COMMISSION
OF THE EUROPEAN
COMMUNITIES

Brussels, 14 February 1992
UPDATED 1 March 1993

Directorate-General XIII
Information Technologies and Industries, and Telecommunications

TIDE

TECHNOLOGY INITIATIVE FOR DISABLED AND ELDERLY PEOPLE

TIDE 1993-1994 WORKPLAN

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UPDATE NOTICE

This document, entitled the **TIDE 1993-1994 workplan**, is an updated version of the 2nd phase draft workplan of 14 February 1992. The updates are limited to:

- the supplementary note concerning the horizontal activities on the next page.

- the current status of the TIDE initiative as described in the Initiative Overview on page 2.

SUPPLEMENTARY NOTE TO THE TIDE 1993-1994 WORKPLAN

CONCERNING HORIZONTAL ACTIVITIES

In addition to the TIDE technology application and development work described by the action lines, work areas and R&D tasks, (which are to be covered by technology projects,) there are a set of horizontal activities to be carried out. These horizontal activities are intended to complement the technology projects and make an additional contribution to achieving the TIDE objective of 'stimulating the creation of a Single Market in Rehabilitation Technology in Europe'. Two roles for horizontal activities are foreseen;

1. **Adding value to the technology projects work by harmonising, organising and collating results**; These are the activities listed as horizontal actions under 1.2.2. of the present workplan. Results here should lead to harmonised reference models promoting a convergent understanding of user requirements (e.g. of elderly persons or people with cognitive impairments), their potential technical solutions (such as user friendly human-system interfaces or working environments), as well as cost-benefits and market factors. These very specialist activities to develop and validate the models will be carried out with a series of small direct contracts, with all the technology projects required to cooperate by providing data for model population. Potential contractors are encouraged to register their interest and present their qualifications and experience.

2. **Exploratory, preparatory and stimulatory actions in support of the TIDE objective**; These activities are intended to contribute to the stimulation of the internal market in Rehabilitation Technology at a Pan-european level. As such they are expected to identify obstacles to achieving this market and present a plan of action to overcome the problem. Such an activity might for example, explore the usefulness of a particular solution, prepare the ground for further action or stimulate emergence of structures that would encourage the development of the internal market. One example of a particular area of importance results from the trend towards decentralisation of control and provision of technical aids and services. The reduction in centralised coordination means we have to redouble efforts to create the networking necessary to avoid overlap and duplication. In this example, it is therefore increasingly important for rehabilitation centres across the Community to work together (e.g. in evaluation and verification of the results of the R&TD projects). It is important that the results of the horizontal actions are measurable against the objectives. Proposers should clearly distinguish what they are going to achieve in addition to what already exists. Bids for funding in this category must represent good value for money and activities which add measurable pan-European value to national actions will be particularly favoured.

INITIATIVE OVERVIEW

Background

TIDE (Technology Initiative for Disabled and Elderly people) is a Community R&D Initiative in the field of Rehabilitation Technology. Rehabilitation Technology (RT), sometimes known as Assistive Technology, is defined by it's customer base: elderly and disabled people. The emphasis on the needs of customers rather than the push of a particular technology, makes it one of the user driven or market-oriented industries of the future.

RT supports the process of rehabilitation[1]. It addresses the technology needs of elderly and disabled people, in particular, the need and desire to maintain independent living. RT supports the integration of elderly and disabled people and their participation in the social and economic activities of the Community.

It is important to distinguish RT from the medically directed technologies with which it is so often confused. Whilst some medical devices can help in rehabilitation, RT is used to support the individual being rehabilitated in the activities of their daily life. Use of RT mostly starts after any medical intervention is complete. For the majority of RT users, i.e. the elderly and those with congenital conditions, there is no medical intervention.

RT has two themes: enabling equal access to new technologies (and the many opportunities for work this provide to disabled people) and harnessing the new technologies to fulfil their needs in everyday life including employment, housing, transport, mobility, learning and education. RT incorporates a wide range of technological building blocks, including Information Technology, telecommunications and control technologies, as well as services based on these.

RT is a growing market. As the European population ages, the incidence of disability will continue to grow. These 'new' old can be distinguished from the 'old' old; they will have acquired the habits and tastes for the new technologies and services, but their access to them will be progressively limited by the multiplicative effects of visual, hearing, speech, cognitive and motor impairments. By the year 2020, one in four will be aged over 60, and can expect to start to experience perceptual deficits. In addition, RT is a market in which good market penetration is the norm, as RT may constitute the only way in which a person can continue the activities of daily life independently.

The need for collaboration at a pan-European level is compelling. Traditionally, the markets in the Member States have been relatively small and fragmented. These markets have often been served by SMEs operating at a local or regional level. This has not allowed the economies of scale that could deliver products incorporating up to date technology at reasonable prices. The effect of the completion of the Single Market and in particular, pan-European certification will be to significantly increase the size of the individual markets. This makes it an economically interesting market for a higher level of technology. Technology transfer from the major European IT&T industry to the SMEs with the knowledge of the customer will be critical to the competitiveness of the European RT industry. This technology transfer opens new markets for European technology. It also helps counter the threat posed to European industry by US legislation in favour of people with disabilities which is both forcing the IT&T industry to take their needs into account and stimulating a strong RT industry in the US.

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1 Rehabilitation is defined according to the United Nations Assembly (World Programme of Action Concerning Disabled Persons, New York, 1983, #11) as "a goal oriented and time limited process aimed at enabling an impaired person to reach an optimum mental, physical and/or social functional level, thus providing her or him with the tools to change her or his own life. It can involve measures intended to compensate for a loss of functional limitation (for example by technical aids) and other measures intended to facilitate social adjustment of readjustment."

Addressing these larger, more technological markets is not only a matter of understanding the user requirements and technology transfer, it also requires the development of technical norms and standards. Technical standards are needed to support interconnectivity and interoperability. This makes it possible to satisfy the complex needs of users with disabilities, in particular multiple disabilities, and to interconnect assistive devices with mainstream technology (e.g. text telephones for deaf persons).

A single Market in Rehabilitation Technology will be stimulated by the TIDE initiative's programme of pre-normative and pre-competitive R&D. TIDE's support for new RT devices and services will stimulate technology transfer, make user requirements more transparent, and provide a basis for the formulation of new technical standards and norms.

Current status

20 projects of the TIDE pilot phase are currently running. These cover a wide range in the areas of general models and tools, manipulation and control, personal communications, safety and daily support, access to information. The pilot phase is 50% financed by the Commission with 8 MECU funding and will finish at the beginning of 1993.

These projects were selected from the 70 proposals received following the call for proposals for the pilot phase in 1991. The total value of the proposals was 70 MECU. This strong response to the pilot phase call demonstrated that the sector actors are capable and indeed eager to collaborate towards creating an internal market in RT.

The 10 MECU available to TIDE in 1992 have been allocated to cover the completion of the existing pilot phase projects and to finance the extension of some of them, as well as to fund a major horizontal study of the rehabilitation market. All of the pilot phase projects submitted proposals for extensions and 10 were selected with total funding of 3.9 MECU, to complete in the course of 1994/1995. Out of 10 proposals received for the horizontal study, 1 proposal was accepted for funding. This study is to be completed by the end of 1994.

The sector actors have been consulted on the priorities for future activities in a major planning exercise. Following the adoption of the main lines of the planning action by the representatives of the Member States on the TIDE Expert Committee (TEC), technical panels met during October and November 1991. The technical panels structured the action lines into work areas and identified 43 pre-normative and pre-competitive R&D tasks. The technical panels also considered the 400 responses to the questionnaire survey addressed to 4000 people and organizations and supplemented the R&D tasks where necessary. The consolidated results of this consultation exercise[2] were adopted by the national representatives on the TEC in February 1992. With the amendment to the horizontal activities which was adopted in March 1993 by the TEC this is now called the TIDE 1993-1994 workplan.

Objective and Scope

TIDE is a pre-competitive technology research and development Initiative specifically aimed at **stimulating the creation of a Single Market in Rehabilitation Technology in Europe**. The harmonious development of a unified Single Market in Rehabilitation Technology in Europe requires the harnessing of scarce scientific and technical resources in the Member States as well as the creation of a partnership between the European IT&T industry, SMEs, Research Institutes and Universities, based on a commonality of interests.

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2 Technology Initiative for Disabled and Elderly people: Consolidation of the Results of the Consultation with the Sector Actors" available from the TIDE Office, Commission of the European Communities, DG XIII/C/3, Avenue de Beaulieu 29, BU29, 3/13, B-1160 Brussels, Belgium.

