used videotelephone service was established by the German telecommunication administration in the period from 1936 to 1940, in and between the major cities in Germany (Figure 34.1). Calls were set up manually with a definition of 180 lines with 25 pictures per second and demanded a bandwidth of 270 kHz.

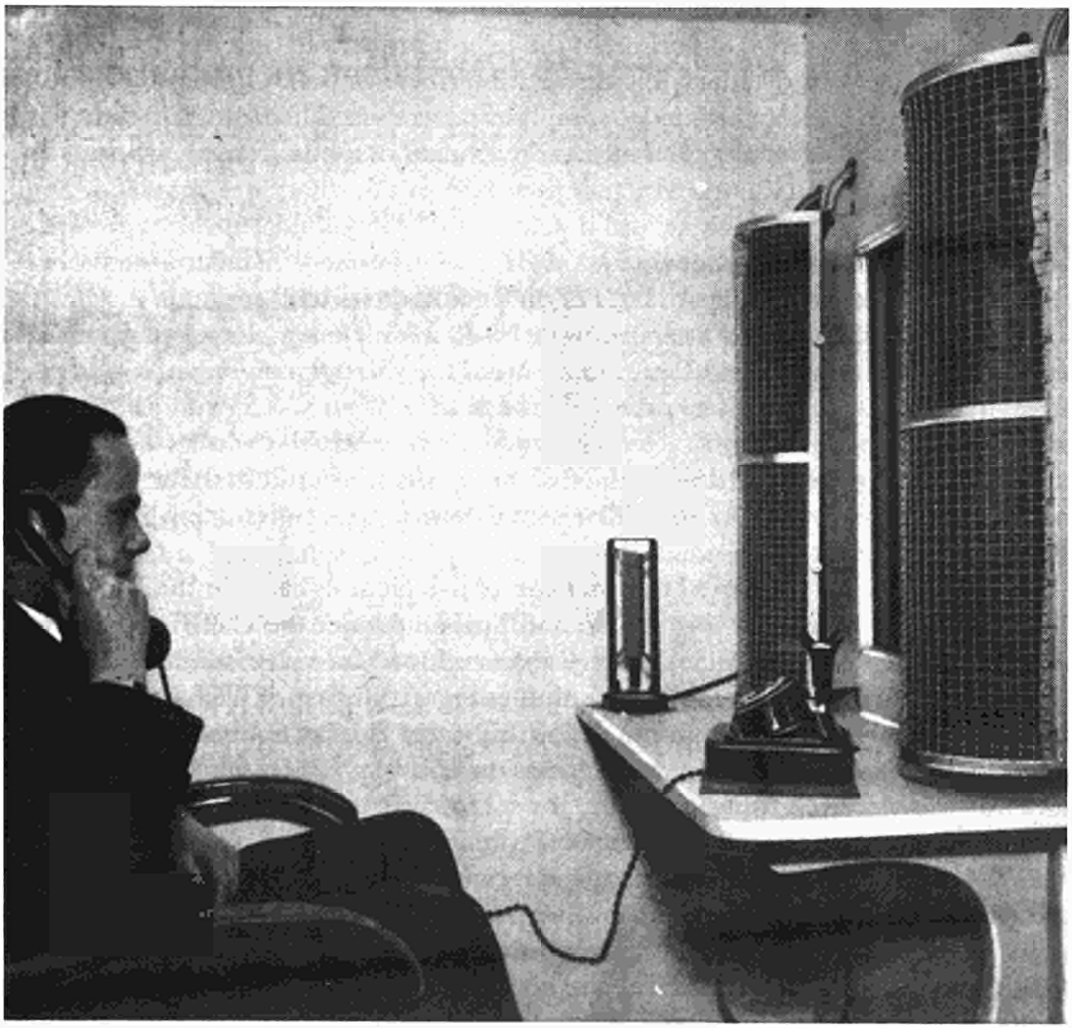

Figure 34.1 The German videotelephony service before the war.

A similar system was introduced in eight cities in the Soviet Union in 1961. At that time, broadcasting standards had been established, and the pictures were transmitted in the PAL standard, which is still predominant. The definition is 625 lines with 25 pictures per second, and the signals require a bandwidth of 6 MHz.

From the sixties onwards, most of the major telecommunication companies have investigated the technical and economic aspects of a commercial videotelephone service.

In the late fifties, the American telephone company AT&T developed a modern videotelephone system, and established a pilot service between Chicago, New York and Washington DC in the early sixties. The terminals that were used rendered a picture definition of 275 lines, 2:1 interlace, 30 pictures per second and the required bandwidth was approximately 500 Khz. In the beginning of the seventies, a new version of this system, called Picturephone, was offered as a service to regular subscribers of Bell Systems on a commercial basis in the same cities. Pictures were transmitted with a definition of 267 lines, 30 pictures per second with 2:1 interlace, and demanded a bandwidth of approximately 1 MHz. The service was introduced as a visual extension of the telephone service with the possibility of communicating with ordinary telephone subscribers as well. Ordinary telephone cables connected to special video amplifiers were used to transmit the video signals. However, the video signal required two wires in each direction, whereas the sound was transmitted via one wire pair as usual.

The service was not a success, and it was 'buried' soon after, but the experiences from the trial contributed valuable knowledge of user needs. Similar systems were also tested in Europe and Japan, but not on a commercial basis.

All the above-mentioned attempts were based mainly on analogue transmission technology, and the bandwidth requirements of the video signals meant high transmission costs. During the seventies, digital transmission was introduced in the telecommunications network. The development in microelectronics, along with considerable progress in the field of signal processing, allowed for advanced mathematical processing of the video signal with a view to reducing bandwidth requirements.

The breakthrough in digital transmission of live pictures came in the late seventies, almost simultaneously in the USA and Europe. Under the COST programme a 2 Mbit/s video codec (*co*der/*dec*oder) was developed for video conference purposes. The algorithm used for this equipment was the first CCITT standard for transmission of live pictures for such low bit rates. Similar equipment was developed by the American company Compression Lab Inc. (CLI), but this was based on a non-standardised transmission method. However, a beginning was made, and the development of advanced picture compression algorithms made headway. In 1982 the American company Widcom Inc., a company of CLI origin, launched the first video codec for transmission of live pictures at 56/64 kbit/s. Along with a sound unit, this equipment was marketed as a videotelephone. In Europe the British company GEC McMichael, in cooperation with British Telecom, were pioneers in the work on the 2 Mbit/s picture codec that was subsequently standardised. It was the Finnish company Vistacom, however, that first produced a

European 64 kbit/s videotelephone. The picture quality was so poor, however, that it was not accepted in the market, and a new improved version is now underway. Norway was the next country on the scene. The Norwegian codec was a result of collaboration between the Norwegian Telecom Research Department and Tandberg. The comparatively low price of the Norwegian equipment represented a further step towards common use of videotelephony. A number of companies, such as Tandberg and British Telecom are now bringing out relatively inexpensive codecs that conform to the latest ISDN standards.

In parallel with the development of videotelephones, the concept of the ISDN was introduced in the early eighties. An integrated services digital telecommunications network became the topic in the telecommunications world. Such a network, with basic access of 2 x 64 kbit/s and 16 kbit/s signalling is now becoming a reality in most parts of the industrialised world. Hence, there is a basis for transmission of live pictures in the telecommunications network of the immediate future.

Obstacles to Success

The three main obstacles to success seem to be technical complexity, network costs and user requirements. Up to now, the work has mainly been concentrated on the first two factors, especially on the engineering side.

The videotelephone service one envisages today will not make particular demands on the transmission network. Videotelephone connections will use the same network as all other ISDN services, such as telephony, videotex, telefax etc. Thus, it will not be necessary to invest heavily in the transmission network in order to make transmission of video signals possible. Resources are rather allocated to the production of videotelephone terminals, which will be technically complex. However, the technological development has generated very advanced microelectronics at reasonable costs. This fact, in addition to an increased competency in putting such components to use, has made possible the production of advanced videotelephone terminals at a reasonable price, providing that there is a market for large-scale production.

With regard to user requirements, it is the case that most early videotelephone trials have not been met with enthusiasm by the users. The exception is the Norwegian videotelephone trials. In general, the reason for this lack of enthusiasm is the fact that the development has been too technology-orientated, – little attention has been paid to the users' requirements and interests.

However, drawing on what has been learned from previous experience, the increased awareness of user requirements that has been gained from field trials, and the present technology push, it is possible to produce an inexpensive and user-friendly videotelephone which is as simple to use as an ordinary telephone and a video recorder, and, which, through good ergonomic design, may be accessible by many people with disabilities.

Given this background, the videotelephone is likely to be one of the most important communication media in the future. This will make new demands on the users; new skills must be developed, particularly in a field which may be called 'visual competence'. The development of knowledge, theories and methods concerning visual dialogue skills in telecommunications is a challenge for research in the years to come, which may render results in the form of new communication patterns, new visual aids and higher user competence.

Video Coding

In the good old days of 'analogue' transmission, the transmission of video required a capacity equivalent to 1000 analogue telephone channels. In today's digital world, the transmission of video (albeit with somewhat reduced quality) requires one or two digital channel with a 64 or 128 kbit/s capacity (Figure 34.2).

Looking into any type of digital video and audio codec system, one will find some piece of hardware equipment that converts the analogue audio and video signals into a format suitable for transmission over a digital circuit at the required bit-rate. The hardware can either be based on standard digital signal processors, dedicated circuits, or a combination of both. Very often one will find dedicated VLSI circuits for audio and video processing inside this kind of system.

The conversion, which is called *coding* or *compression*, takes place after the analogue signals have been digitised. The digital signal processing part carries out an algorithm, which describes mathematically what to do with the audio and video signals in order to achieve the necessary compression. It is implemented either as a software program running on digital signal processors or directly through the hardware.

During the last decade, several sophisticated video compression techniques have been developed. The Norwegian codec Tandberg TT–4001, which has been used in several of the trials presented in this book (cf. chapters 42 and 43), may serve as an example. The algorithm implemented in the video part of this codec uses a combination of some of these techniques. The simplicity can be illustrated by the fact that both the video coder and decoder are implemented in two digital signal processors and two microprocessors.

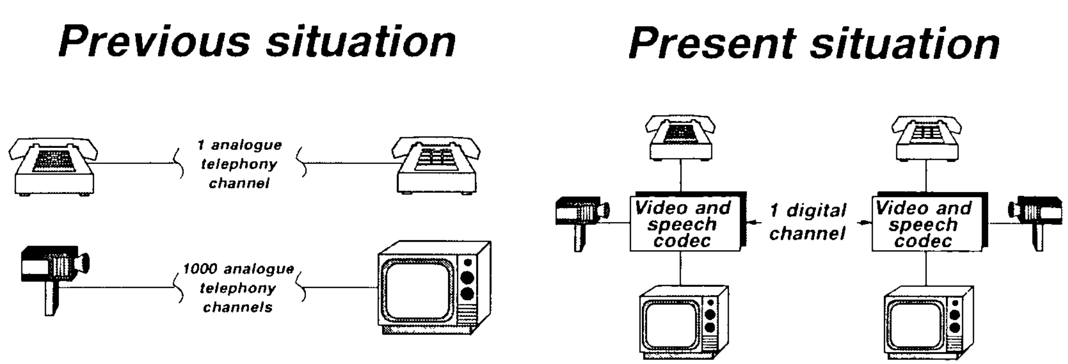

Figure 34.2 Video transmission before and now.

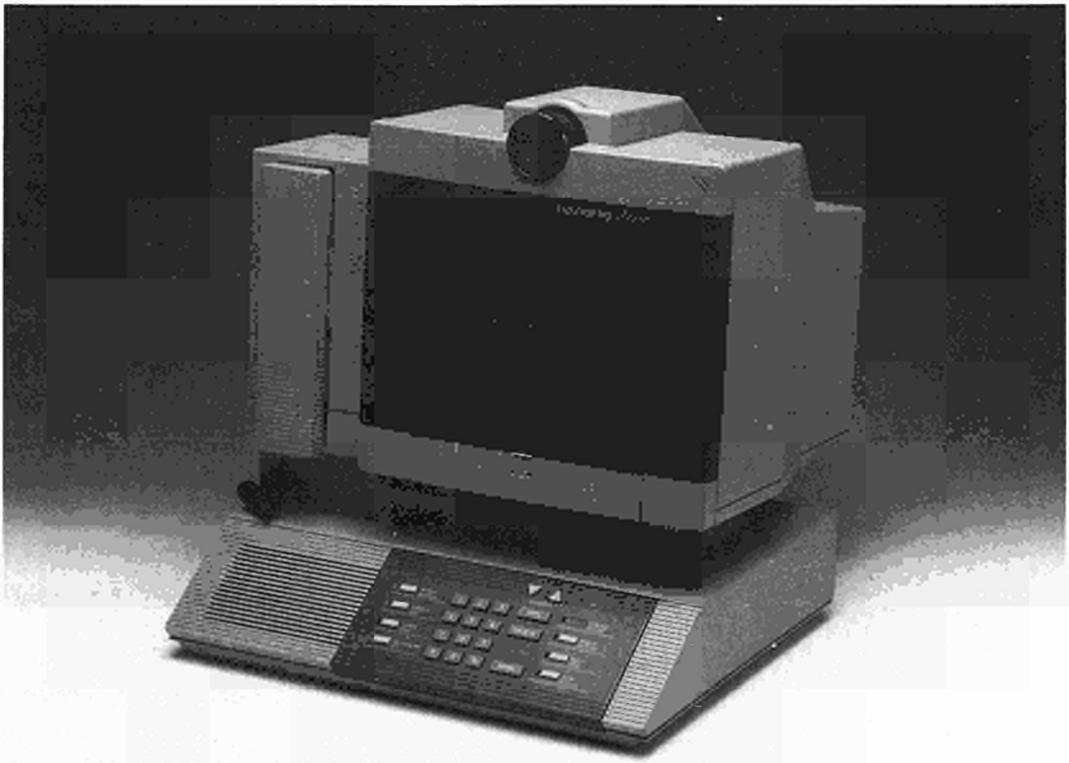

Figure 34.3 The Tandberg ISDN videotelephone.

In the TT–4001, the digitised picture frame is divided into 500 blocks, each block containing 7 x 7 picture elements (Figure 34.4). A method called *conditional replenishment* is used to remove redundant information between picture frames in the video signal. This is done by comparing the blocks of picture elements from the current picture frame with the same blocks in the previous picture frame. If the difference is significant, the block is processed further and transmitted, if not, the block from the previous frame, which has already been received and stored in the decoder, is retained unchanged and nothing is transmitted.

The next method used is known as *transform coding*. The block of picture elements is transformed from the time domain into the frequency domain by means of a Cosine transform. The effect of this transformation is that the same amount of information in the time domain can be represented much more effectively and compressed in the frequency domain (Figure 34.5).

The frequency coefficients are quantised to achieve further compression before they are packed into a format suitable for transmission. Thus, transmitting the frequency domain information generally requires a lower bit-rate than the transmission of information in the time domain.

At the other end of a transmission channel, the video codec acts as a receiver and decodes the incoming bitstream by doing operations which are inverse to those done by the coder parts.

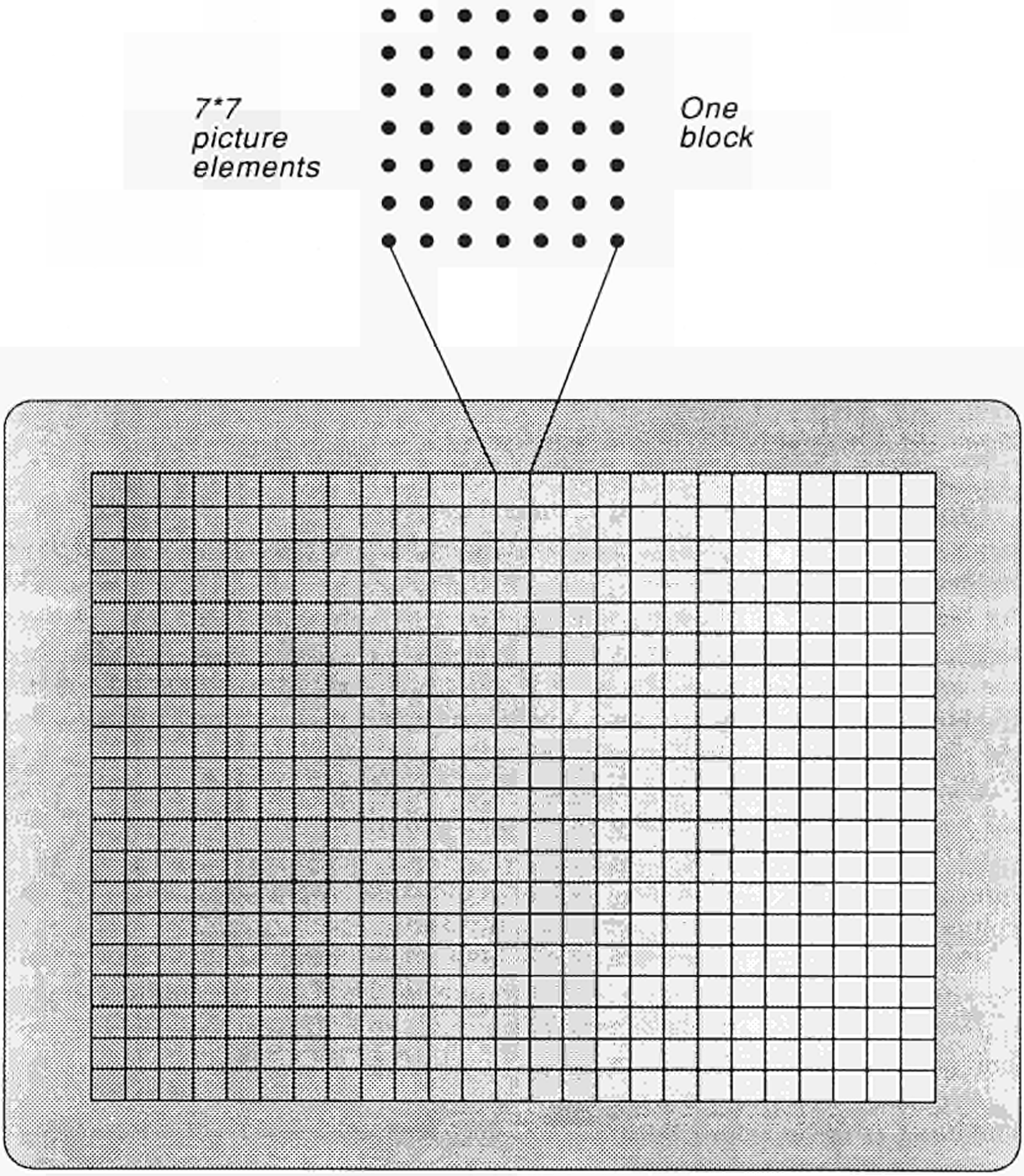

Figure 34.4 Digitised picture frame, 500 blocks.

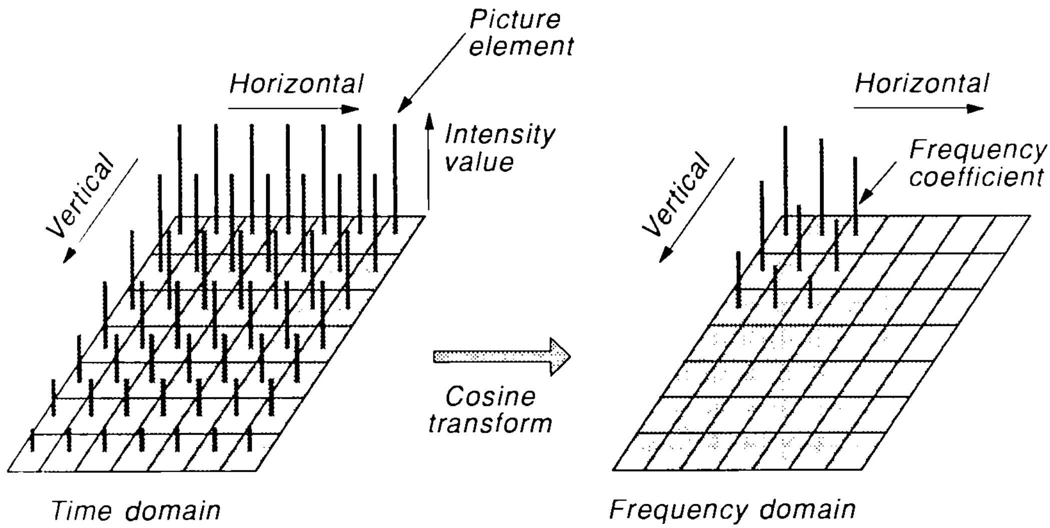

Figure 34.5 Transform coding.

Video Compression Ratio

The term 'compression ratio' is very often mentioned in connection with video codecs. Compression ratios such as 1:3000 are often found in the literature and seem impressive, but the facts behind these figures may need some clarification. Calculation of compression ratios often starts with a CCIR 601 digital video format, which has a bit-rate of 216 Mbit/s, and compares it with a 64 kbit/s digital channel capacity. Taking 216 Mbit/s and dividing it by 64 kbit/s gives a compression ratio of 3375 : 1! Quite impressive.

Looking at the facts, the compression ratio is a mixed calculation based on several methods used to achieve compression. The analogue video signal normally used as an input source is an ordinary consumer video camera with a quality that is not comparable to the quality of the CCIR 601 digital video standard. We prefer to use the term CIF (Common Intermediate Format) to describe the video quality from an ordinary camera. The picture resolution defined by CIF is:

Luminance: 360 pixels x 288 lines per picture
Chrominance: 180 pixels x 144 lines per picture

This gives: (360 x 288) + 2(180 x 144) = 155 520 pixels per picture. Assuming a picture frequency of 15 Hz and 6 bits per pixels, the result is[1]:

155 520 x 15 x 6 = 14 Mbit/s

1 CIF defines 30 Hz as picture frequency, but in a videotelephone it is more likely to assume that 10 or 15 Hz is the actual figure used. 6 bits per pixel is the minimum required to achieve a continuous greyscale.

This is a more representative figure of the input video signal to the video codec. Given a transmission capacity of 64 kbit/s these figures give a compression ratio of:

$$\frac{14\ \text{Mbit/s}}{64\ \text{kbit/s}} = 219$$

It should be noted that this is a simplified example. The actual calculation is much more complicated and takes into account several factors not shown here. The purpose of this example is to give some insight which may be useful, for example, when reading sales brochures or listening to sales people talking about videotelephones.

Standardisation

Video Transmission

A CCITT standard for picture transmission at 2 Mbit/s has existed for some years now, known as the H.120 standard, and it has been used mainly for video conferencing purposes.

In CCITT study group XV, a specialist group on coding for visual telephony was established in 1984. Their mandate in the first years was to work out a new recommendation for picture transmission at n x 384 kbit/s (n = 1 to 5) that would replace the H.120 standard. In the course of their work, they realised that there was a need for a recommendation for even lower bit rates, especially with a view to the ISDN. Consequently, they started working with an m x 64 kbit/s (m=1 or 2) recommendation which was not given a very high priority in the beginning due to scepticism about the quality of the video at such low bit rates.

However, the general progress seemed to favour lower bit rates, and it turned out that the same algorithm they were working with, with some minor adjustments, could actually be used down to 48 kbit/s. As a result it was decided, at a meeting in Paris late in 1988, to combine the two recommendations in one for p x 64 kbit/s (p = 1 to 30). The algorithm was to cover the whole range of bit rates from 48 kbit/s to 2 Mbit/s.

The final CCITT recommendation, given the name H.261, was approved by the CCITT in July 1990 together with four other recommendations (H.221, H.230, H.242 and H.320), which form a basic set for implementing digital audio-visual telecommunication services at bit rates up to 2 Mbit/s.

A number of manufacturers throughout the world are developing equipment based on these new standards. In fact, some equipment has already appeared on the market. There will be both videotelephone and video conferencing equipment based on H.261, and in the years to come, the distinction between the two might diminish.

The Videotelephony Service

On the basis of the progress made in the field of picture and speech coding/compression, standardisation work on an ISDN videotelephony service has also made headway, and is now being finalised.

In the past few years, the major part of this work has been carried out by the European Telecommunication Standardisation Institute (ETSI). The former technical subcommittee NA3, which was responsible for audio-visual telecommunication services, and the present technical subcommittee NA1, have earned most of the credit for this significant work. At an early stage, NA3 saw the possibilities inherent in the development of picture and speech coding/compression, and in September 1985 it started a project aimed at harmonising work within (at that time) CEPT to produce a preliminary recommendation for a videotelephony service. The work also inspired activities in other groups and in CCITT study group I as well.

It soon became obvious that an ISDN videotelephony service with basic access at 2 x 64 kbit/s (2B) for audio, video and data, plus 16 kbit/s for signalling (D), would open up several *modi operandi,* based on the development of ever-improved picture and speech compression techniques.

The videotelephony service is (or will very soon be) defined as a fully standardised ISDN service within ETSI, and it is expected that the CCITT will follow shortly.

The basic videotelephony service is characterised by the simultaneous transmission of moving colour pictures, and the speech of the persons involved in the call. Two main modes of operation can be identified for the videotelephony service:

- videotelephony based on one circuit-mode 64 kbit/s connection; and,
- videotelephony based on two circuit-mode 64 kbit/s connections.

In the first case, the 64 kbit/s connection carries both speech and video information. In the second case, the first connection either carries speech or both speech and some video information, and the second carries video information.

In this mode, the speech quality will be at least as good as that available in the normal telephony service in the 64 kbit/s ISDN, using a bandwidth of 3.1 kHz or 7 kHz.

The videotelephony service should allow communication between:

- two users (e.g. terminals) in a point-to-point configuration via the ISDN over one or two B channels; and,
- three or more users in a multi-point configuration as invoked by some supplementary services.

An essential feature of the service is that, besides videotelephony, it also provides the user with the possibility of communicating with other ISDN telephone or videotelephone terminals using only the speech communication facility. It will be possible to use videotelephone terminals to communicate with 3.1 kHz terminals connected to the PSTN (ordinary analogue telephones).

Sound Transmission

It is said that 'a picture is worth a thousand words', but this is only a partial truth. In connection with the videotelephone, the focus is usually on the transmission and quality of the picture, but it is a fact that our entire present communication culture is based on speech. Hence the quality of the sound transmission will be just as important as the picture quality; for some users, even more important.

An absolute requirement for a videotelephone is that it must function as an ordinary telephone and have interworking with this service, that is, 3.1 kHz telephony. Interworking must be on telephony terms, which means that the videotelephone must have a standard 64 kbit/s PCM codec in accordance with CCITT recommendation G.711. As an optional second mode, it can also have equipment which makes possible 7 kHz telephony in accordance with CCITT recommendation G.722.

Both the above recommendations are well-established, well-defined CCITT recommendations, but in order for the videotelephone service to work in all the three modes, there will also have to be a speech coding standard for 16 kbit/s. Today there is only a European standard for GSM (the new digital mobile telephone network). In December 1988 a CCITT SG X ad-hoc group started to work on the development of a universal 16 kbit/s speech coder with very strict requirements as to time delay. In order to decide which speech coder to standardise for the videotelephone, Norway initiated a pan-European meeting towards the end of 1988. The meeting, held in Oslo, concluded that the European view would be to go for the codec being developed in CCITT and put forward coordinated requirements concerning the videotelephone in this work. The goal of the CCITT group is a well-defined standard, based on an algorithm developed by AT&T, by the end of 1991.

Even if it is not subject to standardisation, it is worth mentioning that videotelephones should be, and in all likelihood will be, loud-speaking. This means that the sound will come from, and you will speak to, the screen on which you can see your communication partner, rather than use a handset. This will ensure a more natural form of communication. In order to secure the possibility of private conversations, the videotelephone will also be equipped with an ordinary telephone handset. However, the loud-speaking requirement creates several problems in relation to electro-acoustics. The hardest challenge and problems are related to echo cancelling. Today there is no feasible, implementable method for acoustic echo cancelling which will handle all conceivable acoustic videotelephone environments. As a temporary solution the first generation loud-speaking videotelephones will probably be based on some form of voice switching.

Cost Considerations

A videotelephone is not, when compared to the price of a normal telephone, a cheap piece of equipment – for the time being at least. This comparison might not be fair but people will nonetheless make such a comparison.

Some of the key components, that is, the camera (including lens) and monitor, are quite expensive. However, the real cost lies within the audio and video codec. The hardware needed to implement the present international standards is expensive because of the requirements of speed and data processing capabilities. A lot of effort has gone into developing VLSI circuits dedicated to meeting the video and audio processing requirements, but until now very few manufacturers have produced commercially available chips. Also, due to low volumes, prices are still very high.

However, looking at trends of average unit prices of 'similar' telecommunication terminal equipment during the last few years might give us some idea of where we are heading. Figure 34.6 shows what is expected if the videotelephone terminal follows the same trend as other customer premises equipment has done. Although reliable market figures are not available, Figure 34.6 shows a possible scenario based on the fact that prices as well as sales will show drastic changes in the coming years.

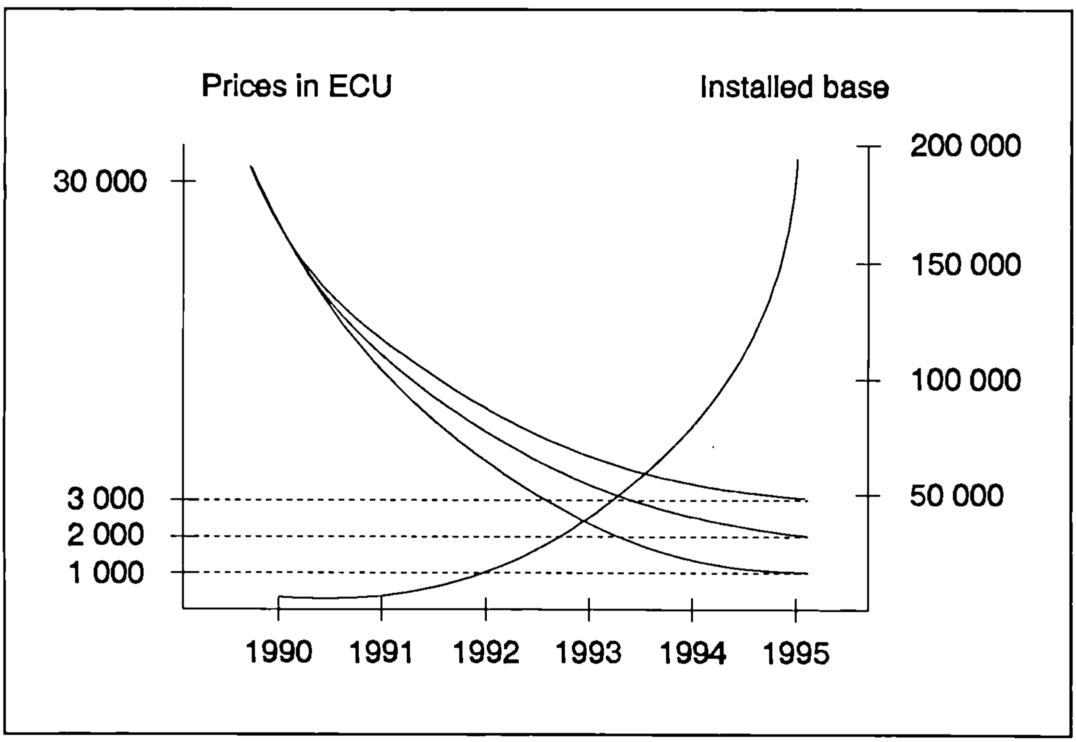

Figure 34.6 Cost development and market growth. Source: Coopers & Lybrand, Management Consultants

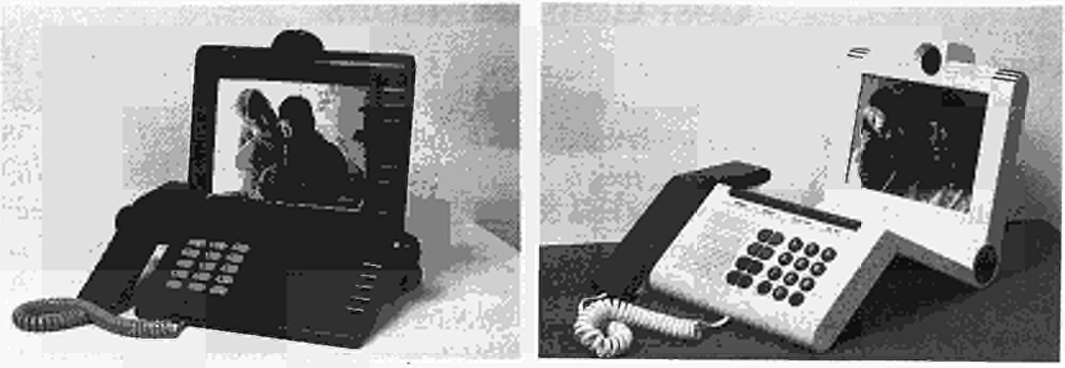

Figure 34.7 Future designers' proposals for future videotelephones. These models were designed by students at the College of Arts and Crafts.

The Future

Until now the videotelephone has belonged to the world of science fiction. The possibility of real-time communication has for years been part of mankind's visionary dream of the future. At the beginning of the 1990s the videotelephone has become reality. A fully digitised telecommunications network (ISDN) is being built throughout Europe, which will ultimately make videotelephony an easily accessible service. User experiences gained in preliminary field trials show that there is great potential for videotelephony in a variety of areas, and, as documented in several chapters in this book, particularly to the advantage of people with disabilities. Taking into consideration the fact that there are still obstacles to be overcome, real-time audio-visual telecommunication seems to have a bright future, and the future is now.

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35

Videotelephony and Speech Reading: The Effect of Picture Quality

Hank W. Frowein, Guido F. Smoorenburg, Liesbeth Pyfers and Dolf Schinkel

It is expected that during the next few years videotelephony will become accessible to both private and business customers. The development of sophisticated video coding techniques allows video transmission at a greatly reduced channel capacity (e.g. Plompen, 1989). The introduction of 64 kbit/s standardised digital networks, such as the ISDN, will provide a suitable infrastructure for a narrowband service to be realised.

People who will obviously benefit from videotelephony are those who are profoundly deaf and hard of hearing. Of these two groups, deaf people are clearly the most in need of visual information for their interpersonal communication. Hence, much of the research and development on videotelephony for hearing impaired people has focused on deaf people as potential users (e.g. Anderson and Nordby, 1985). Laboratory experiments by Sperling (1981) and Pearson (1981) have shown that video transmission of sign language provides a workable means of communication, even at greatly reduced spatial resolution. Narrowband videotelephony for people who are deaf now seems ready to evolve from the laboratory stage into a real service (e.g. Lo, 1990).

Less attention has been paid so far to videotelephony for those who still have some residual hearing, i.e. people who are hard of hearing. Nevertheless, this group forms a significant segment of the population. Most of them are elderly and need to keep in contact with family, friends and providers of medical and social services. For them, videotelephony allows speech reading (also called 'lip reading') as an adjunctive aid in their telephone conversations. In experiments with normally hearing subjects, it has been shown, for instance, that the intelligibility of degraded auditory voice messages can be improved by adding a moving visual image of the speaker's face (Ostberg, Lindström and Renhäll, 1989). Following on from this research, the experiments described in this paper were carried out to prepare for the application of 64 kbit/s videotelephony as a communication medium for people who are hard-of-hearing. The specific aims were:

- to confirm and measure the added value of audio-visual presentation for speech reception;
- to assess the effect of the temporal resolution (frame rate) of the video image on speech reception;
- to assess the suitability of 64 kbit/s video images as an adjunctive aid to speech reception; and,
- to assess the effect of different levels of the spatial resolution of 64 kbit/s images on speech reception.

General Methodology

Subjects

Different subjects were recruited for each of three experiments. A total of 40 persons (23 men and 17 women) participated in the study. The average age was 61.5 years. All subjects suffered from presbyacusis and had a hearing impairment of at least 35 dB; the average impairment was 68.4 dB in their best ear. All subjects normally communicated through speech and used hearing aids and speech reading to support their speech reception. About 25 per cent of the subjects had attended speech reading classes at one time or another. The subjects were free to wear their hearing aids during the experiments.

Language Material

The stimulus material consisted of video recordings of two men and two women speaking common sentences of 8–9 syllables (e.g. 'the cat jumped over the green fence'). They were allotted to 8 lists of 13 sentences each, so that each list was 'phonetically balanced' (Breeuwer, 1985). In addition, it was arranged that the lists had comparable 'visual recognition' values; this was done in prior tests in which hearing subjects attempted to repeat the sentences on the basis of the video signal only. None of the speakers had any special training in communicating with hearing impaired people. When recorded, the speaker was illuminated by diffuse lighting, and seated in front of a light, neutral background. The speaker spoke the sentence while looking directly at the camera.

Experimental Task

The experiments took place in a sound-attenuated room. The subjects were tested individually and by the same experimenter. The subject was seated in front of a monitor with a loudspeaker positioned slightly behind and to the left of the monitor. The sentences were presented either in audio-visual or in audio-only mode. In both, the speaker's voice was presented via the loudspeaker and in audio-visual mode a video image of the speaker appeared on the monitor. The subjects' task was to repeat each sentence immediately after it had been presented. Subjects were encouraged to repeat any word they may have heard even if they were not sure about it.

Degradation of the Auditory Signal

Since it was known from previous experiments (Bosman, 1990) that some hearing impaired people can accurately report these 'everyday' sentences on the basis of the sound signal alone, the sentences were degraded through the addition of noise. In this way, greater dependency on the visual signal was attained.

At the beginning of each session the subject was presented with audio-only sentences and noise was added to the sentences until the subject's accuracy fell to between 30 and 40 per cent. This signal-to-noise ratio was used in the main tests.

Speech Reception Scores

As a subject repeated a sentence, the experimenter marked each correctly reported syllable on a score-sheet. No information was given about whether the response was correct or not. Afterwards the percentages of correctly repeated syllables were taken as the speech reception scores.

Preliminary Pilot

Seven men and one woman participated in a preliminary study to assess whether differences between speakers, image formats (e.g. head-and-shoulders) and the size of the monitor had marked effects on the speech reception scores.

Statistical tests of the results showed that there was no difference between speakers, display size and image format. The subjects were also asked which size image format they preferred, no preference was expressed. Subjects expressed a slight preference for the head-and-shoulder format, so this was used in the subsequent tests.

Experiment 1: The Added Value of Video and the Effect of Frame Rate

The main purpose of this experiment was to test whether audio-visual presentation can result in higher speech reception scores. The experiment also investigated the effect of varying the frame rate of the video image. Videotelephony with a transfer rate of 64 kbit/s implies a significant degradation of the image: not only the spatial resolution, but also the temporal resolution (frame rate) is reduced. It is likely that the frame rate affects the speech readability of the video, because at low frame rates lip movements will be distorted or omitted. Thus, it could be that below a critical rate, audio-visual presentation has no added value over audio-only.

It could even be that the picture would only confuse the listener and impair instead of improve speech reception. These questions are obviously relevant for the design and selection of video codecs, especially if they are to be used to serve hearing impaired people.

To provide answers we determined the speech reception scores at audio-only presentation and at audio-visual presentation with frame rates varying from 5 to 30 Hz. The spatial resolution was kept constant at good PAL Umatic recording quality.

Subjects

There were 16 subjects (7 men and 9 women) with an average age of 57 years and an average hearing loss of 68.5 dB in their best ear. Subjects wore their usual spectacles for visual correction if required.

Procedure

The video recordings were electronically processed in order to present the video pictures at 5, 6, 7.5, 10, 15 and 30 Hz (i.e. images per second). The experimental conditions consisted of six audio-visual conditions at these frame rates and two audio-only conditions. In addition, two audio-only conditions were needed to establish the individual subject's signal-to-noise ratio and there were two practice conditions for the audio-visual presentations (i.e. head-and-shoulders images at 10 and 30 Hz). The screen size was 23 cm and the viewing distance was 90 cm.

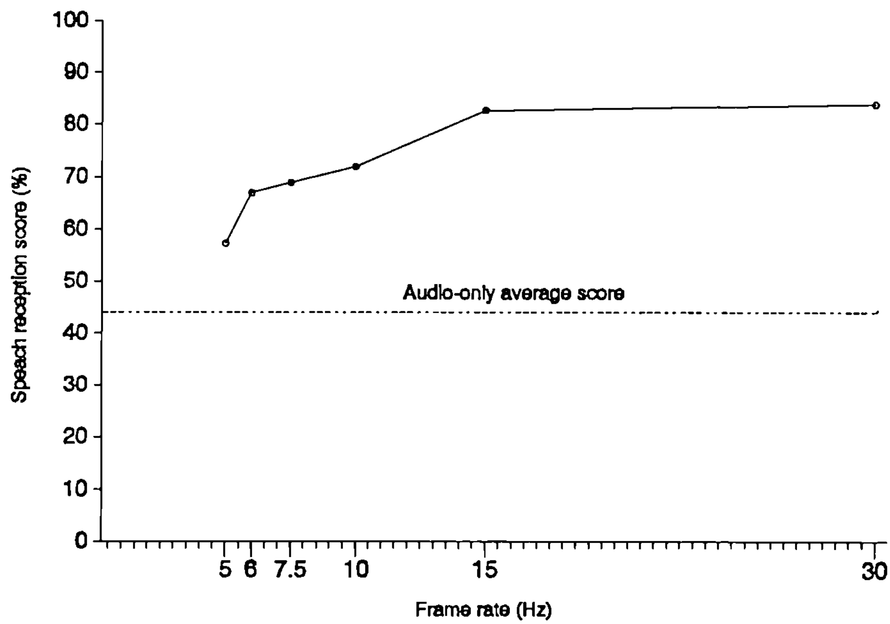

Figure 35.1 Effect of frame rate on speech reception.

Results

The average scores for the audio-only and audio-visual conditions are shown in Figure 35.1. Analysis of variance showed that the effect of changing the frame rate was statistically significant ($P<.001$). Moreover, each of the audio-visual conditions was statistically significantly different from audio-only ($P<.05$).

It is evident from Figure 35.1, that even the addition of a video signal at a very low frame rate (5 or 6 Hz) led to an improvement in speech reception. The added value of the video increases as the frame rate is raised to 15 Hz; an additional increase to 30 Hz did not lead to a further improvement of speech reception.

Experiment 2: The Added Value of 64 kbit/s Video at 1CIF and QCIF

Both the frame rate and the spatial resolution in 64 kbit/s videotelephony will be less than in broadcast television. In accordance with recent CCITT standardisation, the spatial resolution will be either 1CIF (300x288 pixels) or QCIF (180x144 pixels). CIF is an acronym for 'common intermediate format'.

The first aim of this experiment was to investigate the added value of coded 64 kbit/s images on the speech reception scores and to test whether there is a difference between QCIF and 1CIF.

Secondly, it seemed plausible that the effect of decreased spatial resolution on 'speech readability' would be greater if the mouth is a relatively small part of the displayed image or if the screen itself is small. Therefore, the effect of QCIF versus 1CIF was investigated for head-and-torso as well as head-and-shoulders, and the head-and-torso images were presented on two screen sizes: 23 cm and 13 cm.

Thirdly, one of the audio-visual conditions of the second experiment was again repeated to assess the reliability of the speech reception scores. This condition was a head-and-shoulders image presented at a frame rate of 7.5 Hz and the same spatial resolution was used as used in the first experiment.

Subjects

16 subjects (9 men and 7 women) participated in this experiment. The average age was 61 years and the average hearing loss was 67 dB in the best ear; they wore their usual spectacles if required.

Design and Procedure

The video recording were electronically processed to simulate QCIF and 1CIF. Each session started with two audio-only conditions to determine the signal-to-noise ratio, and two audio-visual practice conditions, i.e. a 30 Hz analogue broadband presentation of head-and-shoulders on a 23 cm screen and a QCIF image of head-and shoulders on a 13 cm screen.

The following 8 experimental conditions were presented during each session:

- audio-only;
- 7.5 Hz analogue broadband image of head-and-shoulders on a 23 cm screen;
- QCIF coded image of head-and-shoulders on a 23 cm screen;
- QCIF coded image of head-and-torso on a 23 cm screen;
- QCIF coded image of head-and-torso on a 13 cm screen;
- 1CIF coded image of head-and-shoulders on a 23 cm screen;
- 1CIF coded image of head-and-torso on a 23 cm screen; and,
- 1CIF coded image of head-and-torso on a 13 cm screen.