For the purposes of TIDE, Rehabilitation Technology is defined as: - technologies provided directly to elderly and disabled people to enable them to live more independent lives and become more integrated and live longer in the Community. The technologies concerned cover a broad range which includes among others: information technologies, communication technologies and control technologies.

TIDE Programme Concept

Work under the TIDE 1993-1994 workplan will conform to the five TIDE programme principles:

- **Market Oriented** - Projects should emphasise taking advantage of the opportunities presented by the completion of the Single Market and lead in the short term to the development of technology based prototype products and services with good commercial potential in a competitive environment.

- **Technology Adaptation and Innovation** - Emphasis is to be on innovation and the adaptation and advanced application of new technology and its integration with appropriate international standards.

- **Multi-disciplinary approach** - Projects will harness the scarce scientific, technical and commercial resources in the Member States, providing significant added value from pan-European cooperation. Due account of the social, economic and regulatory context of the technical work will be taken.

- **Technology Verification** - Rehabilitation technology is to be evaluated with real (potential) consumers in field trials or by using scenarios.

- **User-focused** - Users are to be involved in projects. Projects should deliver statements of end user requirements and make statements of anticipated benefits of the technological solutions to the end users.

All technology projects are expected to participate in the TIDE initiative horizontal activities including; - consensus, market study, cost benefit and effectiveness and standardisation.

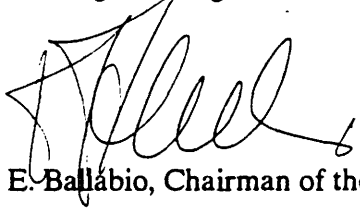
TIDE 1993-1994 workplan: Main lines of Action

1. Access to **Communications and Information Technology**: including terminal accessibility and multimedia environments, technology to facilitate personal communication, information and communication services and applications.

2. **Control technologies**: including environmental control user and system interfaces, robots, mobility and transportation.

3. **Restoration/enhancement of functions:** including prosthetics and orthotics, Functional Electrical Stimulation, technologies for functional assessment and training.

4. **Integrated systems technologies:** including smart houses, navigation systems, education and training, working environments, etc.



E. Ballábio, Chairman of the TIDE Expert Committee

ACKNOWLEDGEMENTS

This workplan is based on an extensive consultation with sector actors with an interest in Rehabilitation Technology. Some 65 experts took part in technical panel meetings and some 400 questionnaire responses were processed. Views were received from major IT&T companies, SMEs, Research Institutes, government organisations and services as well as universities and user organisations.

Five technical panels met during a series of meetings in Brussels between October and November 1991. The technical panels structured each of the four TIDE action lines into work areas and generated 43 research and development tasks. A fifth technical panel considered the options for horizontal, cross project activities. The panels considered responses to a questionnaire survey and amplified the task descriptions where necessary and appropriate in order to include the new ideas from this survey.

The contribution of all involved in the planning exercise and the consolidation into this Workplan is gratefully acknowledged. Without their very professional and highly motivated collaboration, the development of this programme of R&D actions would not have been possible. The TIDE Expert Committee have played a key role in nominating experts, ensuring coherence with action in the Member States and extending the consultation.

THIS DOCUMENT IS STRUCTURED IN THREE PARTS

1. RATIONALE AND OVERVIEW

This part of the document provides an analysis of the Rehabilitation Technology market (RT) today and the opportunities that follow from the completion of the Single Market. The case for Community action on the market in the form of a pre-competitive R&D action is explained and an outline of the Technology Initiative for Disabled and Elderly people (TIDE) programme is given.

2. DESCRIPTION OF THE SCOPE OF THE R&D WORK

This part of the document provides an overview of the TIDE action lines and their division into work areas. This overview is provided in terms of rationales for pan-European action as well as the issues to be addressed, the scope, the anticipated impact of the action and the non R&D actions required to deploy the technology.

3. R&D TASK DESCRIPTIONS

This part of the document provides detailed descriptions of the pre-competitive and pre-normative R&D tasks to be performed, in terms of the background, the objectives, the technical approach and the key results and milestones.

CONTENTS

1. RATIONALE AND OVERVIEW

1.1. Rationale for collaboration in TIDE

1.1.1. Introduction

Rehabilitation Technology (RT), sometimes also referred to as Assistive Technology, is applied technology provided directly to elderly and disabled people to enable them to live independently and participate in the social and economic activities of the community. In essence, RT is defined by it's consumers; - elderly and disabled people. This customer centered approach to technological innovation and development characterises the market oriented, industries of the future.

RT, inter alia, can provide equal access, to all citizens, to the benefits of technology, including telecommunications, information and control equipment and services. It can play a major role in enabling independent living and facilitating the activities of daily life. This is the reason why RT is, by definition, developed and applied taking into account the needs and functional capabilities of elderly and disabled people, providing solutions to rehabilitation problems which by definition have no medical solution. Unfortunately, technology may also cause additional barriers, isolation and alienation if the range of potential users needs are not well understood and multi-disciplinary cooperation is lacking. This is particularly true for Information Technology and Telecommunications technology to which access is becoming ever more important in European daily life.

The market base for RT is growing steadily. People who are old or disabled number between 60 and 80 million in the Community, today. Disability is strongly associated with increasing age; some 70% of disabled people are aged 60 or over. People in the Community are living longer and the birthrate has been falling. By the year 2020, one in four of the population (25%) will be aged over 60. These 'young old' will have acquired the tastes and habits for consuming the new technological tools and services but for many, their access to these tools will be progressively limited by the multiplicative effects of visual, hearing, speech, cognitive and motor impairment that come with advancing age.

RT is important to the economic and social life of the European Community. The demographic shift will result in a steep rise in the cost of caring for elderly people. Providing RT that will enable people to remain living independently in their own homes for longer is a highly cost-effective contribution to containing the growing costs of care. Using RT to enable people with disabilities to gain an education and to contribute to society through working is also cost-effective. Macro-economic factors such as the growing proportion of jobs in the service sector and the expanding use of IT effectively increase the work accessible to people with disabilities and are important market forces.

Today, Rehabilitation Technology cannot count on either a coherent industry or a coherent market. The majority of companies are Small to Medium sized Enterprises (SMEs), addressing local, regional and sometimes national markets. The companies tend to specialise in particular sectors of RT and address very narrow market segments. Thus, the RT market is extremely fragmented. This situation is sub-optimal for all concerned;

- SMEs often lack the resources, particularly in expertise and capital, to take advantage of new technology or expand their markets geographically.
- Users lack choice and are being left behind by technological development. In the private sector, they are forced to pay very high prices for devices and services to meet just some of their needs.
- In the public sector, reimbursement authorities are struggling to reconcile the demands of users and budgets within certification regimes that are frequently protectionist. Macro-

economic arguments that deployment of RT is cost-effective and can show overall a net 'profit', because socially and economically integrated people tend to pay tax and cost social security less, are blurred by the division between the budgets of the different government departments.

- Large high technology companies, particularly given their high operating costs, tend to see the national markets as too fragmented and small to justify investment. In addition there is a lack of information on the consumers and their requirements.

An efficient Single Market in RT would promise better value for money for all of these groups.

The completion of the Single Market provides a window of opportunity to improve the competitiveness and cohesion of the European RT industry and stimulate the creation of an efficient market in RT. The RT market and industry are facing profound structural change resulting from the interaction of three major factors. Two of these impact the RT market within the same short timescale of 1993. These are the removal of internal trade barriers due to completion of the Single Market and the threat to competitiveness resulting from affirmative legislation in the US.

Internal trade barriers are mainly the result of differences between the Member States in regulations and standards. These include such things as protocols, assessments, health and safety standards and certification lists for reimbursement. Among these, a major set of barriers are the national technical standards which tend to lock RT into national technical infrastructures. An obvious example of this is the differences between the telecommunications infrastructures in the Member States. For example, Minitel services in France which are popular and useful to people who are deaf are not available across the Community because of technical differences in the X.25 (data) networks between Member States, amongst other reasons.

A decade of legislation in favour of persons with disabilities has culminated in the "Americans with Disabilities Act" (ADA) of 1990. The net effect of ADA and the previous legislation is to force US I.T. and Telecommunications equipment suppliers to make provision for people with disabilities either by including appropriate basic features, or by providing equipment that can be specially adapted. These RT products and services are becoming available to address new markets. With IT&T companies competing on a global basis, understanding the user requirements of people with disabilities, designing equipment that includes their needs and is easy to adapt has become a competitive necessity.

The third major factor that is forcing a restructuring of the RT market is the increasing sophistication of the technological basis of RT. The use of high technology materials and components, particularly the prevalence of micro-processors is extending the lead time for new products and the costs of R&D beyond the financial and skill resources of individual SMEs.

These factors combine to threaten the competitiveness of the European IT&T industry and the SMEs specialising in RT, in the Single Market. There is a generally high standard of research and basic technology, as well as, a growing level of knowledge of user requirements and possible RT solutions, but today these efforts are too fragmented to support the creation of an RT industry of the future. Overcoming this fragmentation requires collaboration at a pan-European level. If the industry is to develop competitive technologically based products and services and make these available across Europe, present efforts require reinforcing and making coherent through R&D cooperation at the European level, between the many and various organisations involved. (telecommunications and information companies, providers of technical aids, information service providers, user organisations, national research centres, research institutes and universities)

The TIDE initiative is focused on the critical activities needed at a Community level to stimulate the creation of a Single Market in Rehabilitation Technology. Using the principles of Community added-value and subsidiarity, and complementing such initiatives as are happening at the level of the individual Member States, the TIDE initiative will act on the RT market by;

- encouraging innovation and technology transfer in RT.
- making transparent the user requirements for RT.
- accelerating the formulation of technical standards and norms.
- stimulating new partnerships between the sector actors

The results of the TIDE initiative will only become fully developed outside the initiative itself. By encouraging pre-competitive and pre-normative R&D in Rehabilitation Technology, TIDE is intended to provide a stimulus to the RT sector actors, encouraging a cohesion and a perception of the commonality of interest that will lead to a single, open market in RT in Europe.

1.1.2. The state of the Market in RT in Europe today

Today, the Rehabilitation Technology market lacks coherence. It is both highly fragmented and underdeveloped. Product developers lack information on the user requirements of disabled and elderly people, whilst there is also some confusion in the available data on the market segments and the numbers of potential customers within them. Understanding the market for RT is made still more difficult by the situation as regards identifying the purchaser. RT is purchased by both individual consumers themselves and by organisations and administrations on behalf of the individual user.

Large differences exist between the Member States in Rehabilitation Technology provision and reimbursement policy. The type of RT purchase eligible for reimbursement differs not only between Member States but also between agencies, particularly between RT for use in the home and that for use to enable work or learning at school. Gaining entry onto lists of RT approved for reimbursement is not synchronised across the Community and there can be major delays. Traditionally in some Member States, charities have dominated provision, in others the state provides. Purchase by individuals is limited by the high prices that are charged for RT and the limited incomes of many disabled and elderly people.

These consumers, particularly disabled people of working age are caught in a vicious circle whereby a lack of RT provision, training and high unit prices, means they are not enabled to contribute to the community by working. Therefore they have low incomes, therefore many cannot afford the RT, therefore production runs of RT are risky and low volume, consequently the prices of the equipment are high. The situation is made more difficult by the fragmentation of the market and the lack of information on what RT is available. On the positive side, these consumer groups are highly motivated to obtain the very best available in RT in order to enable their independence and empower their participation in the community.

There is a large difference in provision between the Member States. It is difficult for less developed regions to attain adequate levels of technology and training, as well as, to deploy the technology. Europe imports much of it's RT, particularly in the high technology categories from the US. In some of the basic technology areas that can be applied to develop RT products, such as areas of speech synthesis (e.g. adaptation to the many Community languages), R&D in Europe is more advanced than in the US. However, competitive European products are not widely available. This is largely due to the US products emerging from a more homogeneous and vigorous home market.

A more unified European market will emerge from the completion of the Single Market. This will give both European and US companies the opportunity to address the new, pan European RT market sectors which will be of commercially significant size. The Japanese market for RT is currently underdeveloped. This is primarily because rehabilitation services in Japan are still oriented in a traditional institutionalised way. It should be noted, however that Japanese industry is extremely strong in many of the basic technologies that underlie RT, in particular IT and Telecommunications microelectronics and robotics. There are signs that Japanese industry is positioning itself to enter the RT market in force.

Two of the major factors that characterise the current market for RT require further description. These are a high level of market fragmentation, resulting in expensive technological solutions, and a lack of available, commercially useful information about the market and the requirements of the elderly and disabled consumer.

Market fragmentation

Today, the market for Rehabilitation Technology is very fragmented, mostly resembling a patchwork of unlinked products and services available at the regional level. The RT market and industry are fragmented or segmented in a number of different ways. These include;

- Fragmentation by technical area: Manufacturers and suppliers of RT come from a number of different sectors, from major Telecommunication suppliers manufacturing telephony equipment for people with visual impairments to SMEs manufacturing robot arms for wheelchairs. This tends to make integrated solutions and device connectivity difficult to achieve.

- Fragmentation by national regulation: Rehabilitation Technology in the different Member States has to conform to different health and safety standards, e.g. the UK legislation on fire regulations for foam furniture is a potential barrier to wheelchair and static seating. The lists of technology approved for reimbursement in the different member states are also a potential non-tariff trade barrier.

- Fragmentation by culture: There are cultural differences across the Community in the attitudes towards technology in general and the acceptability of RT, and in aesthetic preferences. In addition, similar problems tend to be solved differently, e.g. in developing PBX operators' consoles for the visually impaired some Member States emphasise speech synthesis while others emphasise Braille.

- Fragmentation by impairment: Rehabilitation Technology tends to be developed to address single impairments, such as visual impairment or motor impairment. Customers, particularly elderly people often show more than one impairment and integrated solutions, combining different devices to meet the needs are difficult and expensive to achieve. In addition, different solutions to similar impairments are suitable for different circumstances. For example, Braille displays may be useful for young people with visual impairment who have learned Braille but inappropriate for an elderly person whose visual impairment is caused by a condition that also reduces tactile sensitivity.

Given the range of disabilities and different circumstances that the customers of RT may present, the market for any particular device can be quite limited in any single Member State. This does not mean necessarily that it is uneconomic to supply RT to meet the demand. It does tend, however, to make meeting the demand expensive for either the public reimbursement authorities or for the private individual consumer. For example, speech synthesis devices for the speech impaired tend to be custom built and cost upwards of 10,000 ECU. (Such devices also tend to be imported from the U.S., although Europe has an equivalent level of technical sophistication in speech synthesis.) A consumer item of similar sophisticated, functionality - a six language translator with speech synthesis - can cost as little as 200 ECU. In another example, a modern wheelchair costs of the order of three times as much as a modern bicycle, although of no greater technical sophistication. This can be seen as

partly the consequence of there being more than 400 wheelchair manufacturers in Europe, ranging from the very small to the near national monopoly.

The fragmentation of the current RT market not only results in high prices for RT products, it has also kept down the size of production and thereby the size of many of the companies supplying RT.

Lack of information on market and user requirements

One extremely limiting factor on the development of the RT market is the lack of reliable information about the market. For the RT industry there is a lack of information on market sizes and a lack of commercially useful segmentations of the market. There is also a lack of available information on the user requirements for RT and what technical means are most appropriate to satisfy those requirements. There is a lack of information on how to market products into new environments (e.g. across national borders, into a different provisioning system or into a new user group such as the elderly). For the RT customer there is a lack of accessible information on what is currently available.

The lack of information on RT markets and their sizes is linked to the different definitions and approaches to disability and to the incidence of multiple disabilities. Estimates of the number of persons with disabilities in national populations can vary between 2% and 17% worldwide. Such large differences suggest that very different criteria are being used to define disability and the various categories of impairment. Even in countries with a tradition of good social statistics there is evidence of some confusion. In 1988, the U.K. government released statistics that raised the number of people with disabilities from 3.2 million to 6.1 million, with increases in all the categories of disability. Two years later the Royal National Institute for the Blind and the Royal National Institute for the Deaf released new extrapolations that increased their estimates of visual and hearing impairment by up to 40% over the Government's figures.

A further problem in estimating market sizes for RT is the overlap between the populations of elderly people and people with disabilities. Disability is strongly associated with advancing age; based on UK and Swedish figures it is estimated that some 70% of all people with disabilities are aged 60 or over. Not all older people need RT, but neither are all those who could benefit from R&D in Rehabilitation Technology necessarily classified as either elderly or disabled people. Many people would benefit from technology that was easier to use; screens that are easier to read from, from redundancy in information in publicly available telematic services, systems with alternative output such as speech synthesis etc.