During each session, one list of 13 sentences was presented for each condition. The viewing distance was varied as a function of display size, i.e. 90 cm for the 23 cm monitor and 70 cm for the 13 cm monitor.

Results

The speech reception score for audio-only was 44 per cent, which was exactly the same as obtained in experiment 1. The data for the audio-visual conditions are summarised in Table 35.1 which, apart from the speech reception scores, also presents the 'added value' scores which were computed by taking the difference between the audio-visual and the audio-only scores.

Statistical tests showed that performance in each of the audio-visual conditions was significantly better than an audio-only ($P<.01$ in all cases). However, none of the audio-visual conditions was better than the others. Thus, although Table 35.1 suggests some small differences as a function of display size, image format and QCIF versus 1CIF, none of these differences are statistically different.

	23 cm		13 cm	
	H-S	H-T	H-T	average
7.5 Hz analogue	66 (+22)			66 (+22)
QCIF	70 (+26)	62 (+18)	64 (+20)	65 (+21)
1CIF	69 (+25)	70 (+26)	63 (+19)	67 (+23)
Average (exclusive 7.5 Hz)	70 (+26)	66 (+22)	64 (+20)	

Table 35.1 Speech Reception Scores and Added Value Scores (in brackets) for the audio-visual conditions in Experiment 2.

Conclusions

The experimental method used demonstrated its value as a means of assessing the effects of various video parameters on speech readability. It should, however, be recognised that the added value of audio-visual over audio-only was enhanced by the presentation of background noise, which is not always present in real life. Hence, in everyday videotelephony this added value may not be as great.

Nevertheless, if this degradation of the audio signal is regarded as a way of simulating increased hearing loss, it seems reasonable to infer that people whose hearing loss interferes with ordinary telephone usage will benefit from videotelephony. Moreover, no special training in speech reading seems necessary. The majority of our subjects had never received such training but still achieved considerable improvements of speech reception through the addition of video.

If we use these results to provide guidelines for the design and selection of 64 kbit/s video codecs, there are two main conclusions.

Firstly, temporal resolution (frame rate) is an important determinant of speech readability. Experiment 1 showed that speech reception scores increased significantly as the frame rate was increased up to 15 Hz. Because increasing the rate beyond 15 Hz did not affect the score, 15 Hz appears to be a reasonable minimal rate for videotelephony.

Secondly, the results of experiment 2 provided no evidence that the spatial resolution of 1CIF provides better speech readability than QCIF. Thus, if the aim is to improve speech reception, there may be little reason to prefer 1CIF over QCIF. A comparision of the effectiveness of broadcast quality and 64 kbit/s videotelephony can be derived by comparing the scores obtained in experiment 1 for head-and-shoulders with 30 Hz (i.e. 84 per cent) and the scores obtained in experiment 2 for head- and-shoulders with QCIF (69 per cent) and 1CIF (70 per cent).

Acknowledgement

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The authors are indebted to the editor Stephen von Tetzchner for commenting on this manuscript and greatly improving its readability.

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36

The Use of 64 Kbit/s Videotelephones for Sign Language

Stephen von Tetzchner

Videotelephones make it possible to transfer live pictures over the telecommunications network. However, due to the large amount of information contained in an image, it is necessary to code the picture so that less information is transmitted. This coding leads to a reduction in picture quality, depending on the extent to which the transfer of information is slimmed down. There will also be a delay in transmission of the image because the coding necessitates calculations that take time to execute (cf. chapter 34).

An ISDN videotelephone has a transfer rate of 64 or 128 kilobits per second (kbit/s). This means that the degree of data compression is very high and the quality of the pictures restricted, i.e. there is a lower spatial resolution and fewer frames per second. When the videotelephone is used to show only the face of a person or an object, communication may still be possible. If the communication partners are moving, however, then picture quality may determine whether communication is successful or not.

Sign language, with its rapid movements and slight differences in hand shape, is the ultimate test for any videotelephone. This was one of the reasons for including sign language users in the first field-trials with videotelephones. The other reason was that videotelephones are of particular value for deaf people who use sign language, because videotelephones make it possible for them to communicate over distances with the aid of their first language, similar to the way in which hearing people communicate using the telephone.

Pre-lingual and Acquired Deafness

When discussing telecommunications for people who are deaf, it is necessary to distinguish between pre-lingual and acquired deafness. People who are born deaf or acquired their hearing impairment at an early age tend to be sign users. They have mostly attended schools for deaf people and share a common culture that is not generally known by the hearing population. In the same way as spoken languages, sign languages differ from country to country. Norwegian sign language, for example, differs significantly from the British, American and Chinese sign languages (cf. Klima & Bellugi, 1979; Martinsen, Nordeng & von Tetzchner, 1985).

Although they may have problems coping in a hearing world after they have become deaf, people with acquired deafness have a spoken language as their first language, have attended normal schools and share the general culture (cf. Nordeng, von Tetzchner & Martinsen, 1985). Only a small proportion of this group becomes proficient in signing. They often use cued speech as support for lip reading and writing for communication. Since they tend to be poor signers, text communication will typically be their preferred telecommunication mode.

The studies presented here are concerned with pre-lingually deaf signers.

Some Characteristics of Signing

Sign languages are visual and manual as opposed to the spoken languages which are auditory and vocal. This not only makes the phonology of the two types of language very different, but also the sign languages' use of articulatory space (location) and the possibilities of analogue variation and of signing two signs simultaneously contribute to distinguish the language forms.

Phonology

There are several different ways to describe the phonology (also called cherology) of signs, but for the present purposes, only the basic features are described according to the classical description of Stokoe (1960). He described three aspects: place of articulation, hand form and movement. Most signs will differ in one or more of these aspects, but in rare cases, other aspects of production, for example head and lip movement, may distinguish the meaning of individual signs (cf. Klima & Bellugi, 1979; Vogt-Svendsen, 1981).

Place of Articulation

The place of articulation denotes the place where the sign is performed, for example at different places of the head (Figure 36.1). The place of articulation does not depend on physical contact, only on the area where the sign is articulated.

summer ugly dry

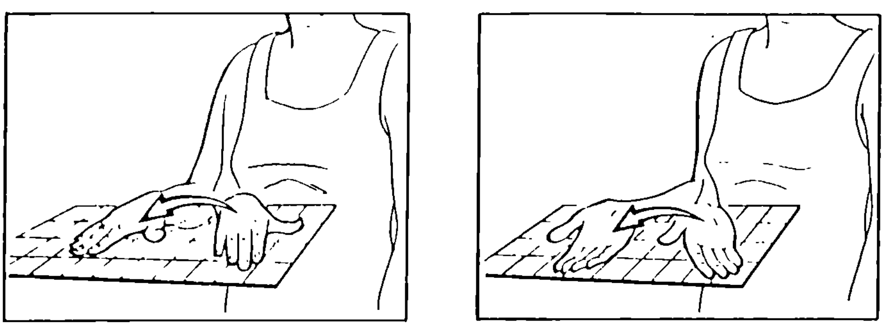
Figure 36.1 Signs that differ in place and articulation (after Klima & Bellugi, 1979).

Hand Form

A large number of hand forms distinguish the meaning of signs (Figure 36.2 and 36.4). The hand forms may differ somewhat from language to language, but most forms are found in many languages. Stokoe included orientation of the hand as part of the hand form (Figure 36.3).

candy apple jealous

Figure 36.2 Signs that differ in hand form (after Klima & Bellugi, 1979).



child thing

Figure 36.3 Signs that differ in hand orientation (after Klima & Bellugi, 1979).

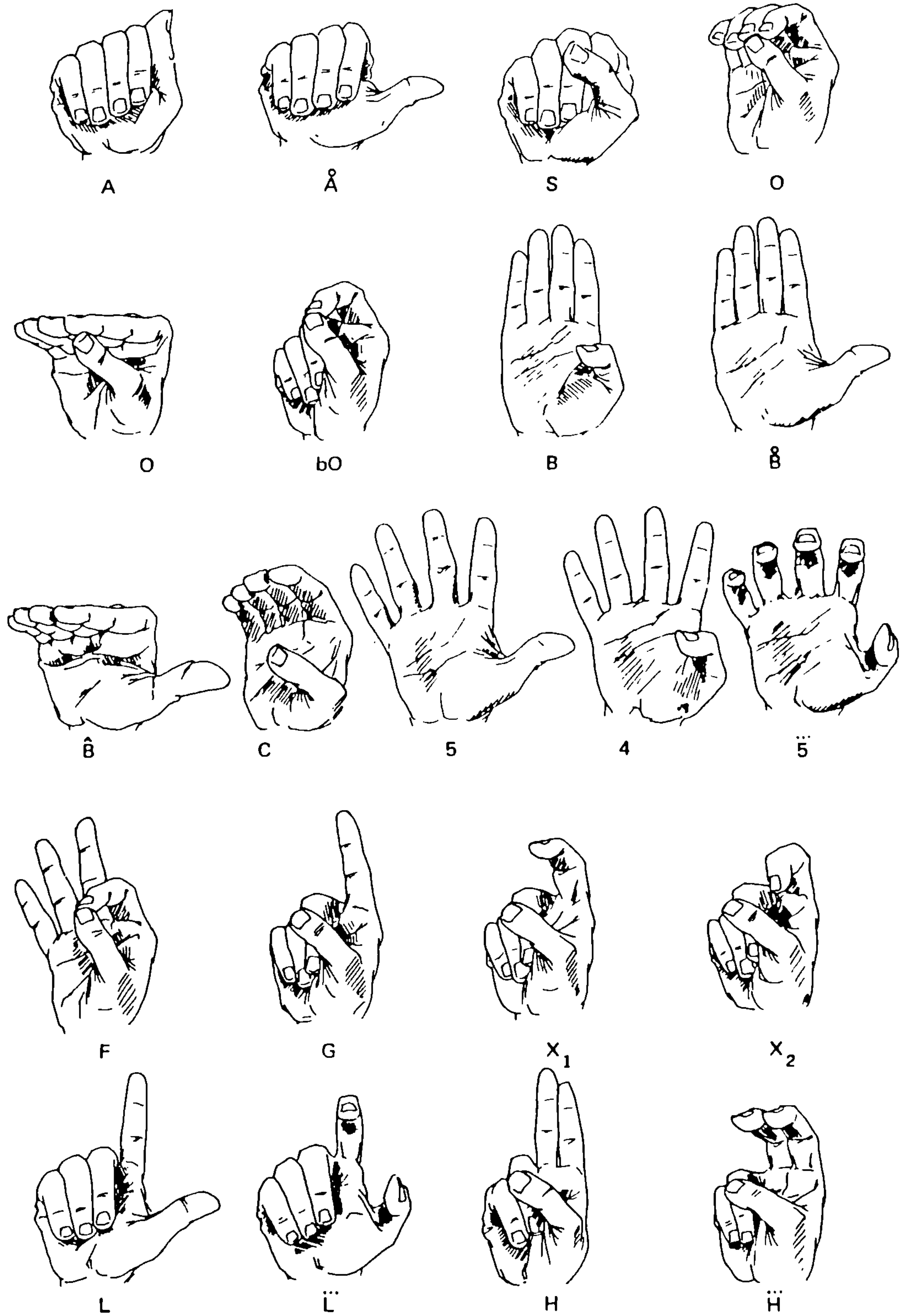


Figure 36.4 Some of the hand forms of American sign language (after Friedman, 1977).

Movement

Small differences in movement may distinguish different signs and inflections of signs. Some signs consist of more than one movement (Figure 36.5 and 36.6).

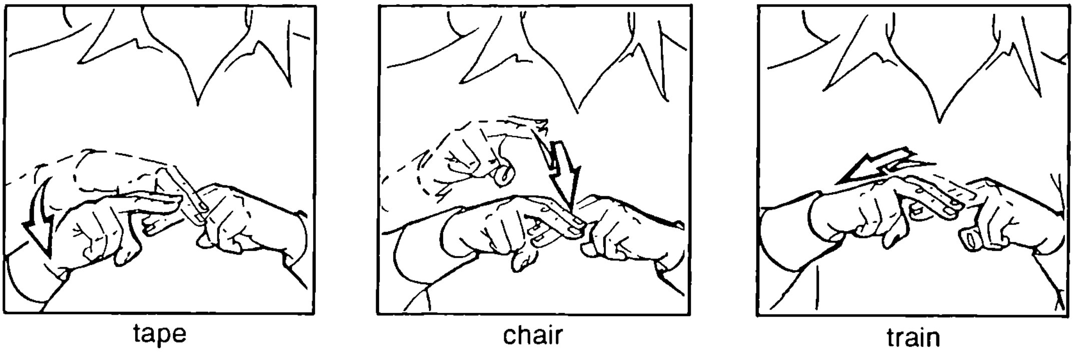


Figure 36.5 Signs that differ in movement (after Klima & Bellugi, 1979).

Figure 36.6 Signs with one or several movements (after Klima & Bellugi, 1979).

Location

In addition to the three phonological aspects, pronoun location is a characteristic feature of signing. This implies that the people and objects that are talked about are given a location in front of the signer, and later referred to as 'he', 'she' ,'it' etc., by pointing to the designated location (Figure 36.7). Location may also be used to build up a 'scene' that indicates a locative relationship between objects. For example, the signer may place a house at one point and then refer to a tree to the right of it.

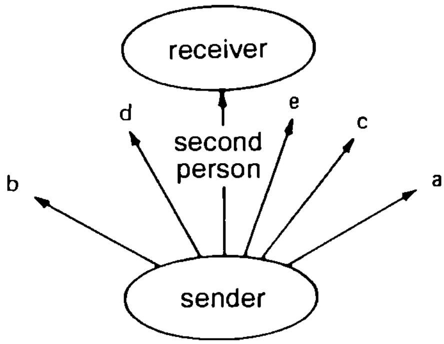


Figure 36.7 Use of location for pronouns (after Wilbur, 1979).

Analogue Variation

Some signs may be performed with analogue variation. Instead of saying BIG CAR or SMALL CAR by combining two signs, the size of the movements will indicate the size of the car (Figure 36.8). It should be noted, however, that inflections with analogue variation are only allowed with certain iconic noun categories.

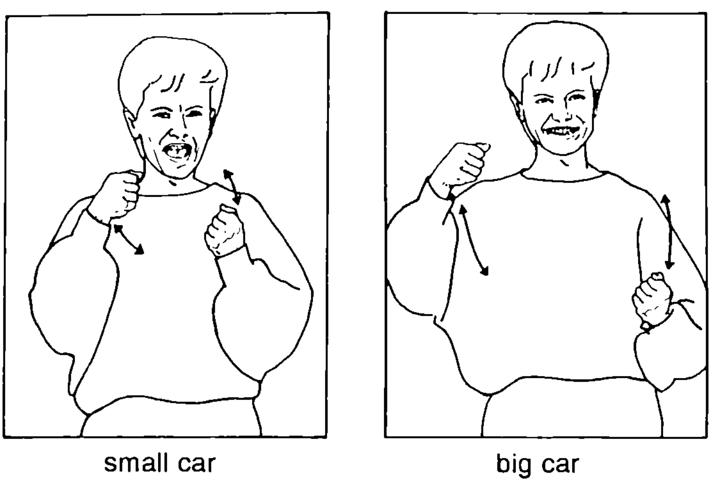


Figure 36.8 Analogue variation of signs (after Martinsen et al., 1985).

Simultaneous Signing

This implies that one sign is incorporated into another. For example, the number THREE may be incorporated into CHILD, meaning 'three children' (Figure 36.9).

three children

Figure 36.9 Incorporation of THREE in CHILD (after Martinsen et al., 1985).

Videotelephony and Signing

The motivation for the short introduction to sign language structure above was to demonstrate how optimal use of signing depends on a good view of the signer and a medium that provides good spatial and sequential resolution.

Any blurring due to movement or poor spatial resolution will make comprehension more difficult, and the signer may have to slow down and use very distinct articulation. The two-dimensional screen makes the representation of location difficult, which may make it necessary to restrict the natural use of pronouns and to use names and nouns instead. In addition, the delay introduced by the video codec may influence turn-taking and the conversational flow.

Below, two projects with pre-lingual deaf signers are reported. The way in which the codec characteristics influence different aspects of signing was not investigated here; that is the topic of a forthcoming study (Schrøder, Greftegreff and Coppock, in prep). The aim of these projects was to obtain different groups of sign language users' reactions to the first prototype of the Tandberg TT 4001 64 kbit/s video codec.

The Kopperud Project

In Norway children generally start school in August in the year they reach seven years of age. This is, of course, also true for profoundly deaf children, and unless they live close to a school for the deaf, this means that they will attend a residential school in one of the larger cities. The rationale for this is that it is impossible to provide a sufficient signing environment outside a school for deaf children to support the children's sign language development.

Deaf children from Gjøvik have traditionally attended Skådalen School and Competence Centre for Deaf Children in Oslo. Due to an epidemic some 12 years ago, however, eight children of approximately the same age became deaf. Because of this large number, it was decided to make a special class for these children at Kopperud school, which is the largest school at Gjøvik. This class constitutes a kind of satellite since it is linked both administratively and professionally to the centre

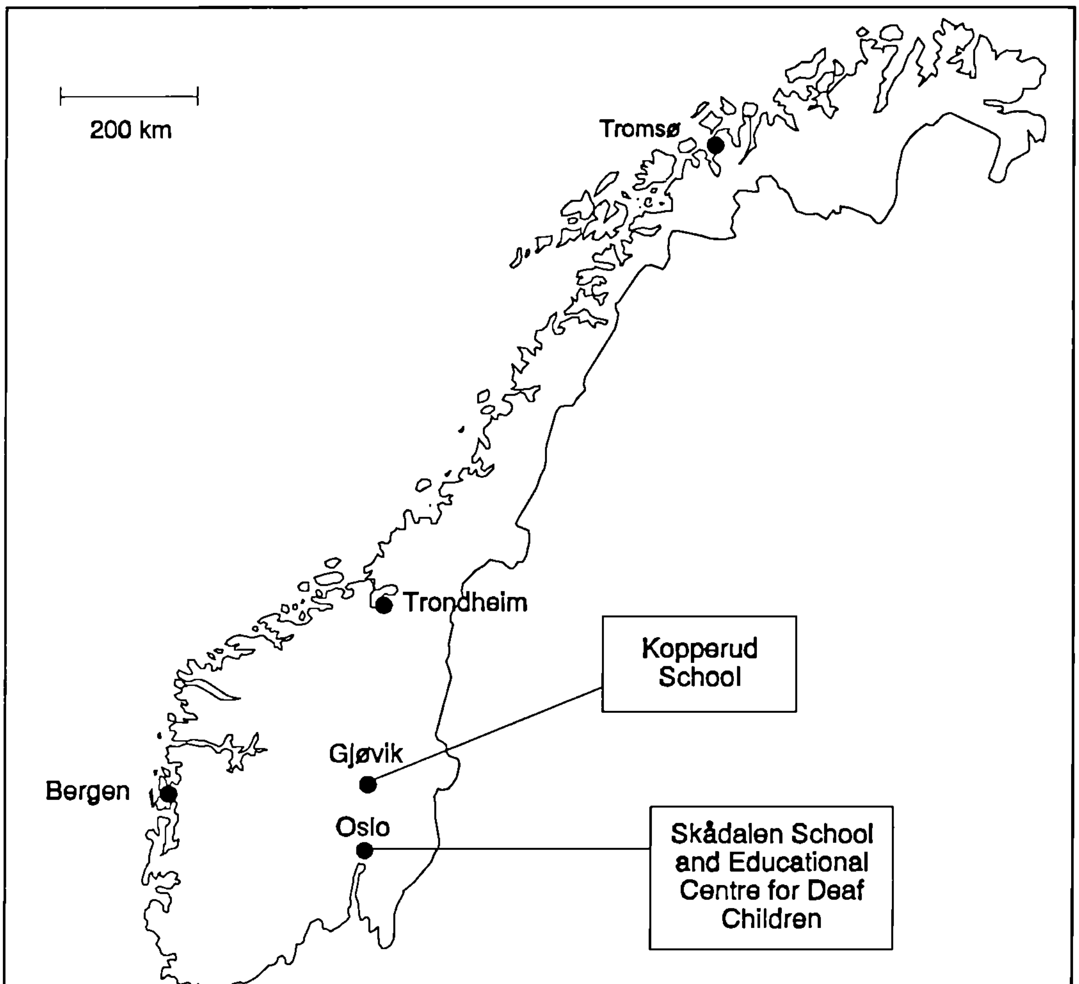


Figure 36.10 Map of Norway with Oslo and Gjøvik.

at Skådalen. The deaf children at Kopperud have visited Skådalen for a couple of weeks twice a year, and children from parallel classes in Oslo have visited Gjøvik for a day or two twice a year. Thus, the deaf children in Oslo and at Gjøvik knew each other quite well when the videotelephone was introduced in 1989.

Conversations

From the technical point of view, the aim of the project was to find out whether the quality of the coded pictures was sufficiently good for them to be used in sign language conversations. From the point of view of the teachers, the aim of the project was to expand the children's language environment.

The first time the children used the videotelephone, they tended to sign too fast and forget to keep within the camera frame. However, they swiftly recognised the need to adapt to the medium. The children usually use Norwegian sign language that has its own structure distinct from that of the spoken language, but during the first period with the videotelephone, the teachers reported a tendency among the children to sign more formally, i.e. somewhat closer to signed Norwegian which follows the grammar of spoken Norwegian (cf. also Stokoe, 1970).

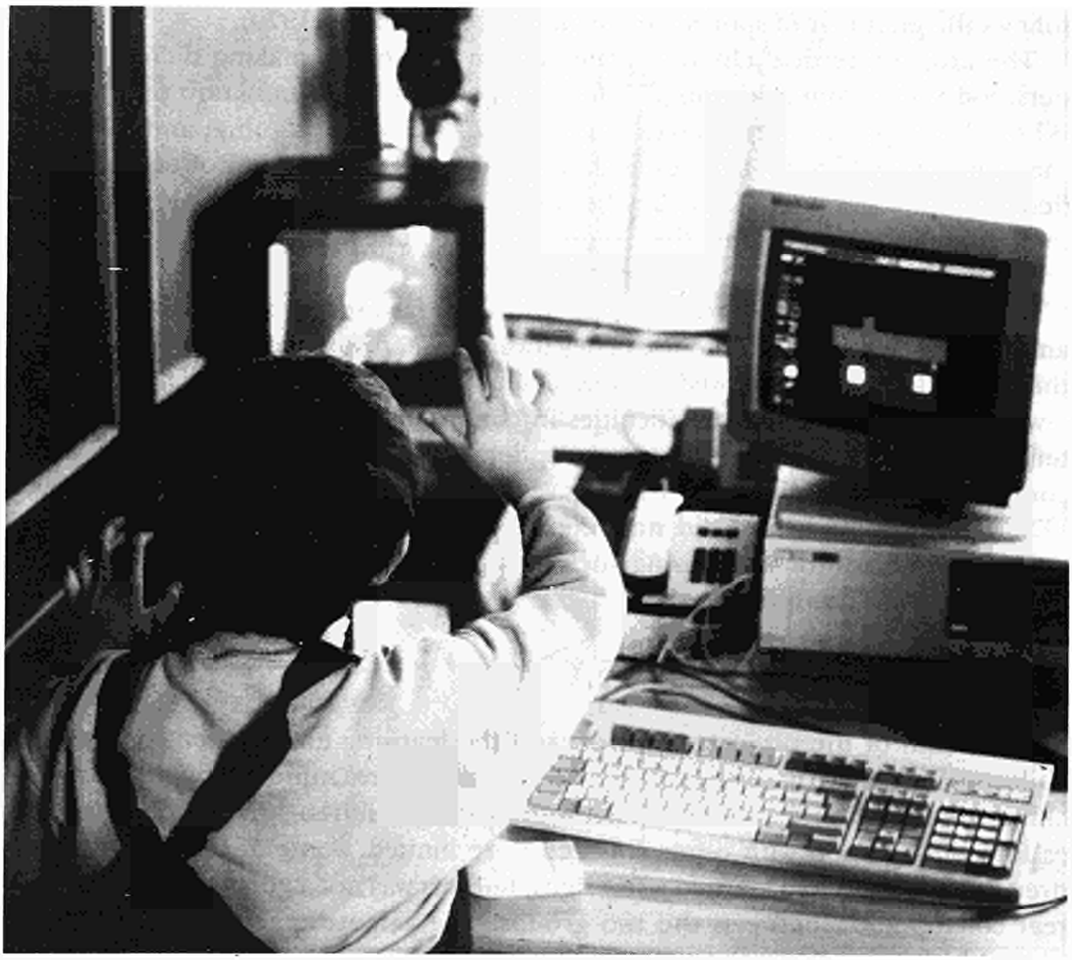
The area where deaf children generally have problems making themselves understood is in communication with hearing people who do not know signing well. When this happens, they change to a more formal way of signing, and they used the same strategy in the trials even though the child on the other of end of the videotelephone was deaf. After they became more used to the videotelephone, this tendency disappeared, and they signed in the same manner as in face-to-face contact.

On the whole the children at Kopperud were favourable towards the medium and did not find it difficult to use. They found it interesting and often asked to use the videotelephone. If allowed, they could chat for quite some time. They reported few misunderstandings and difficulties in comprehension, but they did, however, tend to ask whether the message was understood more often than usual during conversations. In addition, they also gave more feedback by nodding and signing YES. Thus, although they did not report problems in comprehending, they did develop strategies for minimizing such problems. And they did find it somewhat awkward to slow down the signing.

Multimedia: Synercom

Another aim of the project was to expand the learning environment of the deaf children at Kopperud. Although the school has several hundred pupils, the deaf children did not have a lot of contact with hearing children, and hence possibilities for collaboration with other children were limited. Some of the hearing children at Kopperud had learned a few signs, but this was not a good enough basis for real collaboration between the two groups. The videotelephone connection between Skådalen and Gjøvik created such possibilities.

A crucial element in this part of the project was a communication programme, Synercom, which had been developed by Norwegian Telecom and Tandberg Vision. This programme made it possible to communicate with letters, graphics and scanned images in parallel with the signing. A computer was connected to the videotelephone. When loaded, the programme at Kopperud would link with the same programme in Oslo as soon as the connection was established. The program made it possible to write and draw on the same screen. One child could write something while the other child was drawing, or erase what the other was writing. The screen was saved to disk at both locations. A hand scanner was connected to the computer, and a typical project task was to scan a map of a Norwegian county, without the names of cities, rivers etc., and the children would have to agree as to what to write. They would discuss this on the videotelephone screen before writing down the name. Other times, the children at one site would prepare something beforehand and show it to the other class by turning on the computer (see Figure 36.11).



Figur 36.11 A child using Synercom and signing via videotelephone.

It was difficult to have more than one child signing at the same time, and therefore there was usually only one child at each end. The exception to this was when the collaborative work of one class was shown to the other.

The children learned to use synercom very quickly, and this programme became the central tool of the project work. However, the first prototype version of the program was very crude, and the teachers and pupils pointed out several improvements that were gradually implemented. Unfortunately, this also made the program more unstable, and during the second year, the children and teachers were not so much trying out a new programme as collaborating in the development of one.

In spite of these difficulties and the limitations in videotelephone picture quality, the project has demonstrated some of the possibilities the use of multimedia may have in the education of deaf children. Both the children and the teachers had a lot of new ideas about how the videotelephone and Synercom could be used, and wanted to continue with the videotelephone and working with Synercom when the project was terminated.

Pre-school Children

At the time of the project, there was also a small group of deaf pre-school children at Gjøvik. This group had close ties with the pre-school at Skådalen, and the children at Gjøvik visited Skådalen from time to time. It was therefore decided to allow these children to try to use the videotelephone. The pre-school children had, however, limited use of the videotelephone for signing. They were more concerned with showing the things they had prepared and to some degree looking at objects at the other end, than seeing what the child at the other end was signing. Mostly, the teacher had to interpret what the child at the other end was signing. The children did show an increase in interest, but it seemed difficult for them to understand that they were actually communicating with somebody far away. To what extent this was a result of the picture quality is not known. The children were 5–6 years old, and although most children at that age are not very good telecommunicators, the deaf pre-school children seemed even less proficient.

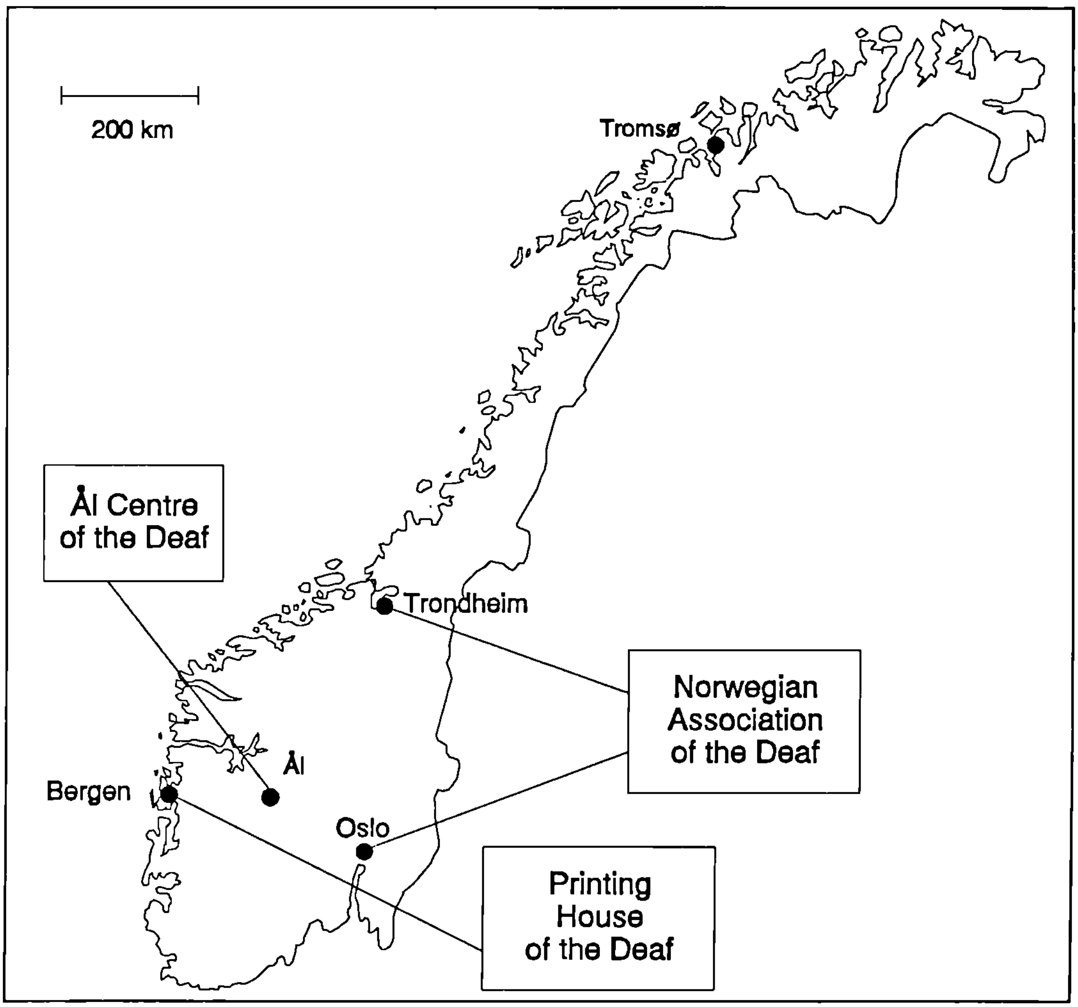
Adults

The participants in the other project were deaf adults. Videotelephones were installed in the offices of the Norwegian Association for the Deaf in Oslo and Trondheim, at a course centre for signing and deafness at Ål, and at the office of *Journal for the Deaf* in Bergen (see Figure 36.12). All the participants were used to text telephones.

At Ål, the videotelephone was placed in a room that was very awkward to get to, and the videotelephone was very little used. Some of the deaf adults tried the videotelephone one or two times, but found the slow signing rate so tiring that they stopped using it. Thus, the videotelephone was used only a few times. Encouragement did not help, and after a few months, the line was disconnected.

The line between Oslo and Trondheim has been used regularly, and some of the users have adapted their signing quite well to the videotelephone. Still, the majority preferred the text telephone, but used the videotelephone sometimes to comply with the project and to show their appreciation of the attempt to provide deaf people with a telecommunications machine for signing. Only a few of the deaf people said that they would have preferred to use a videotelephone of this quality instead of a text telephone, providing that they could reach the same people.

Bergen have used the videotelephone from time to time, but mostly when Trondheim or Oslo took the initiative. When the project started, the Norwegian Association for the Deaf had a small office in the same location as the journal in Bergen, and the man who ran that office used the videotelephone regularly. However, the office discontinued, and the people at *The Journal for the Deaf* did not use the videotelephone much. They said that numbers and spelling were easily mistaken, and since they were concerned with orders, they preferred the text telephones with unambiguous letters and digits.



Figur 36.12 Map of Norway with Oslo, Bergen, Trondheim and Ål

It should be mentioned, however, that in spite of the overall negative evaluation of the picture quality of the present videotelephone, all participants were pleased with the initiative of Norwegian Telecom. They expressed positive attitudes towards the videotelephone, and said that they wanted one when the quality has improved.

Discussion

There was a considerable difference in attitudes between the participants in the two projects. The children were generally favourable to using the videotelephone while the adults were more divided. The majority of the deaf adults found the need to slow down signing too strenuous and preferred to use the text telephone. This probably reflects differences in access to telecommunications. Maybe one or two of the deaf children could have used a text telephone successfully for more than giving and receiving short messages. All the deaf adults were very proficient in written Norwegian and used the text telephone daily. The results may have been different if the trial had ben done with deaf adults who were less proficient in the use of written language.

When the videotelephone was first produced, it was demonstrated at the centre at Ål. The deaf people there expressed a very positive attitude and claimed that they wanted it as soon as possible and that they could use it to communicate with signs. The present studies shed considerable doubt on the value of such demonstrations. They also confirm that the actual need for sign telecommunication and the availability of other means for telecommunication will influence the evaluation, although this varied. However, it seems a reasonable conclusion that video codecs that provide a picture quality at or below the quality of this prototype are not good enough to introduce videophony for deaf signers in general. But all the deaf adults, even those at Ål, regarded signing as their primary form of communication, also for telecommunications. They wanted a videotelephone when the picture quality has improved. This threshold is probably reached with the new ISDN videotelephone.

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37

Visual Telecommunication for Deaf People at 14.4 Kbit/s on the Public Switched Telephone Network

Mike Whybray

Historical Background

It has long been recognised that videotelephone systems could provide a means for deaf (or otherwise disabled) people to communicate with each other by sign language. Some experimental systems were introduced based on coaxial video links (e.g. Pearson and Sumner, 1976), but were of limited usefulness as they could only work on a closed local network, and thus did not really help the general communications problems of deaf people.

It was realised that if videotelephone pictures could be transmitted over the Public Switched Telephone Network (PSTN), the whole world was potentially opened up, so attention turned to this problem. One approach considered was to use a very low resolution television picture format, and analogue modulation. However, the PSTN is designed to carry speech in an analogue bandwidth of around 3kHz – over a thousand times less than that required for an analogue television signal. It is possible to devise a new television standard having a resolution low enough to be accommodated in 3kHz – for example a picture of only 25 lines, with 25 pels per line and a frame rate of 10 frame/s would do, and would in fact be similar to Baird's first television pictures! In practice, the severe phase distortion at the band edges of a PSTN channel, plus the overheads of television synchronisation pulses would reduce the usable bandwidth even further to around 2kHz. A bandwidth of the order of 10 or 20 kHz was found to be necessary for the analogue approach (Pearson, 1981; Sperling, 1980), which was a factor of at least 5 away from the available bandwidth – so attention turned to digital methods of transmission.

The digital approach requires capturing and digitising the pictures, applying data compression, and transmitting the resulting bit-stream using a modem. When the first studies on this were done in the early 1980s, the bitrate available from a modem was of the order of 4.8 kbit/s, whereas a CCITT V32 bis modem can now provide full duplex transmission at 14.4 kbit/s, and even higher rates are achieved by proprietary modem designs. At first sight, digitising the picture looks unpromising, as even the inadequately low resolution pictures described above would require 50 kbit/s at 8 bits per pel. However, data compression can now be applied to give an overall advantage compared to an analogue system. Also, it is far easier to multiplex in additional information such as text or control data, and still maintain a very consistent picture quality.

The above studies concluded that a suitable picture format for this low bitrate could be achieved by sacrificing the normal grey-scale in favour of a binary picture, giving a cartoon-like representation using black lines on a white background (Pearson and Robinson, 1985; Robinson, 1985; Sperling, Landy, Cohen and Pavel, 1985). This was necessary to keep the frame rate above an absolute minimum of 6 frames/s, below which point a sharp decrease in intelligibility of signing occurred. A spatial resolution of 96 pels vertically by 64 horizontally was found to be acceptable (Sperling et al., 1985).

Collaboration between BTL and the University of Essex

Coding algorithm development work had been done mainly by computer simulation in laboratories at this stage. However, in 1986, British Telecom Laboratories (BTL) placed a contract with Professor Pearson's team at the University of Essex, to work together to develop a real-time system that could encode pictures and

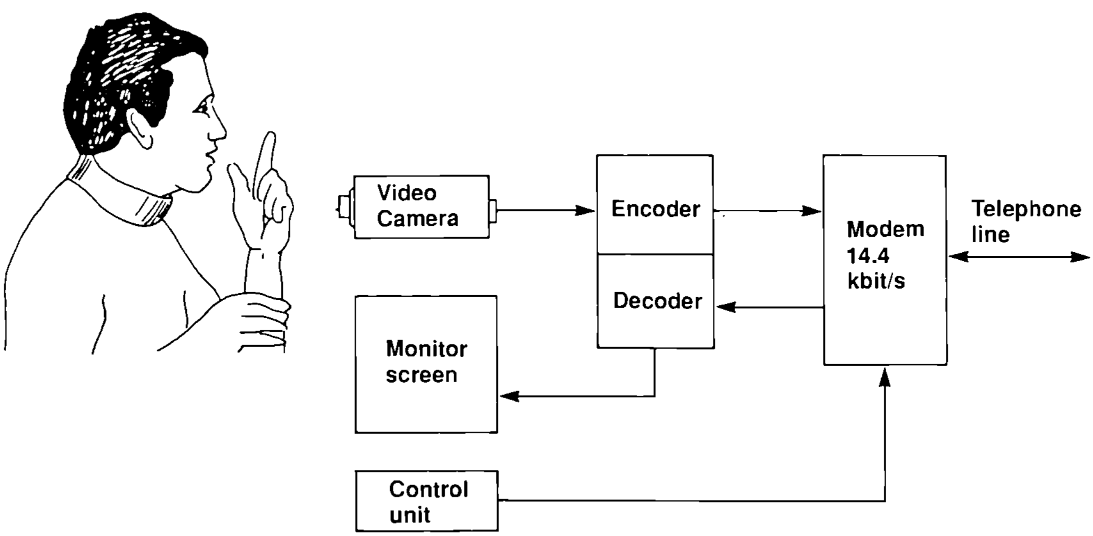

Figure 37.1 Mark 1 terminal block diagram.

transmit them over a real network. This brought together the algorithm studies and experience of the University, with the expertise in video codec design of BTL's Visual Telecommunications Division.

This work culminated in an experimental system working over the PSTN in February 1989, when two deaf people were able to communicate with each other by use of sign language over the PSTN for what is believed to be the first time anywhere in the world.

Moving images from the camera are passed to a video encoder, implemented using a frame-store to capture images at a resolution of 64 by 64 pels and make them available to a DSP for processing. The algorithm which compresses and encodes the image data for transmission (Pearson and Sumner, 1976) is implemented entirely in software, making it very easy to adjust the coding method to optimise performance, without lengthy hardware redesign. A consequence of the algorithm is that the amount of data needed to encode each video frame is variable, so a first-in-first-out buffer was used to equalise the bitrate to the fixed line rate. New frames are accepted for processing only when the buffer level falls below a preset minimum; a variable video frame rate is therefore produced.

Figure 37.2 Mark 1 terminal.

A conventional data modem is used to provide a full duplex 14.4 kbit/s link over the PSTN. Data received by the modem is passed to the video decoder; this is very similar to the encoder except that it is designed to display reconstructed pictures rather than capture them. The complete video codec (encoder and decoder) including power supplies is contained in a unit approximately 10 by 25 by 35 centimetres.

The camera and a 6 centimetres diagonal monitor are housed in a compact table-top unit, with adjustable tilt to enable the user to adjust his position on screen. Switches on a small hand-held unit allow the user to view his or her own coded picture, so as to correct seating position, and to adjust the picture clarity.

A call control unit is provided which has a single button to initiate a call, or to accept an incoming call, which is signalled by an audio tone and a flashing Xenon light. This very simple interface is possible because there are at present only two terminals, preprogrammed to call one another.

Results of Trials of the Mark 1 System

A field trial of the Mark 1 system was initiated in February 1989 using two terminals, installed at the home of a deaf couple, and at the Suffolk Centre for the Deaf in Ipswich, a few miles away.

During the first week a pro-forma was completed for every call, recording any difficulties found in various categories. The general response to the system was very favourable, with the system being found easy to use, and providing a means of natural, free-flowing conversation in which humour and emotion were effectively conveyed. On the other hand there was difficulty in obtaining good picture quality in some lighting and background conditions, and it was necessary for users to adapt their signing technique to suit the new medium.

Good picture quality depends on two main factors: getting an uncluttered background by suitable siting of the equipment, and ensuring adequate diffuse frontal lighting on the subject. These two are to some extent mutually exclusive, as one source of suitable lighting is to face a window, which puts the rest of the room with its contents behind the subject. At night time, normal room lighting was found to be inadequate, as it generally came from above or behind the subject rather than from the direction of the camera. The solution was to provide table lights with white diffusing shades by each terminal, which also improved the image quality in the daytime.

The need to adapt one's signing technique stems from several factors: the binary pictures can require careful presentation of the hands to the camera, preferably being held in front of the chest; the moderate frame rate (variable depending on picture content but typically 6–12 frame/s) cannot follow very fast movements; the limited picture coverage means that the signer's position and range of hand movement are quite important. The result is that signers have to learn to sign more slowly and deliberately than normal, and to be more conscious of their hand and body positions. This learning comes about in practice by recognising problems in understanding the other person's signing, and by direct feedback from the other person complaining of ones own signs being too fast, out of view, etc. Fortunately this learning process seems to be fairly rapid, as experience with naive users who tried the system indicated.

Improvements to the Binary Coding Algorithm

It was apparent from the initial trial that although the system was usable, improving the picture quality was a major concern. The first approach has been to make the binary coding algorithm more efficient, by incorporating motion compensated prediction (as is used in many grey-scale coding algorithms such as CCITT Recommendation H.261, but which had not , to our knowledge, previously been applied to binary pictures) and by improving the efficiency of the variable length coding used.

The general principle of motion compensation is the same as for grey-scale pictures: for each block of pels (8 by 8) in the frame to be coded, a search is made in the corresponding local region in the previous coded frame for a block which is in some sense a good match, but possibly displaced by a few pels horizontally (X) and vertically (Y). This best match block is then EXCLUSIVE ORed with the block to be coded, resulting in the prediction error block that is actually coded and transmitted. For grey scale pictures, there is usually a fairly smooth error surface as a function of the X and Y displacements, and an iterative search may be used to find the minimum error position, which is presumed to be the best predictor. For binary pictures a 'full search' technique is probably required, as the error surface is likely to be very bumpy, and there is more danger of getting trapped in a local minimum.

After finding the best match, the prediction error block is encoded using essentially the same algorithm as in the Mark 1 system. However, the original block is also coded by the same algorithm, and the mode which produced the lowest bit count is finally chosen as the coding mode for that block, the mode being signalled by one extra bit. This dual-mode coding is done because simulations indicated that the full efficiency improvement of motion compensation cannot be obtained if a priori decisions on the best mode, based on for example prediction error versus original block variance, are used.