While the primary focus and market for RT remains elderly and disabled people, it is clear that defining market segments and sizes purely in terms of the categories of elderly and disabled people and the raw numbers in them could be misleading. It could well prove more useful to base market segmentations on sets of user needs and requirements, impaired function and the technological means of providing solutions. There is, for example, a general requirement in the population to be able to access telephone numbers, for most people, most of the time, a telephone directory is the most cost-effective solution (to the operator). For people with visual impairments this is not a viable solution, nor is it viable for people with severe upper limb motor impairment, nor for people in a 'hands unfree' situation like using a mobile phone in a car. Some other solution, such as an operator service, or a voice recognition and synthesis technological solution is necessary. This would also make clearer the scope of user requirements that particular consumer and user groups have in common and the scope of requirements that need to be satisfied in different technological ways.

Sector actors, particularly from the European IT&T industry have pointed out a lack of available information on elderly and disabled user requirements and capabilities. This makes it very difficult to ensure the requirements of these consumers are included in the development of mainstream IT&T equipment or to design these products and services for adaptivity with specialised technical solutions. There is a perception that sources of

information on the capabilities and requirements of elderly and disabled people are fragmented and difficult to use for developing products. At the same time specialist research institutes and universities across Europe have carried out a lot of research on user needs for RT and the technological means of providing support for independent living.

1.1.3. The challenges and opportunities of the Single Market

The completion of the Single Market will provide new opportunities and challenges for RT. As trade barriers come down, the market will become more commercially attractive for suppliers as the numbers of potential consumers in the market segments increase providing scope for economies of scale. Competition is likely to intensify driven by pressure from the purchasers who want to contain costs and consumers who want to improve choice and functionality. There are signs that the RT market is becoming more "consumer" oriented with a trend towards providing grants to be spent on RT as the consumer sees fit rather than reimbursement. Important factors in developing a Single Market in RT include:

- Increasing possibilities of interconnection and interworking across Member States due to harmonisation of Telecommunications infrastructures. It should also be noted that the digitalisation of the network greatly increases the opportunities for translation and changing the presentation modality.

- Pan-European certification; this currently applies to harmonisation of health and safety measures but may also come to apply to certification for reimbursement.

- Increasing harmonisation of education and training standards across Member States, leading to increasing harmonisation of protocols and assessments.

- Pan-European standards for product and service quality, with guidelines to achieve these.

- Coherent classification of technical aids by ISO TC173, improving the understanding of what is available.

Initiatives in many of these areas are already underway. With these factors combining to act on the market, the move towards a Single Market in RT is gaining momentum. There are, however, a number of technical and commercial obstacles retarding progress towards the benefits that could come from a Single Market in RT. The technical obstacles are largely common to both categories of industrial sector actor, the SMEs and the IT&T industry. The major technical obstacles are;

- A lack of consistent, coherent and transparent user requirements for use by marketers and engineers.

- A lack of technical standards and norms such as physical and software interfaces. This limits integration, interconnectivity and compatibility. Combined with the lack of transparent requirements, this makes the production of modular, configurable RT products and services at cost-effective prices virtually impossible. It also impairs such things as servicing and maintenance.

- A lack of effective technology transfer from research into development and manufacturing with regard to high technology RT products and services, as well as, the high technology means of manufacturing them such as CAD/CAM.

Commercial obstacles to the development of the Single Market, and the commercial opportunities coming from it differ somewhat for the SMEs and the IT&T industry.

Many SMEs face the considerable challenge and financial risk of extending their operations to a pan-European level. They frequently lack the resources in both capital and expertise to set up the necessary support structures to market, distribute and maintain their activity across the Member States.

A particular difficulty for SMEs is keeping up with the pace of technology change in new materials, techniques, software and microprocessors. It is particularly difficult for SMEs to support the increasing costs and lead times of high technology R&D on low turnover. Keeping down costs without using obsolescent technology, requires adaptation of current technology. Competition for commercially valued skills is inevitable. Pan-European certification, as well as, increased quality, health and safety testing will further add to costs. The lack of available information on user requirements will make it difficult to expand operations beyond known user groups and niche markets. Appropriate cooperation is becoming a matter of survival for many SMEs.

Major IT&T industries, including manufacturers and service providers, such as Telecommunications network operators have tended to see RT as a set of fragmented, national markets. The completion of the Single Market, however, opens up markets of elderly and disabled people that are commercially interesting for companies that manufacture in the millions. This major opportunity has also been noted by US industry. US IT&T suppliers are in a comparatively strong position vis a vis the European IT&T industry. Affirmative legislation has been gathering pace in the US, fuelled by lobbying from organisations like the war veterans. Empowering people with disabilities has become a civil rights issue.

This has culminated in the Americans with Disabilities Act (ADA) of 1990, which effectively empowers and extends earlier legislation in favour of people with disabilities. Most importantly, the Act sets timescales for implementing parts of the legislation and many of the regulations that impact the IT&T industry come into force in 1993.

Thus the US IT&T industry has been forced by the threat of impending legislation to both consider the requirements and design technology for people with disabilities. A two track approach is required, both including some basic functionality in the standard IT&T systems and developing technology that is adaptable. The US industry has experience and technology on which to build and, further, has well established supplier and dealer networks across Europe and elsewhere.

This threatens the competitivity of the European IT&T industry in the European Single Market, but equally importantly, poses a threat at the global market level. US industry will understand a wider set of user requirements which cannot fail to be a competitive advantage, particularly in designing modularity into technology for export. Technology which is modular, adaptable, and which can be configured by the user is the most cost effective way of developing RT. Developing modular and adaptable products and services is, also, a way of broadening and harmonising markets for the basic, underlying technology. Improving the interface to, and the usability of, technological devices improves the usability for everybody, not only elderly and disabled people. This will also improve the market penetration of the technology. Appropriate actions to obtain an understanding of these wider requirements with organisations and industry already active in the RT sector is a necessity.

In the longer term the shifting demographics in Europe are an important market force that the IT&T industry will have to take into account as the present markets for their technology are reaching saturation. Present projections predict that by the year 2000, 20% of the population , and by 2020 over 25%, will be aged over 60. Taken as a market sector the 'younger old' may be distinguished from the 'older old', as more economically active and powerful, as well as more technologically aware. These people will have acquired the tastes and habits for consuming the new technological tools and services but for many, access to them will be progressively limited by the multiplicative effects of visual, hearing, speech, cognitive and motor impairment. This group of people (increasing by some 80% between

1980 and 2040) combined with both younger adults and children with disabilities will constitute an increasingly important consumer group.

IT&T manufacturers and service providers may see RT as an intermediate market. Technologies and techniques used to address the stringent requirements of these market sectors, can be used to address further markets. For example, a system originally developed for disabled users, the Kurzweil Reading Machine for the Blind has become a device of more general interest as a document reading machine for the office automation market. Likewise meeting the needs of elderly and disabled people for simplified operation of all kinds of workplace and domestic equipment can be translated into a competitive advantage in the wider consumer market.

Europe is in a potentially strong position to compete in the Single Market in RT. In some areas such as speech technology and Braille displays, European technology R&D is comparable with the US. In some Member States the social system is better developed with a large variety of technical aids. It is necessary to act at Community level to take advantage of the historic market opportunity that is facing the potential sector actors of the emergent Single Market in RT.

1.1.4. The nature of the Community action required

Making the user requirements coherent and transparent, developing new, appropriate RT products and services, accelerating the production of new norms and standards, facilitating the transfer of technology and the development of new relationships between the sector actors is a way forward to creating a European RT industry of the future.

Coherent and consistent user requirements are a necessity for both engineers and marketers. It is not that elderly people and people with disabilities have special needs, it is rather that they have ordinary needs that need to be met in different ways. The activities of daily life are more difficult for these groups because the world is designed for people who are both younger and more 'normal'. Some of the IT&T industry, particularly the telecommunications operators faced with a regulatory requirement to provide service for all the population and a saturating market are more aware of the user requirements of these consumers. Individual SMEs tend to be aware of the requirements of particular subsets and market segments. For much of industry however, attempting to design technology to cater for a wider range of the population, or to be adaptable to special requirements is restricted by the lack of a clear picture of the range of users and their different capabilities. Industry has pointed out the bewildering number of organisations and experts with different views of user requirements. Constructing a framework which relates user needs, user profiles and capabilities to technological options would greatly assist the design and development of appropriate RT.