Even this dual-mode approach is sub-optimum, as the best criterion for finding the best match in the motion estimation stage would also be the final bit count, rather than simply a count of the non-matching pels (indicated by a 1 after the EXCLUSIVE OR operation) as is used at present. Unfortunately the overhead of evaluating the bitcount for each test XY offset is too great to implement at present. Despite this, simulations show a reduction in the average bitrate required to encode a given test sequence of two times – i.e. only half the bitrate of the previous system!

As a result of this increased compression efficiency, the resolution of the binary pictures can be increased from 64 by 64, to say 96 by 64, and the frame rate will also increase.

Grey-scale Coding Algorithm

It can be inferred from Sperling's results (Sperling et al., 1985) that a binary picture of resolution X by Y pels will have roughly the same intelligibility for signing and finger-spelling as a greyscale one of resolution X/2 by Y/2. As well as improving the binary algorithm, an algorithm which produces a full grey-scale picture, but at a lower spatial resolution than the binary ones, has therefore been investigated.

The algorithm is based on CCITT Recommendation H.261, but we have reduced the coded resolution to only 48 by 48 pels, and implemented a complex control algorithm to achieve a suitable tradeoff of spatial, temporal, and quantisation degradations. The system has by no means been fully optimised yet, but already maintains an estimated frame rate of over 10 frames/s with a person signing, and we expect to improve the picture quality with further development.

Preliminary subjective tests have been conducted comparing the grey-scale with the Mark 1 binary pictures (the improved binary algorithm not yet being available in a real time implementation), using four deaf subjects in pairs doing interactive tasks requiring signing and finger spelling. The time taken to complete tasks was only about 50 per cent greater than for face-to-face with the grey-scale pictures, compared to about lOO per cent longer than face-to-face with the binary ones, indicating a significant advantage for the grey-scale pictures.

Of equal significance were the reactions of the deaf users, who much preferred the natural appearance of the grey-scale pictures, also finding them less difficult to interpret. They found it far easier to recognise the person at the other end, and to observe facial expressions, which are a critical component of sign language. Although the results for binary pictures would be expected to improve when the latest enhancements to the algorithm have been incorporated, it is not thought that the improvement will significantly affect these preliminary results.

Interestingly, although users of the binary system had criticised its landscape image format as wasting usable space to the side of the body, and recommended a portrait format, when this was tried with the grey-scale pictures they found it rather constricting as it was too easy to move or sign outside the usable area inadvertently. They finally settled on the square format as the best compromise.

An informal lip reading test was done by the same deaf subjects, who found it to be reasonably easy to lip-read using the system – assuming you can lip read in the first place of course, as it is very difficult with no audible cues whatsoever.

During the tests, a continuous self-view display was available, which had not been provided on the Mark 1 system. This proved to be very valuable as it prevented the users and their signs drifting out of camera view – a problem that had been noted with the Mark 1 system, which only provided the option to switch momentarily to a self-view display, during which time the incoming picture was lost.

Specification of a Mark 2 System

As a result of the initial trials and tests described above, background research involving discussions with deaf people, and considering advances in the technology available, the specification for a Mark 2 system has been developed to incorporate all the improvements that have been identified so far.

A 14.4 kbit/s full duplex modem will be used as before, but this time a framing structure will be used to allow the bitrate to be subdivided between several optional data sources, that will effectively be transmitted concurrently.

The primary data source will be compressed video data, using either the enhanced binary algorithm or more likely the grey-scale version described above, and will use all the transmission capacity that remains once the other data sources, described below, have been allocated capacity.

A second source of data will be text, that may be entered from a keyboard, and displayed at the far end on the same screen as the moving pictures. This data only amounts to a few bits per second, but allows the user to spell out precise information such as numbers, or unfamiliar words, as an adjunct to signing or audio information.

A third data source will be compressed audio. This option is present as it is recognised that most people who lip-read are actually using sight of the lips to support failing hearing, so that audio information is usually required as well as video for lip-reading. To avoid taking too much of the video bitrate, the audio rate needs to be as low as possible, but of course the audio quality will thereby suffer. We intend to investigate the best tradeoff between audio and video bitrate allocation, but initial audio coding results indicate that a bitrate of between 4.8 and 7.2 kbit/s is required to maintain acceptable quality. Also, questions such as the appropriate bandwidth, quality, frequency weighting, level, and means of presentation, eg inductive coupling or acoustic, will be investigated.

A fourth data source will be general system control data, and a fifth 'auxiliary' data channel is also specified, for further experimentation. Possible uses are for file transfer or telewriting.

The control and text data streams will always be active, but the video, audio, and auxiliary channels may be independently turned on or off, as best suits the needs of the users, and any spare data capacity so freed will be reallocated.

Figure 37.3 shows the proposed screen lay out, with the incoming picture having a square aspect ratio, also showing the smaller self-view picture provided to assist the user stay in camera shot. It will also be possible to view ones own picture in coded form in the incoming picture area, to optimally adjust the coding parameters – this is particularly important for the binary pictures where the setting of the threshold which fills in dark areas of the image is critical to good image quality.

The small text area immediately below the self-view picture displays the options selected by the far end (video and/or audio and/or auxiliary) and hence being *received* by this terminal (note that a different combination may be selected for *transmission* to the far end; the selected options here are indicated by LEDs on the control panel).

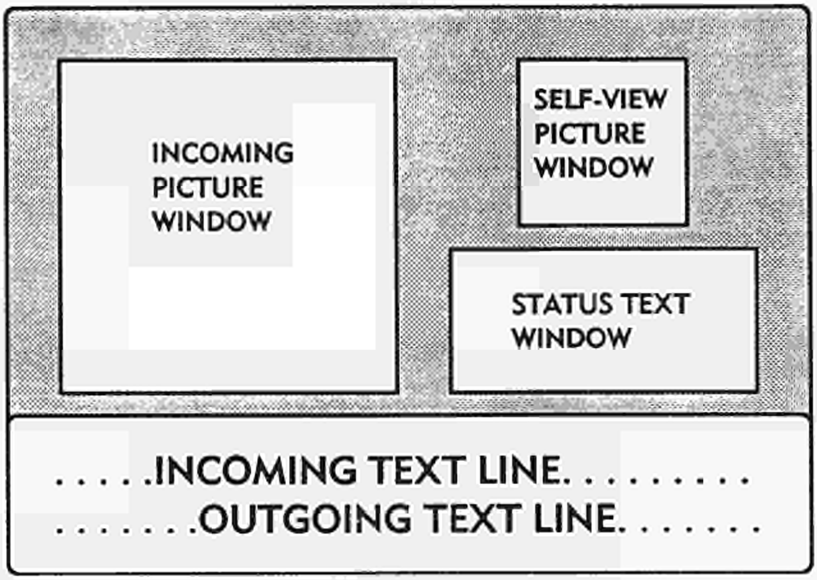

Figure 37.3 Proposed screen layout.

Below that are two lines of text of 20 characters each. These are the incoming and outgoing text information, displayed on separate lines to allow a full two-way text conversation without the need for the usual manual GA (Go Ahead) protocol required on single line text systems.

Figure 37.4 shows a possible control panel layout. As well as the videteleophone mode (which incorporates text plus video, audio, and auxiliary options), two other text modes are shown. These will be text only modes that allow interworking with existing text terminals, at 300 Baud for example. In these modes the full screen area will be available for text display. This, and the concurrent (videotelephone) text mode, form a vital link with both existing text systems, and with people with normal hearing who can not sign or lipread, but can usually cope with a simple text system.

The circles above the keys indicate where LEDs will be used to indicate the facilities currently selected by the user, and the rough state of any call. Detailed call progress information will be provided during call setup by on-screen messages which guide the user through this process. It is recognised that it is vital to keep the user interface simple and intuitive to use, and comply with any existing standards on key layout and general operating procedures.

A larger scale field trial will be mounted with around 15 terminals, towards the end of 1991, to better assess the usability of the videotelephone system, get feedback from deaf and hearing-impaired users, to refine the design, and to gauge the potential market. In addition, prospects for international collaboration will be investigated, with a view to achieving consensus on coding and terminal standards for this type of system. It must be emphasised however that the trial system is designed to be a flexible test-bed and not a fully engineered product – there would still be some way to go before a commercial product at an affordable price could be produced, even assuming that the results of the trial are positive.

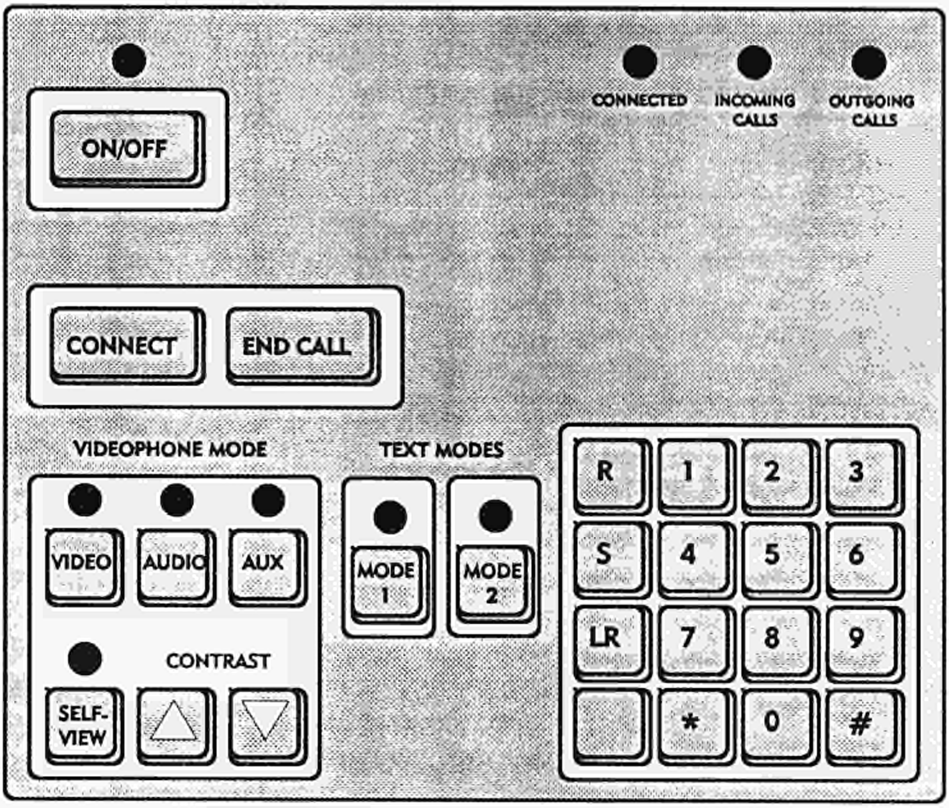

Figure 37.4 *Control panel layout*

Conclusions

A videotelephone system capable of transmitting moving pictures of sufficient quality for communication by sign language to take place over the PSTN has been described. Improvements to the basic system have been developed which address many of the short-comings of the initial design – in particular it is now possible to transmit grey-scale pictures which are more acceptable and easier to use than the previous binary ones.

Additional enhancements such as text and audio will extend the application to lipreading, provide backwards compatibility with existing text based systems, and allow a means of use by people with normal hearing.

This system offers the self-evident advantages of a videotelephone system for deaf or hearing-impaired people, plus compatibility with existing systems, but without problems of cost and limited availability of special networks such as the Integrated Services Digital Network (ISDN). It simply plugs into existing PSTN sockets giving nation-wide, and potentially world-wide access.

Acknowledgements

The author would like to acknowledge the work of the other team members in arriving at the current system design. My thanks (in alphabetical order) to Danny Drake, Bruce Glennie, Rob Hutchinson, Tony Lo, Don Pearson, Mike Punnett, Diane Warne and Dave Whiting.

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38

Use of Videotelephones for Intervention and Independent Living

Leonor Moniz Pereira, Margarido Matos, João Purificação and Stephen von Tetzchner

The realisation that the concept of disability is a social construct (cf. Oliver, 1989), different from both impairment and handicap, has made the full integration of people with disabilities into present day society a matter of urgency. The goal of full integration implies striving towards making life as independent as possible, both for people with disabilities and for elderly people. The development from segregation to integration has become one of the most important goals for society at the end of the 20th century.

Several important documents have contributed to this, such as 'The World Programme of Action concerning the Handicapped', which was developed by the United Nations (1983) for the 'Decade of the disabled' (1983–1992), and the 'Letter for the Eighties', proclaimed by 'Rehabilitation International'. Several countries have made steps towards the progressive reduction – and total removal – of the physical and cultural barriers that are the main causes of discrimination against people with disabilities, and which prevent their full integration in society. In a number of cases, legislation has been approved to ensure impaired peoples' right to equal opportunities and access to all the public services (transport, communications, health, education etc.), as well as employment (cf. chapter 11).

Today, there are expectations that information and telecommunications technology may become a basic force to remove the communication barriers of disabled people, contributing thus, in a decisive way, to the attainment of equal opportunities. However, technological inventions and their introduction into the life of the society do not bring advantages alone; they may also create new barriers to the integration of people with disabilities in society.

New technologies, with their potential flexibility, allow 'dreams' of a society without barriers. It is important, however, to realise that those dreams will not become true if one is not fully aware, from the first phase of conception, of the situations in which new technologies do not lead to an improved life, or may even make life more difficult for some people and lead to their social segregation. To cite a classical example: the invention of the telephone was a by-product of an effort to produce a better hearing aid, but the telephone has, more than any other technical device, lead to segregation of people with hearing impairments.

Requirements should be made to avoid such situations if real progress is to be made, that is, if technology is to contribute to the social integration of *all* people. In the case above, for example, to provide equal opportunities for people with and without hearing impairment, services that hearing impaired people can use should have been developed in parallel to the development of telephone services.

Intervention

Intervention is the sum of the total services that are provided to help people with impairments develop and function optimally in society in accord with their sensory, motor and cognitive skills. Intervention may be regarded as a *scaffold* for the individual that may be more or less strong at different times, adapted to the present needs of the person.

Intervention should comprise the four following aspects:

- restoring lost functions through training;
- compensating for the disability by enhancing other skills;
- compensating for the disability through the use of technical and non-technical aids; and,
- changing the environment to adapt it to the skills of the person.

Intervention includes activities like physical therapy, speech therapy, special education, individual and family counselling, provision of aids, planning of housing etc. These services may be provided locally or regionally, in a local office as well as in a short term assessment institution or a residential institution. In many cases, services are provided from several different levels at the same time.

It is an essential part of full integration that people with disabilities should be allowed to choose where they want to live to the same extent as other people. For children and adolescents, this means staying at home with their parents. For adults, it means staying in the environment where they have their family, friends and acquaintances and their cultural background.

The family plays an important role in intervention (even if it needs help from professionals). Most children and adolescents with severe multiple impairments will have a better life at home than in an institution. If the family does not participate in the intervention process, it may be more difficult for the family to understand the special needs of the person. On the other hand, the family usually knows the person and his or her preferences better than the professionals do, and may contribute significantly to the assessment of the needs and possibilities of the person.

However, a lack of professionals often makes the goal of local intervention difficult. Short term assessment in a specialist institution may be very valuable, but not enough to provide optimal intervention. Centrally placed specialists typically lack in-depth knowledge about the person and his or her environment, and do not have the time and resources to provide the supervision that the local professionals need to make intervention optimal. To some extent, professionals from the special institutions may visit the local institutions. This is a satisfactory way of working, but it may entail a poor utilisation of resources due to costs and to time-consuming travelling, and the specialists rarely have the time and resources that are needed to come to the person. They may spend several hours travelling from one place to another, time that could have been used to attend to other people. This is particularly true in rural areas, but also in larger cities, where travel may take a long time due to traffic conditions. If distances are long, travelling is expensive. Moreover, experience shows that even from a county centre visits to individual clients tend to be sporadic.

Video tapes are sometimes used to supplement verbal descriptions. This provides visual information, but lacks the opportunity for spontaneous correction by instruction and demonstration that are available in two-way picture communication. Commenting on a video is time-consuming, and the commentary is often received long after the tape was recorded. By use of videotelephony, a specialist can comment and offer advice, and talk with the local professionals while the work with the client is ongoing.

The use of Telecommunication in Intervention

Telecommunication is already widely used in intervention. The telephone is an invaluable tool for follow-up, but its uses are limited because it can only transfer verbal information, which entails great demands on the ability to describe and to focus on relevant aspects. Telefax is also used, and, to a considerably lesser degree, data communication. The videotelephone can transfer live and still pictures and sound, and therefore has much greater potential in developing a system that enables better coordination between the needs of the population and the intervention that is provided to them. The videotelephone may be used as a tool for *team work and collaboration, supervision, distance education,* and *support.*

Team Work and Collaboration

Specialisation is increasing, in both the educational and the health care systems and in society in general. In intervention, one has become aware of the necessity of individualised programs. At the same time, relatively rare forms of disabilities, which require large intervention resources, have attracted much interest. This entails a division of responsibility between specialised institutions and local institutions that have a broader competency. It would be neither possible nor sensible in terms of resources for a local school psychologist's office to establish special competency in areas in which there were no immediate needs. This means that there is a need for specialised services that can contribute to the building of local competence when this is required.

The videotelephone may be used in several ways to enhance team work and collaboration. One member of the team may visit a client, and then use the videotelephone to discuss the client's situation with the rest of the team. This model accommodates both the need for ambulant services and the possibility of saving time and resources using videotelephone conferences.

One may also imagine a 'virtual' team, where professionals working in different places make up a specialist team, for example, being responsible for a small group such as people with Spielmeyer-Vogt's disease. Some of the team meetings can be held via videotelephones to save time and travel.

Because disabled people often have to relate to several different institutions at the same and different organisational levels, organisation of intervention has become a major task. Videotelephones may be used for collaboration at and between all levels of the organisational structure. Professionals in the local environment can meet at short notice. Specialists at regional and national levels could have frequent and continuous discussions about special cases and issues, which should contribute significantly to updating their knowledge and ensuring a better geographical distribution of competence.

Supervision and Follow-up

The information flow between the special institutions and the local professionals is primarily in the form of written reports. Direct contact between local professionals and specialists is limited and usually takes place when the client is under assessment. There is usually not much time for discussion, and there is a limit to how much knowledge can be transferred and absorbed in a short period of time. Questions often arise later, when the intervention work has started. In order to secure an optimal effect of the intervention, intensive supervision may be needed over an extended period. This is true even if the local professionals are highly qualified. Unfortunately, in real life there is a shortage of professionals. Those in charge of the day-to-day responsibility of interventions often have limited professional qualifications, a fact which highlights the need for efficient supervision. Hence, good supervision is a prerequisite for optimal utilisation of the limited resources in the health care and education sectors.

Supervision should be part of the follow-up of local intervention prescribed by specialist institutions, and should also include checks of manual and technical aids, and the person's achievements on tasks where 'direct' assessment is not needed.

Supervision is similar to distance education (see below), but typically involves only one specialist institution and one local institution, for example a preschool, school, sheltered work place etc. Supervision is a process where two-way visual communication is important. Because the supervision does not depend on geographical proximity, it is possible to establish a continuity that would otherwise not be possible (cf. chapters 39 and 40). Supervision may also be directed towards parents and other family members.

Distance Education

There are two uses of the videotelephone for distance education in intervention. Firstly, the videotelephone may be used to teach the handicapped person. In this case, the person must be able to use the videotelephone. For some groups of people with disabilities, this require that certain specifications are filled, and there may be a need for adaptations (see below).

Secondly, the videotelephone may be used to lecture and teach local professionals from a distance. This can be part of a continuous education scheme, or part of an intensive course that is needed because a person with a rare condition has appeared. Several local environments may be served at one time. If the professionals are not disabled, no special adaptations are needed.

Support

Many people with disabilities need help to live independently. If severely disabled, there may be many helpers during a single day, and the person may feel invaded and that he or she lacks privacy. With the videotelephone, some of the help might be provided from a distance, leaving more time for privacy. In this case, the videotelephone would be part of the environmental adaptation, to optimise independence.

Some of the services that are usually available only during the daytime may also be provided during the night, thereby making it possible for the person to live outside an institution, with a high level of support and control.

Specifications for Videotelephones for People with Special Needs

To be used by people with disabilities and by elderly people, the functional requirements of the videotelephone must take the variation in skills within these groups into account. One of the present authors (Matos) interviewed nine teachers who use computers in special education. A structured interview was used, based on previous work done within the RACE project 'Application Pilot for People with Special Needs' (Welbank and Ussen, 1989). In that work, requirements were classified as essential, desirable or not applicable by the research team, after they had mapped the requirements of people with special needs. In the present study, the same approach was used for classifying videotelephone requirements.

These requirements were identified in relation to three groups of disabilities: visual impairment (partial and total blindness); hearing impairment (partial and profound deafness); and motor impairment (upper and lower limbs). The study also investigated the needs of elderly people.

The interviews showed that the most general requirement was affordability. It does not matter how useful a videotelephone is if the potential user cannot afford it. Ease of use and the possibility of using the videotelephone without electric power (i.e. battery powered), as well as high signal-to-noise ratio, were considered essential requirements for all the groups. A volume control that is easy to use was considered essential for all people other than those who were profoundly deaf.

Adequate indications of line status in different modalities, i.e. 'on' and 'off', 'line engaged' etc., were considered essential for all of the groups. With the exception of the hearing impaired group, easy activation and deactivation of the videotelephone was considered essential.

Transport facilities, that is, low weight and safety, were considered desirable requirements for hearing impaired people and essential for all of the others. A flat and non-reflective screen was considered essential for visually and hearing impaired people, and a desirable requirement for physically impaired and elderly people. Easy control of colour contrast and brightness were considered essential requirements for all the people, with the exception of those who were totally blind. A high screen resolution was considered an essential requirement for hearing and moderately visually impaired people, and a desirable requirement for physical impaired and elderly people.

Hand free key (on/off) was considered an essential requirement by people with hearing and upper limbs impairment, and a desirable requirement for all the others. Easy call acceptance and termination were considered an essential requirement for hearing and visually impaired people, and desirable for the others. Good audio and video synchronization showed the same pattern of consideration as the previous requirement, except for totally blind people.

For all the people who were interviewed, confidentiality, visual privacy, and easy adjustment of the position of the camera were considered essential requirements. To ensure this, a self-view key, easy zoom operation and adjustment of the position of the screen, were considered desirable requirements for all groups with the exception of totally blind people.

Among other requirements that were considered essential were information about the number that is calling, deactivation of camera, automatic answering and remote control of the user's home equipment.

The Videotelephone and People with Visual Impairment

It may seem a paradox to be concerned with the use of the videotelephone by people with visual impairments. However, the videotelephone is likely to be an essential part of telecommunications in the near future. To avoid the possibility that visually impaired people become excluded from important communication situations, great care should be directed towards the characteristics of the picture. For example, it should be possible to enlarge parts of the picture. Image magnification from 3 to 16 times may be needed for people with low vision, but the dimension of the videotelephone screen creates physical limitations.

People with visual impairment react very differently to brightness and contrast. Some prefer high brightness, while others see better in more subdued light conditions. Accordingly, brightness should be easy to control by the users to permit fast adaptation to the light conditions.

In addition to brightness, contrast may be used to enhance the use of videotelephones by visually impaired people. Since image magnification also magnifies 'jaggies' in the contours, efforts should be made to increase resolution as much as possible.

It should be noted in this respect that people with hearing and visual impairment may have different interests. For people who use sign language, temporal resolution may be more important than spatial. For people with visual impairment who are not using signs, spatial resolution may be more important. The solution to this may be a choice of spatial and temporal resolution.

Use of colour is another way to enhance contrast. Black on white and vice versa, white, pea green, orange, cyan or yellow on black, and yellow on dark blue, are colour combinations that provide good contrast. In view of the large variety of visual problems, the user should have the possibility of adapting the colours of the image as well as the background for optimal functionality.

Contrast is also an important feature for elderly people since sensitivity to contrast changes with the age. For the same luminance level, people aged between 60 and 70 years require 3.5 times more contrast than individuals who are between 20 and 30 years old. Many elderly people are likely to be users of videotelephones in the future, particularly in relation to safety and alarm services (cf. chapters 24 and 25).

As with other telephones, number and function keys should be of light colours with dark grounds or vice versa. The characters should be large and should contrast with the background colour.

The Use of Videotelephones to Enhance Intervention Services

In order to identify situations in which the videotelephone may be useful, one of the present authors (Moniz Pereira) interviewed people at 27 organisations and institutions that dealt with disabled people in the Lisbon area. These organisations and institutions provide a wide range of services to elderly and disabled people of all age groups, and to children at risk. Among the institutions were:

- habilitation and rehabilitation centres for people with visual and motor impairments;
- organisations for people with visual and motor impairments;
- institutions which provide day centre activities and free time activities for culturally deprived children;
- institutions which provide residential support for mentally and visually impaired children, adolescents and adults;
- institutions which provides services for elderly people, including home support, day centre activities, and recreation; and,
- special schools for visually impaired children, mentally retarded, hearing impaired and motor impairment children and adolescents.

According to the people who were interviewed, the following services may benefit from videotelephone application:

- teaching users and their families (activities of daily living, care, sign language and other communication skills, physical training etc.);
- providing general and special information;
- assisting and supervising as part of supporting services in the home;
- obtaining regular information about the users' health condition, including emotional condition;
- holding meetings, for example, enabling a member of the staff, one of the client's relatives, or the people in charge at home, to ask for advice on special subjects from an expert in the institution;
- supporting recreational and educational programs;
- assisting in emergency situations;
- assisting in medication;
- counselling (juridical, social, etc.), particularly beyond the time of home visits;
- reading documents and letters to people who are not able to read; and,
- providing interpretation services for deaf people using sign language.

The people who were interviewed did not expect videotelephone services to replace the already existing services, but rather to complement them.

Counselling

The main purpose of this service is to guide parents of children with disabilities, and to help disabled and elderly people coping with life problems. Counselling services via videotelephone can be useful to different groups of people with special needs and their relatives. It may help in taking difficult decisions and dealing with problematic situations, and in creating opportunities for talking about complaints. The possibility of establishing contact at short notice was considered important.

Compared with other forms of remote services, the simultaneous use of picture and sound may make communication between client and staff much easier, making it possible for the recipient to live at home instead of moving to an institution. The enhanced contact with the institution may lower the sense of loneliness and fear, and thereby increase the client's independence and sense of security. However, it was regarded as an important prerequisite that the counselling services via videotelephone should be performed by staff members whom the clients already know, particularly when more personal matters were concerned.

Information

Many people with disabilities have difficulties obtaining or comprehending information, and improved access to information was mentioned as a major area of concern. The main purpose of an information service is to make different kinds of information on social, educational, vocational and medical matters available to people who cannot easily obtain information through the usual media.

The information service may provide both general information and special information. It may provide adapted forms of general information, such as local, national and international news. However, it may also help users filling out applications and other forms, and give information about useful manual and technical aids, available resources, and health problems that are common in different groups of people with disabilities.

To accomplish this, it may be necessary to adapt either the medium, the information, or both, to the skills of the recipient. Use of sound and pictures will make new forms of adaptation feasible. For example, showing things and demonstrating how things should be done may be crucial for selecting and adapting information to the linguistic and cognitive level of people with language problems and intellectual impairment.

Intervention and Therapy

The people who were interviewed thought that follow-up of intervention and therapy provided by the user organisations and (re)habilitation institutions may be easier using a videotelephone. A videotelephone service may support a disabled client in improving daily life activities, including recreational programs. It may give a remote continuation of specialised intervention initiated in a hospital or (re)-habilitation centre, including education and vocational training. This may make it possible for a disabled person to get training and education in familiar surroundings instead of having to spend time away from home because of a lack of (re)habilitation experts in the area.

The videotelephone service may also be utilised to improve the performance of non-specialised staff members and relatives who are responsible for training.

Services for Elderly People

Three services assumed to be well suited for elderly people were tried out in a mini-trial done by Moniz Pereira and Matos, within the frame of the APPSN project. The aim of the study was to examine the videotelephone quality and the quality of services provided through it.

The following materials were used: a video camera, a television receiver, a remote control, a microphone, and a control box for the video camera and amplifier. Similar equipment was located in two rooms of the same building, interconnected by coaxial cable.

Three experts (one for each service) and nine clients, whose ages ranged between 69 and 86 years, took part in the mini-trial. Five of the clients had mobility problems, two had hearing problems, and two had visual problems.

For evaluation of the videotelephone services, the following scenarios were considered:

- counselling on economic matters and emotional problems;
- providing information about change of diet and getting confirmation of medication; and,
- supervising adapted physical activities.

The people involved were positive about the use of videotelephones to supply these services. The main advantages mentioned by the experts and clients were: travelling was avoided; it was not necessary to spend a long time waiting in an office; it was possible to deal quickly with several problems; it was an easier way to obtain information and more real communication than when using the telephone, particularly because they could see the person during the conversation; and, it was possible to show the medicine, or the form to fill out. During the trial, the clients seemed at ease and did not demonstrate any of the difficulties that may have been expected, such as fear of the medium or difficulties in comprehension. On the contrary, they used the availability of experts to talk about problems outside the trial scenarios that were troubling them.

The experts involved also considered it a major advantage that communication via videotelephones gives better indication of the client's emotional state and need of more direct support than would be possible by ordinary telephone.

Conclusions

The three studies reported here indicate that the use of videotelephones may positively influence the quality of intervention. This conclusion, although supported also by other studies (cf. chapters 39 and 40), is based solely on interviews and on a very limited experimental trial. In order to make optimal use of videotelephones in intervention, more detailed terminal specifications and necessary adaptations for different groups of elderly people and people with disabilities, are needed, as well as more practical studies of videotelephone services. Future studies should include a variety of videotelephone qualities and networks with different bit-rate capacities. The videotelephones should be used by different groups of professionals and people with special needs, including blind and more moderately visually impaired people.

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39

Supervision of Habilitation via Videotelephone

Stephen von Tetzchner, Finn Hesselberg and Hanne Langeland

This chapter describes the use of videotelephones in supervision of habilitation of children. The background for the project was a tradition of contact between the Central Institute of Habilitation at Berg in Oslo and the School Psychologist's Office and other local institutions at Upper Valdres (Figure 39.1). The motivation was a wish on the part of the professionals at Valdres to utilise the expertise held by Berg, in a way that would secure a transfer of competency which would lead to more substantial local discussions and improve the actual implementation of intervention.

According to regulations, the School Psychologist's Office must refer to and cooperate with special institutions. Berg has been a partner for the School Psychologist's Office since this was established in 1973. At Valdres, Berg was regarded as a useful partner. The competency held by the specialists in this institution is rare in this area, and the cooperation offered knowledge and professional support, which was otherwise hard to come by in that region. In addition to the School Psychologist's Office, Berg cooperates directly with health stations, local physicians, physiotherapists, etc. At Valdres there is no fully satisfactory rehabilitation team, hence Berg has filled these functions for some children.

Thus, the children's stays at Berg were regarded as positive. There was, however, a feeling that the available professional resources could be utilised in a more efficient way. Some parents voiced dissatisfaction with the limited help they felt they received from an institution that was supposed to be so knowledgable about their children's problems. The parents' views were a particularly important motivation for the efforts made by the School Psychologist's Office to find a better model for cooperation.

In the autumn of 1987 a joint project was set up by Berg and the School Psychologist's Office at Upper Valdres. The aim of the project was to try out new ways of assessing children and supervising intervention. The previous routine was that after local assessment, the children were referred to Berg for a more thorough assessment and for intervention proposals. Assessments made at Berg were usually followed by a written report. In addition, local professionals sometimes came to

Berg when a child from their area was staying there. During the project period, professionals from Berg sometimes travelled to the area in question and directly supervised those who were responsible for the local intervention.

The Tandberg 4001 video codec was first produced in 1987, and in 1988 a videotelephone field trial was made an independent part of the joint project of Berg and Valdres. With the use of the videotelephone, communication partners are able to see one another and to some extent the room in which the partner is situated. The videotelephone has made more extensive, direct supervision possible and thereby has become a vital factor in the practical design of supervision from Berg to Valdres.

The project included various aspects of communication between local professionals and a central habilitation centre. At the same time the project was an attempt to study certain conditions for distribution of knowledge about intervention for children with extensive and special needs.

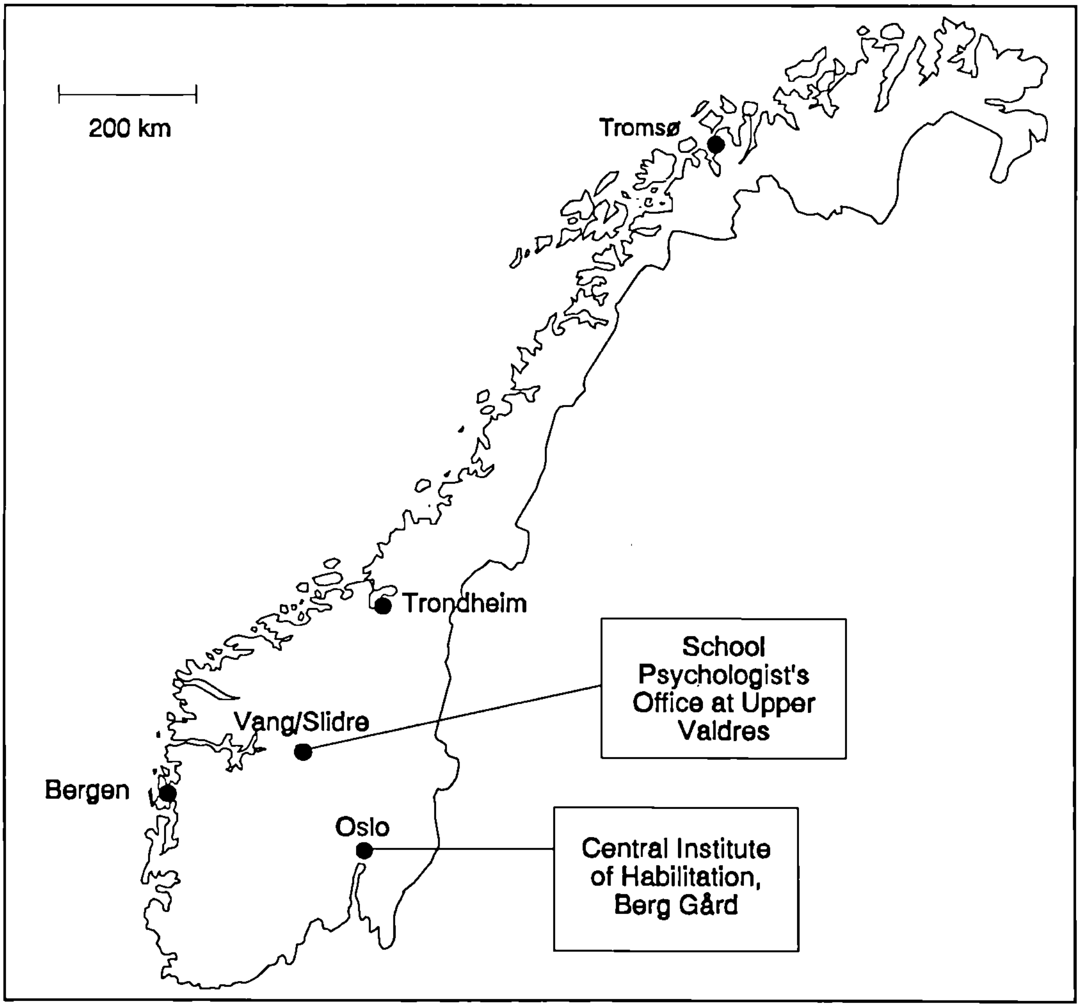

Figure 39.1 Map of Norway with Oslo, Vang and Slidre.

Objectives

From the point of view of telecommunication, the objective of this project was a practical test of a 64 kbit/s videoteleophone. This included an evaluation of the technical functions and the user-friendliness of the videotelephone, and an assessment of the extent to which the videotelephone could fulfil the needs it was meant to satisfy.

The objective of the supervision from Berg to Valdres was to strengthen confidence in local resources and competence in the work with the individual child. Regarding supervision, the objective of the videotelephone project was to evaluate whether a videotelephone connection could make a positive contribution in achieving the objectives of the supervision.

Method

Institutions

The supervision was carried out by the Central Institute of Habilitation at Berg and directed towards three nursery schools in the municipalities of Vang, Western Slidre and Eastern Slidre. The School Psychologist's Office at Upper Valdres had the primary local responsibility for the project. In addition to professionals working at Berg there, was also supervision from a special teacher at the Emma Hjorth's Home for people with mental retardation.

Children from all over the country are referred to Berg, but there are more patients from areas in which the second – and third – line services are not sufficiently developed. Referrals are made by, for example, School Psychologist's Offices and local physicians, and are often supported by reports from local institutions, special schools, etc. All new referrals are considered by an admission team. The children will either be referred to existing second -or third- line services, or they will be assessed at Berg. All children are now going through outpatient assessment before an inpatient admission is given in order that inpatient assessment be as goal-directed as possible.

After the assessment some of the children will be followed up by Berg. This entails controls and new assessments at Berg after a certain time. Other children will be followed up only after a new referral and intake evaluation.

Children

Intervention supervision was carried out for five children from one to five years of age. Berg had the supervisory responsibility for four of these children. Intervention for the fifth child was supervised by a special teacher who had no affiliation with Berg, but who came there to use the videotelephone.

When the project started, the children had recently been assessed, either at Berg or during a team visit to Valdres. Two of them were in the early phase of intervention, one was in an active follow-up phase and the remaining two children were in the control phase.

In addition to the supervision, a preparatory examination was carried out on a child who had recently moved to the area.

Equipment

One of the videotelephones was located in a physiotherapy room at Berg and the other in a conference room in the nursery school at Western Slidre. The videotelephone was a Tandberg 4001 video codec which made possible the transmission of live pictures on a telephone line with a data transmission capacity of 64 000 bit/per second (kbit/s). The equipment included a video camera with automatic white-test and a zoom lens, a 14" monitor for the received picture and an 8" (self-view) monitor to regulate the camera position. The camera was mounted on a tripod and was therefore easy to move as required. In addition, there was a telephone with loud-speaker and voice switching, and a telephone to which a headset could be connected. There were three headsets with long cables so that three people could use the telephone at the same time.

Procedures

There was a point-to-point connection between Berg and Valdres. Sound could not yet be handled by the codec, and there was an ordinary telephone line for sound (later versions of the Tandberg 4001 video codec also included sound transmission). Communication was initiated when one of the parties made a call to establish the sound line. When both videotelephones were switched on, contact was established automatically.

Since there was a videotelephone in only one of the nursery schools, the professionals and the children at the other two nursery schools had to travel there to get supervision. The journey took about 30 minutes. This represented a limitation to spontaneous conversations for the staff of those two nursery schools. However, they could arrange supervision meetings when necessary, but supervision had to take place at certain times so that use of the videotelephone would not disturb the routines at the nursery school where it was located. In some cases exceptions were made to this rule, but in general the videotelephone conversations did not cause any difficulties in the nursery school where the videotelephone was located.

The Nature of the Conversations

Among the intervention activities that were supervised, physiotherapy had a central position. In a typical supervision session, the physiotherapist at Valdres went through the exercises with the child, while the physiotherapist at Berg watched and commented simultaneously or later. After that, new exercises or interventions were discussed, and the physiotherapist at Berg demonstrated these with a doll. The physiotherapist at Valdres then went through the new exercises with the child while he or she was being helped by the specialist from Berg.

Language training was another important area. Supervision was given in sign teaching, sound articulation and language stimulation in general. In addition, one of the psychologists at Berg gave general supervision to one of the nursery schools. To some extent toys and other material were shown on the videotelephone.

Because the child was present most of the time, the supervision also included a continuous assessment of the child's skills.

In addition to supervision, the videotelephone was used for multidisciplinary meetings, in which professionals at Berg who had no direct part in the supervision also were present (e.g. physicians and nursery school teachers). In one case, the videotelephone was used for a preliminary assessment of a child.

Registration

Every time the videotelephone had been used, the conversations were registered as both parties filled in a form. There was also a log book beside each videotelephone in case somebody wanted to make additional remarks. Meetings were held at Valdres and Berg during the project in order to discuss views and solve problems. At the conclusion of the project the participants, including the parents of some of the children, were interviewed about their experiences.

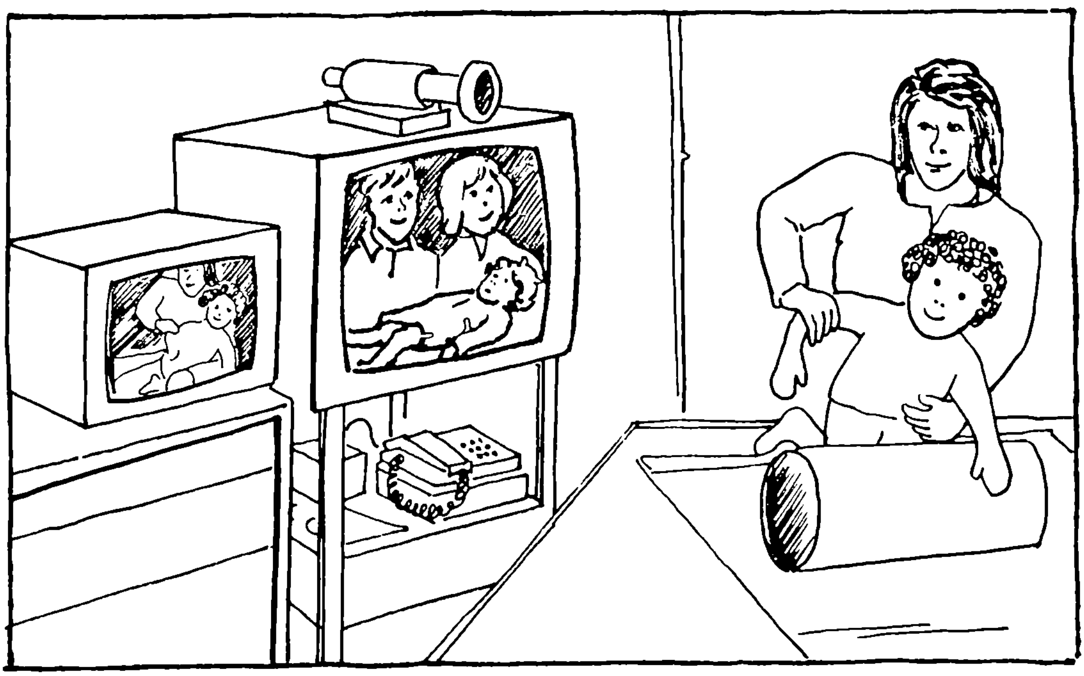

Figure 39.2 Supervision of physiotherapy.

Experiences

Technical Matters

The videotelephones functioned satisfactorily during the entire period, and there were no breaks or problems related to the equipment. There were, however, some breaks due to network errors.

Picture

The coding of the picture, a prerequisite for the transmission of live pictures on a 64 kbit/s line, leads to a reduction in picture quality as compared to a television picture. The picture resolution is poorer, and there are fewer pictures per second, which means that rapid movements will appear to be jerky. Lighting conditions in the rooms varied, which had considerable effect on picture quality. It was important that the receiver rendered feedback about the picture quality, because it was not easy to judge it from the self-view monitor.

In general, the users expressed satisfaction with the picture quality. 'We see what we need to see', was a common response. During speech training, the picture quality was not good enough for the supervisor to evaluate the child's articulation, even if the camera was zoomed in at the mouth. The supervisor did, however, get an impression of how the training was carried out, which was more important. The generally positive attitude to the picture quality was probably due to the fact that the users found that access to visual information was very useful.

Figure 39.3 Supervision of speech therapy.

Sound

At the time of the present project, sound was not included in the video codec, but was transmitted on a telephone line with ordinary quality. It was possible to use either a loud-speaking telephone with voice switching or headsets without voice switching. The loud-speaking telephone was used more frequently, possibly because some of the participants believed that the headset also had voice switching, and therefore they did not to try to use it.

Telephones with voice switching can transmit sound in only one direction at a time. It was sometimes regarded as difficult to 'change the sound direction' and be heard. This was particularly difficult if there was much noise at the other end (for example, children who were crying). Interruptions often meant that part of what was said was not heard, which made it difficult to interrupt the person who was speaking.

Voice switching created problems for some of the users, while others felt that it worked satisfactorily. Especially those who used the videotelephone seldom found it difficult to change their normal telephone behaviour, for instance saying 'yes' or 'right' while the person at the other end was talking. Those who got used to the videotelephone learned to nod instead of speaking.

The voice-switched telephone actually created more frustration than the limited picture quality, probably because the participants had not expected sound problems. The voice-switching instruction could have been better, but some of the problems, like those created by noisy children, were inevitable. A certain continuity in the use of the videotelephone is required to learn not to use one's voice in the same way as when speaking on a normal telephone. Those who used the headsets were satisfied with the sound, and the possibility of using them could have been emphasised more.

Time Delay

The coding of the picture entailed a delay in the picture transmission of 0.3 seconds, while there was no delay in the transmission of sound. Consequently, the speech sound and the mouth movements were not synchronised. This was usually of little importance, since most of the time the camera was focused on something other than the face of the speaker; the partner did not see the person who talked, but rather who or what the person was talking about. The lack of synchronisation was noticeable during the face-to-face conversations and during meetings, but the participants did not see it as a problem. Even during supervision of speech training it was possible to get used to the delay. With more than one person at each end, telephone conferences become strenuous, and the lack of synchronisation may have been balanced by the possibility of using visual cues to signal conversational turns.

Instruction

Before the project started, all the participants were curious as to whether they would manage to use the equipment, but afterwards nobody said that it had been difficult to use. Most participants thought it had been easy to use, and said it was important that it had been easy to switch on. Only with regard to voice switching did the participants express a need for more training.

Time

During the project period there were fifteen supervision sessions following up physiotherapy interventions, six supervision sessions with emphasis on language intervention and special teaching, one conversation to discuss the speech therapy plan for a child and seven multidisciplinary discussions on preparations and follow-up plans related to the joint project.

Individual needs varied, and the number of supervision sessions for each child varied between two and seven. The supervision sessions were given in addition to ordinary stays at Berg and the team's two visits to Valdres. In some cases there were also ordinary telephone contacts between the videotelephone sessions. Hence the videotelephone sessions constituted an addition to, rather than a substitute for, other forms of professional contact.

The average length of the supervision session was 42 minutes, which corresponds to an ordinary training or teaching session. For the nursery schools in Eastern and Western Slidre, a 30 minute journey each way and the time it took to prepare the children must be added. For these two nursery schools each supervision took about three hours. In one of them there was some staff absence and three hours with additionally reduced staff was considered a long time. Except for the staff problems, the travelling time was not regarded as an obstacle, and the benefit of the supervision was seen as great compared to costs, i.e. the time that it took. The external supervisor at Berg also had about 30 minutes travelling time each way, and he also expressed satisfaction with the benefit compared to the time invested.

The participants found the videotelephone sessions very efficient. Except for the usual polite greetings at the beginning of the conversation, little time was spent on social chatting. The supervision sessions were goal-directed, and the degree of efficiency the same as in similar supervision sessions at Berg, where supervision also usually takes place within a limited period of time.

There was little spontaneous use of the videotelephone. This was largely due to the travelling time. Unfortunately, the nursery school where the videotelephone was located was supervised by the special teacher who did not work at Berg. Hence immediate, spontaneous, conversations were not possible. All supervision entailed travelling, either at Valdres or in Oslo. The external supervisor in Oslo said he would have liked to have use the videotelephone more, but the travelling distance made this impossible. Also the professionals at Valdres said that the videotelephone would have been used more if it had been located in their own nursery school.

The professionals at Valdres felt that supervision every second to fourth week would have been suitable. It would have been advantageous to be able to call spontaneously, but this was not regarded as crucial, as it was never a long time until the next supervision session. It gave a feeling of security to know when the next session was going to take place, and only rarely did questions arise that could not wait for one or two weeks.

Quality

The quality of the supervision via videotelephone was not considered equal to supervision in the same room, but it was regarded as being significantly better than via an ordinary telephone. There was more sense of nearness. Berg received much more knowledge than usual about the local intervention. One of the physiotherapists at Berg said that she 'could not have given better supervision without holding the hands of the physiotherapist at Valdres'. The fact that the physiotherapists knew each other and had the same professional background also contributed to the high quality of the supervision.

In some cases there were ordinary telephone contacts between the supervision sessions. The impression of the work and the skills of the child that the supervisor formed from these telephone conversations sometimes turned out to be wrong when the child was seen over the videotelephone. With the videotelephone, the impression was more correct, hence the supervision was more in accordance with the actual needs.

At Berg, the more frequent supervision placed greater demands on the staff in terms of concrete and focused supervision than would have been required in a written report once or twice a year. This was regarded as positive because the benefit of the work also increased. Intervention could be followed up in more detail, and the training could be tailored in such a way that it was neither too easy nor too difficult. Modifications of local work could be carried out immediately, modifications which might otherwise have been carried out at the next stay or not at all.

For example, one of the children developed much quicker than was expected. This was seen during the videotelephone sessions, and the interventions were altered in such a way that the positive change was taking into account. Normally, the same training would have been carried out until the next control at Berg. This training would not have adapted to the child's present needs, and in addition she would probably have become bored, and might have developed negative feelings towards the training.

The closer follow-up was seen as positive at Valdres as well. Misunderstandings were cleared up, and the local professionals felt more confident that what they did was right. It became easier to ask questions that would have been difficult to explain in a letter or an ordinary telephone conversation. It was also easier to express disagreement and discuss the intervention measures with Berg. This last point is particularly important, because local professionals often sabotage interventions that they do not understand the point of, do not agree with, or do not know how to carry out. Several of the professionals at Berg and Valdres emphasised that mutual cooperation had been established. Information flowed in both directions even if the professional supervision was given by Berg to Valdres. The increased knowledge about local conditions made it possible for the professionals at Berg to make allowances for conditions that they otherwise would not have known about. Both the visits to Valdres and the videotelephone contributed to the improved intervention.

One of the questions that was often discussed during the project was the degree to which the improved access to specialists would entail a shift in the responsibility for interventions in that the specialists would be drawn into decisions that the local professionals themselves were competent to make. In this project such a shift in responsibility did not take place; the supervision was distinctly focused on tasks where there was a need for increased local competence.

The supervision not only benefitted the quality of the work with the individual child. The professionals at Valdres expressed that what they learnt was also useful in their work with other children. The supervision thus entailed the building up of a special competence related to the type of problems that the work with the individual children represented, and a general competence on working with disabled children. Also at Berg it was felt that the close follow-up had been of benefit and made it easier to render useful advice in general. Thus the videotelephone contributed to reaching the objectives that formed the basis of the supervision.

Familiarity

In many forms of supervision the feeling of cooperation and nearness is an important prerequisite for the success of the supervision. In this project the participants said that they had managed to establish a sufficiently close relationship over the videotelephone for those activities that were supervised.

Some of the professionals at Berg visited Valdres just before the videotelephone was installed, so almost everyone who took part in the supervision sessions had already met. Some of the participants had met at Berg earlier. Thus, for most of them, the videotelephone conversations represented a continuation of an already-established acquaintance. They felt, however, that they had got to know each other better and had become closer during the project.

The interviews indicated that familiarity was an important reason for the great success of the supervision. But the participants also said that they did not think that familiarity was a prerequisite for successful videotelephone supervision. It appeared that the supervision also worked satisfactorily for people who had not met face-to-face.

Other Uses

The objective of the videotelephone project was linked to supervision of intervention after the children had been assessed. During the project a child with obvious needs for intervention moved to Valdres. There was a waiting list at Berg, and it was decided to try to carry out a preliminary assessment by using the videotelephone. The objective of this was not to substitute for an ordinary assessment, but to make some preliminary observations so that the local professionals could commence intervention while they were waiting for a full assessment at Berg. The purpose of the assessment via videotelephone was also that the professionals at Berg should get an impression of the child in order to make a priority list of observations and tests which should be carried out before the assessment at Berg. Further, the professionals at Valdres found it reassuring that the team at Berg had seen the child and given a preliminary confirmation that the planned intervention seemed sound. With this limited objective, the assessment was successful.

In addition to the supervision and the single assessment, the videotelephone was used for meetings between the professionals at Berg and those at Valdres. During these meetings the camera was not moved from person to person, but held a picture of all the participants at the same time. The objective of the meetings was to follow up the joint project, discuss clients, and plan visits. At these meetings, the information in the picture was not vital; however, the videotelephone meetings were regarded as considerably better than ordinary telephone conferences. More so than in a telephone conference, the participants had the feeling of sitting together in discussions. The loud-speaking telephone with voice switching was most frequently used, and in the same way as during supervision this proved to be a little difficult. However, the participants got used to waiting their turn, and since there were quite a few participants present, there would have had to be some arrangement of speakers' order in any case.

Future Developments

During the project the question was raised whether the use of the videotelephone in the future would substitute for some of the present routines. At Berg, it was emphasised that diagnosis and assessment could not be carried out via the videotelephone: the use of the videotelephone was linked to the follow-up phase, and access to videotelephones would not necessarily mean that the children would stay at Berg for shorter periods of time, because they would still need the same time for assessment. However, the need for routine controls would be less. The time spans between the stays at Berg could be better adjusted to the needs of the children and the local environments, and thereby resources would be used more efficiently. Sometimes, visits to Berg might be more frequent, but there is reason to believe that the time between the visits could be prolonged if there was videotelephone supervision. The intervention will be followed up from Berg on a more continuous basis, and the local professionals have, as a result of the supervision, gained higher competence in the work that is to be carried out, and may be able to do some of the work that earlier was referred to Berg.

Also some of the children's parents said that they would prefer videotelephone conversations to routine controls, and would make the long journey to Oslo only when it was clearly required.

Conclusions

The joint project between Upper Valdres and Berg brought to light the importance of competency transfer in an intervention follow-up phase. Assessment results and other crucial knowledge must be transferred in such a way that it can be translated into committed local interventions. Direct contact between the central and the local bodies is often necessary in order to agree on the organising as well as the more detailed objectives of the interventions. Improved local problem-solving, with competence build-up and a sound division of tasks between first, second, and third line services requires that the various bodies are well- acquainted with each other's capabilities and limitations.

The project has demonstrated in an efficient manner how videotelephone technology can be used as an efficient tool for transferring knowledge. Hence it may be important for the future development of the educational system and the health sector in Norway and other countries, especially when it comes to securing the same quality of intervention regardless of where the client lives. In the project, the supervision represented a supplement to ordinary assessment, reports and telephone contact, but there is reason to believe that this type of supervision would lead to fewer traditional controls, because these could be more easily adapted to actual needs than is the case with today's routines, which are regulated by the calendar. The extra work this supervision entailed in the form of organising and travelling was regarded as unimportant compared to the usefulness the supervision represented.

The Central Institute of Habilitation and other central institutions should plan a future use of the videotelephone in follow-up and supervision. The use of videotelephones may also be of interest when planning the organisation of any communication between first and second-line services.

Acknowledgement

We would like to thank the children, their parents and the professionals at Berg and Valdres for their positive contribution to the success of this project.

40

Two Field Trials with Videotelephones in Psychiatric and Habilitative Work

Unni Holand, Stephen von Tetzchner and Kari Steindal

With its four million inhabitants and an area of 324 thousand square kilometres, Norway is a rather sparsely populated country. There are large differences between rural and urban areas, and between the north and the south in terms of the availability of public and private services. The majority of the population lives in the southern half, and this area also has the best coverage of services. This asymmetry between urban and rural areas and north and south is particularly pronounced with regard to the availability of academic specialists. Within the fields of habilitation and psychiatric work, there is a considerable lack of specialists, and a great need for continuing education and training. Courses, however, when available, tend to imply high travelling costs. Since there is also a lack of funding, the risk of professional isolation is high.

The project presented here consists of two field trials that took place in the north of Norway. In the first trial, videotelephones were used in the supervision of sign language instruction which formed part of the habilitation of two autistic children. In the second trial, videotelephones were used in the supervision of general psychiatric work.

The evaluations were based on both a questionnaire, which all of the participants had to fill out independently after each session and interviews with the participants. Both technical and functional aspects were evaluated.

The project lasted from October 1989 to June 1990.

Objective

The objective of the projects was to evaluate whether a 64 kbit/s videotelephone connection could be used for sign language instruction and supervision, and for supervision of psychiatric work with children and families.

Institutions and Equipment

One 64 kbit/s videotelephone with a Tandberg 4001 video codec was installed in the Child and Adolescent Unit of Nordland Psychiatric Hospital in Bodø. The videotelephone was placed in an office. In addition to the camera which was orientated towards the face of the user, there was an extra camera that gave a view of the whole room. This was used when more than one person participated in the conversation. There was also a separate telephone with hands-free headsets.

The same kind of equipment was installed in a similar, but smaller unit at Mosjøen, 200 kilometres from Bodø (Figure 40.1). The videotelephone was placed in a large therapy room to make it possible for children, parents and additional professionals to participate in the conversations. In addition to the ordinary videotelephone monitor, there was also a larger monitor to make it easier for more people to follow what was going on, and microphones and loudspeakers for sound.

The project lasted from October 1989 to June 1990.

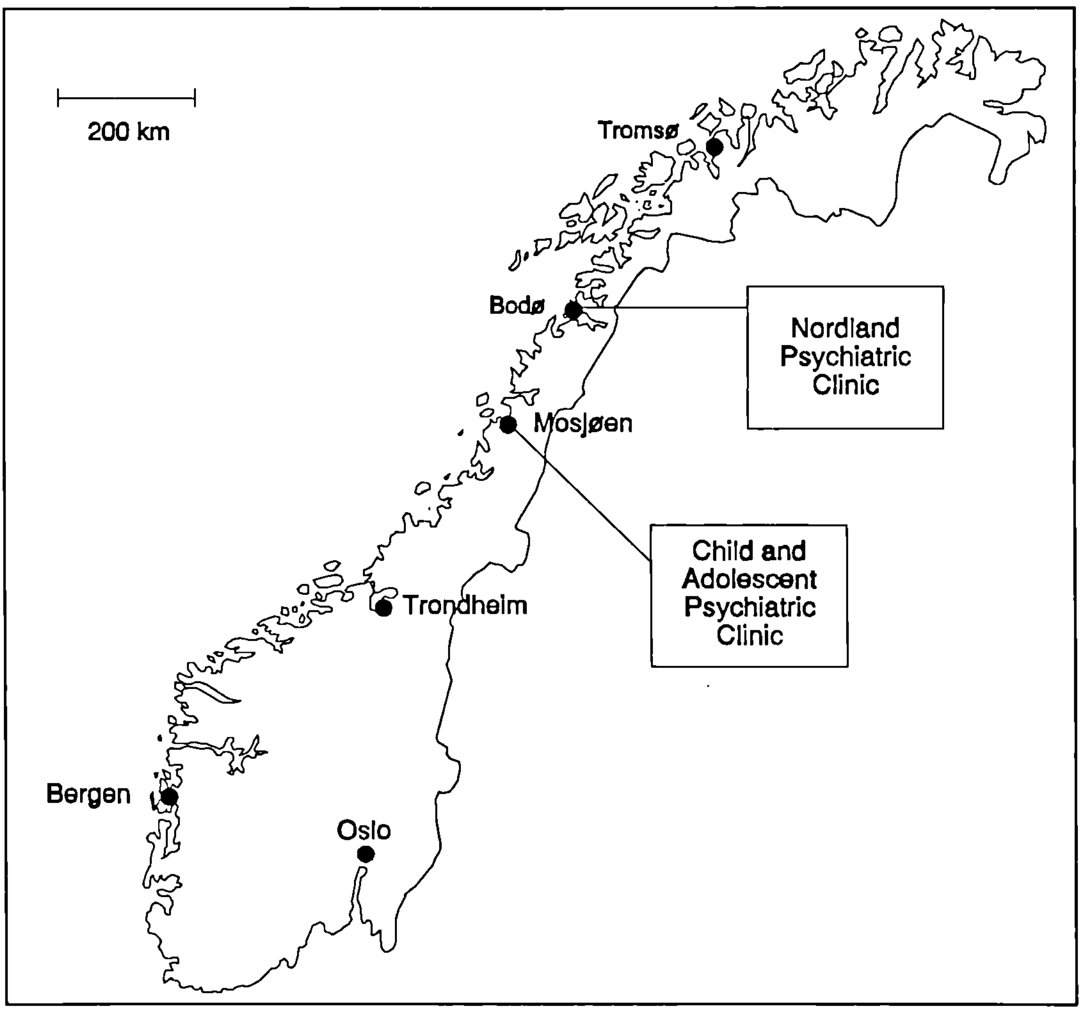

Figure 40.1 Map of Norway with Bodø and Mosjøen.

Technical Problems

In general, the equipment functioned satisfactorily. There were few instances of connection failure, and only on one occasion was this not corrected within a few minutes.

The participants noted the picture had a limited quality, but did not find that this hindered effective use of the videotelephone, however, in meetings with many people participating, the function of the videotelephone was restricted because the visual information became limited.

It was the sound which created most problems. There was often a high noise level, and the headsets had different intensity levels which made it difficult to use more than one of them.

Sign Language Instruction

Today, many autistic and profoundly retarded children with little or no speech are taught sign language. At Mosjøen, there were a three year old and a five year old autistic child who had not learned to speak, and for both children, sign teaching was initiated. The local professionals had little experience with teaching signs to autistic children, and needed both sign instruction and supervision of teaching. In the interviews, they said that they often found themselves confronted with issues which they did not know how to solve, and that it was not easy to find these discussed in the literature. Some of these problems could have been discussed on an ordinary telephone, but they found that many of the issues were difficult to explain without being able to demonstrate with the child present.

One of the present authors (Steindal) was associated with the autism unit in Bodø, and supervised this work. She used the videotelephone connection to teach signs to professionals and parents, and to supervise the sign instruction of two autistic children who lived at Mosjøen. The two children went to different nursery schools, and the work was supervised individually.

At Mosjøen, the nursery school teachers, and sometimes the parents, participated in the signing lessons. They did have sign dictionaries, but since they were not used to signing, they found it difficult to understand from the dictionary how an unknown sign should be articulated. Trying to explain sign production in an ordinary telephone conversation proved quite impossible. With the videotelephone, it was easy to demonstrate signs, although the supervisor had to sign very slowly for the sign to be understood. She had to spend some time training with the modem set to internal loop mode. This allowed her to watch herself signing, and to find the correct speed of sign production.

There were a total of 22 videotelephone conversations.

Supervision

During supervision, the teachers showed the supervisor how they worked. The supervisor demonstrated signs and teaching situations, discussed the situation along with the work which the teachers had demonstrated and made suggestions about how to enhance spontaneous signing. The picture quality made it difficult for the supervisor to see how the children did the signs, and she had to ask the adults for supplementary information. The main objective, however, was to see how the training was done; what kind of method they used, how they helped the child, how they motivated it, and how long a period of time was spent on training. These are essential factors for successful teaching of autistic children.

There is often a considerable difference between what people say they do and what they actually do. The reason for this may be a different focus and use of terms. The videotelephone made it easier to get a correct impression of the teaching, and thereby to provide better supervision and advice about how the training should be done.

For example, it is easy to give the child too much help and hand guidance. The result may be that the child fails to become independent and acquire spontaneous use of signs. Via the videotelephone, the supervisor was able to adjust the hand guidance and help given to the child, to a more optimal level.

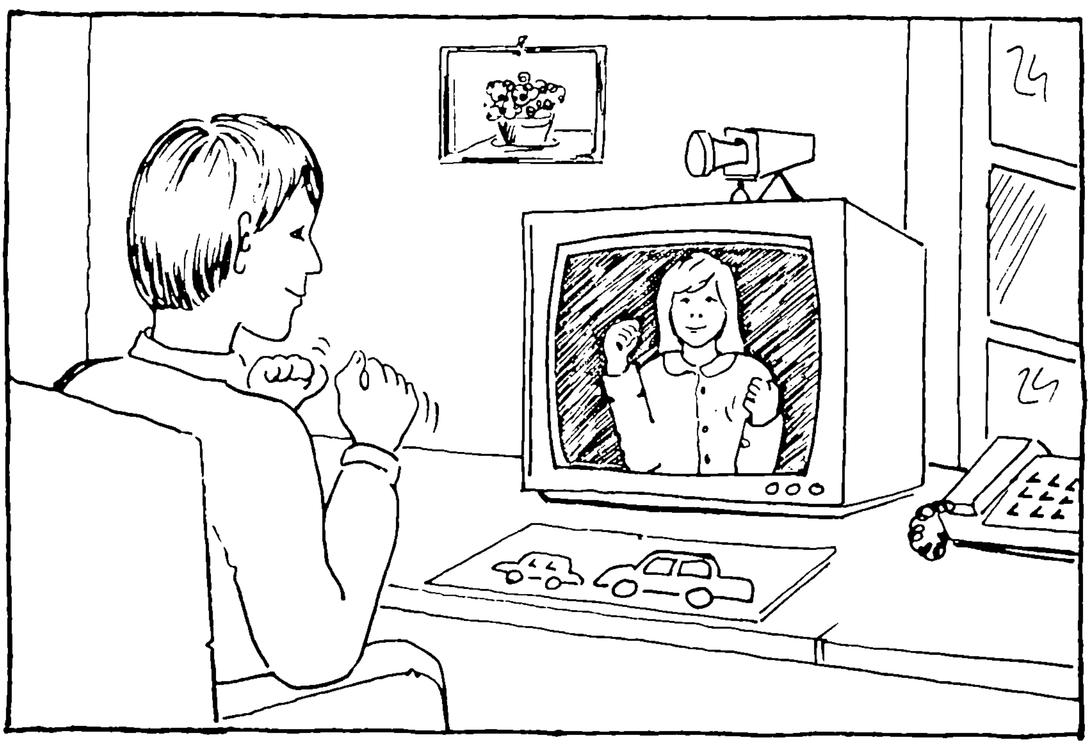

Figure 40.2 Supervision of sign language instruction.

Both the nursery school teachers and parents at Mosjøen and the supervisor in Bodø said that they found the supervision very useful. The professionals at Mosjøen said that they felt that they became more proficient at their job, and the parents that felt their children received a better standard of help. The supervisor in Bodø found that she could provide better follow-up than would have been possible without the videotelephone.

Meetings

The videotelephone was also used for meetings. These tended to be quite structured, but there was a tendency to let the person who had the floor go on talking. People in the same room as the one person talking tended to look at the people on the screen, and therefore the speaker did not get turn-shifting signals from them. The quality of the picture made it difficult to see and react to small turn-taking signals from the other side.

Usually, some people talk more than others. This tendency increased during the videotelephone meetings because those who were outside the focus tended to be forgotten. In an ordinary meeting, it is more likely that someone would have ensured that everyone got their turn. Despite these minor problems, the atmosphere during meeting was good, and according to the interviews and comments, the participants did not think that the quality of the discussions would have been better with face-to-face meetings. The limits were caused by the number of people that could be active at the same time.

The Videotelephone as a Supplement

The videotelephone did not replace the ordinary telephone, which was used to arrange meetings and to discuss matters that could not wait. The telephone conversations, however, were of an entirely different nature than the videotelephone conversations. They typically took place during or just before or after another meeting, and therefore often had to be limited with regard to length and scope. The videotelephone meetings were more similar to ordinary meetings. People arrived in time and both parties respected the time allocations that were agreed upon. Thus, there were seldom interruptions and nobody felt hurried or that they were disturbing an other person.

Both the supervisor in Bodø and the people at Mosjøen regarded the videotelephone as a supplement to other forms of contact. There was still a need for the autism team in Bodø to visit Mosjøen and get direct observations, and for the people at Mosjøen to go to courses. The videotelephones made more frequent meetings and supervision possible, and thereby contributed to more continuity and better quality of work. Videotapes had been used in supervision before the introduction of the videotelephone, but in both Bodø and Mosjøen they found that using the videotelephone was more efficient. Written reports had to be produced as before, but these could be less detailed since the intervention had already been thoroughly negotiated.

To sum up, in the present trial, the videotelephone proved a useful tool for increasing supervision and professional contact. It is often a difficult and lonely job to teach autistic children, and even the two teams at Mosjøen had limited benefit of each other because the two children were quite different. Thus, for the nursery school teachers, being able to use the videotelephone was a very positive experience. The more frequent supervision lead to fewer frustrations, more faith in what they were doing, and a better situation in general. Also the parents who participated expressed enthusiasm about the use of the videotelephone.

General Psychiatric Work

The psychiatric unit at Mosjøen was quite new when the project started, and the professionals in the more established unit in Bodø gave those at Mosjøen support during this initial phase. They supervised the therapeutic work, particularly the ongoing therapies with families whose children had behaviourial disorders.

To give and receive supervision via the videotelephone is quite different from supervision with face-to-face contact. Despite this, the professionals who participated said that they found the quality of the interaction satisfactory, and that they were able to maintain the degree of nearness in the relationship that is necessary in the supervision of psychiatric work.

When children and families were present during supervision, however, problems emerged. Due to the low spatial resolution of the picture, it was difficult to get all the participants simultaneously on the screen without the picture becoming unclear. It was also difficult to see children who were moving around in the room. When in addition there were problems with sound quality, the conversational situation, and thus also the supervision, was perceived as poor. Both the therapists and the families felt that the picture quality had to be improved before such sessions could provide any useful function.

In spite of these problems, the therapists who participated in the project said that they found the communicative accessability created by the videotelephone to be beneficial. The access to other therapists seemed to reduce the feeling of isolation which often arises in smaller psychiatric units. They would have had supervision without the videotelephone, but this medium lead to more continuity in the relationship, which also increased the collaboration between the two institutions in general. If a similar degree of continuity had been maintained without a videotelephone connection, significant changes in working routines and an increased amount of travelling would have been necessary. Such changes were not wanted and would also have implied a significant increase in resources, and it is very unlikely that they would have been initiated.

The therapists also maintained that over time, the greater continuity and collaboration between the two institutions, would make the smaller unit able to handle a wider spectrum of psychiatric problems than is the case today.

To sum up, in spite of the limited picture and sound quality, the users found the videotelephone useful for giving and receiving psychiatric supervision, and for maintaining close professional contact over distances. Larger meetings, with children and families present in addition to the professionals, were more difficult to conduct, mainly because the technical limitations became more evident when many people were participating.

Conclusions

In rural areas and sparsely populated countries, access to specialists, professional supervision and collaboration is often limited. This influences the quality of the local work and the variety of clients that may be helped in their local environment. The field trials that are reported here have demonstrated that, in spite of the limited technical quality of the first videotelephone prototype, videotelephones did increase local competence and lead to better psychiatric and habilitative work. The participants also expressed the belief that, as technical quality improves, the uses of the videotelephone may expand, making the videotelephone an important tool in psychiatric work and habilitation in the future.

Acknowledgements

We would like to thank the children, their parents and the professionals in Bodø and at Mosjøen for their positive contribution to the success of this project.

41

Videotelephone-Based Support Services for Elderly and Mobility Disabled People

Jukka Perälä and Lea Lounela

The aim of the pilot projects reported here is to use videotelephone based support services over an analogue broadband videotelephony system in three individual pilot sites in Finland, namely in Helsinki, Tampere and Kuusamo. The target group of the pilot consists mostly of elderly people living in their own homes or in service houses. The target group also contains several people with a mobility impairment.

Elderly people were chosen to be the primary target group because the proportion of elderly people over the total population in Finland is growing rapidly (about 13.5 per cent at the moment; estimated to rise up to 14.8 per cent in year 2000 and 25 per cent in year 2030). In the light of these figures, one can say, that principally the only way to avoid the coming 'care crisis' is to minimize the number of elderly people living in institutional care by enabling them to live in their own home as long as possible.

On a practical level this means that, in addition to the existing conventional support services like 'meals-on-wheels' and 'home health care', new support services based on advanced information technology must be developed. While conventional support services are concentrated mainly to fulfil the physical and social needs of the client, the support services based on information technology are intended to help in fulfilling the information and safety needs of the client.

Service Description

The project provides two individual support services, which are:
- Safety Videotelephone Service; and,
- Remote Advice and Guidance Service.

The *Safety Videotelephone Service* enables the client to have instantaneous help in various emergency situations taking place in his or her home (e.g. feeling of in-security and loneliness, accidents, sudden attacks of diseases, need of police or fire brigade). The service gives the client a feeling of security, because the client is aware that help is available at any moment, if needed. The Safety Videotelephone Service also improves the ability of the servicer to calm down the client. In addition, the videotelephone makes it easier for the servicer to assess the condition of the client.

The aim of the *Remote Advice and Guidance Service* is to help the client with everyday problems dealing with household, daily living skills, and general need of information. Together with the Safety Videotelephone Service, this service makes it possible to increase, or at least maintain, the level of independent living of the client.

Equipment and Network

The basic idea of the project has been to create an analogue broadband videotelephony system using standard off-the-shelf equipment together with the existing communication networks. The general description of the system is presented in Figure 41.1.

The support service system is based on a common *Safety Telephone System*, which is already widely available for elderly and disabled clients in Finland. The Safety Telephone System enables the client, for example, in a case of emergency, to establish audio connection between his or her home and a service centre via the public switched telephone network (PSTN).

In the project, an additional video communication channel has been added in parallel to the audio channel of the Safety Telephone System. In other words, the audio and video signals are transferred bi-directionally between the clients home and the service centre, using two parallel communication channels: the PSTN for audio signals, and the local cable-television distribution network (CATV) for video signals.

The equipment is made up of standard off-the-shelf products with some minor modifications and a specially developed switching unit.

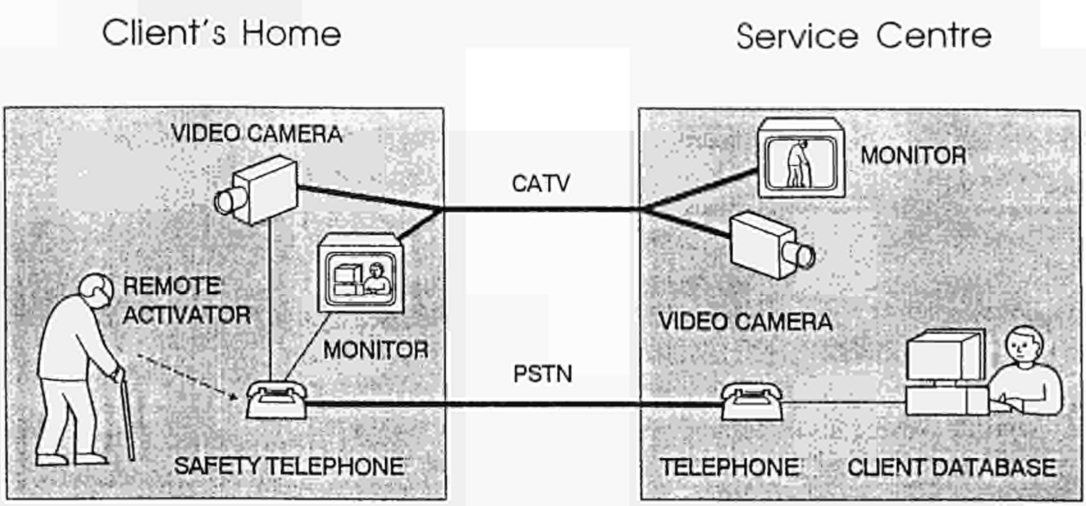

Figure 41.1 Analogue broadband videotelephony system.

Equipment at the home of the user includes:
- safety telephone unit (built-in microphone and loudspeaker);
- remote activator;
- video camera;
- television-set; and,
- switching unit.

Equipment at the service centre includes:
- safety telephone monitoring unit;
- data terminal and printer;
- data disc (system software and client database);
- video camera;
- television-set;
- 2 video recorders (for incoming and outgoing audio and video signals); and,
- switching unit.

The CATV-Network components are:
- transformers;
- amplifiers; and,
- scrambling equipment.

The equipment has been provided by Sondi Oy (safety telephone equipment) and Salora Oy (television-sets, video cameras, video recorders and scrambling equipment). The Technical Research Centre of Finland and Sondi Oy have carried out all the required modifications to the equipment. In addition, the Research Centre has designed and manufactured the switching units for the service centre and the client homes.

The network operators at the three pilot sites are as follows:

Helsinki	Helsinki Telephone Company	(PSTN)
	Helsinki Television Ltd	(CATV)
Tampere	Tampere Telephone Company	(PSTN)
	Tampere Television Ltd	(CATV)
Kuusamo	Telecom Finland/Kuusamo	(PSTN & CATV)

The support service system operates in the following way: The client initiates a videotelephone call simply by pressing one single button either on the safety telephone unit or at the remote activator. When the servicer at the service centre has received and accepted the call, the safety telephone system automatically establishes the audio connection between the clients home and the service centre. At the same time, the safety telephone system automatically activates the video connection between these two points. This is carried out with the help of the switching units located at the client's home and at the service centre.

The client alone is able to establish a videotelephone connection between his or her home and the service centre. When the service session has been completed, the servicer alone is able to terminate the call.

Description of Location and Service Provision

There are three individual project sites. These are located in the cities of Helsinki and Tampere in the southern part of Finland, and in the rural municipality of Kuusamo in the northern part of Finland (see Figure 41.2).

The three sites have their own special characteristics. Helsinki is the capital of Finland, an urban area with very high population density. Tampere is the second largest city in Finland, an industrial city with relatively high population density. Kuusamo, in turn, is a typical rural municipality with long distances and very low population density. In addition, Kuusamo is located about 70 kilometres south of the Arctic Circle and its northern climate is a particularly interesting feature of the pilot in Kuusamo. All in all, the variety of the pilot sites gives a good opportunity to compare the function of the support service system in different environments.

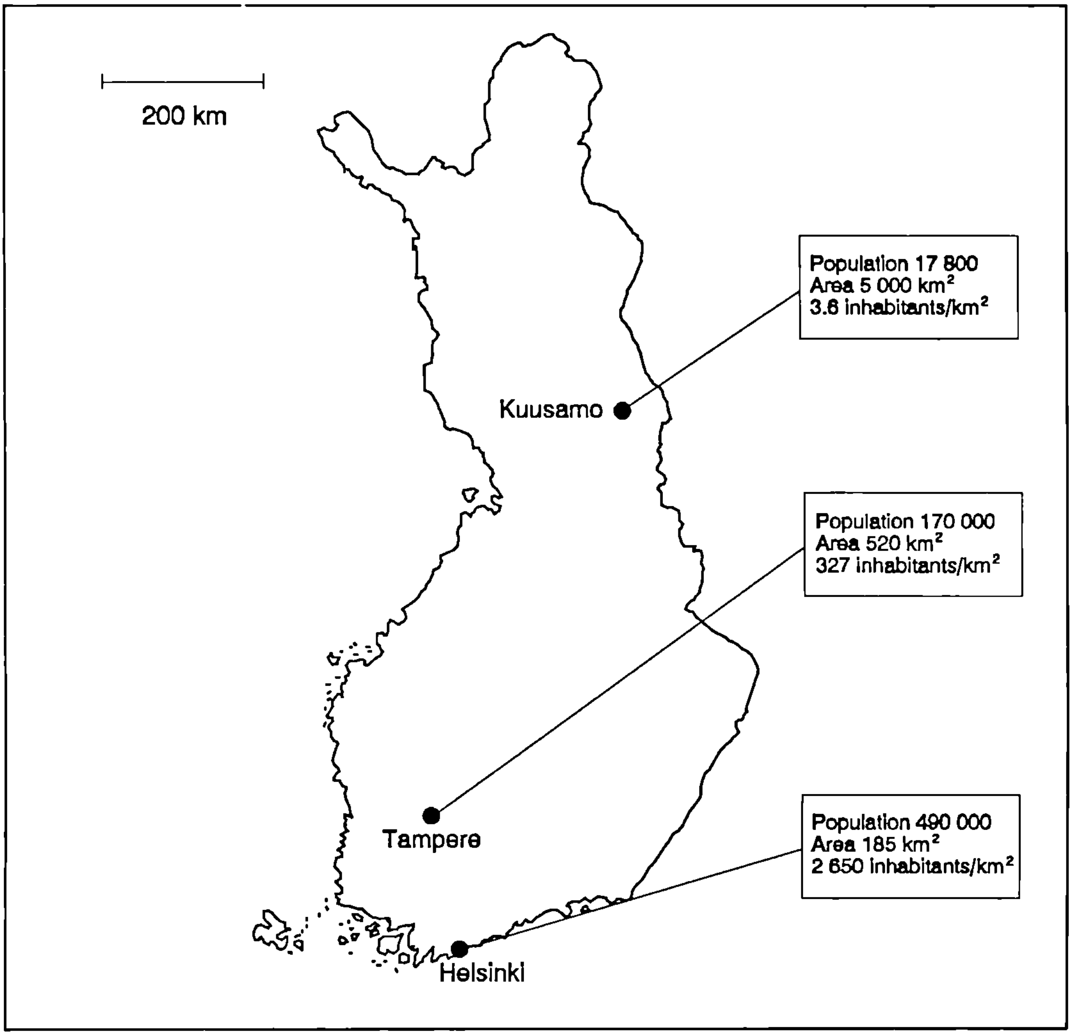

Figure 41.2 Map of Finland with Helsinki, Kuusamo and Tampere.

Helsinki

In Helsinki, the videotelephone connection serves 15 elderly clients living in two apartment houses especially designed for elderly people. The majority of the clients (12) live in apartment house A in Itä-Pasila, Helsinki, while the other 3 clients live in apartment house B in Länsi-Pasila, Helsinki. The distance between these locations is about 2 kilometres.

There are two service centres. The primary service centre is located in apartment house A, and operates during office hours, i.e. from 8 am to 4 pm. This service centre employs 2 servicers. Outside office hours, the videotelephone calls are automatically transferred to the secondary service centre, located about 1 kilometre from apartment house A. The secondary service centre employs 4 servicers, and is capable of handling all emergency calls (Safety Videotelephone Service) and some of the normal service calls (Remote Advice and Guidance Service). The service provision is carried out by the Social Department of the City of Helsinki.

Kuusamo

In Kuusamo, the project includes 5 clients; 4 elderly people and one mobility impaired person. All of them live in their own homes in the centre of Kuusamo. The distance between the clients' homes and the service centre varies between 0.5 and 2 kilometres.

The service centre is located at the Kuusamo Regional Alarm Centre, and operates 24 hours per day. The service centre employs a total of 6 servicers in three shifts. The service provision in Kuusamo is provided by the Kuusamo Regional Alarm Centre together with the Health Care Centre of Kuusamo.

Tampere

In the city of Tampere, the project includes 15 elderly clients living in an elderly people's home (1 client) and in two service houses for elderly people (14 clients). All of them are located close to each other in Kyttälä, which is a part of Tampere.

The service centre in Tampere is located in the elderly people's home, and operates 24 hours per day. The service centre employs a total of 6 servicers in three shifts. The service in Tampere is provided by the City Mission of Tampere.

Figure 41.3 A user at home and the servicer at the centre in Kuusamo.

Current Status

The equipment and services of the Finnish pilot project were tested during a three-month mini-trial in Kuusamo in January–March 1990. The results of the mini-trial showed that no re-design of the equipment or the support services was required. However, some fine-tuning of the system has naturally had to be made.

The pilot project in Kuusamo started in June 1990, the one in Helsinki in December 1990 and the one in Tampere in January 1991. Services are now being provided 24 hours a day.

After all the pilots projects became fully operational, the principal task has been the evaluation of the system. The main aspects to be evaluated were:

- learnability, i.e. how easy is it to learn how to use the system;
- usability, i.e. how easy the system is to use;
- functionality, i.e. how the system meets the demands set by the users;
- acceptability, i.e. how easy the system is accepted in the support services;
- flexibility, i.e. how well the system adapts to users with different disabilities,
- reliability, i.e. how reliable the system is, for example technically; and,
- utility, i.e. what the user benefits of the system are.

An evaluation was performed at the beginning of the pilot study, and evaluations will be performed at the middle and at the end of the pilot studies. Evaluation methods include interviews, observations and data-logging.

Subjects

The ages of the 32 clients are between 63 and 93 years old (with the exception of one 27 year old mobility impaired person). Most of the subjects are between 73 to 85 years (23 out of 32 clients). Two thirds of them have had only little (2 weeks–2 years) or basic (2–4 years) education, and half of the clients have a blue collar working history. Two thirds of them live in one room apartments and one third in apartments of two or more rooms.

Half of the clients say that they are happy with the amount of social contact while the other half felt lonely at times and wished they had more contact. The health situation of two thirds of the clients affects their daily living and prevent them from living a normal life. Only four clients feel that their health situation is normal. One third of the clients depend on technical aids for mobility and another third use such aids although they are not dependent on them. Twenty-six clients out of 32 have some difficulties with mobility.

First Impressions

The run time of all three pilot studies is approximately one year. Thus the results of the evaluation will be available in December 1991. However, some of their attitudes towards the videotelephone – based on evaluation done in the very beginning of the project – can already be presented. It should be noted, though, that at this time, the clients had used the system for an average of only a few days.

The general attitude of the clients towards the system was positive. Half of the elderly clients (15/31) thought, that the system was easy to use, and they did not have any ambivalent or negative thoughts about the system. A third (11/31) said that they found the system good and easy to use, but they wanted some changes or expressed some negative impressions. The attitudes of these clients towards the system can be said to be conditional. A sixth (5/31) of the clients were undecided or ambivalent in their first impression. Thus, for the majority, the first impression was fairly positive.

Value of the System to the Client

The clients in Helsinki and Tampere (18/27) perceived the videophone mainly as a security or emergency system. This is partly due to the fact that the system is based on a standard safety telephone system. The safety services provided in the pilot project seem to be easy to understand and accept, since they represent an already existing, quite ordinary type of service. It is also possible that a safety service is what the clients feel they need most. One third of the clients (9/27) said that the system was valuable to them because they did not have to walk to the office so often to get answers to questions that are not convenient to deal with over the telephone; now they can use the videotelephone. Three of these nine clients found the system valuable because it meant development in general terms, and that they played a part in this process.

Positive Aspects of the Videotelephone

According to half of the clients (13/27), the best thing about the videotelephone is its safety functions; it is a means by which they can get help when they need it. A quarter of the clients (7/27) were undecided with regard to what to think of the system. This may be interpreted as a sign of how difficult it may be to perceive and understand new technology, and how it influences one's own life. A quarter of the clients (7/29) were divided on a number of issues (it is easy to use; it is nice to see one another; etc.).

Negative Aspects of the Videotelephone

The most common negative comment concerned the size and appearance of the client equipment (11/30). Nine clients felt that the remote activator was difficult to put on the wrist and that it was uncomfortable to use. The remote activator is now being re-designed on the behalf of the manufacturer. Seven clients did not have any negative comments about the system – some of them said that they did not want to be prejudiced, and therefore wanted to wait before giving comments.

Note

The research presented in this chapter is part of the RACE project 'Application Pilot for People with Special Needs' (see chapter 15).

42

Videotelephony on 2 Mbit/s for Deaf People in Their Working Lives

Olof Dopping

On October 25, 1990, an experimental videotelephone network with a capacity of 2 megabits per second (Mbit/s) for users of sign language began operation in Sweden (Nilsson, 1990). The users were two small groups of people – most of them pre-lingually deaf – working for or associated with the Swedish National Association for the Deaf, hereafter called *SDR* (the initials of the Swedish name).

***Figure 42.1** A video terminal with its video camera, video monitor, and control unit.*

The establishment of this communication system forms part of a project designated as the 'Video Communication Project', the main cost of which is borne by Swedish Telecom. At the time of writing this chapter, about half of the experiment's projected life span has passed.

Distinguishing Features

Several experiments are going on in the field of videotelephone communication for sign language, some of which are described in other chapters of this book. However, the present project is a complement to the other trials, rather than a duplication.

While most of the other experiments are directed at finding a good compromise between low bit rate videotelephony costs and picture quality, this project is aimed at studying the effects that a video communication system may have on the working conditions of pre-lingually deaf people. Therefore, a system with high picture quality was chosen, minimizing the influence of picture quality limitations (which may more or less disappear in the course of technical development anyway).

For reliable results, a trial duration of the order of one year has been chosen, during which time operational statistics are collected continuously. To the greatest possible extent, the statistical information is recorded by computers in real time.