New, appropriate, high technology RT devices and services are needed since many of the activities of daily life critical to empowering independent living are inadequately supported. In many cases technical solutions could be based on technology that has been developed for other purposes. A particular example of this at the present moment are the light weight materials developed by the defence industry that could prove extremely useful for prostheses and orthoses. Image enhancement and intensification technology developed by the defence industry could also prove useful to facilitate viewing of displays etc in public places. These new RT device developments require multidisciplinary, collaborative efforts at Community level as the appropriate knowledge to provide is distributed both across sector actors and across Member States. Action needs to be taken at Community level to attain the critical mass and bring those with the knowledge of user needs together with those who understand the technology.

The development of norms and standards provides for a more 'open systems' modular approach. This allows greater interconnection and integration of devices and services, from

Braille displays for computers to smart houses and navigation systems for the blind. Thus a wider range of economic and social activities necessary for daily life are supported by the integration of technology. In the comparable IT market, the trend to a more modular, managed open systems approach has led to substantial reductions in the relative costs of IT systems to end users and an increase in the business effectiveness of systems through interconnectivity. The overall result of new norms and technical standards on the RT marketplace should be to improve the effective coverage of handicaps through integratable technology and to reduce prices.

To tackle the challenges presented by the Single Market in RT, new relationships between the sector actors are necessary. If all are to profit from the Single Market in RT, these new relationships have to be built on the separate self interests of the sector actors. From these self interests, partnerships based on a commonality of interest have to be built. The attitudes of sector actors will have to be modified, particularly in the European IT&T industry so that they become aware of the new business opportunities opening to them. It is clear that the categories of sector actor; the specialist SMEs, the IT&T industry, the research institutes and universities all have different interests and bring different experiences, strengths and constraints.

- The European IT&T industry is interested in maintaining and expanding the market for it's technology and services. The companies tend to have a tradition of R&D and a relatively strong technology base. In addition, some of them have experience of operating across Europe in both marketing and distribution. To extend their saturating markets they have to address new users and consumers. This can be achieved by designing to include a wider scope of requirements and by adapting their technology to make it usable by more people. (It may be in the interests of the IT&T industry to have specialist SMEs address niche markets with adaptations of their technology).

- Small to Medium sized Enterprises see the potential market for their products expanding from the regional or national level to the pan-European level. This potential expansion in their market results largely from pan-European certification, norms and standards. At the same time their certification costs will also increase. This increase in cost is but one element for SMEs in the upward spiralling costs of doing business in RT in the Single Market. These include the increased commercial costs such as marketing and distribution in new European markets, as well as, the increasing costs of R&D and product development as RT becomes more technologically sophisticated. SMEs with their smaller overheads and greater flexibility can provide the larger IT&T companies with channels for their technology into specialist markets.

- Research institutes and universities are investigating new ways of meeting the needs of elderly and disabled people. Their innovative solutions need to be transferred in order to develop products for the market. Traditionally, there have been technology transfers to spin-off, start-up companies. However, competing in the Single Market will require, also, the implementation of cost-effective products to industry standards, as well as, professional marketing and distribution. Research institutes and universities are developing extensive knowledge of user profiles and requirements together with their possible technical solutions.

Facilitating the appropriate links between the sector actors and bringing about the change in consciousness to realise the commonality of interests in taking advantage of the opportunity of the Single Market in RT requires action at Community level.

An efficient Single Market in RT and a customer focused RT industry of the future can only be based on firm technological foundations. Turning the user requirements into technologically based new devices and services that are market-oriented and customer-focused necessitates developing RT prototypes and verifying their utility with users. This, in turn, necessitates multi-disciplinary collaboration at a pan-European level to harness the scarce and fragmented scientific and technical resources that the new technological RT solutions require.

The case for a pan-European effort is made by the need to provide cost-effective solutions which require the economies of scale inherent in the larger market sectors. This collaboration will form the model and basis for the development of the new partnerships of sector actors that will compete effectively in the Single Market in RT. A sound technical basis is also necessary to achieve the new norms and standards that form the technical basis for an open and efficient Single Market in Europe. This complex interaction of factors demonstrates the need for pre-competitive, pre-normative R&D in Rehabilitation Technology. To take advantage of the completion of the Single Market and to compete with US and Japanese industry it is essential to take action at a European level immediately.

1.2. TIDE Programme.

1.2.1. Introduction

The realization of the situation of Rehabilitation Technology in Europe has prompted the setting up of some cooperative actions at European level. The most notable example of this is COST Project 219: 'Future Telecommunication and Teleinformatics Facilities for Disabled People'. Activities are also going on in Community research and development programmes like ESPRIT and RACE and social action programmes like HELIOS. Unfortunately COST 219 activities are very limited in budget, RACE and ESPRIT very limited in scope in this field of rehabilitation technology and HELIOS does not deal with technological problems (except for using technology for the collection and exchange of information). It is clear that the present level of technical R&D activities at a European level are insufficient to support an efficient Single Market in RT in Europe, or a healthy indigenous RT industry of the future.

The Commission has examined this problem with the assistance of a number of studies carried out by industry and academics, as well as, launching the **TIDE (Technology Initiative for Disabled and Elderly People)** pilot action, which is currently underway. It has concluded that the use of advanced technology to provide equal access to telecommunications, information and control systems for all people is not only a social goal towards the full participation and equal rights for all European citizens, but also a viable proposition from a market and economic point of view. The completion of the Single Market offers a window of opportunity to stimulate the creation of an efficient Single Market in Rehabilitation Technology in Europe. The economic and fiscal effects of a Single Market in Rehabilitation Technology are seen as potentially positive to the Community fabric.

The Commission has also concluded that a major reinforcement of effort is needed in the research and application of advanced technology to accomplish the goal of an efficient Single Market in Rehabilitation Technology. This will accelerate the emergence of a customer-centered, market-oriented, Rehabilitation Technology industry of the future and facilitate independent living and participation in economic and social activities by elderly and disabled people through technological intervention.

There must be a new, greatly enhanced level of cooperation in the research and development of applications of existing and new technology in the fields of information, telecommunications, teleinformatics, robotics and environmental control. The enhanced effort must be focussed on the collaborative research and development of prototype RT devices and services.

The activities must involve the whole range of sector actors including end user organisations, major industry, service providers, research institutes and universities, small/medium enterprises and professional groups. A particular emphasis must be given to providing a framework for the transfer of high technology into the RT market. This responds to the need of the many small and medium sized enterprises with the knowledge of the sector to update their technological base.

To this end, a technologically based, market-oriented, customer-focussed action of pre-competitive and pre-normative R&D in Rehabilitation Technology is proposed. It is essential to act immediately to meet the window of opportunity inherent in the Single Market.

The preparatory activities, in particular, the Technology Initiative for Disabled and Elderly people (TIDE) pilot action has demonstrated that the sector actors are capable and indeed eager to respond to the challenge. However, both earlier studies and the large number of consortia responding to the pilot phase call for proposals confirm that a great deal more needs to be done and that the impetus must be maintained.

Accordingly the Commission has undertaken a major consultation exercise with the sector actors. Technical panels of experts from the Member States and EFTA countries have been

invited to recommend pre-competitive and pre-normative, technical work to be carried out in a collaborative pan-European R&D action. A questionnaire inviting sector actors to contribute ideas has been circulated and the responses have been considered by the technical panel experts in preparing their recommendations.

1.2.2. Objectives and scope of TIDE

The TIDE programme (Technology Initiative for Disabled and Elderly people) is a Community initiative to develop new technological tools and applications for people with disabilities and elderly people, to enable them to live independently and participate in the social and economic activities of the community.

TIDE is a pre-competitive, pre-normative, technology research and development initiative with the specific objective of:

stimulating the creation of a Single Market in Rehabilitation Technology in Europe

TIDE's contribution to this objective is to be achieved through the collaborative research and development of high technology prototype products and services. This R&D activity will be carried out with the specific aims of;

- Encouraging innovation and technology transfer in RT.
- Understanding and making clear the needs of the user groups.
- Accelerating the development of technical norms and standards.

TIDE is focused on Rehabilitation Technology which is technology, including both devices and services, used directly by the primary user groups which are people with disabilities and elderly people. This definition corresponds closely to the spirit of the United Nations definition of rehabilitation (see footnote in section 1.1.1.) in providing tools to the individual to change his or her own life. This distinguishes RT from technology for medical rehabilitation purposes and clinical practice which is designed primarily for use by the medical and other professions. The functioning of Rehabilitation Technology under TIDE is usually under the direct control of the user. This further distinguishes RT from more medical and bio medical technology such as implants. The high technologies concerned which provide a basis for RT applications cover a broad range which includes among others: information technologies, communication technologies and control technologies.