Most of the data for statistics are picked up automatically, but in addition, the computer system prompts the users for one-digit answers to four questions at the end of each call. Some additional information, including 'soft' data, is periodically collected by a person trained in the social sciences – and skilled in Swedish sign language – who interviews each user according to a predetermined plan, ensuring that questions are put to all the users in the same way. One series of interviews were performed before the actual start of the trial, and a second series after a few months of operation. Finally, further interviews will be carried out at later stages of the trial.

A relay system for sign language is another distinguishing feature of the project. A sign language interpreter can be contacted by all the users of the video communication system and by all telephone subscribers in the world. In this respect, thus, the deaf videotelephone users have the same opportunities as the users of text telephones and other telephone devices for deaf people.

There are also plans for providing the interpreter with a text telephone, enabling deaf text telephone users to communicate with the deaf videotelephone users. At the time of writing, this feature has yet to be implemented.

Difficulties in finding sign language interpreters delayed the start of the relay service by about six months, with respect to the other parts of the trial. At the time of writing this chapter, the whole system has been operational for about eight months, and the relay service about two months.

Communication Network and Equipment

Network

The videotelephone network provides communication within and between two offices of SDR. One of the sites is the Association's central office, situated at Västanvik in Dalecarlia. The other one is SDR's office in Stockholm, a distance of around 240 kilometres.

Figure 42.2 shows some details of one of these sites, while the other site can be thought of as a mirror image of the one in the figure. The open-ended lines to the left of the personal computer and the video/audio exchange symbolise the connections to the other user rooms, not shown in the figure.

The long-distance communication is digital, with a bit rate of 2 Mbit/s. With this bit rate a reasonably good picture quality can be obtained, although some picture deterioration due to the bit rate limitation is clearly discernible. Another reason for choosing this bit rate was that it is identical to that used by Swedish Telecom uses for its Video Conferencing Service, enabling people at locations all over the world to set up meetings with visual contact, thereby saving time and travel costs. Swedish Telecom was therefore able to set up the network in a relatively short time, utilising well-proven equipment and procedures.

At the time when the project was started, 'calls' in the Video Conference network were still set up under manual control, although the actual connection was performed by a computer. Calls would normally have to be booked in advance. However, Swedish Telecom agreed to let the present connection between Västanvik and Stockholm be open for 24 hours a day, with some exceptions.

Therefore, the videotelephone users in this project can make even a long-distance call without previous booking, as long as the line between Västanvik and Stockholm is not busy. (Since then, Swedish Telecom has started to build a public 2

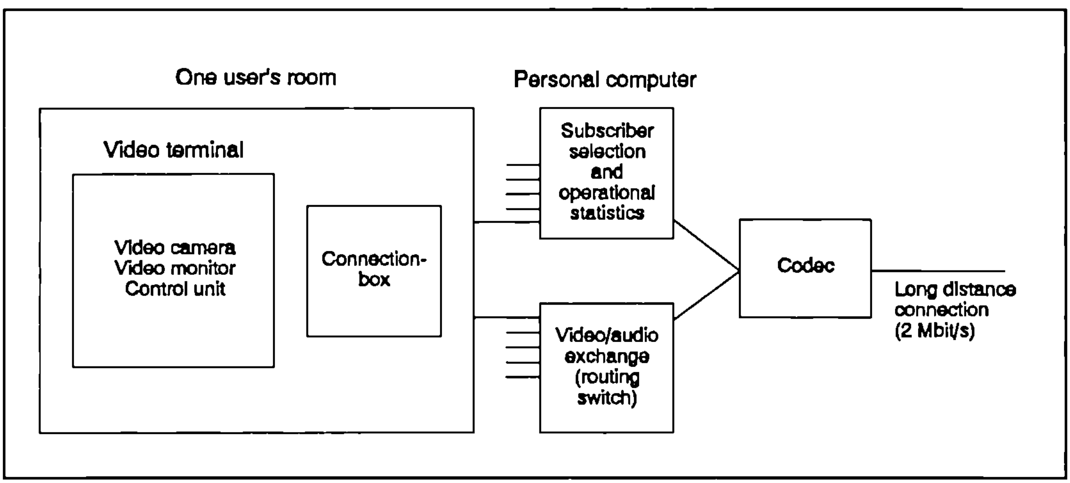

Figure 42.2 Equipment at one of the two sites (which are in principle equal).

Mbit/s EBIT network, which is switched, enabling all its subscribers to obtain connections in this convenient way).

In principle, Swedish Telecom can set up a call between the users in the videotelephone project and almost any video conference user in the world – it is just a matter of communication costs. Some video conference users may have codecs which are incompatible with the codecs that are used in the project. However, Swedish Telecom can provide a gateway by using two different codecs 'back to back', within its premises with a short analogue communication link between them.

For internal communication at each location, analogue video communication carried on coaxial cables is used. Since the coaxial cables – unlike the 2 Mbit/s link – do not impose any noticeable restrictions on the communication bandwidth, the users can compare the picture quality provided with and without such restrictions.

Equipment on the User's Desk

Each user has a video terminal which consists of a number of physically separate parts including a monitor and a video camera. It also includes a control unit for subscriber selection (dialling) and for some other functions. A microphone and a loudspeaker are built into the control unit.

The camera is an amateur video recorder – with the recording part disabled – and the monitor is a domestic television receiver. These devices turned out to be more cost-effective than professional video equipment, and fully adequate in terms of picture quality. In all but one case, the cameras were mounted on top of the monitors.

The microphone and loudspeaker are not used in conversation between two deaf people, and the volume control knob on the control unit will normally be set to zero output. In fact, these audio devices can be a threat to privacy if a deaf user has inadvertently turned on the sound and carries on a conversation via the relay service. People with normal hearing in the deaf person's vicinity may then be able to hear the interpreter's voice.

The audio devices were included as they may be of help during conversation between one deaf and one hearing sign language user. Especially if these two people know each other well, the conversation may sometimes be facilitated by words or other sounds produced by the deaf person even if he or she cannot be understood by means of sound only.

The control unit has been specially designed for this project. For subscriber selection it has pushbuttons of the same type as an ordinary pushbutton telephone, but where a user of an ordinary telephone would lift or hang up the receiver, the users in this project push a button marked LINE on the control unit.

One button on the control unit is marked INTERN. This button toggles the monitor screen between the incoming and the outgoing picture. Thus, the user cannot normally see his or her own picture during a call, the idea being that monitoring one's own picture is only necessary for a short while at the beginning of a conversation, to check one's position in the camera's field of view.

An LCD display on the control unit enables the system to convey alphanumeric messages to the user, such as 'line busy'. The questions for statistics are also presented at the display together with a small menu showing which digits to use for the different alternative answers.

A lamp at the control unit indicates a call in progress by means of steady light. When somebody is calling, it flashes. This flashing is a little too discreet to always draw the called party's attention, but the control unit also delivers a call alerting signal to a relay output connector. A relay connected to this output can make an external lamp of any size flash as an additional incoming-call signal.

There are also some other controls on the unit, which enable the user to adjust such things as the sound volume.

In the room housing the relay service there is also an ordinary telephone (audio telephone) with a headset, enabling the interpreter to have her hands free for signing while listening and talking. This room must be soundproofed for privacy. (The interpreter has an unconditional obligation of confidentiality, of course).

Central Equipment at Each Site

Because the long-distance communication is digital, a codec is needed at Västanvik and in Stockholm. If the installation were to be made now, codecs adhering to the relatively recent standard designated as CCITT H.261 would probably have been chosen, but such codecs were not available at the time of procuring the equipment for the present system.

A codec is really a converter between analogue and digital transmission, whist at the same time it provides some very advanced signal processing. The purpose of the signal processing is to 'compress' the video information, fitting it into the limited communication capacity which is expressed as a bit rate.

In the system used in this project, the codec is connected to an audio–video exchange. This exchange can connect any user within the project to the other users at the same site or to the exchange at the other end of the long-distance communication link. Thus, local calls are handled entirely on an analogue basis, whilst long-distance calls are digital between the two codecs.

The exchange is controlled by a personal computer, which in its turn is controlled by the users via their control units. The computer is also charged with collecting the statistics, which are stored on a diskette.

Network Structure for Relaying

Figure 42.3 shows the parties who can be involved in a relayed conversation. The rectangles to the right in the figure represent two of the deaf people who have videotelephones for sign language. They can communicate with the interpreter (and, of course, directly with one another). The rectangles to the left symbolise people outside the project system. They, too, can communicate with the interpreter using either an ordinary audio telephone or, when the system is complete, a text telephone.

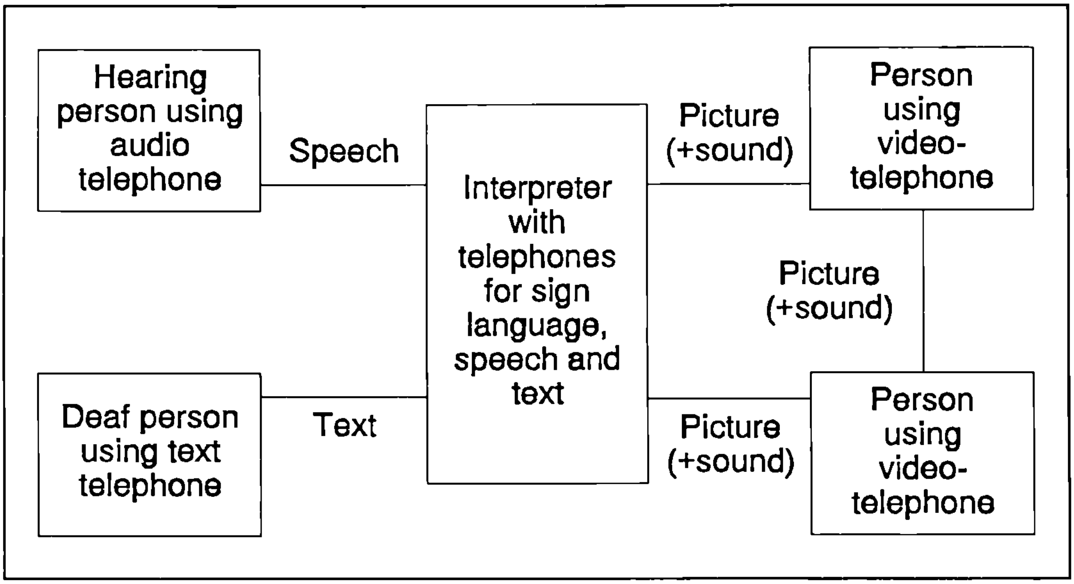

Figure 42.3 Sign language relay.

Some Preliminary Findings

Naturally, problems have appeared in the project system. Although some of these problems were due to local phenomena, an account of them may be of help to others planning to establish similar services elsewhere.

About two weeks after the start of operations, follow-up meetings with the users were held to collect their reactions. It was reported that the users had many complaints and only one positive remark.

The positive remark was, however, that everybody was enthusiastic about the system. The users had already started to worry about what was going to happen after the end of the one-year experiment, when the videotelephone service would be terminated, as it would be according to the original plans.

However, the possibility of a more permanent videotelephone service is being investigated. (This service would perhaps also be extended to a third location within the SDR organisation.) The limiting factor, as always, is money.

For cost reasons, a lower bit rate would probably be chosen for such a long-term solution. With newer codecs, a bit rate of 384 kbit/s might give adequate picture quality, and still lower bit rates are not ruled out, but this remains to be tested.

A further outbreak of enthusiasm occurred when the relay service finally started. This service has widened the contact area of the deaf users enormously.

Observing an incoming call has turned out to be a problem in many cases. Because several people may have to share one of the precious videotelephone terminals, it is difficult to know who is being called.

To alleviate this problem, a sort of paging system has been ordered, so far only for one of the two sites. Each deaf person at this site will carry a paging receiver on his or her body. This receiver is provided with a vibrator, producing a tactile signal when there is an incoming call for him or her. (For this system to work as intended, the acquisition has to be followed up with some engineering modifications of the existing system). The paging receiver will also indicate incoming text telephone calls, doorbell signals, and entrance telephone signals.

Another reason for complaints was camera parallax. Because the camera is mounted on top of the monitor, the impression is that of a person looking at the one's own belly rather than the face and hands, especially if the other person is sitting close to the camera. Some were disturbed by this feeling, but others said that they did not notice it at all.

In principle, the parallax problem can be eliminated by using a camera–monitor combination equipped with a semi-transparent mirror placed at a 45-degree angle to the user's line of sight. The user will see the received picture while looking straight into the camera. Either the light for the camera will pass through the mirror while the received picture is reflected by it, or the reverse. This is the same idea used in the 'teleprompter' for news readers in television studios.

Such a camera–monitor combination was tried out. So far it has not become popular among the users, but the reasons for this have not yet been thoroughly analysed. If the problems are due to some factors which are not inherent in the teleprompter principle, it may be possible to eliminate these factors and arrive at a satisfactory solution of the parallax problem.

Auto-focusing of the camera caused some problems because the camera tends to focus too sharply on the user's hands, blurring the picture of the face. Therefore, the auto-focusing option has been put out of function.

The interpreter reported a problem with the 'line busy' signals. Because she has to use two communication circuits simultaneously – one for the videotelephone and one for the audio telephone – both lines should produce a busy signal as soon as one of them is in use. An engineering modification to this effect is under way.

Another problem for the interpreter was caused by imperfections in the soundproofing of her room. Room echo has been reduced by means of carpeting and curtains, but it is sometimes difficult to prevent eavesdropping.

For some time, the interpreter tried to solve the eavesdropping problem by placing the headset microphone close to her mouth and lowering her voice. She abandoned this policy for a curious reason. She got the feeling that some of the male audio telephone users misinterpreted her tone as being a bit intimate.

Also, putting the microphone close to the mouth makes it more difficult for the deaf user to see her mouth, which has great importance for conveying her message. Thus, the ultimate solution to the acoustical problems is to arrange for a room without much echo and with adequate sound insulation. This lets an interpreter place the microphone at a suitable distance from his or her mouth and talk with a reasonably loud voice.

Although videotelephone relaying is similar to text telephone relaying, there are also major differences. In text telephone relaying, one of the communication links is of a rather impersonal nature, but the videotelephone interpreter has closer 'human' contact on both sides. Also in sign language communication, body language and other non-verbal signals play a greater role than the intonation does in a telephone conversation. These factors make the sign language interpreter's task delicate and difficult but also rewarding.

The second interview series – after a couple of months of operation – as well as the computer statistics collected during this period, confirm the findings already reported. The users were generally happy with the system, but they reported some teething troubles, many of which have already been eliminated. (A concluding report with more detail will appear early 1992).

Further Improvements

The sign language relay service is rather vulnerable because at present there is only one interpreter, working four days per week. If she gets ill, for example, the whole relay service stops.

A solution to this problem would be to let the relay service be handled by an existing sign language interpretation centre, where several interpreters are working. However, such an arrangement would entail the set up of a third site with a third codec. The present budget does not allow such an expenditure, but in the event of a permanent and enlarged system, the situation would be different.

In face-to-face signing, the partners can exchange written documents. In a long-distance videotelephone conversation, this is obviously impossible, but many users have expressed a wish to be able to show a typed or handwritten document to the other party. Holding up a page in front of the camera is not a satisfactory solution.

In principle, a document-showing option could be provided by means of a separate document camera, mounted over a table with its optical axis vertical. The H.261 codec standard includes an option to 'freeze' a picture and transmit it at a lower speed and with higher resolution. For such a system to function satisfactorily, the monitor at the other end must be able to present pictures with this higher resolution, which could be a problem.

Even if the above-mentioned problem can be solved, the document camera solution adds to the cost and bulk of the terminal. A cheaper solution is to send the document by fax before or during the conversation. Some of the users already practise this method regularly. Some of those who resent the fax method may do this because they don't have a fax sufficiently close to their desks, but fax equipment is now fairly cheap, and with a suitable switch, several fax devices can share one telephone line (or, in the future, one ISDN line).

In the future, a deaf person may have many digital devices on his or her desk, such as a text telephone, a fax, a videotelephone with its control unit, and a personal computer with a printer. It is clearly desirable to have these devices integrated into one, even if the combined device would have to consist of more than one physical unit. From an engineering point of view, such an integration would not meet with any major difficulties. Component prices may even be lower than for the separate devices, but development cost might be a problem. There may be too few sign language users in the world to warrant the development costs, but if an integrated unit becomes popular among the general population, the picture would change.

An automatic answering device for videotelephone communication would certainly be desirable. It would not be too difficult to build such a device utilising well-established video cassette recording techniques. The question is, however, if such an answering device would justify its price. A person who has access to an expensive videotelephone to be used for sign language will normally also have a text telephone, and this can serve one of the two functions of an answering device, namely to inform the user that somebody has called and who this is. Although the text telephone is less well suited for the other function – to receive and store other messages – its existence will certainly reduce the need for a video answering device.

Summing up the unfulfilled wishes, then, there are clearly some things that remain to be done in the field of videotelephony and sign language, but the experience to date, together with findings from other projects, shows that videotelephony, if and when it can be implemented at a sufficiently low cost, will be a blessing for many deaf people and for the people with whom they communicate.

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Non-Visual Screen Representations

The trend towards having information stored in digital form has been welcomed by visually disabled persons since it gives the potential for accessing the information in an alternative medium (e.g. synthetic speech). Lack of privacy is one of the deprivations caused by blindness, therefore direct access to personal information is important for many blind persons. For instance, since computers are used to print bank statements of account, it has been possible to automate the production of bank statements in Braille and large print; this service has proved very popular. Another positive effect of the use of digital storage has been the development of systems to permit blind persons to have access to the full text of a daily newspaper. However there have been negative effects – the most obvious has been the move from purely text-based computer and telecommunication terminal displays to ones using graphics which are difficult to convert to non-visual representations.

Considerable work has been done in converting text displays to synthetic speech, Braille or large characters. Speech synthesizers exist for a number of languages, but for many minority languages they do not exist or they are very expensive. Most synthesizers work for only one language, but the trend is towards multi-lingual synthesizers. However there are considerable differences in speech quality between the different models on the market. Also there are differences in the facilities provided on the various models – most can output in line mode, word mode or spelled-speech mode. This facility is almost essential if reading text which contains foreign names (e.g. Gorbachev or Walenska).

Since synthesizers do not speak with the redundancy of a human speaker, the users need to have good hearing. Unfortunately over one third of visually disabled persons in developed countries also have a hearing impairment. The main reasons for this are that some eye diseases are correlated with a hearing impairment, but the numerically larger group is elderly persons who have unrelated visual and hearing impairments.

The trend is moving away from purely text displays to those using graphical representations with facilities for the user to interact directly with the display (e.g. a mouse). Currently no generalised solutions exist for giving blind persons access to such graphical displays, but if satisfactory solutions are not found, blind persons will be severely restricted in their employment opportunities.

John Gill

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Access to Pictorial Information by Blind People

Pier Luigi Emiliani, Constantine Stephanidis, Jan-Ingvar Lindström, Gunnar Jansson, Heikki Hämäiläinen, Carl Richard Cavonius, Jan Engelen and Jan Ekberg

One of the major obstacles to the socio-economic and cultural integration of blind people into society is the problem of making graphic information accessible to them in the various application environments that they face in everyday life.

Methods for producing, distributing, and presenting information are currently undergoing a radical change. For centuries the traditional method of presenting visual information has been to print text and graphical material on paper. This is rapidly being replaced by systems in which electronically coded information is interpreted by computer-based systems, either on a local level or through communications networks. This offers the possibility of a major improvement in the availability of information to visually impaired users.

This is relatively simple in the case of line-by-line text, which is already coded in a way that lends itself to automatic translation to Braille, or to conversion to synthetic speech. However, current trends in the development of computer technology and in its application to telecommunications (since all modern terminals are computer-based systems), rely heavily on the use of direct-manipulation techniques in a graphics environment to enable the user to interact with the terminal. Moreover, graphical and other pictorial representations of information are expected to become predominant as integrated networks, both narrowband and broadband, come into use.

At present, totally blind users have essentially no access to graphic material on a visual display unit. A further obstacle is presented by the increasing use of WIMPS (Windows, Icons, Mice, and Pull-down menus), which are convenient for most sighted users, but which cause severe problems for blind users. Thus, instead of technology helping visually impaired people, as was optimistically predicted a few years ago, technology is moving further from the grasp of these users. It is therefore essential to develop new methods for making man-machine interfaces more accessible to this considerable portion of the population, so as to give them some access to graphical and pictorial information.

The purpose of this chapter is to identify problems that blind users may encounter in different application environments (e.g. home, work, travel and leisure); to review the situation of research and development in this area; and to propose possible directions of further activity. The analysis will be primarily concerned with the problems that users face when using terminals to access the services and applications that are available through telecommunication networks.

Visual information may be divided into two main categories, which are:

- hard-copy representations of unconstrained pictures in an analog environment; and,
- computer based pictorial information.

This chapter is primarily concerned with the second of these. This has two main consequences:

- problems related to the acquisition of information will not be considered (i.e. information is assumed to be already available in a coded form in the computer system); and,
- problems that arise during real-time interaction with information during a telecommunication session will be the main concern, although the possible impact of hard-copy techniques may have to be taken into account, since often these are the only solutions that are technically feasible at present.

Application Environments

In this section, some examples of environments in which graphics and pictures play an important role are briefly described, and the main problems that visually impaired people are apt to encounter are briefly described.

Vocational

Many tasks in the office environment have recently been made accessible to visually impaired people. These are normally related to the processing of text documents, since sufficiently efficient software (screen readers) and hardware (speech synthesizers and transitory Braille displays) adaptations are becoming available for accessing and processing text. The situation is now changing because:

- programs for office tasks (e.g. word processors, spreadsheets) are evolving toward an increasing use of graphic interfaces based on the WYSIWYG (What You See Is What You Get) principle and on direct manipulation approaches. Moreover, such programs increasingly include drawings and pictures;
- the use of multimedia databases, which combine text, graphics and pictures in complex documents, is expanding;
- the increasing use of graphics imbedded in office documents fosters the use of drawing programs, the output of which can be transferred into the text document;

- workplaces are being integrated into computer networks. This normally increases the range of tasks that can be carried out by employees at the different nodes, due to the different and distributed organization of office work; and,
- programs for accessing the network are evolving toward an increasing use of direct manipulation techniques and graphical interfaces.

The last two points have an impact on the situation of the blind employee from a different point of view as well. The integration of the individual's office in a computer network leads to standardization of equipment and software, thus reducing the possibilities for a blind user to choose the most suitable products.

Educational

The use of computers in education is increasing rapidly. Computers are used to introduce new concepts as well as to give additional information in traditional curriculum areas, and are used in connection with telecommunications (distance education). Their use may create new problems in the education of blind people because educational programs make extensive use of graphics. This is true not only in higher education, but even at the pre-reading level, where computers are used to help children to learn special concepts and forms of representation. The acquisition of social skills and vocational training are also areas that can present serious difficulties.

Leisure

Leisure is an important aspect of modern society. Today many leisure activities such as watching television, playing computer games, and even playing music rely heavily on visual presentations.

A typical example of the impact of new technological developments in leisure activities is given by the problem of accessing music scores and operating complex computer-based musical instruments. Music scores are essentially a graphic representation of information, which must be transduced if they are to be presented as music Braille. Blind people also need to produce normal scores in order to communicate with sighted persons (this is particularly important in the case of blind music teachers, and therefore also affects their chances to find employment). Problems are also caused by new musical instruments, most of which are in fact computer-based. They have to be programmed; and they often have very complex graphical man-machine interfaces.

Home

The new approaches to the development of intelligent houses, which also include connections to telecommunication networks, will have an important impact in supporting many activities related to the access to information by visually impaired people (e.g. access to digital newspapers) and to other remote activities (e.g. teleworking, tele-shopping, tele-education). This is expected to afford new opportunities for blind persons to lead independent lives. However, difficulties in accessing these facilities are certain to arise. Because most users will not be accustomed to dealing with computerized systems or terminals, interfaces will have to be very simple to use. In computer science, 'simple' often means graphical and iconic. Problems will therefore be created for visually impaired persons, even if the inherent simplicity of the interfaces helps to reduce the problems of their adaptability.

Visual Information and Problems Faced by Blind People

For visually impaired people, the increasing use of graphics in computers and telecommunication systems creates problems on two different levels: in interacting with the graphical interface, to access functions of the terminal itself and to connect to services and applications; and in accessing the graphical and pictorial components of services and applications.

This section is primarily concerned with interaction, which is crucial to get started and to get access to (at least) the text component of services and applications, even if these are represented in a graphic (bit map) form.

Visual Information

The types of visual information normally encountered in man-machine interfaces of computers and telecommunication terminals and in available services and applications are:

Text
This consists of a sequence of codes which represent characters (e.g. alphanumerics and punctuation) and lay-out control characters (e.g. carriage return and line feed).

Graphics
These are data that are generated, stored, and manipulated by computers. They consist of a set of simple graphic primitives (e.g. point, circle and straight line), which can be combined together and structured in hierarchical or non-hierarchical forms.

Still pictures
This type of information is normally represented as integer matrices, which are the result of digitising real images. The elements of such matrices, called picture elements (pixels), correspond to picture points, and their value specifies a picture characteristic (i.e. grey level, light intensity, colour etc.).

Moving graphics
The term moving graphics refers to a sequence of still graphics that can be dynamically represented on a two-dimensional display.

Moving pictures (video)
The basic element of video information is the frame (still picture), since video is a sequence of still pictures, with frame rates normally above 10 pictures per second (television uses 25 pictures per second).

User Interface

The user interface is a set of services provided to a user in order to allow efficient use of a computer system and/or telecommunication terminal. User interfaces control various input and output devices that may or may not be accessible to blind users.

A three-component model of man-computer interaction has been proposed by Ziegler (1987):

- *The semantic*[1] *level* describes the tasks provided for the user by the system. It may be regarded as a user's mental model of a particular system;
- *The dialogue level* describes the dialogue structure and the associated syntactic rules.
- *The lexical level* describes the structure of input-output items.

User-system interaction takes place in terms of cycles, in which each cycle consists of a user action followed by a response from the system.

Basic Interaction Techniques

To make a graphics user interface accessible to blind people, it is necessary to divide the graphic environment into basic components, and reconstruct a new graphic interface that utilises the sensory abilities blind people may have. In the following, the main emphasis will be on techniques that are relevant in a graphics environment: that is, purely text-based displays will not be considered.

Menus

A menu is a list of options from which a single or multiple selections can be made by the user. It provides the user with an explicit list of available options, permitting selection by recognition, rather than requiring recall from memory.

Several problems may complicate the conversion of menus to non-visual forms. One is that the visual organisation of menus is not standardised. Several variations

1 It should be noted that the use of the terms does not correspond to the use of the same terms in linguistics.

exist, such as standard text (a single font style), text in different fonts, and graphic objects. Colour may also be used to convey information, and not just for decoration. Another problem is that several menus may be active simultaneously, and may even overlap, so that the front menu is active, while at the same time the display allows the user to see what other menus are available. Presentation of such information in a non-visual form is obviously more complicated than when only a single menu is active at a time.

The menu needs to be presented in a form that allows a blind user to scan through the options and to locate the desired requirement.

Messages

A message is textual information that is provided while the user is interacting with the system. Other than user confirmation it does not demand further processing, and may subsequently be removed from the display. In graphics-based systems, graphic images may be used, in addition to text, in order to add emphasis and to attract the user's attention. Such combinations are usually not very complex.

The conversion of messages to a non-visual form is simplified by the fact that the text contains all of the necessary information; any other visual symbols are used only for decoration or to attract the user's attention; in principle they could be omitted or replaced by sound effects.

Soft Buttons

Soft buttons are small displayed objects that are metaphors of real-world objects, such as calculator key-pads. They are usually labelled with text, which indicates what action will be initiated if they are activated, and they may be 'pressed' by using a pointing device.

A standard representation of all classes of soft buttons on a display should be defined. The label could be positioned close to the representation of the button, in Braille, or it could be spoken. The activation procedure also should be standardised.

Icons

Icons are graphical representations of objects and actions that are available to the user. 'An icon is something that looks like what it means; it is representational and easy to understand' (Brown, 1988). Icons may represent objects such as printers, files, windows, and folders; and actions such as 'wait' (a clock face), 'point' (an extended finger); and many more.

Tactile reproduction of an entire graphic object may be technically possible, but nevertheless not the most appropriate solution for blind people because of the difficulty and effort involved in understanding condensed visual information. Actually, only the object or action represented by the icon needs to be provided. The icon could be represented in a standard and universal manner on the display, and the actual object or task could be provided on user request, either in audio (synthetic or digitised speech) or tactile (Braille) format.

Dialogue Boxes

A dialogue box is an aggregate dialogue structure consisting of primitive techniques. It is useful when one wishes to combine, in a single framework, various interaction methods that have common semantics in a particular application, and which have to be provided concurrently to the user.

Dialogue boxes are used extensively in graphics-based systems. They are very helpful, because they provide a well-structured method of grouping related concepts in the dialogue. In a representation for blind users, a dialogue could be provided as a sequence of the reproduced primitive techniques, allowing the user to move freely from one to another.

Windows

Windows offer a well-structured method of dynamically dividing the computer display into multiple regions that are physically (visually) separated from each other, each used for a well-defined purpose. Because of its dynamic division, the topology of the screen varies with time. The number of screen areas, and the physical (spatial) interrelationships may change and cause re-arrangement of the contents of the display.

While accessing windows might appear difficult or even impossible for blind users, a closer examination of the problems reveals that under certain circumstances blind people may in fact be able to access a window-based system. For example, if tiled (i.e. side-by-side) windows were used instead of overlapping ones, an auditory output could be used more efficiently. Furthermore, with a small, fixed, number of windows, different sounds or musical tones could be used to tell the user on request which window was active. As the cursor moved out of the active window an additional, distinctive, tone could be sounded to signal crossing a border, and so on.

Man-Machine Interaction at the Lexical Level

Prior to describing the interaction tasks in a graphics environment, it is important to identify some of the criteria that determine the acceptability of existing or proposed tasks and techniques for blind (as well as for sighted) users. These include the amount of perceptual, cognitive and motor effort required by the various techniques, the load that they impose on a user's memory, the fatigue that they may cause a user, and the pleasure that the user may derive from using a specific technique.

Memory Load

The load imposed on a user's memory by the various interaction techniques comes in two forms: short-term and long-term memory load.

For efficient use of a terminal, a blind user needs to remember a substantial part of what is presented on the screen; for example, the content of menus. Because of the lack of visual cues that are available to sighted people, the short-term memory of a blind user may easily be overloaded, Furthermore, the continued tactile stimulation required during the use of a physical device such as a mouse, which is normally out of the field of view of a sighted user, may put an additional load on short-term memory.

Long-term memory load may be minimized by, for example, reducing the number and complexity of operations required to accomplish a task, by maintaining overall consistency, and by providing prompts at appropriate intervals.

Learning and Re-Learning Time

With regard to terminal use, the perceptual learning time involved in the use of a terminal may be regarded as the time it takes for a user to learn the patterns to be used as signatures for the elementary figures and sounds that make up a technique (Foley, Wallace and Chan, 1984). Within the same context, cognitive learning time may be regarded as the time required to learn the techniques needed to accomplish a task, while motor learning time is the time required to acquire the physical skills that are necessary to carry out the action. Re-learning time is a measure of the ease with which a user regains competency after not using the technique for some time (Foley et al., 1984).

Fatigue and Error

When using a terminal, cognitive fatigue may be caused by insufficient variety in a repetitive task, or by tasks that involve unpleasant stimuli, uncertainty, or excessive memory loads. Blind users are more susceptible to cognitive fatigue, since speech, hearing and touch, which have to substitute for vision are sequential in nature rather than simultaneous as is the case for vision. This results in an increase in memory load, in the time taken to complete a task, and in uncertainty about when the correct completion of the task is reached.

Perceptual fatigue may be more common among blind than among sighted users because of auditory and tactile clutter. Motor fatigue may be caused by poor mechanical design of the physical devices or by techniques that require the user's limbs to be placed in an unsupported or awkward position. Blind people are not guided by sight as sighted users are, and may therefore be more susceptible to motor fatigue.

In general, fatigue results in an increase both in error rates and in the time taken to complete a task, and in a decrease in user satisfaction.

Naturalness and Boundedness

Naturalness and boundedness may make the interface friendly and partly determine the pleasure a user derives from accomplishing a task. For example, naturalness may be a guide to the visual, auditory, and tactile forms that should be used and to the combination in which they should be used. Thus, if a blind user 'bumps' the mouse icon against the edge of the screen the sound of a bumping object should be provided.

Naturalness may enable users to put facts or data in an order that facilitates analytical thinking. Naturalness in motor activity coordinates devices with surroundings and context, and gives the user a proper sense of kinaesthesia, while boundedness is a measure of the size of the space within which the user must work: perceptually, cognitively, or mechanically (Foley et al., 1984).

Investigations of various graphics-interaction environments have led to the identification of several fundamental types of interaction tasks. These tasks are independent of specific applications or hardware and form the building blocks for more complex interaction tasks, and ultimately for the complete interaction. Foley et al. (1984) have proposed six types of interaction tasks:

- *Select:* an item is selected from a set of alternatives;
- *Position:* a position is indicated on a visual or a pin-matrix display;
- *Orient:* a direction in a two, three, or higher-dimensional space is specified on a visual or pin-matrix display;
- *Quantify:* a value is specified in order to quantify a measure;
- *Text:* if a text-string is part of the information transferred to, or stored in, the system by the user and does not serve as a command or is not converted to a value, position or orientation, text input is considered as a separate interaction task; and,
- *Path:* a specified path constitutes a series of positions and/or orientations created over time.

The main problem is that until now analyses of graphical user interfaces and related interaction tasks have been made for 'ordinary' users (and for most telecommunication designers, 'ordinary user' means young, bright and computer-literate). The same analyses should be carried out with reference to people with different types of impairment, and in particular for visually impaired people. This is one of the main tasks that needs to be carried out by designers if they wish to design telecommunication equipment, services and applications which can also be used by elderly people and by people with disabilities.

Access to General Graphical and Pictorial Information

The preliminary analysis given above has been carried out primarily with reference to those graphical user-interfaces for computers and telecommunication systems in which adaptations for visually impaired people seem feasible at present, through the use of multimedia representations of information (e.g. descriptions of the lay-out of the screen and of graphical components, using synthetic speech and/or transitory Braille). The same is also true for access to the text component of man-machine interfaces, services, and applications, which can be trapped and transferred through synthetic speech and/or transitory Braille.

A higher level of complexity is introduced by the problem of accessing the graphical, pictorial, and video components of services and applications. This is a completely new problem, created by the proliferation of computers and telecommunication terminals and networks.

Efficient methods for transducing these non-text information components in real time are not available at present. The problem has traditionally been studied, and partially solved, by using hard-copy tactile representations. Possible solutions that use tactile transductions to transitory displays and/or verbal descriptions after automatic interpretation or recognition have been proposed, but practical results have not yet been obtained.

It is only in the case of graphics, where a formal description is already available in the systems, that some results appear to be possible in the near future, even though criteria for describing complex drawings are not yet available.

Characteristics of the Haptic Observer

It should be self-evident that making information available is not the same thing as presenting useful information. However, in practice this distinction is easily forgotten. For instance, information that seems so unambiguous to the sighted inventor when presented on a tactile display may be of little use to blind users. In spite of the availability of the information, observers may have considerable trouble in understanding it; they may be quite unable to use it. The risk of this happening is especially high in cases in which the display attempts to reproduce information that was originally presented to another sense, as is the case in aids for the blind in which visual information is transformed in order to be presented to another sensory modality. The special characteristics of the substituting modality must be taken into consideration, especially those aspects in which it differs from the substituted modality. It has also been reported that blind persons differ in their ability to interpret spatial information. In particular, congenitally blind individuals, who never experienced the visual environment, may have difficulty in understanding spatial relationships.

In the following section some characteristics of touch, or rather of the haptic sense, will be described. The parts of the body that are especially involved are the finger tips, the skin of which is most often used to substitute for the visual sense. But not only the skin, with its several types of receptors, is involved: the receptors in the muscles, the tendons, and the joints also play a role. Together these receptors and the related executing muscles form a unified sensory system that is often called the haptic sense. In this context, touch is active; by moving the fingers, the observers search for information. This activity greatly extends the potential of the haptic sense, as compared with passive touch, where stimulation is applied to the skin of an immobile observer.

Much of our knowledge about the sensory functions of the skin comes from basic psychophysical studies of passive touch, including studies of the sensitivity of the skin to punctate static or vibrating stimuli, and the variability of this sensitivity in different regions of the hand and other parts of the body. This regional variation coincides with the innervation of different skin regions by different patterns of mechanoreceptors in the skin. Furthermore, the traditional basic measure of spatial resolution – the two-point threshold – has also been shown to vary considerably, since it is related to density of innervation and to the size of the cortical representation of different parts of the body.

The sensitivity of the skin to variations in temperature appears to be used in some situations for discriminating and identifying surfaces and objects. The sensitivity of the skin to electrical stimulation has also been utilized in some artificial displays.

These elementary forms of sensitivity are combined in a very complex way when stimuli vary both temporally and spatially over the skin, giving rise to such phenomena as temporal and spatial summation, funnelling, and masking. One important feature needed for tactile and haptic acuity in both passive and active presentations is the ability to adequately detect lateral movements across the skin and to identify the direction of this movement. This task calls for integration of information from several successively-stimulated points in the skin, and is aided by special movement- and direction-sensitive neurons at the cortical level.

A perceptual phenomenon that is of potential use for tactile displays is that a series of successive movements with different directions may be perceived as a form drawn on the skin, a sensitivity called graphesthesia. This may be related to another skill called stereognosis. By manipulating an unknown object with a series of exploratory hand and finger movements it may be possible to perceive essential features of the object and to recognize it.

Finally, it should be noted that – in common with most human skills – there is a wide variation in the abilities of haptic observers. It is sometimes claimed that blind people have a fundamentally better tactile or haptic sensitivity than sighted individuals have, but there is no sound evidence for this. It is not uncommon for blind persons to have below-normal haptic skill because of diabetes. When, as often happens, blind people are extremely skilful in using their haptic system, it is likely to be due to the fact that they have had more extensive training and experience in using this system than sighted people have. One important aspect of this training is the learning of more effective strategies for the haptic exploration of the environment.

Existing and Emerging Display Technologies

In order to obtain access for blind users to information provided in visual form, transduction techniques are needed to provide alternative forms of presentation. Image analysis and acoustic and tactile output are the primary techniques that can be used to solve some of the problems faced by blind and partially sighted users.

Image Recognition and Analysis

Computer image recognition is a promising research area that might allow blind users to interpret displayed images, and thus increase their access to visual information. Although computer image recognition is currently constrained by a number of limitations, within certain well-specified applications and under certain well-defined conditions (low noise, high contrast, two-dimensional images), reliable automatic image analysis can be achieved.

Some character-recognition systems are currently available. Although the problems involved in graphics recognition, interpretation and description are far from completely solved, it is probable that many of them will be overcome in the near future. Severe problems arise when image analysis has to deal with unconstrained images taken randomly from the analogue environment. Concise and meaningful descriptions of such images are not yet feasible, and much further research on image-recognition techniques, as well as on knowledge-based and artificial intelligence techniques is necessary in order to produce meaningful natural-language descriptions of the image content in the form of text or speech.

In cases in which automatic image analysis is not feasible or sufficient, human intervention could be considered as an alternative or supplementary solution. For example, a sighted person could simplify a complex picture by reducing the information contained in it to its most essential parts, after which image analysis could be applied. Such a method would only be economically feasible if the material that the human processed could be used repeatedly by the computer.

One of the important features employed by image analysis designed to produce useful and meaningful descriptions of images for blind people, is the perception of spatial or spatio-temporal relationships between objects or between whole images. Some kind of spatial and temporal knowledge of the world that is modelled, and from which the images under recognition are taken, should be included in these systems in order to distinguish such relationships. These may take the form of spatial knowledge that is based on spatial relationships ('above', 'between', 'to the left of'), and information about form (points, curves, regions, surfaces, volumes, location in space and continuity constraint), or temporal knowledge, based on temporal constraints and sequences.

Auditory Displays

Auditory displays may be divided into two fundamentally different classes: those in which information is processed and displayed as synthesized or recorded speech, and those in which the graphic information is converted into non-speech sound.

One of the easiest ways to achieve automatic speech output is to use a computer as a sophisticated random-access tape recorder (digitised speech). Recordings can be stored and played back as required. In its simplest form, this strategy is appropriate for applications in which a restricted set of high-quality predictable words or phrases is required to provide commands or to give information. Much greater flexibility can be achieved by concatenating stored waveforms that correspond to syllables or words, so that a novel message having high quality can be built up from a relatively small set of meaningful elements.

A modern alternative to machine-controlled concatenation of stored speech elements is to synthesize speech from a set of parameters. This method requires much less machine memory than the stored-waveform techniques. It eliminates the need for recording a human voice and makes available a virtually unlimited vocabulary. Rapid progress has been made during the past two decades in the development of algorithms and hardware for speech synthesis, at least for such common languages as English, French and Spanish. Modern circuits are compact, and offer speech that has lost much of the motion-picture-robot quality that characterized earlier efforts. The resulting synthetic or recorded speech displays are used in conjunction with ASCII-based text and numerical information.

The use of speech is not only a matter of presenting an utterance. Non-verbal features may be used functionally. For example, different voices (e.g. male and female voices or different speakers), can be used in analogy to the use of highlighting or colour on visual displays to highlight similar features as these do.

For most people, it is takes longer to listen to a message than to read it. To compensate for this, many blind people prefer a faster than normal rate of speech. Sophisticated speech-synthesis systems are capable of adjusting the speech rate according to the user's request without losing too much intelligibility, and this feature may prove important for efficient use of terminals for obtaining information.

When speech output replaces text or other visual symbols, the speech used should be consistent within its operation, that is, if the same function is used in different contexts, the speech output for this function should be the same. If a voice change is used, for example, to indicate a change of mode, this should be done every time that this change occurs.

Some efforts have been made to represent the shape of letters or simple pictures through the use of tones of different pitch or spectral composition. However, with very few exceptions no practical result has been obtained. One exception is characterized by a class of reading machines, developed in the USA after the World War II, in which manual scanning of lines of text with a special device resulted in a tone pattern that could be interpreted as shapes of letters and figures. Such systems were never widely used, and have been superseded by those that use synthesized speech.

Tactile Displays

Tactile output is an alternative method of presentation which utilises the tactual sense of the user. Tactile displays may be divided in two classes: the so-called soft-copy displays, and hard-copy displays. Soft copy means that the tactile stimulus is temporary, whereas in hard-copy the stimulus is made permanent, usually as a raised pattern on paper.

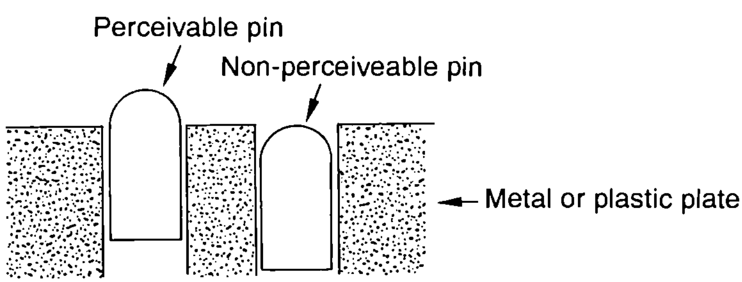

Figure 43.1 Section of a pin display.

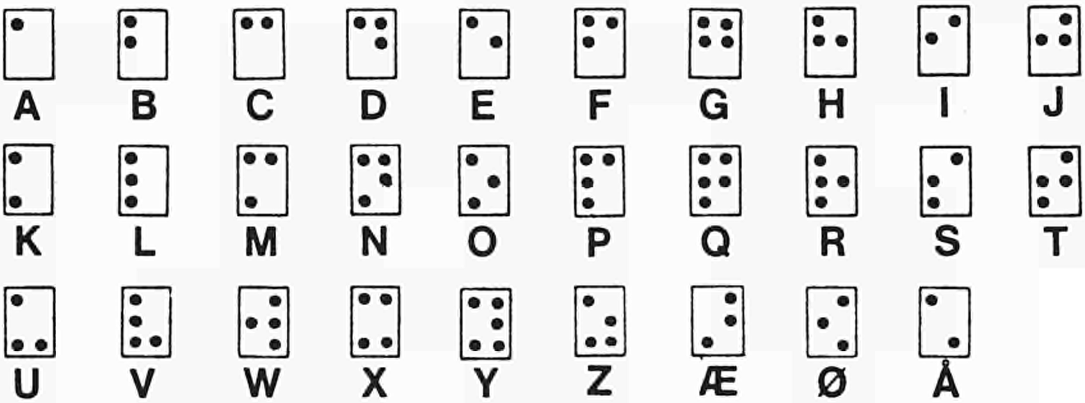

Figure 43.2 The Braille alphabet.

Tactile displays are normally perceived with the fingertips, but other parts of the body, such as the skin of the back, have also been used. Soft-copy displays are normally composed of a line or a surface of points, which can either be in an external (protruding) position or internal (withdrawn) position. The dots are often one end of a small bar or pin, which can be placed in the 'in' or 'out' position by a driving mechanism (Figure 43.1). The most common application is that of presenting the Braille alphabet (Figure 43.2).

Several other mechanical principles have been used to obtain the needed mechanical displacement. One produces bubbles on a plastic film, which can take one of two stable positions. The finger only detects a 'bubble' when it is in the outward position.

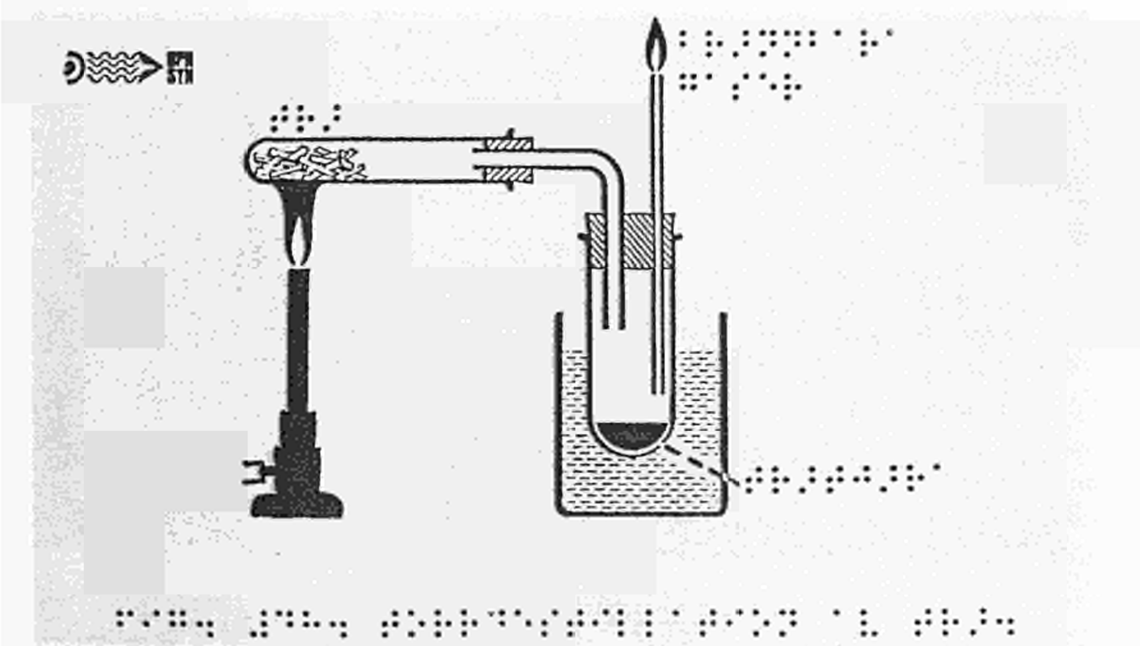

Figure 43.3 Swell paper with reliefs of picture and Braille letters.

In order to overcome the problems with mechanical devices, electrical stimulation of the skin has been tried in order to generate an 'artificial' tactile sensation. However, no practical device has so far been designed.

Hard-copy reliefs are normally made by embossing on paper, and different methods can be used. A simple method is to put the paper sheets between a soft-copy display and a corresponding die or rubber plate. Pressing the display and die together causes corresponding relief on the paper. A different method is to cause swelling of certain parts of the paper. This can be done either with the aid of special paints, which swell when they dry, or by using a so-called swell paper. Swell paper is a special type of paper that swells when heated. Heating can be confined to black (printed) areas of the surface, which thus protrude above the surface (Figure 43.3).

All soft-copy displays need a driving mechanism to move the pins to the upper or lower position. The most common technique is to use electromechanical devices, which are usually electromagnetic coils that operate the pins. Better from many points of view, however, are devices in which piezoelectric bimorphs are caused to bend by applying an electric current. Research in new areas has also been utilized in experimental devices. These include studies of magnetostrictive devices, memory metals, and micromechanics.

The need for soft-copy displays is wide-spread. Applications include those in which presentation is needed of only a few letters or digits (digital watches, lift indicators), one or two lines (computer applications) and full pages (computer applications, display of diagrams or pictures). The problems are challenging, and much effort in this field is needed in order to solve them (Figure 43.4).

Figure 43.4 A one line Braille display placed below a computer keyboard.

Perceptual Aspects of Currently-Available Displays

This section is concerned with how pictures and graphics may be presented in a way that is useful for a blind computer user, with special emphasis on some of the main perceptual aspects that are important for the effectivity of different technical options.

Pictorial Information with Different Demands

It should be noted that there are several different kinds of pictorial information, which place very different demands on the user and for which different solutions are appropriate (Vanderheiden, 1990). There are relatively simple graphics, such as icons that have the same form every time they appear, and stereotype figures that vary only within a specific format, such as histograms. In these cases the predictability of the figure may make it possible to replace a visual picture with verbal information. But there are also more complex still figures that have very unpredictable formats, such as maps and pictures representing real-world scenes. To these can be added moving pictures that change over time, such as animated graphics and television. The problems of reading non-visual versions of such pictures may be very different not only for the different groups of pictures, but also within each group; this is especially true within the more complex groups, in which there are many different degrees of difficulty.

Auditory Displays

A common solution to the problem of making pictures available to a blind reader is to provide a verbal description, in oral or written form. In the case of icons, this may be a adequate solution. In a similar way, stereotype pictures, such as histograms, may be transformed rather easily to a verbal explanation describing its content. It should be possible to present a description of such stereotype images in an automatic way without the intervention of a human interpreter. The problems are quite different with more complex figures. In these cases, for which there is no standard format, no automatic procedure is presently available. The possibility of using automatic image analysis, at least for some types of pictures, should be carefully investigated.

The other main auditory method of presenting a picture consists of a series of tones varying in frequency and/or amplitude according to a code for position and/or other properties of the picture, possibly combined with haptic information about the position of the hand. The identification of letters and simple geometrical figures has been studied experimentally. However, this method has not been very successful. This is not astonishing, since there is no natural context in which the sense of hearing has learned to interpret such information.

Tactile Pictures

The main alternative to presenting pictures for a visually impaired person is to make them available for tactual inspection. There are biological reasons for expecting that touch, or rather the haptic sense, will function well in such a task. The hands, and especially the finger tips, have demonstrated their great capability in providing information about many aspects of the environment; sometimes even more effectively than vision. For instance, it is often easier to judge whether a surface is smooth by using the finger tips than by visual inspection. Similarly, the quality of cloth can best be judged by feel. In spite of this, many problems have appeared in the interpretation of tactile pictures (Jansson, 1988; for a general discussion, see Kennedy, Gabias and Nicholls, in press). An extended discussion can be found in Schiff and Foulke (1982).

The conversion from visual to tactile presentation automatically implies a drastic reduction in the amount of information that can be presented, due to the relatively low information-handling capacity of the tactile system; this is a problem which probably can never be overcome. However, some kind of reduction or compression of information could be very useful to blind users (and to those with low vision as well), if the information provided to them were as condensed as possible. The information could be reduced by a person, utilising suitable tools; or it could be reduced automatically during a transduction process.

One of the major problems is the difficulty of getting an overview of a tactile image. This problem can be better understood if tactile perception is compared with the task of looking at a visual picture through a narrow tube that exposes only a small section of the picture at any moment. It is not possible to grasp the whole picture at one time, even if all of the fingers are utilized. To what extent the use of several fingers and exploration over time can be used to get a perceptual integration are interesting problems that deserve much more investigation.

Another problem is concerned with the perception of detail. It is puzzling that this should be a problem in tactile pictures, since there are many real-life examples of the haptic sense having very good discriminability, sometimes even better than vision (Katz, 1989). But for reasons that are not very well understood this discriminability does not seem to be fully utilized when interpreting tactile pictures. One obvious possibility is that we do not yet know how to encode information in a way that fully utilizes the capability of the haptic system.

A third problem concerns the representation of depth in the tactile pictures. This problem is related to a special limitation of tactile pictures, as compared with visual pictures. Tactile pictures do not have the remarkable double character of visual pictures: that of being, in a very natural way, both a two-dimensional surface and a representation of a three-dimensional scene (Gibson, 1974). A tactile picture is primarily perceived as a two-dimensional surface, if we disregard the variations in height necessary for the embossment.

A final problem to be mentioned concerns tactual coding of visual properties. In many cases such properties are translated, when transferred from a visual picture to a tactual one, in an analog form, as is the case with shape and size. This is not always possible. There are visual properties that cannot be translated into an analog form, but have to be coded: colour is an obvious case. There is no natural tactile counterpart to colour, and if something corresponding to colour is introduced into a tactile picture it must be by another tactile property, such as texture. It has not yet been possible to find enough tactually discriminable dimensions to replace these visual properties, nor – considering the relatively coarse coding of the haptic system – does it appear likely that a full substitution for vision will ever be possible.

Tactile Soft-Copy Displays

Soft-copy displays consisting of matrices of points have been used for both text and pictures. Displays for text may be rather small and have different distances between and within Braille cells. The ideal picture display should be larger, and the distances between the points should be equal in both height and width. From a perceptual point of view, it is not important what technical method is used to produce the vibration, elevation, or electrical current. What is important is an accurate description of the stimulation reaching the skin, usually at one or more finger tips (Jansson, 1991).

The properties that are important for enabling blind users to obtain an overview of the information have not been studied in detail. In practice, the usual procedure is to decrease the amount of detail, so as to prevent an excess of information from masking the main features. One interesting problem, again one which has not been investigated in depth, concerns the proportion of the display that is simultaneously in contact with the skin; that is, a comparison between displays in which the entire surface is continuously attached to a certain skin area, and displays that are available for exploration but in contact with a skin surface only when a finger tip touches it: for instance, a large pin-matrix such as the one developed in Stuttgart (Schweikhardt, undated). The latter kind of display allows extensive exploration by moving a very sensitive area of the skin over the display.

Another difference between displays that may be important is the display size in relation to the total picture. Can a small display, such as the Optacon (24 x 10 mm, covering the tip of a finger), be used to read a much larger picture, thus integrating over time? To what extent the possibility of obtaining an overview is affected by these different display properties is largely unknown.

A very important physical property of any display is its spatial resolution. This affects, for instance, the accuracy with which the display can reproduce different forms and textures, and also the possibilities for the user to detect three-dimensional features. The restrictions in soft-copy displays are severe because of the technical and economic problems of constructing a array of densely-packed stimulators, such as those used in the Optacon. It may be difficult to get an overview of a large picture from such a small display. A quite different solution is to build a display of a great number of stimulators spread over a large area, with lower spatial resolution. The possibility of perceiving three-dimensional properties in a stationary, soft-copy, tactile picture with low spatial resolution is rather slight, and may be non-existent. Many of the most effective forms of depth information in a visual picture, such as texture gradients and brightness distributions, depend on high spatial and brightness resolution, and are thus not available in a low-resolution tactile picture. The introduction of motion in the picture increases the possibilities of perceiving three-dimensional properties, but they are still rather limited (Jansson, 1980; 1983; Jansson and Brabyn, 1981).

The problems of coding in soft-copy displays are considerable, again because of the low spatial resolution. Most of the research on these problems has been concerned with hard-copy displays, and research concerning soft-copy displays is very much needed. In addition to these general aspects of matrices of soft-copy pictures, there are specific aspects for each kind of point stimulation, such as the frequency at which pins are vibrated and the amplitude of vibration; the height to which pins are elevated and the form of the top of the pin; and in the case of electrical stimulation, the different properties of the electric current such as voltage, frequency, and waveform. There are research results that are relevant to many of these aspects, but much remains to be done.

Tactile Hard-Copy Displays

The hard-copy versions produced by Braille printers have, in common with soft-copy displays, a rather low spatial resolution, so they share the same limitations concerning reproduction of forms and textures as those described above. There are, however, hard-copy alternatives that have a much higher spatial resolution. One of them is swell paper and another the Pixelmaster printer.

There are no exact data on the spatial resolution available with swell paper, sometimes called capsule paper, because its resolution is variable. Before heating, the spheres vary between roughly 5 and 100 micrometres and expand to different degrees depending on the amount of heating. With this spatial resolution it is possible, for instance, to present attributes, such as texture gradients, that are important for information about three-dimensional features. Recent experiments have shown that the fingertips can pick up this kind of successive change when it is presented on swell paper (Jansson & Hughes, in preparation). To what extent this capability of the haptic sense can be utilized for reading depth in a tactile picture is presently being investigated. The Pixelmaster 2 is a special adaptation of a general-purpose colour printer, which creates pictures by placing plastic dots of different colours on an ordinary paper with high spatial resolution. This method of producing embossed pictures with high precision is a very interesting one, and its potentials for reading tactile pictures should be carefully studied. Unfortunately, the manufacturers of Pixelmaster have decided to discontinue production, although it is possible that a similar device may be made by another company in the future.

Multi-Media Forms of Presentation

The area of tactile presentation of visual information is still beset by many problems, some of which may never be overcome. It seems obvious that the interaction of a blind user with a graphics-oriented system cannot be based on a simple tactile display, but requires a more sophisticated solution in which an 'intelligent' interface is able to provide the proper accessibility to a specific user. Thus, alternative forms of presentation need to be considered, which could be used in parallel with tactile information. For example, some acoustic signals (such as a sequence of tone frequencies) as well as speech could be provided concurrently with the tactile presentation, in order to allow an initial survey or a more detailed description of the structural organization of a screen. For example, the appearance of overlapping windows or menus on the screen could be indicated by acoustic signals and the content of the menu could be given by synthetic or digitized speech as well as in tactile form. This procedure could be combined with a speech input for menu selection. Another approach is the combination of tactile presentation with spatial hearing, or with kinaesthetic processes.

Conclusions

Once graphical and pictorial information becomes predominant, further problems may be experienced by blind people in addressing terminals and, hence, services and applications via telecommunications network. These have been briefly described, together with possible solutions based on transductions of visual information into alternative modes (audio, tactile and haptic) in order to provide an analysis of the present situation and possible future developments.

Possible solutions can stem from:

- developments in technology, which could make available at least limited capabilities of image understanding; and,
- the inherent multimedia quality of new integrated networks, which could allow the introduction of parallel representations of information.

From the point of view of man-machine interfaces, new approaches to the standardisation of software development systems, aimed toward software portability, could allow the development of standardised procedures for the implementation of man-machine interfaces. This would normally simplify the implementation of adapted man-machine interfaces for blind persons.

Acknowledgements

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44

Access to Newspapers via Telecommunications

Jan-Ingvar Lindström, John Gill and Carl Richard Cavonius

In most democratic societies, access to a range of daily newspapers is considered to be a normal right of every citizen. However, groups such as people with visual impairment, with a combination of hearing and visual impairment (deaf-blindness), with severe motor disabilities (e.g. tetraplegia) and with dyslexia or other reading disorders, have problems with access to printed material.

Many individuals feel that an important element of their quality of life is access to the daily newspaper of their choice. Therefore a number of projects have been done in various European countries to help more people achieve this facility.

The Users

Visually disabled people comprise about 1 per cent of the population in Europe, but it is likely that only 20 per cent of them would want to read a daily newspaper in a non-print medium. A printed newspaper frequently has relatively poor print quality compared to that needed by someone with impaired vision. Therefore access to the conventional newspaper is denied to many partially sighted people.

The number of people who have the combination of visual and hearing disabilities is fortunately small (about 100 per million inhabitants), but they have very restricted access to information: they have access to neither television and radio, nor printed material.

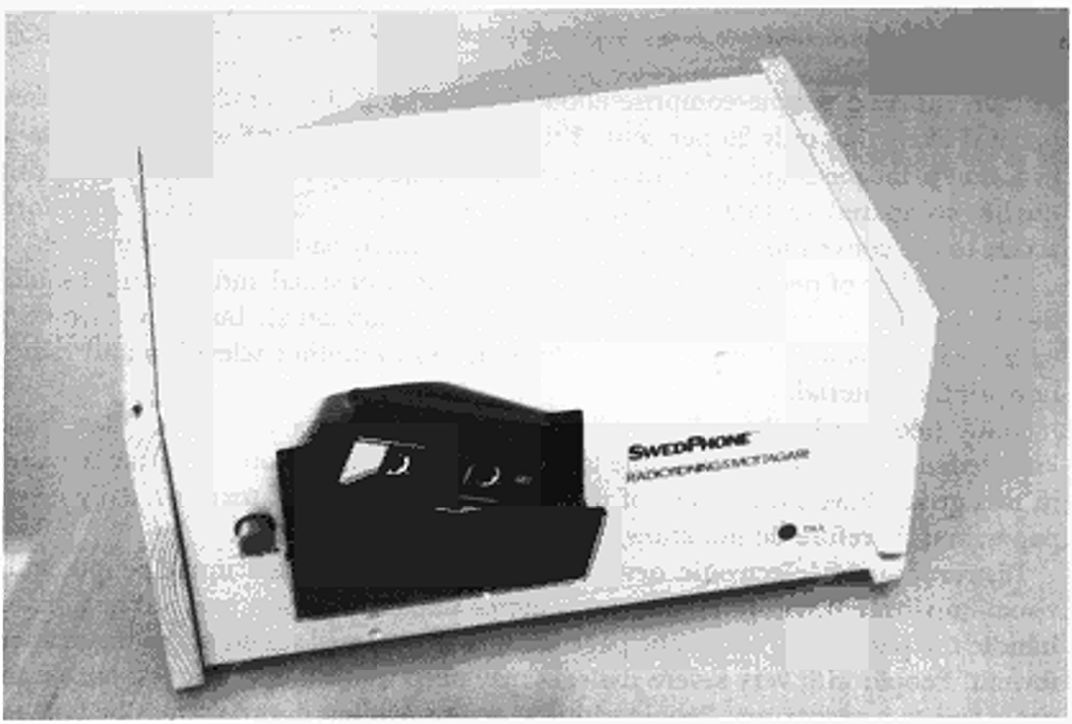
Many people who have been blind or deaf-blind since childhood have little knowledge of the services available to the rest of the population; for instance many in this group have no concept of the content or quantity of text in a daily newspaper, and therefore do not know what they could have access to.

Distribution of 'electronic newspapers' has mostly focused upon people with visual impairment. However, a severely motor impaired person may not be able to handle the paper, and automatic page turners are not well suited to the newspaper format. People with very severe dyslexia may need a (synthetic) spoken output to get access to a newspaper. People with less severe reading disorders may be able to read, although slowly, the headlines, shorter articles and part of articles. For this group, an electronic newspaper and synthetic speech output may be a supplement to ordinary reading, which gives them greater access to news and information, and thereby also more use of the standard newspaper. The size of these two target groups (people with severe motor impairment and those with reading disorders) is not well known, at least not with regard to the number of people who may want an alternative or supplement to printed versions of daily newspapers.

The Possibilities

For visually disabled people, the information can be presented in Braille, in audio or in large characters. Conventional techniques impose many practical restraints. For instance Braille embossed on paper can be produced directly from the computers used for composing the newspaper, but Braille is bulky as well as expensive to produce. A typical newspaper would need 5 volumes in Braille (each volume 5 centimetres thick). Therefore this method of production is only used for selected articles or for producing a weekly summary.

Another possibility is for readers to record the newspaper – again these are only extracts since a whole newspaper can typically take 15 hours of recording. These extracts can be distributed on cassette tapes or transmitted by radio. The cassette tape approach is used very successfully in many countries for distributing extracts of the local newspaper (there are about 400 weekly talking newspapers in the UK). With the transmission system, a radio channel is used at night with the broadcast being preceded by a coded signal which turns on a tape recorder in a blind person's home.



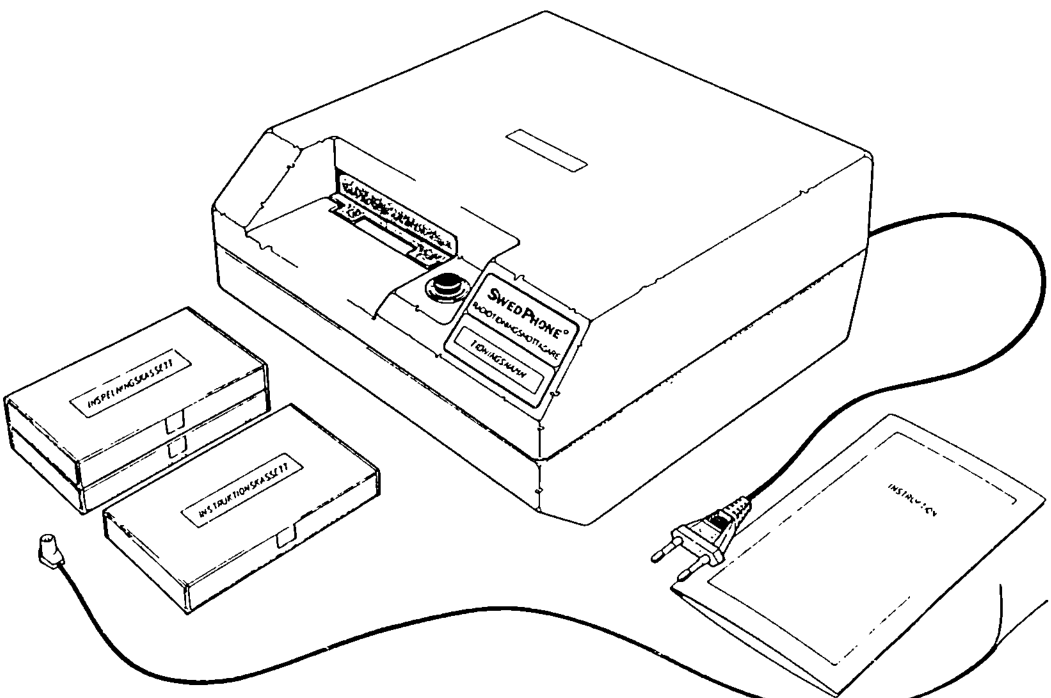
Figur 44.1 *Swedish radio/tape system.*

Listening to audio material recorded on tape does not require special skills, but it is difficult to maintain concentration over long periods of time. Also the speed of output is determined by the speed at which the material is recorded. A tape recorder can be speeded up but this normally results in a frequency shift in the output signal (i.e. the Pinky-Perky or Donald Duck effect). This frequency shift can be compensated with an electronic chip – this is often referred to as 'compressed speech'. However a number of elderly listeners would like to slow down the recording, which is referred to as 'expanded speech'.

Newspapers in large print are usually weekly summaries with the print set in a 16–18 point bold typeface; photo enlarging is not a satisfactory method since it does not achieve sufficiently good quality print. However access to a database containing the text of the articles can significantly reduce the cost and increase the speed at which a large print edition can be produced.

Access to the full text of a daily newspaper is the ideal but more difficult to achieve. It is technically possible to store the text centrally in audio form (either a human speaker or synthetic speech) and provide telephone access. This involves the user in navigating through the newspaper using the telephone keypad or speech recognition. This is relatively easy if the user knows what it is he wants to read (eg any article mentioning 'Gorbachev'), but it is very difficult to provide user-friendly methods for browsing (a facility which is readily available to a sighted person reading the print edition).

If access to the newspaper is in digital form, then the users need a device to convert the output to a form they can read – synthetic speech, a transitory Braille display, or large characters on a screen.



Figur 44.2 The transmission system.

The full text can be transferred to the user's personal computer by floppy disk but this is too slow a method for distributing a daily newspaper. Therefore other methods have been investigated – these include transmitting the text on a dedicated radio channel or using subscription teletext. The latter approach has the advantage that the transmission system already exists in most European countries, and teletext boards are available for IBM-compatible personal computers. It is this method which is currently being evaluated in a number of countries, and initial results are very promising.

For the text to be easy to read it needs to be structured such that the user can easily navigate through the text (a typical newspaper has 500 000 characters of text). In practice, this can be achieved by using the database structure used by the newspapers for retrieving articles from back issues. With the aid of menus, the reader may be able to jump quickly between headlines, introductions of articles, different authors etc.

Figur 44.3 A blind person reading the daily newspaper.

The Situation in Some Countries

Sweden was the first country to have an operational system. Their first version was based on using the whole capacity of a radio channel in the middle of the night; this meant that the complete text of the newspaper could be transmitted in a few minutes, but it did involve developing a special purpose receiver (Hjelmquist, 1988; Rubinstein, 1984). Therefore the German and British systems used spare capacity of subscription teletext to minimise the development costs of their systems. Finland has been experimenting with access via a modem, but they are planning to convert to the teletext system. Other European countries are mainly planning services based on teletext transmission. Another advantage of using subscription teletext is that it is a relatively small extension to the software to permit the user to have access to conventional teletext. The various projects in this area are being coordinated through the project 'Technology and Blindness' in the European Community.

In the USA many newspapers are facing increased competition and falling readership, and are therefore exploring new methods to attract readers and advertisers. A number are offering their subscribers news and advertising in an electronic format that can be displayed on a home computer. The Denver, Colorado, Rocky Mountain News offers its subscribers software without cost, with which they can receive a frequently-updated version of their newspaper by telephone. In Fort Worth, Texas, the Star-Telegram offers, for $10 per month, a service that not only supplies information from the Star-Telegraph but also stories from major wire services, and access to a reference file.

Since this information is transmitted in ASCII code, it is already in a form that is suitable for entry into a speech synthesizer or transitory Braille display. With the rapid change in newspaper technology in response to rapidly falling advertising revenue in the United States, it is safe to assume that many more papers will offer electronic news in the future.

A related but separate technology is 'audiotex', in which the user receives recorded information by telephone. Newspapers in the USA that offer audiotex, typically have several numbers, each carrying specialised information, such as general news, sports, travel, financial news, and the like. A variant of this technology requires a touch-tone telephone: the user dials a number to be connected with the newspaper, and then enters a 4-digit code to reach a specific service. This gives blind users an opportunity to obtain news without specialised equipment and software, but it does not permit browsing in the way that a computer-based system would.

Some newspapers that offer audiotex charge for the service (the charges appearing on the regular monthly telephone bill), whereas others sell time to advertisers and include the advertisers' messages with the news. The latter method is used by the Atlanta, Georgia, Journal and Constitution, which has what may be the largest audiotex service, receiving between 35 000 and 40 000 calls on a typical day.

The Future

Distribution based on computer and telecommunications technology is unlikely to replace conventional Braille embossed on paper or audio recordings ('talking books') for leisure reading, but does show significant advantages when the user wants to retrieve selectively from a large quantity of text (e.g. an encyclopedia or a reference book). If the delay introduced by using the postal service is acceptable, then floppy disks or – in the future – CD–ROMs may be less expensive media for distributing the information. However, for information that has to be current, such as newspapers, transfer via telecommunications is a necessity.

The systems described in this chapter are only suitable for text, and they are often difficult to use when there are tables or other special formats. None of them tackle the problem of communicating pictorial information; for some newspapers, the text makes little sense if the picture is omitted.

However, despite limitations, the use of digitally stored information for people who are handicapped in their access to important media, such as newspapers, is very promising. The results from field trials show that those who request information, in most cases cope with the added inconvenience of having to use menus, speech synthesis or Braille displays in order to navigate through their newspaper.

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45

Requirements for Telecommunication Terminals for People with Combined Visual and Auditory Impairment

Stephen von Tetzchner and Jan Håvard Skjetne

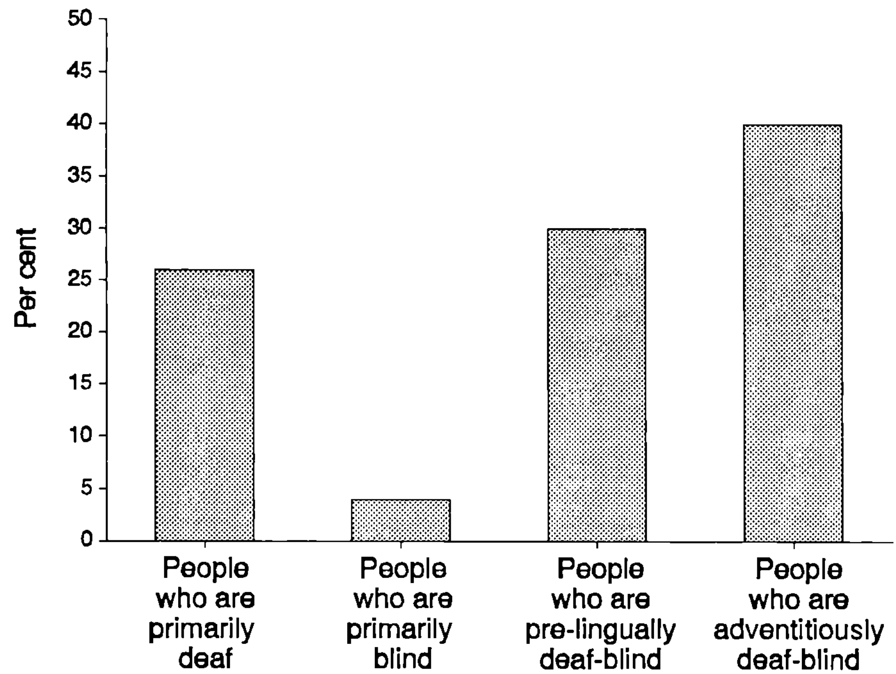
Telecommunication requires both communicative and non-communicative skills. In order to use a normal telephone, it is necessary to master spoken language, i.e. one has to be able to hear and speak. Instead of speech it is possible to use written words, but that requires the ability to read and write. The person must be able to perceive the writing by visual, tactile or haptic means and to have a way of forming his or her own writing using a pencil, computer etc.

There are four main groups of people with combined visual and auditory impairment, namely (Fuglesang, 1991):

People with congenital or early acquired deaf-blindness
This group includes people born with severe combined auditory and visual impairment, or who have acquired these before they learned to speak. They usually have lived in institutions and attended special schools. They make up about 30 per cent of the deaf-blind population (cf. Figure 45.1).

People with acquired deaf-blindness
This group includes people who have grown up with normal sensory abilities, developed the usual speech and language skills and have had a normal school background. They make up about 40 per cent of the deaf-blind population.

People with congenital or early acquired deafness
This group includes people who were born deaf or became severely hearing impaired at an early age, and have acquired a visual impairment later in life, often caused by Usher syndrome. They will usually have attended a school for deaf children. They represent about 26 per cent of the deaf-blind population.

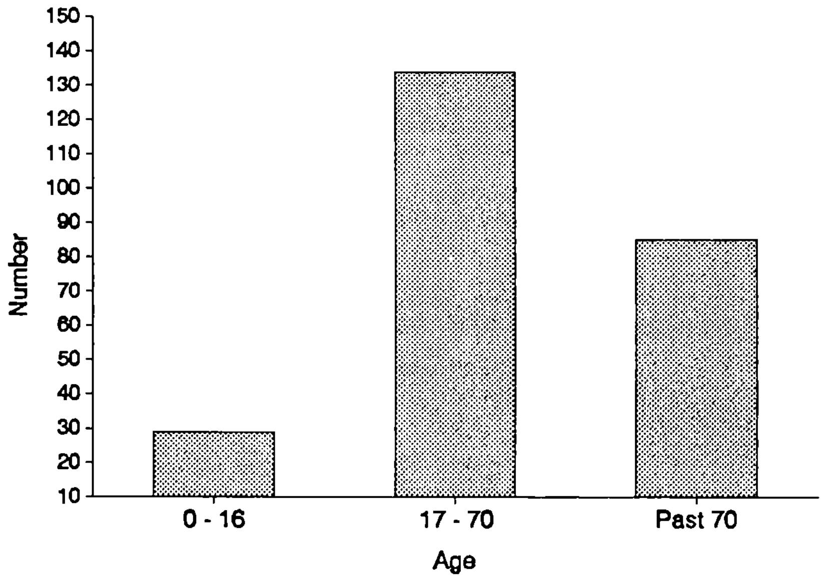


Figur 45.1 Different groups of deaf-blind people in the Norwegian register in 1990 (after Fuglesang, 1991).

> *People with congenital or early acquired blindness*
> This group includes people who were born blind or became severely visually impaired at an early age. They will often have attended special schools or classes for blind children, although today, most blind children attend ordinary classes. They constitute about 4 per cent of the deaf-blind population.

People with combined severe visual and auditory impairment make up about 0.005–0.006 per cent of the total population in Norway, but figures differ from country to country. In Sweden, for example, the percentage is twice as high. The average age of the Norwegian population is 55 years, and 30 per cent are 70 years of age or older (Figure 45.2).

Communication skills vary among people with combined visual and auditory impairment. Those who have become deaf-blind as adults usually have normal reading and writing skills. This is also the case for deaf-blind people who are primarily blind. Those who have grown up with Braille usually have the writing skills that are a prerequisite for communicating by text. Only a few of those who are outside this



Figur 45.2 Distribution of age among the registered deaf-blind population in Norway (after Fuglesang, 1991).

group will ever become proficient Braille users. Among those who are primarily deaf, reading and writing skills vary significantly. Most are able to understand and transmit written communication, but few are proficient. Most will be limited in their use of telecommunications because of their limited knowledge of spoken and written language, and a substantial proportion will have difficulty in communicating in writing beyond the exchange of simple messages.

Physical conditions also vary within the deaf-blind group. Some have useful residual sight and/or hearing, while others are totally dependent on tactile communication. These differences are also apparent in the choice they make for their preferred form of communication (Fuglesang, 1991). It should also be noted that many achieve the best communication by combining different forms at the same time.

Some general requirements should be specified for the telecommunication terminals for deaf-blind people. It is particularly important to find ways of conveying the fact that someone is calling and for providing information about the status of the line (dial tone, engaged etc.). Beyond that, different telecommunication terminals for people with combined visual and auditory impairment will have different advantages and disadvantages, and will require and utilise the different communicative skills of individual users.

Forms of Telecommunication

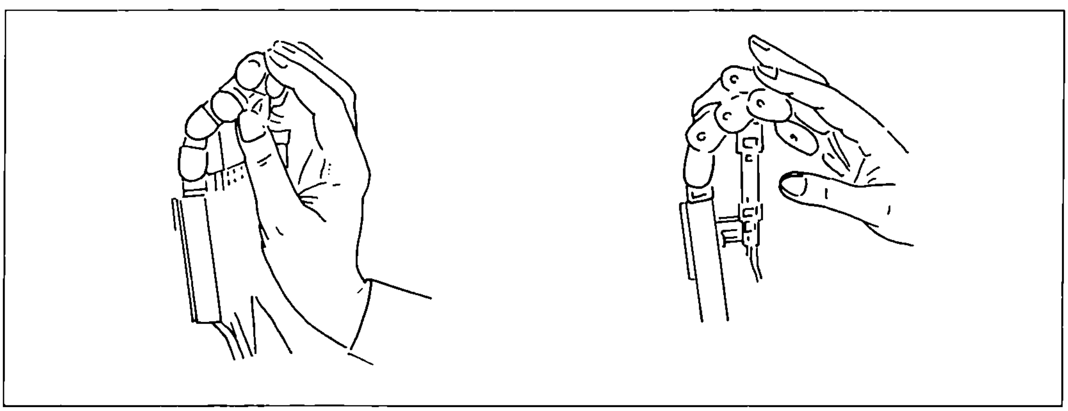
Some people with combined visual and auditory impairment will be able to make use of telecommunication terminals that are designed for people with visual *or* auditory impairment. They may be able to read enlarged print and hear amplified sound. There are, for example, telephones with extra sound amplification and text telephones with enlarged print. With the use of computers, there are programs that make it possible to adapt the size of the letters to the needs of the person.

One simple way to hold a telephone conversation is to base it on yes-no questions. This requires that the deaf-blind person can talk and that he or she can ask questions. The conversation partner can choose between several pre-arranged answers, such as *no, yes/yes, please repeat* and *wait wait wait wait wait.* The deaf-blind person can perceive these signals through a sound sensor that is connected to the telephone receiver. If the user has some residual light sense, a lamp can be used to indicate the length of the partner's utterance; or the sound signals can be transformed to vibrations, making it possible for the deaf-blind person to feel their length.

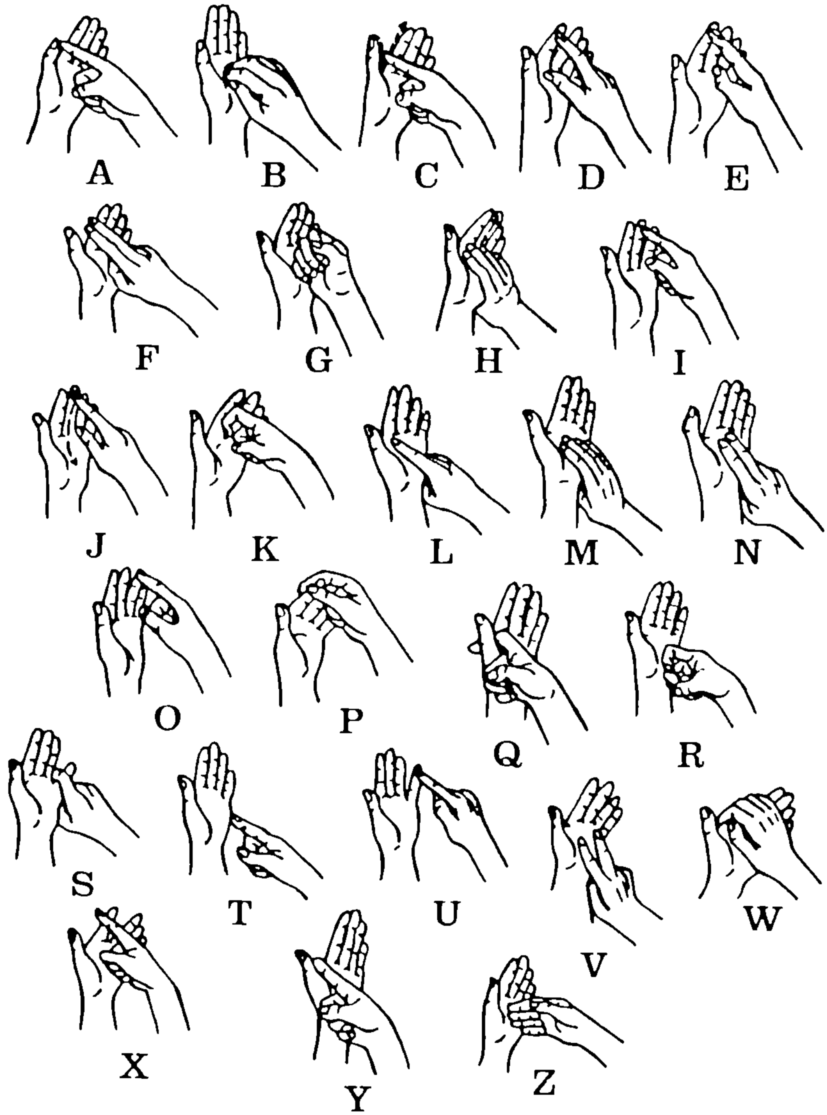
Commercially available telecommunication terminals for deaf-blind people are mainly based on Braille. This is unfortunate since only a minority of this group is competent in Braille.

Terminals are being developed that are based on writing, but which do not use Braille. DiaLogos is based on the Braille code, but uses larger vibrating pins instead of Braille cells. A mechanical hand, Dexter, has been developed in Palo Alto in California (Figure 45.3), which forms the letters of the American one-hand alphabet (Gilden & Jaffe, 1986). Dexter was originally a student project and it is not clear if and when a commercial version will be available.

In England Peter Grigson has developed Hand-tapper, a telecommunication terminal based upon the English hand alphabet (Figure 45.4). The user places one hand upon a plate, and small vibrating pins come up at locations on the hand corresponding to the letters of the hand alphabet (Figure 45.5). In the first prototype, the user writes on a normal computer keyboard or a Braille keyboard (Grigson and Giblin, 1989). Hand-tapper is expected to become commercially available soon.



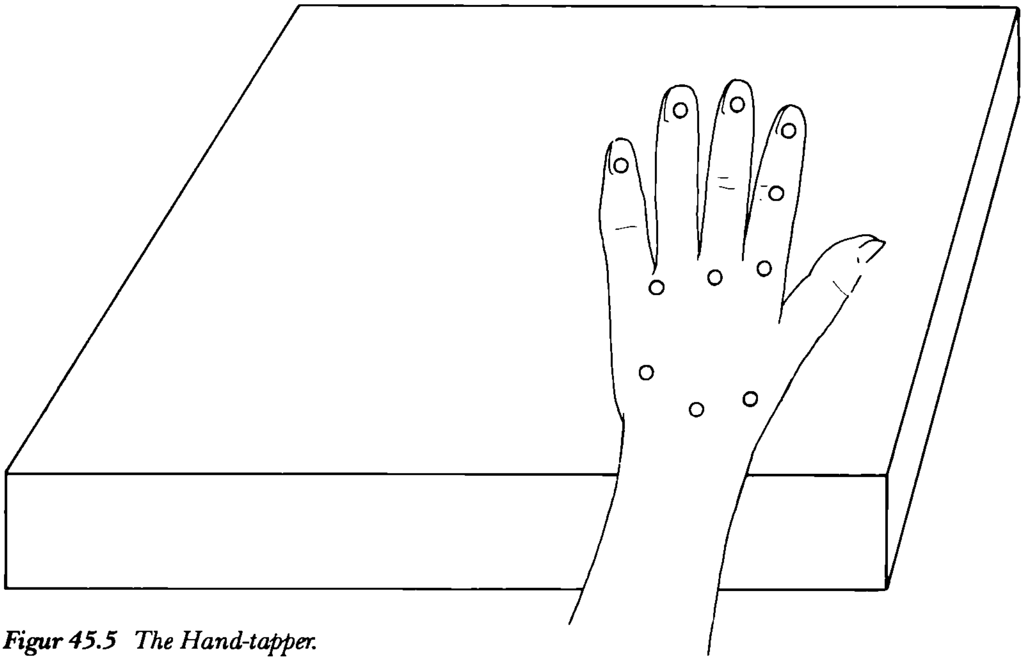
Figur 45.3 Dexter.



Figur 45.4 The English hand alphabet.

The advantage of Hand-tapper and Dexter is that they are based on hand alphabets that many users are already familiar with, so few new skills need to be learned. There is no documentation about how difficult it is to understand such mechanically executed letters, but there is reason to believe that they are easier to perceive than ordinary Braille print, and that these terminals may contribute to fulfilling the objective that more deaf-blind people should have access to telecommunications.

With regard to those who do not understand ordinary orthographic writing, there are no commercially available terminals today. One solution may be to apply tactile graphical forms, since some of those who are born deaf-blind show an ability to understand tactile graphics (Grønvik, 1990). It is not enough, however, simply to transfer visual figures to tactile ones, as has been done, for example, with some



Figur 45.5 The Hand-tapper.

graphic sign systems. A shape that is easily recognized visually is not necessarily easy to recognize as a tactile form. And what may be an immediately recognizable symbol for a sighted person, may not be obvious for a person who has learned to recognize things through his hands. Even large and simple drawings may not be recognized by intellectually well-functioning blind adults (Tollefsen 1991).

At present work is going on in several countries with the aim of developing telecommunication systems for graphical sign systems (cf. chapter 31). It would be natural within the context of this development to look at non-orthographic written communication for deaf-blind people.

Another solution may be to apply Teletouch, Dexter or similar devices, to convey coded signs. The touch patterns on Teletouch, or the finger positions on Dexter, would correspond to signs used by deaf and deaf-blind people. It may be possible to use only a limited number of signs, but this may still be a useful tool for sending and receiving simple messages. Even a limited number of signs may mean that the section of this group who are less proficient in reading and writing will gain greater independence and abilities to decide for themselves.