The scope of the TIDE programme is best described by the action lines and the work areas. There are four specific TIDE action lines, each with a number of work areas. These are :

1. Access to Communications and Information Technology and support for interpersonal communication.

    i Access to and interaction with multimedia environments: concerned with the development adaptation and demonstration of interaction technologies, techniques for designing and implementing dialogues and for managing the user interfaces of application and services.

    ii Technology to facilitate personal communications: concerned with support for the generation and reception of interpersonal communication of all kinds.

    iii Services and applications: concerned with the development of innovative services and applications to meet specific needs of disabled and elderly people.

2. Control Technologies.

   i User and System Interfaces for Control: concerned with assessing the suitability of control systems and accessibility to appliances and control systems.

   ii Robotics: concerned with integration of robotics with wheelchairs and robotic systems for home and workplace.

   iii Mobility and Transport: concerned with improving wheelchairs, access to public and private transport, and transfer.

3. Restoration and Enhancement of Function.

   i Functional assessment and training: concerned with assessment and training of people with communication disorders, cognitive and functional disabilities, and normal/abnormal motor function.

   ii IT for individualised plans for rehabilitation and maintenance in the community: concerned with advanced information processing applied to the devising of individualised plans for rehabilitation in the community, providing a service to the individual elderly or disabled person.

   iii Technology for rehabilitation and maintenance of motor function: concerned with rehabilitation of temporary functional impairment, preserving motor control in the elderly and optimising available motor function.

   iv Substitution devices for motor function: concerned with prostheses and orthoses, the body-device interface, as well as, appropriate high technology manufacturing.

4. Integrated Systems Technologies

   i Smart environments and systems: concerned with a multidisciplinary, systematic approach to adapting smart house technologies for elderly and disabled users.

   ii Orientation and navigation systems: concerned with orientation and navigation in unfamiliar, public places.

   iii Education and training: concerned with new technology training for disabled and elderly people, use of new technology for training elderly and disabled people.

   iv Working environments for disabled and elderly people: concerning new systems technologies, subprocesses and interfaces enabling the employment of elderly and disabled people.

The structuring of the four action lines of TIDE into work areas and tasks is largely to better describe the focii of project activities that TIDE is designed to support in terms of objectives, scopes etc. **It should be noted that projects may well chose to address more than one task, aspects of several tasks, or a only a part of one task. All these combinations are allowable.** The most important thing is that project should make good technical sense and the results should have potential for commercialisation. Projects should have clear objectives, a sound technical approach and demonstrable results.

Whilst the scope of activities to be covered by TIDE are largely restricted by the work areas outlined above (and in part 2 of this document) and the task descriptions in part 3 of this document, the principal purpose of this document is to encourage innovative work towards meeting the TIDE objective. Work that is outside the work areas and task descriptions may be considered for funding if;

- it comes within the four TIDE action lines (above).
- it contributes to meeting the TIDE objective and aims
- it conforms to the TIDE principles and concepts (see sections 1.3.1. - 1.3.8.).

In addition to the action lines and work areas outlined above there will be a small number of horizontal activities, split between the TIDE office and common responsibilities placed on the individual technology projects. These will focus on providing:

- A solution framework: This incorporates the concept of a reference model, categorising user needs and requirements, functional impairments, and technological solutions. Reference performances and criteria are also included. Design guidelines for (industrial) design could also be included.
- A cost-benefit model: This provides a common model, allowing projects to consider the cost-benefits under various market conditions and situations of deploying RT.
- A market factors model: Linked to the cost-benefit model, describing the factors important to developing the market for RT and, specifically, a Single Market in RT.
- Information distribution and publicity activities: two types of activities are envisaged. For example:
  - focused workshops
  - focused newsletters

1.2.3. Benefits of the TIDE programme

In making user requirements transparent, in prototyping new technological solutions and in accelerating the formulation of new norms and standards, as well as, bringing the different sector actors together, TIDE will be helping to create the conditions for a Single Market in Rehabilitation Technology. Whilst deploying the technology developed within TIDE will take place outside the R&D programme, TIDE can provide a sound technological basis for an efficient market in RT to develop. To the consumers and end users, the growing numbers of elderly and disabled people, this should result in more customer focused technology, improved functionality, more choice, and lower prices.

The benefits of an efficient market in RT should help to empower the independence of disabled and elderly people, and improve their quality of life. This should extend to improving the quality of all the aspects of their life, including leisure activities. Improved RT products and services, including improved access to RT, will mean that the elderly and disabled can become more integrated and make a greater contribution to economic and social activities. TIDE will help improve the cost benefit of RT aids through the provision of lower unit cost and enhanced quality. Over the coming years of demographic shift, RT will make an increasingly important contribution to the containing of the rising cost of care, in both cash and human carer terms. At the level of the Common European Home, a Single Market in RT will be a large step towards equal access and improved civil rights for all our citizens.

The TIDE programme is specifically aimed at the RT sector actors, with an emphasis on stimulating multidisciplinary R&D activities with industry. This includes both those industries presently active in the RT market, and those industries which have a potential contribution to make to RT, such as basic technological components. Improving the competitiveness of the European RT industry by stimulating innovation and collaboration in R&D is a major aim of the programme. The RT market is important to European industry because it is an increasingly high technology market that is projected to grow steadily for the next 50 years.

1.3. TIDE Programme Principles and Concepts

Attaining the objective of the TIDE programme - *stimulating the creation of a Single Market in Rehabilitation Technology* - requires that work carried out under the programme conforms to the basic principles of customer focused technology development. These principles are explicitly elaborated in TIDE as the five TIDE Programme Principles. These five interlinked principles are;

- Market Oriented principle
- Technology Adaptation and Innovation principle
- Multidisciplinary Approach principle
- Technology Verification principle
- User Focused principle

All projects carried out under the auspices of TIDE are required to demonstrate their compliance with these principles. These five principles will form the basis for some of the criteria against which the projects will be evaluated and selected for funding.

In addition to the principles, projects are also required to conform to the three TIDE programme concepts;

- TIDE Round Table Concept
- TIDE Cooperation Concept
- TIDE Programme Management Concept

1.3.1. Market Oriented principle

The development of Rehabilitation Technology under the TIDE programme must be oriented towards the market. Projects should emphasise taking advantage of the opportunities coming from the completion of the Single Market. Whilst TIDE supports pre-competitive and pre-normative R&D, this should not be taken to mean that the R&D work may be undertaken without a very clear idea of what the market for the technology will be. Technology development work should be carried out with an emphasis on working for customers. Both understanding and satisfying user needs and desires are essential. This market oriented approach to technology is seen as critical to developing the market for RT and to competing in the Single and global markets. Projects should lead in the short term to the development of technology based prototype products and services which have a good commercial potential in a competitive environment. Projects are required to explicitly describe the market segment (or potential customer base) which their technology is addressing. Project partners will be required to submit exploitation plans for the anticipated results of the project. Projects may request that the detailed information on exploitation plans be kept commercially confidential.

1.3.2. Technology Adaptation and Innovation principle

To compete effectively in the market, Rehabilitation Technology developed under TIDE must make best use of mainstream technology development and standards. The TIDE programme emphasis is on adapting existing technology where this approach is feasible and cost-effective. A further programme emphasis is on injecting the user requirements of disabled and elderly

people into the mainstream of technology development and standards, where this is an effective means of satisfying the needs of these customers. Throughout the programme there is a strong emphasis on innovation in meeting the needs of the elderly and disabled consumer through technology adaptation. Whilst the development of new basic technology is not ruled out, a very strong case for this would have to be made to show there is no more cost-effective alternative through adapting mainstream technology. It is important, therefore, for projects to show the positioning of their intended Rehabilitation Technology development with regard to industrial and international norms and standards. Projects will also be expected to indicate where contributions could be made to standards resulting from their work. Projects should recognise that accelerating the formulation of standards in Rehabilitation Technology is seen as a major result of the TIDE programme.

1.3.3. Multidisciplinary Approach principle

Rehabilitation is by it's nature very much a multi-disciplinary activity. Technology to support rehabilitation is deployed within this multi-disciplinary context and must therefore build on the knowledge and experience that is available in the field. The technology development must, also, build on the knowledge of researchers in the fields of rehabilitation and gerontology, as well as, the technical knowledge of the technologists themselves. The RT will be deployed within a social, economic, legal and market context. These various interests and considerations must not be ignored within the context of the TIDE programme. Projects should demonstrate expertise in the broad range of disciplines necessary to explore the issues surrounding the uptake and deployment of the technology developed within the programme. Explicit provision should be made for this work.