The videotelephone may provide a solution for those who use sign language and who have some residual vision. The contours of the signs can be made sharper through image coding, and thereby easier to perceive, even if the person under normal circumstances is not able to understand signs through vision alone. Some aspects of the signs are likely to be lost when this method is applied. However, if sign communication via telecommunications is made possible for deaf-blind people who have sign language as their primary form of communication, and who have difficulty in using other forms of communication, it will nevertheless represent a significant improvement. Videotelephones will in time come into common use, and consequently some deaf-blind people will be able to maintain contact with deaf people and other sign users through the help of a videotelephone with amplified contours. This requires that videotelephones with augmented contrast should be compatible with standard videotelephones.

Non-verbal and Paralinguistic Communication

Telecommunications are essentially a tool for achieving social contact. The way telecommunications is carried out should therefore be as close as possible to ordinary conversation. With a standard telephone it is not possible to see your partner, but through the intonation and intensity of the voice, it is still possible to get an impression of how the other person is. In written communication one has to rely solely on the text. The communication becomes 'flat' compared to face-to-face communication.

For people who are deaf-blind, the movements and physical posture of the conversation partner provide non-verbal information. A videotelephone that sharpens the contours of pertinent characteristics of the signs may be able to show some of these special attributes. Among the terminals based on the tactile sense, only Teletouch places emphasis on conveying this type of information.

Comprehension and Production of Language

For most deaf-blind people, comprehension and production of language are not equally affected. The main problem is to understand what others communicate. Those with acquired deafness and blindness normally have good vocal and written language skills, and are able to talk and write in a normal manner. Comprehension and production of language therefore become asymmetrical skills, and it is important to distinguish between them when discussing telecommunication terminals for this group. This means that the presentation to the deaf-blind person and the control of the terminal need to be flexible.

Common and possible ways of presentation are:

- display (VDU) with enlarged print;
- light;
- amplified speech;
- Braille;
- pins for tactile graphics;
- pins (e.g. DiaLogos);
- vibrating pins (e.g. Hand-tapper);
- touch (e.g. Teletouch);
- mechanical hand (e.g. Dexter);
- adjusted image coding; and,
- vibration (e.g. a membrane).

Common and possible ways of input and control of terminals are:
- standard keyboard (Qwerty);
- specialized keyboard (e.g. Dvorak);
- Braille keyboard;
- chord keyboard;
- teletouch;
- one hand keyboard (Microwriter);
- handwriting (computer with handwriting recognition);
- concept keyboard;
- voice recognition;
- switches (e.g. Morse); and,
- data-glove.

It is important to see comprehension and production in relation to each other, even if the skills required differ significantly. They must be adjusted to each other in order to optimize the simultaneous reception and transmission of text, as is the case in conversations between people who can hear and see. For a deaf-blind person with good vocal language skills, the most practical solution is to talk to the partner, so that the hands may be kept free to receive text. This requires simultaneous transmission of speech and text over the telecommunication network. This is not possible today if a standard modem is used, but the problem could be solved when the new telecommunication standard (ISDN) becomes available, since this has the capability of simultaneous transmission of speech and text. Consequently, the implementation of ISDN will be of great importance for people who have a combined visual and auditory impairment, but who are still able to talk.

One of the problems with Braille terminals is that it is not possible to send and receive text at the same time. It therefore becomes difficult to interrupt the partner. The ability to interrupt is especially important when communication is slow. The listener can become very impatient when listening to a long story he or she has heard before or when receiving the same message twice. With Hand-tapper it is possible to send and receive text simultaneously, because only one hand is used to receive. However, this requires either that the user writes with one hand on a standard keyboard or that a one-hand keyboard, e.g. Microwriter, is connected to the computer. The first prototype of Hand-tapper was designed so that the user writes on a Braille keyboard with both hands. Similarly, with Dexter, only one hand is used to receive text, and the other hand may be used to transmit text at the same time.

Teletouch is also primarily based on spelling (cf. chapter 46), but it is possible to interrupt a transmission and to give small comments (e.g. 'yes' and 'no') while the other is communicating, because the user sends and receives with the same hand (or hands).

It is very arduous to comprehend a sentence spelled out letter by letter. It is easy to lose coherence and misunderstand the meaning. Therefore it is important to be able to interrupt the partner and to ask for clarification when needed. It would also be helpful if particular key strokes could be used to repeat the last stored letter, word or sentence.

Storing conversations is a common feature in text telephones. This practice is unfortunate. Conversations contain mutual social actions that are not meant for later playback. In many countries it is illegal to record conversations unless the other party has given consent. If one wants to communicate something that should be stored, a letter, either through the mail or electronic, is a better choice. It is important to distinguish the functions of conversation and written correspondence, even if the disabled person uses the same terminal to converse and to produce letters. If the communication is slow, which is normally the case if one of the parties is deaf-blind, there is also a danger that the other person will not work hard enough to make the communication successful, because he or she may assume that the deaf-blind person will reread the conversation and get the meaning later.

Calling and Line Status Indications

To establish communications, the person who is called must be aware that someone is calling. This means that every telecommunication terminal that is intended to be used by deaf-blind people, must be fitted with some form of output device that the user can perceive, such as Teletracer with vibrator.

The line signals (e.g. dial tone, engaged etc) must be communicated in an unambiguous way. This is vital if telecommunications is to be independently employed by a deaf-blind person.

The security of knowing that they are reachable is essential for people who are deaf-blind; and knowing that they themselves can reach others is equally important. A deaf-blind person will encounter situations where he or she is unsure of what has happened or how to respond to it. An alarm device, which calls up an emergency service provides assurance, especially for the large proportion of deaf-blind people who live alone (Jakobsen, 1991).

Portability

Telecommunication terminals that are designed for people who are not able to use a standard telephone should be portable. Portability should be real, i.e. the terminal should not only be transportable by trained technicians, but should actually be light enough to carry and easy to set up by a person with no particular technical skills. A deaf-blind person who uses a large work station for telecommunications at home may need a smaller portable unit for use outside the home.

To obtain more control over their own personal lives, people who are deaf-blind must be able to communicate via the telecommunication network without needing to ask somebody to interpret. Although many in this group are fairly immobile and seldom travel, they may wish to travel and to visit others, stay at cabins or hotels, visit a doctor or go to a hospital, etc. Contact with family and close relations when away from home can be of vital importance, particularly in hospital. The average age of the group is rather high and the probability of periods in hospital is high.

Thus, there is a need to develop a portable telecommunication terminal for people who are deaf-blind. This would alleviate the problem of telephoning during travel and in strange places, and at the same time widen their activities in their immediate community, because the person will be able to call for help or information at any time.

Standardisation and Compatibility

The number of people who are deaf-blind is relatively small. Some of them know one another and have regular contact. It is therefore important that the different terminals used by this group are able to communicate with each other. However, compatibility does not have to include all functions. For instance, the non-verbal aspects of Teletouch cannot be easily transferred to Versabraille or other Braille-based terminals, but despite this it should be possible to transfer text between the terminals. The compatibility requirement is basically the transfer of text – i.e. ASCII characters – but this must be an unconditional requirement.

For deaf-blind people, the major part of their social network typically consists of people outside their own group. For those who are primarily deaf, including the large group with Usher syndrome, it is vital to be able to communicate with standard text telephones.

Today, a growing number of people have personal computers. Large sales have led to reduced prices on computer equipment. The price level is one of the reasons that one increasingly tries to utilise standard off-the-shelf products to put together equipment for people with disabilities. Custom made equipment is usually much more expensive. As a result of this, the same basic equipment may serve people who have different disabilities. Text telephones used in Finland, Sweden and Norway, can communicate with standard personal computers. A text telephone program has been developed which enables one to use a personal computer as a text telephone (cf. chapter 29). The computer is used by people with visual impairment for written communication and different forms of information gathering. Many people with a combined auditory and visual impairment may prefer to have a more generally useful computer than to use a text telephone, which cannot be used for anything other than text telephone communication.

Telecommunication terminals should be based on personal computers or be able to communicate with these, so that deaf-blind people can reach as many of the people they know and need to contact as possible. This should also be the case with terminals which only have the very basic functions, designed for less able people.

One argument for not using new equipment is that it is frequently not compatible with existing equipment. Compatibility with existing equipment is often emphasized for computer equipment produced for a large market (with variable success). By staying as close as possible to industry standards, one will also guard against too dramatic changes. Thus, communications based on personal computers as a common standard for all terminals will make it easier to try out and implement new equipment.

Integration of Other Functions

People who are deaf-blind are not only limited in their direct communication. Written communication is also difficult. Most deaf-blind people cannot read text even if it has been magnified, nor understand synthetic speech which many visually impaired people use to listen to text on the screen. It is therefore often desirable that the telecommunication terminal be a part of a more general work station (normally a computer) so that the user requires only one tool to communicate, either by ordinary letters, electronic mail, or text telephone. Ideally, the same terminal should be useable for reading books and other written material.

It is possible to use a computer where the text on the screen can be transferred into a readable form for the person involved and hence into a wide range of telecommunication functions. Some of these are:

Electronic mail
Letters are transmitted as electronic mail via the telecommunications network, either to the user's mail box in a data base or direct to his or her own computer (cf. chapter 30). This means that a deaf-blind person can handle the mail independently.

Electronic conference systems
Electronic conferencing and electronic mail are closely linked. It is possible to mail letters to individual persons in an electronic conference, as well as giving and receiving individual presentations in more general discussions. It is a form of communication well suited to deaf-blind users because the users can retrieve other people's presentations and read them and prepare their own presentations, at their own pace. However, the conference must not be too large and difficult to navigate in. The Swedish Association of the Deaf-blind has positive experiences with electronic conferencing (Ohlsson, 1991), and regards electronic conferences as an important service for deaf-blind users.

Newspapers
There are currently several attempts in Sweden and some other countries to transfer newspapers to computers (cf. chapter 44). The Swedish Association of the Deaf-blind inputs news on a daily basis to a data base called 'Permobasen' (Ohlsson, 1991).

Fax
Computers can now transmit and receive fax messages. The problem with receiving a fax, which is a graphical medium, is that it has to be encoded into text – i.e. ASCII characters – before the computer can present it in a readable form to a deaf-blind user. The relay services may possibly undertake this translation and thereby make use of fax available to deaf-blind people.

Videotex

It is possible to use a program which enables a computer to operate like a videotex terminal. Such programmes are normally free of charge (for example PC-Tex in Norway). By using an output adapted to the individual deaf-blind user, videotex may give such users access to interactive and many other useful services (e.g. the telephone directory).

Education

Since telecommunications are an important part of society, learning how to use telecommunication terminals should be a natural part of (re)habilitation.

It is often said that equipment should be so easy to use that training is not necessary. However, it is not always the case that what is simple to use the first time is best in the long run. For example, the equipment may have a somewhat detailed interface which makes it easy to understand without instruction, but after a while, when the user has become more familiar with the equipment, this level of detail may become a source of irritation. The user may then want a faster way to carry out functions.

The objective of simplicity can also contradict the function of the equipment. No-training is not always desirable because some functions are more useful after training. Deaf-blind people are able and willing to train. They often do not have a lot else to do, and it is not necessarily a disadvantage that training takes time, provided that it is functional and that the users are able to understand what they are doing. The ideal telecommunications device should have a low barrier to simple entry functions, and the opportunity, with time, to learn more advanced functions.

Relay Services

Very few people outside the group of deaf-blind users have a terminal that is designed for this group. This is also the case with those who are part of the deaf-blind person's support system, as well as his social circle (family, friends etc.). Some may have a text telephone or a computer, but not all computers have modems and suitable software. Equally, the user may not know enough about how a deaf-blind person communicates. It is therefore necessary to have a service that can relay conversations.

This service may be handled by the ordinary relay service for text telephones, but preferably by operators who have a good knowledge of terminals used by deaf-blind people, the forms of communication used by this group and how this communication is actually carried out. Furthermore, there should be special telephone numbers for this group, so that there is no waiting. This form of telecommunications is very demanding, and having to wait could make the deaf-blind person give up the call.

Economy

Written communication is normally slower than speech. It takes longer to read Braille than ordinary writing. When only one or a few letters can be read at a time, this means that the communication will be slow. However, in practice conversations by deaf-blind users do not tend to last longer than ordinary telephone calls. The reason may be that they usually limit the conversation to what they have planned to talk about, and omit unnecessary words (Ohlsson, 1991). This seems to indicate that for this group, telecommunications is mainly used to pass on messages rather than for chatting.

In Norway, disabled users of text telephones receive a refund of 600 time units (approximately 600 Norwegian kroner) in order to compensate for some of the time difference between written and vocal conversations. The compensation should be larger for deaf-blind people, because their written communication is slower than using an ordinary text telephone. The Swedish Association for the Deaf-blind refunds their members' use of the data base 'Permobasen' by a logging routine. On average, forty-five members call once a day and stay on-line for fifteen minutes (Ohlsson, 1991).

Many deaf-blind people have limited financial resources. It should be a governmental responsibility to make sure that it is not more expensive for a deaf-blind person to purchase and use a telecommunication terminal, than it is for other people, especially since this group of people is socially isolated in both their close and distant communications. A system which refunds their costs is therefore needed, so that economic barriers do not limit the opportunities telecommunications can create to overcome social isolation and provide access to information for people with combined visual and auditory impairment.

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46

Teletouch

The Transfer of Tactile Kinaesthetic Information through a Telecommunication Device for Deaf-Blind People

Warren M. Brodey and Hans Kristian Holmen

Perceptual and communication aids for those with sensory loss is a field of increasing interest to those involved with telecommunications. The present chapter reports on the development of a communication aid for deaf-blind people.

The chapter is divided into a functional description of the work and the concepts on which it is based, and a technical description.

Perceptual Resources of Deaf-Blind People

In addition to possible residual vision and hearing, deaf-blind people use the touch and kinaesthetic senses for communication. These senses are rarely conceptualised by those who see and hear.

The kinaesthetic sense is the sense of position and movement. It allows us to walk upright and perform the movements with which we do work. The kinaesthetic sense organs are attached to the muscles where they sense muscle extension, to the tendons where they sense muscle contraction and they are mounted on the joints where they signal joint angle by sensing pressure.

The tactile and kinaesthetic senses work as a system. This system allows people to feel their own body, to know and control its dynamic liveliness, to learn body skills and to use them, and to know the intimacy of body contact.

Because of these senses we can feel a handclasp in complete darkness and stillness. In meeting another, the rhythmic dance of the handgrasp is both extremely meaningful to making decisions, and difficult to describe. Is the handclasp one of wet cold tension, or stiffness, or flabbiness, or forcefulness, or angry resistance then sudden collapse?

For the deaf-blind person who cannot see the details of facial expression, or know changing voice tones, decisions must be made from close contact exchanges as well as words spelled onto the hand.

Tactile Kinaesthetic Telecommunication

For convenience, it is easiest to present Teletouch in terms of the hand as the sender and receiver of tactile kinaesthetic communication. The development of Teletouch has been focused on the need of deaf-blind people to have a telecommunication device that will allow them to use the hand's:

- light touch, texture and shape sense;
  vibration recognition;
  deep touch or pressure sense;
- sense of light passive pressure as when holding a lightweight object;
- sense of actively pressing and manipulating what is held with muscle force as in doing delicate skilled work;
- sense of actively opposing resistant forces, as with holding an angry child; and,
- capability to grasp without looking, using remembered force and counterforce, and the complex patterns these create as they change dynamically. When we catch a ball thrown from one hand to the other without looking, we use such remembered skills.

It is difficult to objectively describe the dynamics of a handshake, or the force exchange between two people cooperating in muscular work. But these exchanges are basic, and it is these experiences we seek to transmit over the telecommunications network with Teletouch.

The Teletouch Telecommunication Module

The Teletouch telecommunication module as presently constructed allows one person to feel another person's hand pressure and movement telecommunicated over a distance.

The principles used in constructing a pair of Teletouch modules are:

- for the users, both modules are analogue devices;
- both modules can send and receive information simultaneously. (The sender knows what he or she is sending, and recognises the remainder as being from the other person);
- the terminals press onto and receive pressure from the hand sufficient to cause the muscles to move, respond, and to activate the hand skills and memory banks etc; and,
- vibration is added to reduce accommodation.

The familiar telegraph key is not an analogue device. It is an 'on' or 'off' device. Our normal computer keyboard is the same. A Braille point display lifts a pin to show a point or it does not. It is also, for the user, a digital device.

In contrast, the Teletouch key is analogue. How the key is pressed is transferred to the receiver. Just as with the telephone, the whole voice is sent. The finger's force of touch and movement are sent, and simultaneously received by the person

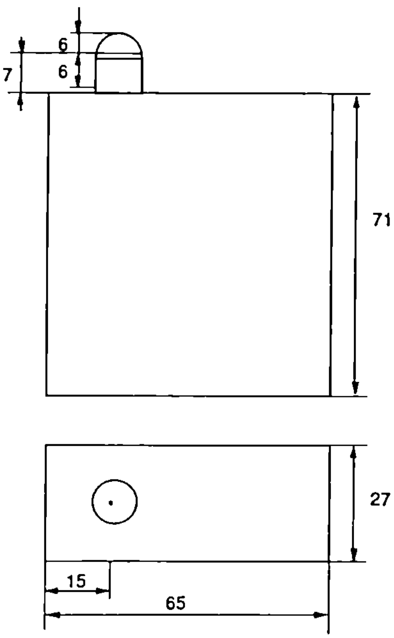


Figure 46.1 Teletouch module.

at the other end of the line. The receiver feels the pressure and movement generated by the sender against his or her own finger.

When holding hands, the person's hand sends and receives information simultaneously, and in the same location. In contrast, the mouth as sender and ear as listener, are in different locations. They may send and receive simultaneously and/or sequentially.

Our aim is to use the natural simple skill of the hand learned from birth. Therefore, Teletouch is structured to take advantage of the essence of tactile kinaesthetic communication. Teletouch users can both press and feel the return pressure with the same muscles and sensors. Sensing how the pressure pattern one sends is resisted, is a part of reading the reply.

An Example of Single Module Communication

A deaf-blind man who is able to speak is at his office. He wishes to call his wife. He dials, waits for what he guesses to be the right interval, and speaks into the phone, telling of his plans to go home. Not being able to hear, he does not know if the line was busy, whether his wife was home to receive his call, nor whether she heard his message. And if she did hear his voice, whether she had replied with reasons that he should come home at that time or earlier.

If the husband's and the wife's phone each have a Teletouch module connected to them, then she can answer his questions. The module vibrates in a characteristic way to indicate that the line is not busy. When the wife answers the telephone, she can press on the module to signify that she has answered. The husband feels the way she has pressed and knows her mood. Her hand movements he knows well since he is so dependent on such information in daily life. Her greeting signal is different from the children's, who also could have answered the call.

The communication continues. The husband asks questions to which the wife can reply by using a code they have chosen. She can shape whatever pressure sequence they have agreed to mean 'yes', 'no', 'maybe', 'wait' etc. He can reply with his voice or by shaping the pressure he uses on his module surface. By opposing her movements he can express his disagreement in addition to saying what he means.

Thus, whatever pressure is exerted on each key is transferred to the other, and the nonverbal context which helps define the meaning of what is said is not removed as it would be if the system was based on a simple 'on' or 'off' signal.

Multiple Module Communication

The assembly of Teletouch modules into a Teletouch terminal is presently under way. Each module has a 2,7 x 6,5 centimetres active area, a height of 7,1 centimetre, and weighs about 80 grams. Two different configurations have been devised:

- A six to eight module terminal configured to imitate a Braille keyboard, but used for both sending and receiving. This prototype will consist of two groups of three modules for two hands (Figure 46.2).
- A five module keyboard based on the Microwriter spelling system. This would use all the fingers (Figure 46.3). A sixth module may be added to be operated by the wrist.

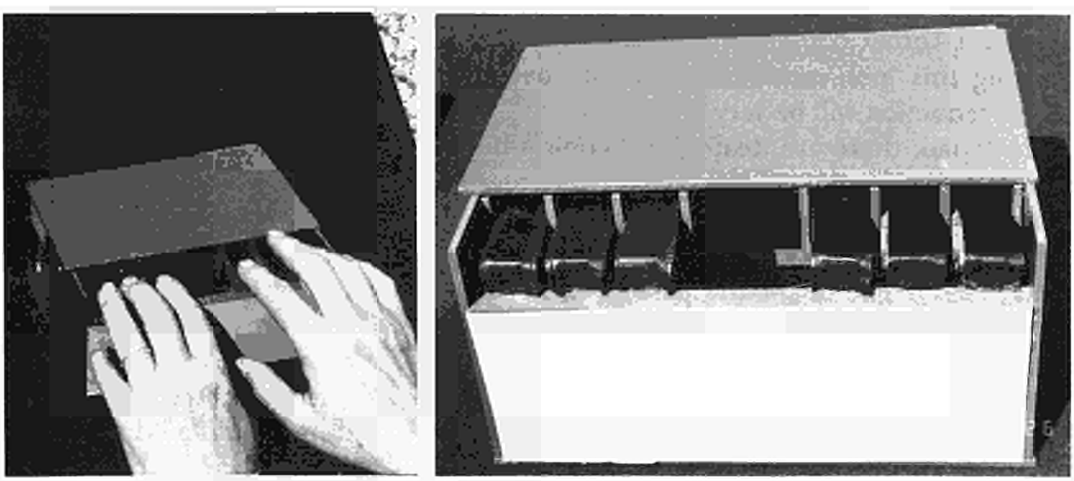


Figure 46.2 Teletouch modules grouped as a Braille keyboard.

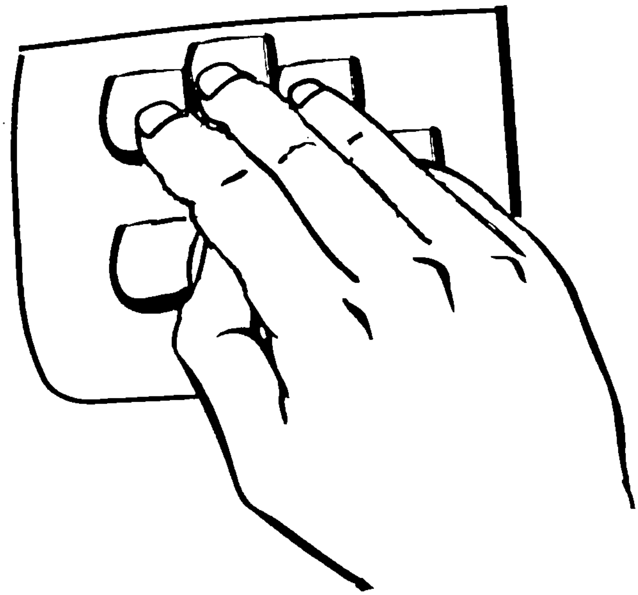


Figure 46.3 Teletouch modules grouped as a Microwriter keyboard.

Initially, these modules will be mounted on flexible frames and moved about to obtain an ergonomically optimal arrangement. For example, it will be necessary to adapt the modules to the size of the user's hand. The prototype structures will be evaluated by a user test group of deaf-blind people, who function as consultants throughout the development. In addition, there is collaboration with interpreters and professionals working with rehabilitation of people with combined visual and auditory impairment.

Codes for Teletouch Communication

As argued above, there are 'natural' codes for tactile kinaesthetic communication. The non-verbal context should modify a specified verbal content. It is in transmitting this 'non-verbal' information that speed of transmission, resolution and noise reduction will be very important.

In Japan, there are deaf-blind people who use the Braille code for face-to-face communication (Fuglesang, 1991). The interpreter presses the person's fingers as if his fingers were Braille keys, and in this way they read as if reading Braille. It has been suggested that a Teletouch terminal may function in a similar way (Fuglesang, 1991). The deaf-blind person spells his or her message by pressing the keys with the usual Braille finger combinations. To read, he or she feels the keys pressing up against the fingers.

However, conclusions with regard to suitable codes, teaching techniques and function commands, must await further field studies with the multi-modular units. The aim of this development is to make users able to utilise as much of their communicative competence as possible.

Requirements for a Teletouch Telecommunication Terminal

Structurally, the terminal should be lightweight, pocket sized, and battery operated.

It should fit comfortably into the hand. The active elements should be adjustable in position to fit many hand shapes, and be easily customised to be used by those with deformed hands. Similarly, adjustment of the key dynamics, e.g. preferred pressure and excursion, should be possible to optimise user skills and styles.

Easy connection to ordinary telephones provides many possibilities. The terminal should, but need not, have a mobile telephone (radio) capacity. Lightweight mobile telephone units are becoming available.

For communication with sighted people, for example in a store or a coffee house, the Teletouch terminal should have a small (calculator size) keyboard so that sighted people can type in their messages. These could be translated to the Teletouch spelling code, and the deaf-blind person's reply could appear on a liquid crystal display. The use of modular add-on synthesized or stored voice equipment gives other capabilities. Size, weight and power requirements set the limits on these possibilities.

The terminal should be built so that it can be used as a computer peripheral, i.e. as an interactive mouse. The computer can be local, or accessed via the telecommunications network.

The non-verbal codes that are used to transfer context information e.g. 'slow down', 'I want to speak now', 'I don't understand', 'I am laughing', should be either 'natural' codes, for example the different ways people touch, or they should be well based in experience and easily learned, for example gestures like wiping the hand across the keys in one direction or another, or tilting the hand so one side presses up, or wiping the fingers across the keys one at a time etc.

More abstract codes should be based on already developed codes such as hand spelling, Braille, stenotype codes, etc. Icons for indicating computer windows, and tactile illustrations, should be creatively considered.

Computer based teaching programs and exercises can be developed to help the user to fully utilise his or her Teletouch, thus reducing dependence and teaching costs.

Technical Description of Teletouch

General System Requirements

The prototype is a basic module consisting of an activating element formed in the shape of a simple 'push button'. Each module is made up of a sender and a receiver. Two modules can be coupled together for duplex transmission. Between the modules there can be transmitted two way tactile information. That is to say, this tactile information can flow from module A to module B and vice versa.

The way the system works and its functions can be described thus:

> The two modules A and B are controlled by two persons, person PA and person PB. The activating element each person controls can be called 'a' or 'b'.

Consider that PA presses on 'a' (his or her activating element). Consider further that PB at the outset does not press against 'b'. PA will now feel that 'a' can be pressed without noteworthy resistance, while at the same time 'b' will move up without noteworthy time delay. But if person PB now presses on 'b' then this information will almost instantaneously cause 'a' to press against PA's finger with almost the same force that PB used (see Figures 46.4 and 46.5).

Thus, persons PA and PB will both feel the force from their communication partner's finger via the activating elements. (It is of course acknowledged that the feeling of directness in the communication is dependent on rapid transmission of the response).

Possibly each and every finger, and eventually also parts of the hand will be able to interact with several modules. Teletouch could in this way be developed to transmit information about moving shapes and eventually structures.

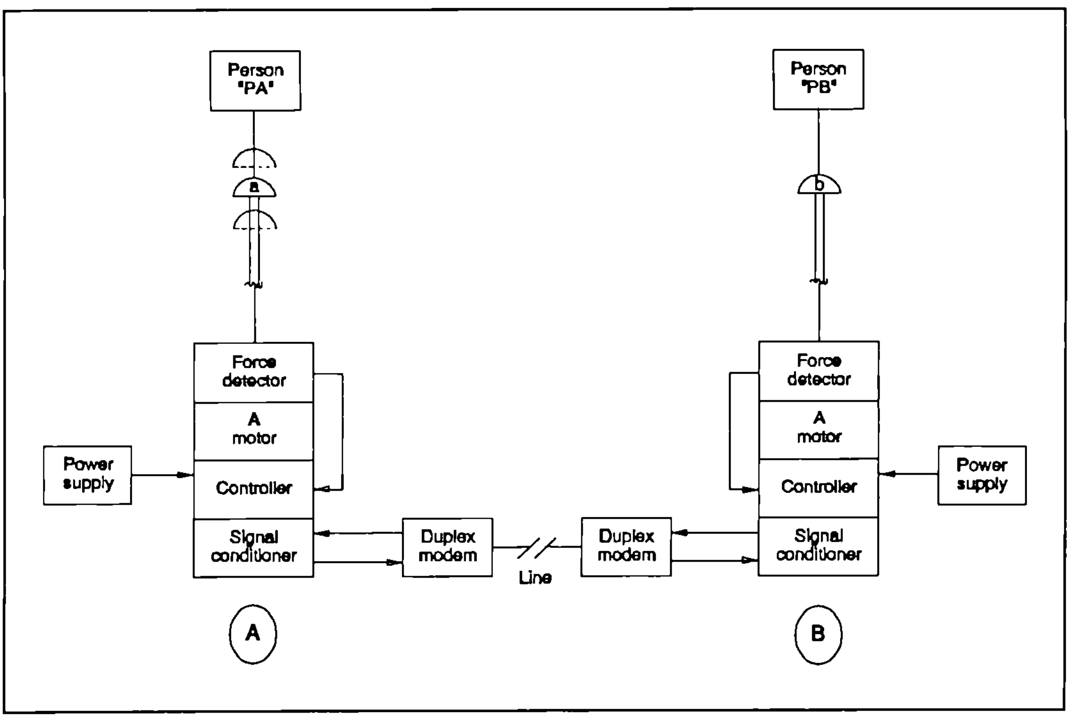
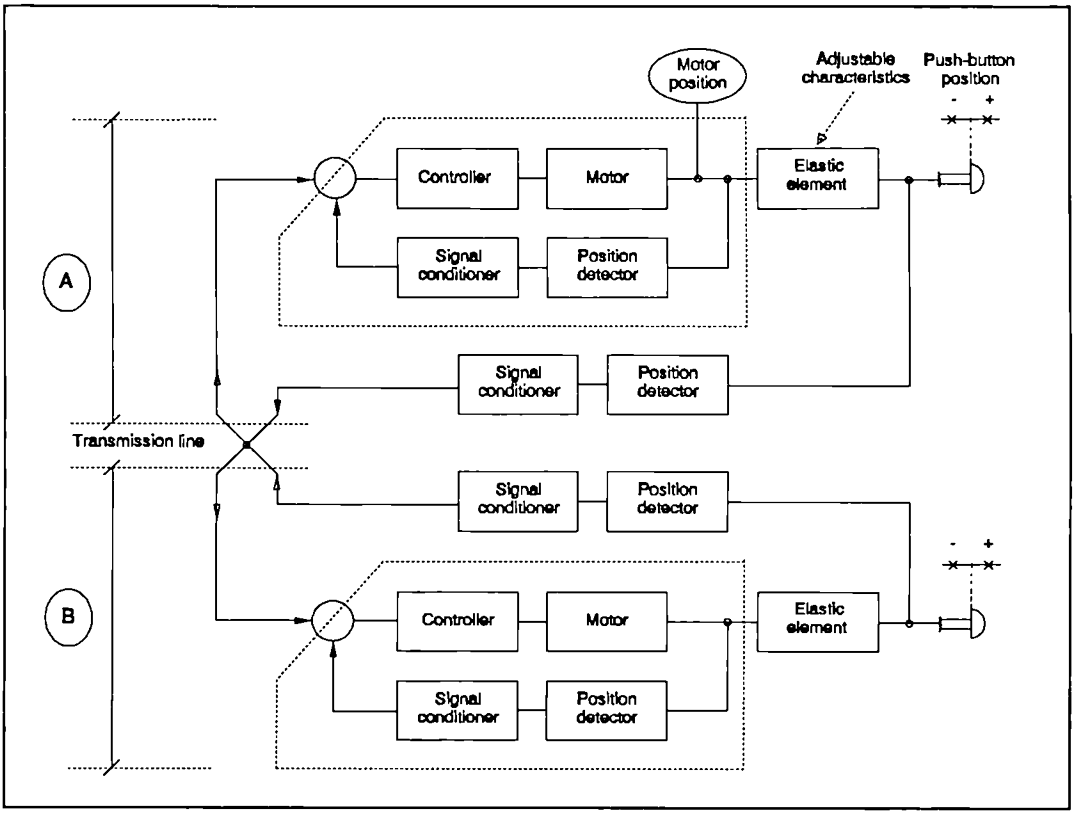


Figure 46.4 Communication between two Teletouch modules.



Figur 46.5 Block diagram of Teletouch modules in a one-to-one duplex transmission.

The Basic Components in a Teletouch Module and in an Established Communication Between the two Modules

The block diagram in Figure 46.4 illustrates the functional description in the above paragraphs. Figure 46.5 shows two modules coupled for one-to-one duplex transmission between elements A and B. The most important components are the 'push button', the elastic part, motor, position detectors and signal conditioning elements.

Push button
'a' and 'b' provide the interface between the user and the module (see detail in Figure 46.4).

Elastic element
When the user presses the 'push button' he or she compresses the elastic element. The more he or she presses, the more the elastic element is squeezed together. The project has, so far, worked from the assumption that the force used to push the 'push button' will represent the force that the user wishes to send i.e. that there will be a linear relation between the counterforce experienced by the sender and the force generated by the receiver.

In principle the transfer function can be made non linear. The force (as well as the amplitude) can be scaled up or down, and the signal or force can be modulated with additional information, for example in the form of vibration of a controllable frequency. However, so far no effort has been directed to this possibility.

Motor

The motor has the task of positioning the reference part of the elastic element. A motor with position feedback must be dimensioned such that the position reference does not give way or move when it is exposed to the force which is transmitted by its own 'push button' via the elastic element, at least as long as that force does not exceed the value the equipment was built to withstand i.e. 2,5 N (ca. 0,25 kp force).

In addition, the motor's position reference, i.e. it's reference for the elastic element, must move rapidly to the position indicated by the 'push button' on the distant module to which it is directly coupled. Thereby the motor simulates the muscle function and movement of the remote person sending the tactile information.

The elastic element simulates in an equivalent way muscle force. In a later stage of the project, after the system has been shown to be practical and user experience has been analysed, it is anticipated that there will be a basis for developing and testing alternative transfer functions relating to force/deformation/amplitude for the combination push button/elastic element.

Position detector

Each of the modules must contain two position detectors. One detector establishes the position of the reference part of the elastic element in relation to a reference baseline. In practice this base line reference will be the surface the Teletouch module is resting on. The other position detector will specify the position (degree of depression) of the 'push button'.

Signal conditioning

Figure 46.4 shows also various signal conditioning devices in block form, such as the controller for the motor, and the signal conditioning unit for the position detectors. The control element for the motor regulates the power supply such that the motor will move quickly to the desired level but not beyond.

Specifications

Requirements for a set of prototype modules consists of specification for the force transmitted, amplitude of movement, response time, dimensions and weight, communication interface and power consumption.

Force that can be transmitted

Minimum dynamic region 0–2,5 Newton (ca. 0,25 kp).

Minimum amplitude of movement
Transmitter button should be able to be pressed down about 5 mm. The receiver button should likewise move 5 mm up. This means that the preferred movement amplitude is 10 mm peak to peak for each module.

Response time
Changes in the transmitter's activating button's position requires that the receiver's button tends to change correspondingly without the operators registering any delay.

In practice the following response was considered acceptable: With an immediate change of the transmitter's activating button's position from 0 to 100 per cent the receiver shall reach 90 per cent amplitude within 100 ms, that is 4.5 mm in 100 ms.

Physical dimensions; size and weight
No special requirements have been set for the prototype. Later it will be necessary to specify detailed requirements regarding small dimensions and low weight.

Communication interface
No special requirements have been set for the prototype. Later the equipment must allow parallel and duplex communication between several parallel cooperating modules (most likely a minimum of 5 modules) over one analogue telephone line.

During further development the advantages that are created by adopting the to ISDN must be taken into consideration.

Power consumption
Power consumption should be low such that the equipment can be powered by dry cells and eventually rechargeable batteries. The use time per battery or per charge should be long.

Future Trends

The importance of telecommunication for everyday life in society has been growing steadily ever since Bell invented the telephone, and one may expect this trend to continue in the future. The last section of this book takes a careful look into the future, trying to determine what possibilities technology may provide for improved telecommunication for disabled and elderly people.

The future is approached by looking first backwards, trying to find out how technology and services have developed in the past, and then follows these developments a little further into the future, assuming that the trends will not change abruptly.

The historical perspective is followed by a technology forecast along the same lines, looking at new devices and services that may appear. A further chapter then looks at the possibilities of a society that is more accessible for people with disabilities.

To forecast the future is not easy, particularly as one has to do it beforehand! The motivation for a forecast is not necessarily to predict the future correctly, but rather to make the goals one should try to reach clearer. Some of these goals may be achieved later than expected or never come true while others are reached much earlier than expected. The overall goal is a good life for everybody with optimal independence and self-reliance, and telecommunications are one means of achieving this. However, without a clear view of future trends, one may not be able to know neither what specific goals to aim for nor what strategies should be applied. The aim of this section is to provide a basis for monitoring and evaluating future developments.

Jan Ekberg

47

Projections from the Past

Jan-Ingvar Lindström and John McEwan

Remote communication is almost as old as mankind. There is evidence that optical signalling by means of fire, torches and so on, was part of early civilizations, and long before the discovery of electricity, optical signalling was organised for the transmission of important messages. This formed an early part of nation's safety, especially in times of warfare and other disasters. This optical signalling had an important drawback, however, it was completely dependent upon clear weather.

A big step forward was taken with the discovery of electricity in the eighteenth century, and its later exploitation as a carrier of messages. The great breakthrough came with the development of the telegraph, which became an important part of the development of railway transportation. One can postulate that without the fast signal transmission provided by the telegraph, railway transport could never have developed to the extent and importance it did in the nineteenth century.

The next important step came with the development of the first primitive telephone, invented by Graham Bell and patented in 1876. As an interesting side-note, Bell was trained as a teacher of deaf people. Obviously, some of those people were not profoundly deaf but had some residual hearing, and that inspired Bell to develop a sound amplifier, based upon an electro-magnetic principle. He failed in so far that the device didn't amplify very well, but it had the capability of transmitting sound via electric wires over some distance. Thus, the remarkable invention of the telephone was made. His basic idea however, the hearing aid, was not realised until the invention of the electronic valve was made in the beginning of this century.

A few decades earlier, another important discovery was made, namely that of the transmission of radio waves. This made it possible to go beyond earth-bound transmission and reach vehicles in the air and at sea. It is no exaggeration to say, that what the telegraph had meant for the development of railway transportation had a parallel in radio transmission for ships and aircraft.

Two remarks can be made on this first era of telecommunications. One is, that the new inventions were also used for security and emergency situations, and that without these inventions, most of the mass transports could not have developed in the pace and scale they did about one hundred years ago. Secondly, the needs of disabled people were a low rated activity, which meant that once again exciting possibilities were not followed up. Indeed, a third conclusion is temptingly close, that powerful inventions on behalf of society in general, are not always beneficial to people with disabilities. The telephone is perhaps the most important invention ever for the benefit of remote communication, but it has also widened the gap between the normally hearing and the hearing impaired members of society. The hearing part of the community could rationalise their activities and increase the comfort of their lives, whereas those who were deaf and hard of hearing still had to use mail or travel themselves in order to transmit messages.

Transmission technology developed over the years, and remote text as well as picture communication was realised, albeit based upon electro-mechanical principles, and consequently rather slow. It is interesting to recognise that during this period text communication was established in the form of the Telex transmission system, which in principle was a versatile tool for deaf and hard of hearing people's remote communication. However, it was not until the 1960s that this category of people got access to text communication by buying secondhand telex machines and using them as text telephones. This happened in the USA, and it took more than a decade before the possibility was tested in Europe, with electronic terminals as text telephones. Again an illustration of society's priorities: the technology was there for a very long time before it was made available to those who perhaps needed it most: the disabled part of the population.

Is today's situation any different? Since the Second World War electronic information and communication technology has developed tremendously. It is difficult to measure the pace of change, but in terms of inventions per time unit it is true to say that the development is exponential. There are a number of key inventions which have accounted for this: the invention of the transistor just after the Second World War, the laser technology that took a big jump forward in the sixties, and the development of fibre optics that was developed during the seventies. In parallel with this went the miniaturization of electronics, with the micro-chip as the most significant example. Together with industrial processes for mass manufacturing, this has led not only to the provision of devices for safety and military purposes, but to large supplies of general consumer goods at low prices. Perhaps this is the most important development of our time: to be able to produce sophisticated electronic equipment for special groups of consumers at reasonable prices. Regrettably this does not mean that the development will happen by itself. In order to promote a development of this kind, particular directed efforts have to be made.

What next?

Communication and information technology is developing at a speed which is difficult to follow, even for people who are experts in the field. This means among other things that the impact upon society is difficult to forecast in general, and still more so in special areas such as that of the needs of people with disabilities. The future is full of possibilities and, regrettably, problems.

The most overwhelming problem on behalf of people with disabilities will be the inability to be aware in time about what is going on, and to take steps and measures in time to avoid problems. An illustration is the on-going development in the field of codec technology for digital transmission of sound and picture communication. Who has cared about the needs of lip reading for hard of hearing people or what parameters that are important for the transmission of easily discernible sign language? Or take the spread of service handling public terminals for banking, travel information and so on. Nothing has been done in order to supply those who are blind or partially sighted with alternative modes of information. The social needs are obvious and the technology available. Who decides what to do?

Service facilities are needed and possible to provide once designers get the required knowledge and decision makers take their responsibility. There are numerous examples of the possibilities in the presentations below.

The recognition by some technological societies, for example the USA, of the needs of disabled people to participate in paid employment, has led to laws which try to prevent discrimination against people with disabilities when technical solutions are available. On the other hand, deregulation and the subsequent privatisation of telecommunication operators can lead the benevolent actions of the previously public owned telecommunication companies having to reduce subsidies on devices and services for disabled people in due recognition of their duties to their new shareholders and the laws that protect the shareholders from bad management by the directors of the company. Ironically, we may have to bring in re-regulation to protect underprivileged citizens. For example, the situation concerning the proliferation of handsets, in homes as well as public places, that lack induction coils restricts the ability of many hard of hearing people to use the telephone in conjunction with their hearing aids.

The progress of micro-electronics and micro-processor based devices will widen the gap between mass market devices and adapted devices. In the past it was possible to adapt a software package or computer input or output device and still have a product that was 'state-of-the-art' and not much more expensive. This is no longer true with products changing every one to two years, shrinking in size through integration by the use of chips and with more and more feature-laden software based user interfaces. The engineers can no longer gain access to the inside of the chip or the software to make the modifications or achieve them in the lifetime of that product's generation. This leads to devices for people with special needs which are obsolete, non-competitive and no longer maintained.

It makes sense that pressure should be brought to bear on manufacturers and service providers to consider this need for modifications to cater for the needs of disabled and elderly people. This can be done through the provision of defined interfaces that allow for the addition of new facilities or devices for these groups of people. Experience from the USA shows that if customers, in this case the Federal Government, requests its suppliers to provide suitable equipment that can be adapted for disabled employees, it will be done.

However, the attitudes of designers and those responsible for the marketing of products needs to be changed. It is often the case that many engineers see themselves as typical users and that their successful use of the product will ensure its usability by the population at large. However, as designers they are most likely to be in the top quartile of ability and they also bring to it internal models of how the product operates. Unfortunately, the opposite is true for most users of their products – the variation of users' abilities, both physically and mentally, is great. Nevertheless, the consideration of the needs of disabled and elderly people in a product design will ensure a sounder and much wider base of user requirements and thus produce a more acceptable and easier to use product.

Many of today's hi-tech communication devices use intelligent or computer based terminals. This places a high cognitive load on users, requiring them to remember large amounts of information and often to have some degree of training. This will impede the uptake of new telecommunication services by disabled and elderly members of society. Hopefully in the future, videotelephony will be available without the intervention of computer based user interfaces. This service provides a simple and immediate communication channel between two or more people at a distance. As is being shown, for example, by experiments being conducted under the European research programme RACE, its simplicity can make a strong impact on the lives of elderly people and people with disabilities by allowing them to be 'visited' more often by carers through the videotelephony link. The presence of the person's image makes the communication more real than sound only telephony and may provide social interaction which gives relief to the isolation many of these people suffer.