1.3.4. Technology Verification principle

It is necessary for the projects to make an assessment of the RT they have developed within TIDE. The utility of the technology should preferably be verified with the users or consumers of the technology, either in a field trial or by using a scenario. Projects are required to make explicit provision for such testing, reporting the results of testing with users and to revise statements of user requirements where necessary.

1.3.5. User Focused principle

TIDE is a user focused programme with an emphasis on the market and the customer. Users or potential users of the technology to be developed under TIDE are to be appropriately involved in all projects. Projects should deliver statements of end-user requirements and make statements of the anticipated benefits of the technological solutions to their end users. Projects should take into account the level of acceptability across Member States and cultures. Wherever possible they should strive for Pan- European solutions.

1.3.6. TIDE Round Table Concept

Cross programme activities are necessary to achieve the TIDE objective of *-stimulating the creation of a Single Market in Rehabilitation Technology.* A series of technology projects alone would tend to perpetuate the fragmentation of the market. Cross initiative activities will not be entrusted to a single project. Rather a series of accompanying measures will be undertaken, consisting of those needed to provide a framework for the proper technical

execution, management and evaluation of the programme, as well as adequate dissemination of results and coordination. The measures include those described under Section 1.2.2. above:

- A solution framework
- A cost-benefit model
- A market factors model
- Information distribution and publicity activities

A set of common responsibilities will be placed on the individual technology projects, largely consisting of validating the models provided and providing data. Projects will also be expected to provide for dissemination of their results.

1.3.7. TIDE Cooperation and Management Concepts

Projects must approach the technical work and coordination activities as outlined above. In particular, the technical approach must reflect the five TIDE programme principles outlined above, and there must be a commitment to participate in the TIDE Round Table activities. In addition:

- TIDE operates under the subsidiarity and Community added value principles, so that only work which clearly requires action and collaboration at Community level is eligible for inclusion in the programme.
- The approach taken must not distort competition.
- Each organisation acts under it's own responsibility and with it's own view of market needs.
- Projects will be reviewed and evaluated on the basis of their **effectiveness** - whether their objectives make a contribution to the TIDE objective, and their **efficiency** - whether they are cost-effective in achieving their own objectives and contributing to the TIDE objective.
- Results from all projects should have a clear exploitation potential.
- Project consortia should contain at least two industrial partner capable of exploiting the project results.
- Each organisation should have a clear role in projects and workpackages.
- Each workpackage should have a clear lead partner.
- Optimal use should be made of assets and expertise.

1.3.8. TIDE Pre-normative concept

The TIDE programme is concerned accelerating progress towards standardization but is not directly concerned in the production of standards. However, it is recognised that the successful introduction of systems, devices and products is dependent on the appropriate adoption or development of standards and access to appropriate certification mechanisms. Standards may have significant impact on the specification of requirements, the method of design and construction, the design of interfaces, the testing and evaluation of performance of the products of the TIDE programme.

All development activities within the programme must:

- position themselves with respect to existing and emerging standards,
- identify new areas of standardisation which could be developed from their work and which is specifically relevant to the market for products to meet the needs of disabled and elderly users,
- address the issues of certification and evaluation concerning such questions as effectiveness, quality, safety.

The establishment of de facto and de jure standards on a Europe wide basis represents the essential first step in the creation of the single market in rehabilitation technologies and products. It is apparent, however, that very few existing standards are directly relevant to technology or devices for disabled or elderly people. The publication of design and implementation guides, codes of practice and submissions to appropriate standards bodies such as IEC, ISO, CCITT, CEN, CENELEC and ETSI represent valuable contributions to the standardisation process.

2. DESCRIPTION OF THE SCOPE OF THE R&D WORK

2.1 Access to Communications and Information Technology and support for interpersonal communication.

2.1.1. Overview of action line

Interpersonal communication is one of the most basic needs of the individual. Without it we are not able to fully participate in human society. Society is coming to rely increasingly on Information Technology and telecommunications systems and services as a medium for communication. This action line focuses on two challenges and opportunities in relation to disabled people:

i What special Technologies, systems and services are required to meet the specific needs of disabled people in the area of interpersonal communication.

ii How can the needs and preferences of disabled people be incorporated into the design, construction and adaptations of all communications and information technology,

Telecommunications and information technology are undergoing very important changes world-wide (and particularly in Europe) with the restructuring of telecommunication networks and services.

Telecommunications and information technology have reached a level of development and a cost, which allow them to have impact not only on professional applications but also on everyday life. On the other hand it is not expected that drastic reduction of prices, as has been the case for personal computers, will occur. What probably will happen is an increase of performances at stable cost. This fact will allow the allocation of resources not only to the computational and/or control tasks to be performed but also to the support of the users, by permitting the production of sophisticated I/O peripherals (not only keyboards) by simplifying interfaces and ways of using them (dialogues), by introducing "intelligence" in the systems (e.g. adaptive and learning interfaces).

The new telecommunication and information technology scenarios have to emerge in such a way as to take into account the needs of all the potential users, including elderly people and people with disabilities. The activities within this action line will promote this by:

- increasing awareness about the corresponding needs;
- investigating technical and economic feasibility of adaptations;
- contributing to the specifications of new services and systems;
- piloting demonstrations of adaptation of commonly used technology and developments of special applications;
- contributing to standardisation in the sector.

2.1.2. Rationale for pan-European action

From a purely economic point of view, elderly and disabled people who are economically and socially active represent a positive contribution to the productive capacity of the community and show an economic saving by not requiring costly care. Elderly and disabled people are a significant group of potential consumers in the markets for information, systems and services

to the general public. They can only become real consumers in these markets if the products and services are accessible to them, usable by them and useful to them. To achieve the appropriate level of access, use and utility, the design process must take into account:

- The reduction in mobility which is associated with some forms of disablement, emphasizing the need for use of telecommunications and information technology for independent living at home (e.g. tele-work, home shopping, home banking, environmental control);

- Reduced perception capabilities, with a resulting need for all kinds of amplification, enhancement and transduction of information.

- Reduced cognitive capabilities in using complex systems, with resulting need for adaptation or simplification of man-machine interfaces;

- The need to support and augment the communication and social interaction capabilities which are impaired in some types of disablement.

For disabled people to achieve their full productive potential, they require access to all the information and communications systems and services on which the business infrastructure of modern economy is based. The ability to use these systems and services effectively is a key factor in employment in an increasing number of economic and industrial sectors. This dependence is likely to increase with the introduction of ISDN services followed by broadband communications. These developments create the possibilities for improvements in accessibility for disabled and elderly people but only if their needs are fully understood and incorporated in the new services.

Elderly and disabled people represent a specific market for products and services which mediate communication both with systems and between individuals. The provision of such products should not be viewed as the end of the value adding process. The users and consumers add value by achieving improved independence and effectiveness. For the more complex applications and technologies, the level of investment required to develop and prove solutions makes a co-ordinated approach, on a Europe wide basis, the only commercially viable one.

For the designers and developers of applications services and products, addressing the needs of elderly and disabled people often leads to better, more usable solutions which are capable of achieving greater market acceptability for all sorts of user.

The aim of this action line is not to provide individual solutions for disabled people, although all solutions must be adaptable to individual needs, it is to establish a single market for information and communication systems that simultaneously addresses the needs of both able and disabled users. Consequently better tele-terminals and computer systems will be introduced which are easily adapted to the physical, sensory, perceptual and cognitive abilities of potential users.

If the developed solutions are flexible enough in terminals, services, computer applications and human computer dialogues in order to make them accessible by disabled people, then less adaptations and less effort will be required in the future each time new information and communication systems are introduced.

Aspects of competition between Europe and other major economies also have an impact on the TIDE rationale. In a number of non-EC countries, particularly the U.S., regulations are made or are in preparation stating that all equipment for particular and specific purposes must be accessible for the people who have disabilities. This will be an important issue in the future, especially for public procurement. If the EC IT&T industry does not anticipate adequately on this matter, then they might lose important segments of their market in those countries or they may retard the introduction of socially desirable and economically

advantageous legislation. If the European IT&T industry fail to establish adequate collaborations and pan-European activities based on common standards, the development costs to address markets within single Member States will be prohibitive.