Technology and telecommunications are changing the lives of all of us. It can integrate or isolate people with special needs from the society around them. Efforts to integrate these people more into our communities must be strengthened, if necessary by legislation, if technological isolation is to be prevented. The work of COST 219 in raising the importance of these issues in the telecommunication industry has impacted, and hopefully will continue to impact, designers until they consider all their users and not just the elite.

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Technology Today and Tomorrow

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The aim of the following chapter is to present some potential developments of telecommunications, signal processing and related technology and to suggest their possible impact on the socio-economic integration of people with disabilities. The main concern is not to elaborate on technical detail, but to make general suggestions of what could happen or would be necessary in the future, for the attention of those who work within telecommunications and disability and who plan future services and applications.

Many of the suggestions presented in this chapter are for future developments and applications of available technology, which may make it difficult to distinguish between the technology of today and projections for tomorrow. There is both hope and reason to believe that other unexpected developments may also occur in addition to those which can be predicted today.

Future Telecommunications

The key date for advanced telecommunications in Europe is 1995, at least, this is the year in which the programme on 'Research and Development in Advanced Communications Technologies for Europe' (RACE) foresees the introduction of commercially integrated broadband communications (IBC) services. The main elements of this progress are the developments in digital electronics and optical communication technologies. The first of these makes possible the compression and encoding of information in such a way that huge amounts of text, images and sounds can be 'packaged' and transmitted efficiently and economically, and decoded and presented in many different forms. The 'highways' of optical fibres, with their enormous capacity and low loss, will greatly increase the speed and fidelity of the transmission and multiply the amount of information that can 'travel' at the same time through the same telecommunication channel.

But to be fair the advances in telecommunications should to be viewed in conjunction with the computer technology revolution. This is also the only way to understand scenarios of everyday life of citizens in the electronically conditioned societies of the next century. Environments at home and work, communications, leisure, as well as art and creativity, are and will be increasingly supported and shaped by electronic systems.

The Leitmotifs

Multiplicity

Multiplicity could be one of the leitmotif in the technological evolution that will help shape the environment in the next two decades and beyond. A multimedia system can process, store and transmit moving and fixed images, data, text and sounds in real and non-real time. This includes to information from data bases, such as text, audio and video; interpersonal messages through voice, text and images in real time (allowing people to communicate in a way as similar as possible to being in the same room) or in a delayed mode; distribution of video, audio and text materials, and many others.

The terminals for these systems are called multimedia terminals, and as such, they are multifunctional. They integrate at least three elements: the telecommunication terminal, the television set and the computer. That is why one speaks about *telematic systems* or *telematic terminals* (merging telecommunications and informatics).

A multimedia terminal offers many services or media, and the opportunity to operate many functions in the same unit, such as television, video, radio, videotex, teletext, electronic mail, telefax, telephone, videotelephone, computer, audiovisualrecording and answering, video and computer conferencing, a learning/ training tool, a trading instrument, a working place, a leisure station, a surveillance and control channel, and a telecare linkage, to mention the most obvious.

Interacting and Interfacing.

Computers bring into the multimedia systems the possibility of going beyond the simple reception or exchange of communications (like in television, telephone, radio or video services). They offer the means to act on the contents of such communications. This is the *interaction.*

This aspect of the relationship between the user and the telematic terminals is closely linked to the way in which the user deals with the terminal hardware (physical elements) and software (logical functions). Despite the great development of very attractive interfacing solutions, the techniques for interacting with multimedia telematic terminals seem to become technologically more complex, and less easy to use for most people. The development of more user-friendly interfaces seem crucial for use of future telecommunication terminals and services, and will probably be the main criterion for evaluating the degree of accomplishment of the IBC expectations.

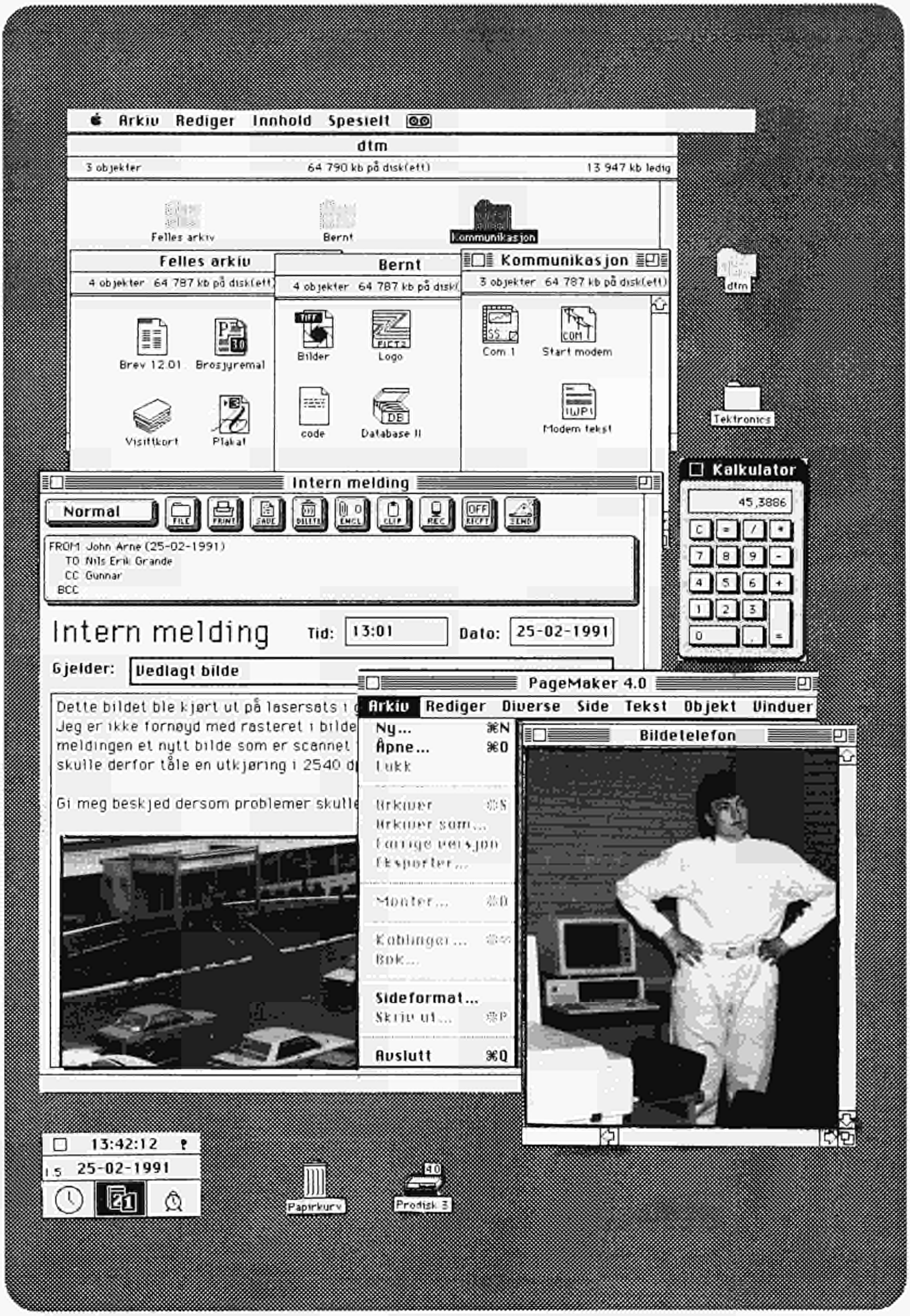

Figure 48.1 A multimedia terminal. (Source: Norwegian Telecom Research Department)

Intelligence

Advances in software within the computer industry are being transferred to telematic terminal design and development, in as much as the computer capabilities are being integrated into the telecommunication system. Distributed computer networks allow delivery of information from one group, individual or machine to another. Systems are becoming more 'intelligent' as elements of human expertise are transferred to the computer, allowing it to 'assess', 'decide' and 'choose' among various options for the solution of a problem or the control and management of a situation. A typical example may be the 'intelligent' or 'smart' house, a house in which data bridges are established between the power lines, the telephone line and the cable television connection (or the fibre optic line, in the future). The combination of this home based network with infrared or radio frequency carriers makes possible the synchronisation and control of many devices and services, through the combination of the dedicated intelligence residing in each of them or in other complementary elements.

Processing and Transmission

Several changes are under way in the organisation of telecommunication services worldwide. The main characteristic of these changes from a user's point of view is that the telecommunication channels are being integrated; that is, different forms of information (data, voice, graphics, images and video) are being made available through a single multimedia terminal. Therefore, irrespective of the bandwidth (narrow band with ISDN or wide band with IBC), the main new functional feature of telecommunication is that it will be multimedia. The different media can be integrated to support the needs of particular users and special services, and alternative representations of information may be introduced into the system, when direct access through suitable terminal interface adaptors is not possible.

People with disabilities may benefit from the perspectives offered by multimedia. However, if implementations are aimed solely at optimising multimodal access to communication systems, people who do not have full use of their senses may experience a loss in their possibilities for communication, for example:

- visually impaired people will have problems accessing picture and graphic information (which is expected to become predominant), and therefore in coping with complex interactions;
- people with motor impairment may have problems using keyboards and complex control procedures; and,
- hearing impaired people, although getting increased access through text transmission, may have problems with acoustic aspects of the multimedia presentations.

Design criteria for multimedia terminals and their integration into the network of special services are based on an understanding of user-machine interaction and human information processing. Developments within cognitive science (see Stillings et al. [1987] for a general introduction) are likely to change views on human information processing in the future, and therefore also change the bases of terminal design. In particular, an understanding of these developments is of vital importance in the planning of future communication systems for people with special needs.

From the point of view of special services for disabled people, it seems that some can be implemented more easily than others. For example, any terminal of the ISDN or IBC network can be used directly as a text telephone. The possibility of transmitting images can be used for lip reading and sign language. Videotelephones can be used to set up services for remote reading and information about objects and the environment for blind people, while graphics transmission could allow the use of graphic sign systems for communication. Efficient transmission of information (newspapers, news, timetables etc) could be realised using data channels. Finally, efficient alarm systems with the addition of remote visual inspection of the situation would in principle be possible to the benefit of elderly people and people with disabilities.

The situation is different when direct access to the network by disabled people for data retrieval or communication with other users (outside their own group) demands the capacity of the full sensory function of non-disabled users. Such a development may lead to segregation between those who are and those who are not able to use the system.

On the other side, multimedia links may improve communication, if some adaptation of the terminal and/or some overlap of the modes of information is available, such as:

- integration of video and audio information (which will mostly be the case with videotelephones; and,
- integration of video and text information, to be transduced in the local terminal and subtitled.

When adaptations of terminals and special interfaces are not sufficient to solve the problems of some users, additional telecommunication channels and alternative information formats may be considered. Several examples of this may be found in existing trials, such as:

- transmission of documents to service centres where they can be read to blind people and people with reading disorders;
- text and image mailboxes used for communication by deaf and speech impaired people;
- organisation of relay centres for users of different kinds of equipment (e.g. text, sign and audio terminals);
- newsletter services for reading disabled, visually impaired and motor impaired people; and,
- tele-care, that is, simple observations on a person's condition might improve independence and safety, such as checking the self-testing of blood glucose by blind people.

Other important features of the new networks are related to their digital nature, which allows the integration of telecommunication and information technologies. Digital information is controlled and switched in the network by computers. As a consequence of this, networks are inherently 'intelligent'. Many new options are made possible by this feature.

One example is the possibility of monitoring the interaction characteristics of users by the terminal and the network itself. This can allow an automatic adaptation of the terminal characteristics, of the media transmitted on the network, of the speed of transmission and so on, as a function of the characteristics of the user. Special services can automatically integrate different communication modes as needed (an example could be the intervention of a centralised, high-quality speech synthesis system, when text has to be sent to a blind person).

Complex facilities may be made available in the digital integrated network. One example is image analysis. It is not likely that advanced image recognition techniques will be integrated into user terminals in the near future. However, centralised facilities could take care of such operations in order to transduce information for selected classes of users. Centralised optical character recognition with high accuracy for remote reading of documents is another example.

Computer image analysis is a promising research area today that might allow blind users to understand a displayed image and thereby increase accessibility of visual information to them. Although computer image analysis is currently constrained by a number of limitations, within a well specified application area, and under certain well-defined conditions (low noise, high contrast two-dimensional images), reliable automatic image analysis can be attained.

There are many issues in the field of machine image analysis that await solutions, and many questions that need to be answered. The engineering of systems for visual analysis is not yet completely based on scientific principles; thus, there is a great need for a scientific framework within which to design, describe, experiment and document one's experiences in the implementation of such systems; it is clear that there is still a long way to go before truly general-purpose systems will be available.

Other fields of activity in signal processing, which may have an important impact on the applications of telecommunications in disability, are picture coding and picture compression. Use of visual communication by hearing impaired people (e.g. sign languages and lip reading) and speech and motor impaired people (e.g. manual and graphic signs) could be made more affordable by reducing the bandwidth.

Image compression and coding are very much focused on solving specific problems. For example, there are applications (e.g. medical imaging) where lossless techniques must be used due to legal issues. In other fields one may want to achieve maximum reduction of the quantity of data, subjected to only the constraint that a reasonable amount of fidelity needs to be preserved.

Error-free encoding is usually based on an entropy encoder associated with run length coding techniques. With these techniques compression ratios up to 5:1 may be reached. Image encoding relative to a reduced fidelity criterion can use

Differential Pulse Code Modulation, transform coding and neural network techniques. Ratios between 15:1 and 50:1 can be obtained, depending on the degree of fidelity required.

Another important feature of new telecommunication systems, which could have an important impact on the situation of disabled people is the introduction of mobile terminals. A mobile telephone or terminal could in fact solve many of the communication difficulties of disabled people, avoiding problems of finding facilities and operating non-adapted systems.

Output Interfaces

Future development of output interfaces are expected within visual, auditory and tactile modes.

Visual Displays

Visual displays are expected to be thinner and lighter, have better colours and resolution, and to develop the ability to represent three-dimensional objects.

The most common form of visual display today is the Cathode Ray Tube (CRT) used in most television sets, computer terminals, cash dispensers etc. The CRT provides a bright, sharp, relatively cheap display, but its main disadvantages are its weight, bulk and power consumption. Liquid Crystal Display (LCD) technology is the main competitor to CRT, but 10 inch colour displays represent the current state of the art. LCDs have the advantage of being flat, and of having relatively low power consumption and weight, making them the first choice for portable applications. At present, their disadvantages include low contrast, a restricted viewing angle, and slow response compared to CRTs. The speed of advance of LCD development suggests that these limitations will be overcome, and large colour screens will soon be available at reasonable prices. This will improve mobile terminals, which will move closer towards the goal of personalised and mobile telecommunication terminals that make the user independent of the use of non-adapted equipment in other locations.

Displays will also move progressively towards higher definition, with technology-led High Definition Television (HDTV) being the main driving force. This service will approximately double the spatial resolution of conventional television in both the horizontal and vertical directions, giving startling realism and impact, but debate still rages as to precisely what the standard should be, and how the pictures will be delivered to the home. Many historical, political and market protection factors are at play here. It may be that the currently proposed analogue methods of broadcasting, such as MAC (Multiplexed Analogue Component) – seen as a possible 'evolutionary' route to HDTV, will be overtaken by advances in digital compression, and HDTV will eventually be introduced by a 'revolutionary' process employing highly compressed digital video transmission. The higher resolution will provide more comfortable viewing for everyone, including people with partial sight.

Another extension of visual display technology is to provide a stereoscopic or a three-dimensional display. A stereoscopic display gives a realistic impression of depth in the image, but if the users move they only see the same thing, whereas with a three-dimensional display, users can actually see behind objects to reveal hidden details by moving their viewpoint. Many stereoscopic displays require the user to wear glasses with lenses polarised in different linear or circular directions, and monitors are now available with liquid crystal shutters to switch rapidly between the differently polarised views, to present the two eyes with the different images necessary for stereo vision. To dispense with the glasses, various systems based on projectors and lenticular screens or parallax barriers (multiple slits) have been developed, and these are called 'auto-stereoscopic' since they can be viewed directly. More radical approaches to presenting stereo information have been proposed involving the utilisation of low power lasers to write directly onto the retina. Holographic techniques are also being studied.

One interesting use of three-dimensional displays is to create so-called virtual realities, in which the user appears to exist inside a world perceived as completely surrounding him or her in three dimensions, with the view seen responding naturally to head movements, walking about etc. This is usually done by having the user wear a helmet to present his or her eyes with computer generated stereo images that are rotated and adjusted in real time to match head movements detected by position sensors. Others sensors, such as data gloves, can be used to allow the user's arms and body to appear in the scene, and manipulate virtual objects in it. Even with crude computer graphics, the effect is reported to be extremely vivid and engrossing such that one may forget the world presented is only an illusion. Advances in the quality of images produced to make them more lifelike can only enhance this feeling. The combination of virtual realities with appropriate input devices will be particularly powerful for people with various physical handicaps, allowing them greater control of movement and operation, and thereby also greater freedom of communication and self-expression; the technology of virtual realities may in fact become a bridge into the 'real' world.

Speech Output

It is useful to distinguish two different forms of speech output: speech replay and speech synthesis.

Speech replay systems, also called *digitised speech* and *voice store and forward systems,* are based on human speech which is recorded and stored in a memory. The vocabulary of speech replay systems depends on the system's memory and the coding technique. Since in the past memory capacity was very restricted, there was a need for high compression coding schemes. Now memories are available which allow the storage of a medium-size vocabulary of speech (about 60 seconds or 120 words) with natural quality on a single small board, and this development is likely to continue, so that in the future large vocabularies may be stored and retrieved.

In some cases an in principle unlimited vocabulary is needed, for example reading machines for blind people. These systems transform any typed text, for example a letter, into speech. Since the vocabulary is unlimited, it cannot be spoken (and coded) in advance. Therefore speech synthesis is used which generates completely new speech, using natural or artificial speech elements like phonemes, diphones, demi-syllables etc.

The synthesized speech that is available today sounds artificial and many problems, above all a natural intonation, are not completely solved yet. At the moment, there are several speech synthesis systems on the market. Within the next five years improvements in the speech quality can be expected, but it will not be possible to synthesise speech of completely natural quality for some time. However, in the long-term view, synthesised speech is likely to take over the functions of digitised speech, in which case one will be able to change speaker characteristics, for example to optimise it to the profile of a person's hearing loss, or to customise the voice of a non-speaking person, making it possible for other people to recognise that person by voice. Users may also want to change features such as dialect or accent and speech rate.

There is also a development toward multilingual speech synthesis, making communication with foreigners and travelling easier for people who use speech synthesis for face-to-face and telecommunication.

Speech output systems are already in development which combine speech replay and synthesis. Speech replay is used for system messages (which are always restricted) and the information itself, which might consist of any text, is transformed into speech with a synthesizer. This may represent an intermediate step on the way toward high-quality speech synthesis.

Acoustic Screens

Acoustic screens transform visual information (e.g. the content of a videotex terminal) into a 2- or 3-dimensional acoustic signal. They utilise the ability to distinguish location and intensity of sounds. Thus icons, windows or other graphical information can be identified by a blind person as *spatial acoustic events.*

Some experiments made in the field of artificial-head recordings are very encouraging, but at the moment there is only limited knowledge about the possibilities and limitations of acoustic screens. Above all, it is not known what a suitable acoustic equivalent to a graphic item is, how precise acoustic events can be localized, and how movements of graphics or cursors are adequately simulated by acoustic information.

The use of acoustic screens is not only a way to represent visual information in another mode to visually impaired people; it may also represent a way to supplement visual features, so as to obtain better understanding of the contents of pictures. With the continuing development of multimedia terminals, sound may fill new functions.

Tactile and Kinaesthetic Output

Additional effort should be given to the presentation of Braille text and graphics on a single 'tactile display' in order to find a way of efficiently presenting icons and menus to blind users. The refresh time of current displays is still too long, since at present, in most devices the whole page needs to be refreshed each time. This problem could be solved if the display were implemented as a matrix of vibrating pins and each pin of the matrix could be controlled individually. Then, all changes could immediately be presented on the display and thus the refresh time would be reduced significantly. Unfortunately, the production cost of such displays is still too high, and consequently, their price might be prohibitively expensive for some applications. The situation could improve in the future with the introduction of new technology such us piezoelectric plastics, which could reduce the cost of the implementation of tactile two-dimensional displays.

Currently telecommunication systems are primarily concerned with speech and text, and only lately a trend towards images has emerged. The use of touch in telecommunications is very rarely discussed, although many people with visual impairment gain knowledge about the world through touch, and may benefit from this information. In telecommunications, discussions on tactile information are usually related to Braille. However Braille is just another way of presenting text, and does not provide information about objects. Tactile graphics presents pictorial information, but again not about real objects.

In the future, it may be possible to actively touch a remote object or person (blurring the distinction between input and output). For people with combined visual and auditory impairment, the possibility of remote touch may be crucial for establishing close contact. But also for those whose disability is confined to an impaired vision, the enrichment in telecommunications will be to some extent analogous to the communicative quality that is provided to sighted people through the videotelephone. The possibilities of touching another person or an object may also provide mentally retarded people with situational cues that are important for them in establishing telecommunication.

Finally, to touch another person is a sign of sympathy and affection. For all people, with and without impairments, to be able to touch and be touched means adding a communicative element that will give telecommunication a new dimension. It may prove particularly useful in communication with people one cares about, but who for different reasons one may not be able to meet as often as one may wish.

Input Interfaces

It is possible to operate a telecommunication terminal or computer in a number of ways. The most common ones are keyboard, mouse, joystick, switch input, head pointing and eye gaze, voice and gesture, touch and myo-electric control.

Switch Based Systems

When the severity of a physical impairment prevents the person from using even modified keyboards, it may be appropriate to use switches as input devices. Depending on just how severe the impairment is, it may be possible to utilise several switches at different sites around the users body. The number could vary from as few as one, and might be operated in a number of different ways; for example, by hand, head, foot, knee, eye movement etc. In recent years, a number of ingenious switches have been developed to utilise the movement over which the user has best control.

The terminal can be made to interpret the switch operations in many ways. The simplest and most common is to display an array of letters, numbers and symbols and allow the user to use his or her switches to scan through and select the character desired. Generally speaking, the more switches that can be used, the quicker the overall operation.

There are many specially written programs available, some of which are quite inexpensive, that can provide the scanning matrix, manipulate the resultant text and print it. Most, however, limit the switch operator to those facilities provided within the suite of programs. Impressive as this may be, it is restricted, meaning that a disabled user can only choose software from a relatively small range, when compared to that available in the market. To remedy this problem, a number of programs have tried to produce an environment which allows character input into normal programs. These are sometimes termed 'RAM resident', or background, programs. While not perfect, they can be a very simple solution, easily installed on a machine.

A better solution, from the point of view of transparency, is to modify the hardware of the machine to interrupt the transfer of characters from the keyboard to the central processor, and allow switch-generated input to be accepted. If carried out properly, it can provide fully transparent access. In some cases two screens are necessary, one to allow the switch input to be selected, and one functioning as the normal screen of the machine. Difficulties can arise when the user has to move his or her head between the two screens, so other approaches use only one, and display the scanning matrix near the bottom.

The use of switches is slow; it is quicker to be able to directly select the character required. However, there may be a considerable potential for increasing speed and accuracy through interfacing techniques that are better adapted to switch use. Today's solutions are relatively primitive, and development of more creative retrieval and selection techniques is a major challenge for future research in this area.

Head Pointing and Eye Gaze

Optical methods may be used to allow use of the eyes or the head as pointers. One example is the use of a small projector affixed to the side of the head which can be used to move a spot of light around a computer screen. A second screen displays a facsimile of the keyboard. The user moves the light spot to the required position on the screen, and pauses for the input to be accepted. Such systems may be supplemented by a blow-or-suck switch to accept the input in a more positive way.

Another technique is 'eye typing', in which a camera follows the user's eye movements and interpret them in a way similar to key strokes; that is, a letter or command is selected by looking at it for a pre-determined length of time (e.g. three seconds). This technique is quite strenuous because the head has to be held in a fixed position. Further developments in visual recognition by computers may greatly improve this operation and make it possible for people who today are dependent on switch use to convert to direct-selection techniques.

Eye-gaze input devices have been developed for controlling devices in which the operator is not able to use his or her hands, for example aircraft pilots. If further developments can miniaturize these devices, such input possibilities would be a vital aid for mobility impaired people with no arms and/or hands and for people with reduced coordination of movement to interact with the telecommunication systems and with housing control systems.

Speech Recognition

Disabled people who retain clear speech have a very powerful communication mechanism left to them, which they could use to operate a computer if they had a dependable speech recognition system. Speech recognition may also in time permit automatic relay services for communication between text and audio telephones (cf. Harkins and Virvan, 1989).

At present most speech recognisers work with single stored words, and there are systems on the market with vocabularies up to 30 000 words. These are mostly speaker-dependent, and need a training phase in which the user has to speak all of the words in the vocabulary at least once before the system can subsequently recognise them. Within the next five years, continuous speech recognition can be expected, and first versions of these systems are now working in research laboratories. These systems will have a vocabulary of up to 5 000 words, but with restrictions on the syntax and semantics; that is, they can only cope with a relatively simple sentence structure. It is expected that these continuous speech recognisers will be able to adapt themselves to different speakers without having to go through a formal training phase. Another important problem to be solved is that of performing correctly in the presence of background noise which can severely limit the performance of existing systems even in only moderately noisy environments such as offices.

The main problem with the above systems is their lack of 'intelligence', because although the system may recognise every word the speaker says, it may not necessarily be able to understand the whole sentence. To extend a speech recognition system to a speech comprehension system, techniques based on artificial intelligence are necessary. New approaches like 'neural networks', which claim to emulate some of the characteristics of human nerve cells, are more resistant to variability in the input speech. Techniques based on artificial intelligence may make it possible to have reasonably meaningful voice interaction with computers as long as the subject is well defined and limited to matters of fact.

To be useful, speech recognition and understanding systems must recognise words with insignificant delay, and huge amounts of computational power and speed are needed. Very fast and efficient digital signal processors are required, and suitable ones are now appearing on the market. The cost of recognition systems is still extremely high, but with mass production it is now expected that prices will fall to a moderate level over the next few years.

Signs and Gestures

Signs and gestures are a compelling form of input. The user can point at a certain content of a screen, or to a location in three-dimensional space, or use signs in a manner analogous to speech commands. For recognition of signs and gestures, new devices have been introduced, such as the *data glove* that evaluate hand and finger movement and orientation. In sign language input, the hand shape and motion could be processed for transmission over a network, or be translated to another mode.

As well as using data gloves, techniques are being developed to analyse video images in order to extract gesture and other information such as facial expression, allowing a non-contact means of input. It is currently possible to identify the positions of human beings in images, and track the main limb movements, but more work is required before individual finger movements can be identified. For signing, for example, it may be necessary to use multiple camera views to extract depth information and to cope with occlusions. The first systems that will be capable of extracting basic sign language information from images are expected within the next five years. Facial expression is an important modifier of the meaning of signs, and there is also much activity in this field, which will allow some facial expressions to be interpreted automatically.

Gesture input can be complemented by other kinds of input; above all, voice input, in which case there is no need for other input devices such as a keyboard, mouse etc. Gesture and voice input seem to be one of the most attractive alternatives to a conventional input, particularly if they can be combined with a voice output.

Electrophysiological Control

Instead of analysing a person's movements, it is also possible to monitor the electrical activity of the muscles and of the nervous system. The first is a technique that is already widely used in prosthesis development. It has also been used to control a computer, although in a very crude sense. For example, a pair of eye switches were operated by the user moving the eyes to one side or the other. A sensor on each side of the head registered the electrical neural activity when the eyes were moved, reacting to it as if a switch had been pressed. There is reason to believe that developments will continue in this field, easing operation of equipment and making it possible for the user to develop new skills for terminal operation.

Another method is to use evoked potentials from the visual cortex of the brain. They depend on the characteristics of the visual image projected on the retina of the eye, and can be detected with the aid of an electrode taped to the skin of the back of the head. In a system developed at the Smith Kettlewell Institute for Visual Sciences in San Francisco, a letter matrix is presented on a television monitor. The letter generating electron beam is modulated with a signal of a character specific for a certain letter position. The background area of the letter 'A', for example, may be superimposed with a saw tooth signal, 'B' with a sinousidal, 'C' with a square formed signal etc. Thus, when the person looks at the area with an 'A', the electrode detects a saw tooth signal and triggers a printer to write that letter, and so on.

Input and Output

There has been a tendency to regard the functions of input and output independently of each other. However, these functions should be seen as complementary. For some devices, such as Teletouch, the function is based on use of the same mode of communication for sending and receiving. In other cases, use of the same mode for input and output may not function well. For example, if a person uses synthetic speech output, voice commands may be both confusing and create technical problem due to feed-back. Voice input may, however, function optimally for a person who reads Braille because it leaves the hands free for reading instead of having to move the hands back and forth between the keyboard and the Braille display. A tactile mouse may be a good instrument for navigating on the screen with speech output. In this case, the hands are reserved for navigating and input functions.

Functional development of both input and output devices depends on how they can be used together. The possibility of different input and output modes has made it possible to optimise functions in an entirely new manner. What is needed is knowledge; very little is known about the complementary functions of input and output and research should be directed at these issues.

Portability and Modularity

Future telecommunications networks will have a transmission capacity which will enable a series of new broadband services. The services will be based on the transmission of any combination of high quality speech, data, high resolution pictures, video as well as three-dimensional pictures and videos. The telecommunications terminals for these services will, of course, include an intelligent, user friendly interface and will without any doubt have a modular structure. This modularity will enable the disabled user to attach simple or more versatile input or output modules to the terminal in those cases where the facilities of the terminal are not powerful enough to allow the terminal to be adapted to the user.

Terminals will also accept optional conversion programs from the user or by actively searching for augmentative services in the network. This trend may be most apparent in the more sophisticated versions of the terminals, such as the first multimedia terminals that are already being introduced or the broadband mobile telephones that are likely to be available before the end of the century.

One example of a future modular terminal may be a broadband mobile videotelephone. The person being called would be seen on the small flat high resolution screen. The functionality would be the same as for an ordinary videotelephone, with portability added. It may not be a good idea for a car telephone, however, since it may greatly increase the risk of accidents.

A blind person could use a mobile videotelephone to send the picture of the environment in front of him or her to a person, or, further into the future, to an artificial intelligence computer in the network. The computer would use picture recognition and expert systems to analyse the picture while the blind person is walking, sending back control signals helping the walker to decide to go to the right, to the left or to slow down and analyse the area more carefully. The expert system could perhaps analyse smaller unknown objects by three-dimensional measurement of the object. Information like 'shop to the right' and 'newspaper stand to the left' could be given by using a speech synthesizer module.

Conclusions

From a technical point of view, the field of telecommunication for disabled people is still a fragmented area. As amply demonstrated in the present volume, many new devices and possibilities have emerged in the last few years, mainly as a result of the general technical development. However, these devices and services are rarely seen from an overall perspective, mapping functions and relating them to each other. The slogan of the gestalt psychologist of the beginning of this century, 'The whole is more than the sum of the parts', is still valid and applies also to the field of telecommunications. It may well function as a lead in the research for making telecommunication terminals and services optimal for as many people as possible. The most formidable – and profitable – task for the future may be to develop coherence in our knowledge about different terminal features and characteristics, and integration of this with knowledge about typicality and variation in the functions of users with different kinds of impairment. The result may be an entirely new view of how terminals should be designed to provide optimal functionality for the individual user, and to any profile of abilities or disabilities.

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Scenarios

Jan-Ingvar Lindström, Stephen von Tetzchner, Carl Richard Cavonius and Gunnar Jansson

'While all earlier forms of technology extended a part of our body, one may say that electricity is an extension of the central nervous system itself' (McLuhan, 1964).

The impact of information technology on the communication patterns of modern societies can hardly be overestimated; telecommunications play an increasingly important role, and a modern society would not be possible without them. Telecommunication may be used as a tool for human interaction, via text, sound and pictures. New developments may dramatically change the interaction patterns of disabled people, as well as their possibilities of obtaining and relaying information, and thus their total life situation and participation in society.

Human Factors

The media used, and the contextual cues they allow, influence the quality of communication over telecommunication networks. The first telecommunication service, the telegraph, was based solely on the transmission of letters and numbers, which were received as a series of acoustic clicks. Since then, other language forms and modes of communication have been gradually introduced. This has changed the way telecommunication is used. The telephone made telecommunication independent of specialised operators, and thus more generally accessible for people who are able to speak and hear, and the use of ordinary speech gave the communication a more personal quality.

Most people use a variety of communication forms, and are able to adapt to the demands of different communication situations. However, those users whose communication is limited by sensory impairments, speech or language disorders or other disabilities, are more dependent on an optimal communication situation. This often implies the availability of more than one mode of communication, but the requirements may sometimes be very specialised, as in the case of a deaf-blind person who needs tactile information.

The introduction of text telephone services (cf. chapter 26) made telecommunication possible for many people with speech and hearing impairments, and opened up new areas of society to them. Fax, videotex services and data communication have made transfer of script and graphics more common over the network, and opened it up for more creative uses of telecommunication. Videotelephony will make telecommunication accessible for people who depend on signing (cf. chapters 36, 37 and 42).

However, the potential for the use of telecommunication in the service of people with disabilities is far greater than the simple use of language in different modes (writing and signing) as is the case of text telephones and videotelephones. The quality of the interaction is changed when new situational cues are made available, and multimedia terminals are likely to change the way people will communicate via the telecommunication network in the future. The difference, however, may be much greater for people with disabilities.

For many people with impaired hearing, increased amplification is sufficient for effective use of the telephone (cf. chapter 21). For others, amplification is not enough. They must rely on script because their comprehension of speech depends on receiving cues simultaneously from both speech sounds and lip movements. With the videotelephone they may cease to be dependent on text communication, and can use a wider part of their spectrum of communication skills.

The visual information provided by the videotelephone does not relate only to the language form itself. It gives the viewer access to situational cues that are not available in ordinary telephones or text telephones. People with intellectual impairment, although able to speak, may have difficulty understanding what is being said without the situational cues that are present in face-to-face communication. For some, it may be crucial to see the other person in order to understand whom they are communicating with, but it may be more important that with the videotelephone that the user can show or point to things, or demonstrate something. This may be important in critical situations, such as a fire, but it may also be useful in practical matters, such as getting help in measuring the right amount of coffee before making it. Furthermore, visual cues may support and make a social chat possible.

Less advanced equipment than videotelephones may also fulfil some of the functions mentioned above. A picture telephone, which is able to relay a still picture in 6 or 7 seconds on an ordinary telephone line may be used to show the communication partner objects or graphic signs such as Bliss or PIC (Brodin and Björck-Åkeson, 1991). Graphic signs may also be transmitted with the help of a computer. Although limited, such cues may serve as a structure that makes telecommunication possible.

The future is not always bright, however, as exemplified by the experience of blind people. During the early 1980s both the disabled population and the public at large increasingly believed that microcomputers would revolutionise life for people with visual impairments, by freeing them from the limitation of the printed page. It was confidently predicted that not only would their lives become richer and less restricted, but also that they would be able to participate in a far broader spectrum of pursuits than those available through the conventional trades of disabled people. In particular, office activities that traditionally required typed or printed documents, written ledgers, and the like, would change as these documents were transferred to computers that, with the addition of appropriate interfaces, would enable visually impaired users to gain the same access to information as that enjoyed by those with normal sight. Additionally, such tasks could be carried out in an individual's home, thus freeing the user from having to contend with public transport.

All of this was based on the premise that the information normally displayed on a video screen could be transferred to other modes, by using methods such as speech synthesis or Braille displays. As long as the information consisted of a string of ASCII characters, this presented no fundamental problem, and was seen as a straightforward technical development that could be solved in the near future. However, recent developments in display and software technology have altered the situation drastically. Visually-orientated displays are appearing in virtually every branch of commerce and industry, and are by no means limited to conventional terminals. A common example is the 'automatic tellers' that are used in ever increasing numbers by banks, in which both the input and output require vision. here the only information output mode is a screen, while the input is a set of switches that are set in a smooth surface, so that they cannot be discriminated by touch.

Displays that use a mouse are essentially unusable for visually impaired people. Many modern software programs cannot be used effectively without the mouse, and hardware is becoming increasingly dependent upon this technology as well. For some computers the mouse has become almost as important an input device as the keyboard.

The use of icons to present information is often quite efficient for sighted users, but disastrous for those with impaired vision. Icons may be thought of as a form of visual shorthand, in which a graphic symbol represents an object or an action. These may be fairly realistic, such as a sketch of a wastebasket that is selected when the user wishes to delete a file; or they may be quite abstract, so that their meaning must be learned. In either case, they represent an almost insurmountable problem for anyone who cannot seen them, since there is no general method for mapping them on to a tactile display or translating their meaning by means of a speech synthesizer. Even if it were possible to convert icons into their equivalent in tactile symbols, it is unlikely that they could generally be discriminated, since they often differ from one another only in detail.

It is not likely that the general developmental trends will change: rather, it seems likely that blind people or other disabled users will be faced with new problems. Thus, a positive development requires an awareness that new problems may appear and a willingness to provide resources for finding solutions. For example, the audio telephone was a great invention that has been of great benefit to society. Although the telephone led to a separation between hearing and deaf people, it was not the invention and implementation of the audio telephone that was disadvantageous for deaf people, but the lack of efforts to provide them with a a functional equivalent of the audio telephone, that is, a text telephone or videotelephone.

Information

For many people with disabilities, one of the most important and frustrating results of the impairment is that their access to information is limited. These people experience an *information handicap.* For example, blind people can listen to the radio and audiotapes that provide *sequentially* presented information. However, they face great difficulties in obtaining information presented in such a way that they can choose between *simultaneously* presented alternatives without having to listen to lengthy passages of speech.

Information technology and the widespread use of computers have changed both the use of media and the ways in which information is stored. Today, almost all printed information is stored in digital form at some point in the production process, and can be extracted and transmitted via telecommunication networks. The actual transfer may be via the ordinary telephone network, or by data networks, cable, fibre optics or radio. This increases the access to most sources of information for people who have difficulties in handling and reading ordinary print in books, magazines, journals and daily newspapers.

In some countries it is already possible to transmit daily newspapers to a personal computer (cf. chapter 44). The limited number of books that are available on disks are typically distributed by mail, but as the capacity of the network is increased with ISDN, this slow procedure will probably be replaced by transfer via telecommunications.

Future potential is, however, not only a matter of technological development. With the exception of telephone directories, most databases today are based on user groups that comprise a limited number of people who share a hobby or professional interest *and* an interest in computing. The user interfaces of most databases typically exclude all but the most computer literate users. This was not a problem when the users were a small and exclusive group. However, the use of technology is spreading like ripples on water. In the very near future, today's advanced technology will be everyman's technology, with a user interface that is friendly towards most people. As is the case with cars, microwave ovens and compact disc players, the inner complexity will not show in use.

The new media situation will not only influence one's private life; education, for example, is a major area in which people with disabilities tend to be at a disadvantage. This is due both to a lack of accessible information, such as books and journals for people with visual impairment, and to the scarcity of teachers and other professionals who are trained to educate people with different forms of impairment. Distance education with the use of all available media may be used in direct teaching of disabled people and as a teaching and supervision tool for professionals (cf. chapters 38–40). Both applications contribute to changes in the educational pattern of people with disabilities.

Another major area that is likely to change in the future is the working situation. Even though many people with disabilities fail to register for work, and are therefore not considered as unemployed, the unemployment rate among people with disabilities is significantly higher than that of society at large. Increased access to information provided by telecommunication may make new domains of work available to people with disabilities through the creation of jobs. The greater independence from geographical location made possible by multimedia telecommunications may give people with disabilities more jobs to chose from (cf. chapters 10 and 11).

Structure

Many of the ways in which telecommunications may be used to inspire self-reliance and independence are largely a matter of creativity. For example, elderly people and people with intellectual impairments and communication disorders often need help in structuring their daily life, and in remembering certain task and obligations in the course of the day. It is possible to utilise telecommunication services to create a support structure that makes direct help less necessary and which fosters independence. For example, automatic calls to the user's telecommunication terminal may direct attention to certain tasks at predetermined times of the day. This may imply only a minimal level of surveillance. Another example could be a central service that may be alerted if the system does not receive a response to a message (for instance, by the user lifting the receiver), but nothing is done to ensure that the message or instruction has been acted upon.

The help that is needed makes many people severely dependent on others. But by using telecommunication to provide help in structuring the day, they may be able to lead a more independent life, and to a greater extent to chose how and where they want to live.

Mobility

Full participation in society and social life is to a large extent dependent upon one's ability to get around. Many people with disabilities are restricted in their movements, often because they have difficulty orientating themselves or contacting somebody who can assist them if they need help. In this area as well, telecommunication may serve to give more people opportunities for fuller participation.

In the future, databases will contain information about access for people with disabilities, and help them plan business or vacation trips. The growing mobile telecommunication networks are making telephones available at all times to wheelchair users, increasing their independence and security.

The development of travel aids for blind people has been very slow and only partly successful. Guide dogs, introduced in larger numbers after World War I, and the long cane, first used by veterans blinded in World War II, are still the most widely used and most effective aids for travel by foot They give basic information about the walking surface and obstacles in the immediate environment, and no technical aid has been able to replace them in this function.

In the 1960s, a number of development programs attempted to provide electronic travel aids (cf. Brabyn, 1985). The most successful was the sonic guide, but there were also sonic torches and laser canes. These aids were not widely accepted, probably because they were not able to add much to the information provided by guide dogs and long canes.

The developers of electronic travel aids in the 1960s seem to have underestimated the problems of constructing a truly useful travel aid for blind people. These aids were simply clear-path indicators (Foulke, 1971), but more functions are necessary for successful, safe and relaxed travel. It is not sufficient to be informed about the ground within the nearest meter, which is what the traditional aids provided. Neither is it enough to know about objects above the ground within a few meters, which is what the electronic aids provided. There is a need for information over a larger range, for instance about objects that are to be approached, or that are approaching (cf. Jansson, 1987; 1991).

Mobility is not only dependent on knowledge about objects in the environment. In order for a person to be orientated, it is necessary for him or her to know his or her own position relative to a goal. Currently, a global positioning system is under development that can provide very accurate information about a person's location. The system is an extension of a navigation system designed for ships and aeroplanes, and has reached such a degree of accuracy that it may be used for individual manoeuvering. With airplanes and ships, position is indicated in degrees of latitude and longitude. The most important task in making navigation devices that are useful for people with visual impairment is to find a way of indicating where the person is located in a manner that makes sense to the user. This must be a map that is both readable and which presents an environment with landmarks that the blind reader can experience. In this way as well, telecommunication can contribute to equality by making society more open to its citizens, and making them independent of impairments and disabilities.

Impact on Disability

The new media with videotelephones and the possibility of combining live pictures, sound, text and graphics may give new sections of the population access to telecommunications terminals and services. However, efficient use of multimedia terminals depends on the availability of ISDN or similar systems. Although the development of ISDN has been driven mainly by technology, with the needs of industry and service providers at the fore, its impact on the lives of many people with disabilities may actually be much greater. The cost, however, may create an insurmountable barrier for a group that traditionally has limited economical means.

In the forseeable future of telecommunications (beyond the ISDN), it will be possible to transfer all the different modes of communication that human beings use, including the grip of a handshake. It is a significant step towards the fulfilment of McLuhan's vision, and toward a society in which people are able to extend their communication skills. Furthermore, most difficulties specifically related to telecommunication may disappear. People will still have communication disorders, and some of these disorders cannot be easily compensated. However, an enhancement of face-to-face communication will, in turn, lead to an enhancement of telecommunication.

In this scenario, the different telecommunications modes will be generally accessible to disabled users, and the need for special terminals will be limited. It is a communicatively open society, where telecommunication is a natural part of everybody's communicative repertoire. Therefore, when telecommunications become more varied as well as more generally accessible, they will represent a major step towards equality in education, work and everyday life.

Modern telecommunications have the potential to make society less closed to people with disabilities. To what degree this potential will be realised depends on politicians and other influential members of society making the right decisions, both with regard to standardisation and technical solutions, and to the pricing of equipment and services.

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A Bibliography of Telecommunications for People with Disabilities

Collected by Stephen von Tetzchner

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