Due to the special nature of the EC-market (different languages, different governmental regulations, different approaches to the specific problems of disabled people) a lot of experience and knowledge is available to make the most flexible products and services for customers with disabilities. If this experience and knowledge is brought together, then the EC has all that is needed to become market leader in this field.

Taking into account the needs of the whole range of physical, sensory and mental impairment, this work area will concern itself with:

i The accessibility, usability and acceptability of physical interfaces to services and the systems through which they are delivered.

ii The construction of service and application dialogues appropriate to these user groups.

iii The development or adaptation of technologies and systems required to transform all types of communication between different modes and media of expression.

iv The problems of integrating these approaches, technologies and sub-systems into existing services and applications and of creating new products and services to meet the needs of elderly and disabled people.

Work is envisaged in three areas under this action line:

i **Access to and interaction with multimedia environments** concerned with the development adaptation and demonstration of interaction technologies, techniques for designing and implementing dialogues and for managing the user interfaces of application and services.

ii **Technology to facilitate personal communications**, concerned with support for the generation and reception of interpersonal communication of all kinds.

iii **Services and applications** concerned with the development of innovative services and applications to meet specific needs of disabled and elderly people.

This action must result in the publication of guides and recommendations of good practice, backed up by sound specifications and working prototypes which clearly demonstrate the benefits of disabled user oriented design of services and applications.

The TIDE programme must also result in prototype products and services which have the potential for Europe wide application and exploitation. There are between 36 and 50 million people in Europe suffering from some form of disability. This represents about 12 to 15 % of the population and equates to a demand for communications related services and products in the region of 4,500 Million ecu per year (Sandhu and Woods 1990). There is also a much wider potential market for improvements which help all non-technically trained people cope with increasingly complex communications, control and information systems. Research which leads to improved access for people with either physical or mental impairments often has immediate application for the general population with little or no modification.

Finally, the action will result in the formation of networks of collaboration, expertise and joint ownership of technology, designs and products between all relevant enterprises. A coherent Europe wide development and supply sector can develop from this grouping through which the inefficiency of the duplication of effort would be avoided by effective co-ordinating and targeting and the benefits of concerted action can be shared.

2.1.3 Access to and interaction with multimedia environments

2.1.3.1. Issues

The interfaces to systems and services at the levels of physical interaction, syntactic structure and semantic content are designed on the assumption of an able bodied, averagely intelligent user. The characteristics of such users are incorporated in the physical and cognitive ergonomics guide-lines which have been developed in recent years and which have become part of the accepted approach to interface design.

Equivalent information regarding the range of disabilities and dysfunction which occur in significant minorities of the population is fragmentary, dispersed and rarely in a form which is of use to the designer of equipment, interfaces, applications or services.

This action line addresses all the issues related to the fact that the terminal and user interface must not put any physical, perceptual or conceptual barriers between the user and the application or service. Both hardware and software have a significant impact in addressing these concerns.

The tasks within this action line are interrelated: it is expected that demonstrations of solutions in flexible interactive systems for disabled users will combine issues from all of them.

2.1.3.2. Scope

Three tasks have been identified in structuring the work to be undertaken in this area (T100, T101 and T103). The first of these concerns the physical means and mechanisms for interaction. It includes the adaptation of conventional I/O devices such as keyboards and screens and the use of new technologies which are coming into use such as speech recognition and synthesis. Specialised devices which are specific to the needs of the disabled are also included such as eye gaze monitoring or movement analysis.

The second task concerns the issues of the design of dialogues which are appropriate to the different means of interaction and which address the particular problems of different groups of disabled users. Approaches such as simplification, the introduction of redundancy and user selection and new approaches to user feedback would be considered as part of this task.

The third task area deals with the introduction of intelligent mechanisms in user interface management to assist disabled users. This may include, for example, the development of active and anticipatory help systems, user modelling and automatic adaptation for disabled or elderly users.

Activities in the above task areas must result in developments in telecommunications and Information Technology which having a potentially European wide impact. Therefore, the corresponding activity meant to guarantee accessibility has to be organised on a European basis in order to:

- identify approaches and solutions that can have a wide acceptance;
- harmonise the market of adaptations of technology and applications of technology on behalf of elderly people and people with disabilities;
- increase the market of the products throughout Europe;
- foster standardisation.

In conclusion, this area of work has been divided into three tasks related to efficient control of information systems, easy access to information by the use of improved interface design, and provision of intelligent systems that support the users' cognitive and conceptual abilities. The objectives of these tasks are to:

- Enable disabled and elderly users of interactive systems to select the desired medium or media to interact with the system, depending on user abilities to handle and perceive the media.

- Give the opportunity to access information provided in different media (the trend is towards systems that handle text, graphics, pictures, animation, voice, sound, etc).

- Provide intelligent systems which assist the user to understand and perform application or service tasks.

2.1.3.3. Anticipated impact of the action

While the activities which have been defined for this area of work relate directly to the needs of disabled and elderly users, it is the designers and implementers of services and applications who must adopt and exploit the results. The overall outcome required of the tasks in this area is a material improvement in the quality of user interfaces in relation to the special needs of disabled users. This implies that particular emphasis will be placed on technology transfer to the engineering and systems design sector.

2.1.3.4. Non R&D actions required

The tasks in this area of the programme can, ultimately succeed only if its results are incorporated in the industry and consumer standards of Europe. In order to facilitate this transfer of knowledge and practice to the standardisation process, projects will need to pay particular attention to the creation and timely publication of results in a form which is appropriate for submission to the standardisation process.

2.1.4 Technology to facilitate personal communication

2.1.4.1. Issues

The second work area addresses the problems and opportunities presented by information and communication technology to provide support to elderly and disabled people with difficulties in interpersonal communication. Here we are concerned with facilitating interaction between people rather than between a user and an information or control system.

Technology offers many possibilities and options, some of which will be more effective than others and some will be more expensive to develop and deliver. One of the key issues to be addressed in these tasks is the identification of priorities and analysis of those factors which should be taken into account in the development of a concerted Europe wide strategy for the development and introduction of products and services.

2.1.4.2. Scope

There is a matrix of devices and systems which can be used to facilitate interpersonal, face to face communication. This matrix, with examples of each of the types of device or system associated with it, is given below:

	Expressive	**Receptive**
Systems based on orthography	Speech synthesis	Alpha-numeric display
Non-orthographic (speech based)	Speech enhancement	Hearing aids
Non-orthographic (Non speech)	Pictographic control of synthetic speech	Pictograph generators and displays

All these items would benefit from specialised rate enhancement and data base searching software and, in the case of natural speech systems, the application of digital technologies.

The expressive - receptive dimension is more directly concerned with the user need rather than the nature of the device or sub-system. A deaf person needs help to receive communication, the speech impaired person to produce it. Care must be taken to ensure that the interfaces between these devices and systems allow for appropriate combination and translation: it must not be assumed that only one of the participants in a conversation requires support. This represents a particular feature of the TIDE programme approach which takes a broad view of the range of disabilities rather than focussing on specific areas of need.

The orthographic - non-orthographic dimension expresses the capability and appropriateness of text as a medium for the participants and the context. It also includes the use of sign and picture based communications which do not require literacy on the part of their users.

2.1.4.3. Anticipated impact of the action

The key results of the tasks in this area are:

i An improvement in the level of awareness and understanding of the technological possibilities and opportunities and their relevance to different classes of communications-related disability and dysfunction

ii The embodiment of this knowledge and practice into a framework for the design and implementation of services and applications and the adoption of these advances by the systems and service development sector.

2.1.4.4. Non R&D actions required

The actions defined for area 1 above apply here.

2.1.5. Services and applications

2.1.5.1. Issues

The problem of access to services and applications by disabled and elderly people will not be solved simply by modification or augmentation of terminal functions. The underlying organisation and structure of the service must be sufficiently flexible to cater for the particular needs of these users. The design of services and applications for the disabled customer must be centred around his or her needs and not those of the organisation which is to provide the service. In commercial practice, cost considerations will have an important impact on the level and quality of service delivered. These should not, however, be of primary concern in the initial specification and technology development phases.

Both the information technology and telecommunications industries have been developing methodologies for the functional definition and design of services and applications. The standard, structured approaches to the specification of new services and applications do not encourage or assist developers to take the needs of elderly or disabled users into account.

Whether a service is targeted on the general public or any specific sector, the requirements of elderly and disabled users should be catered for at the earliest possible stage. Delaying these considerations to later stages in the process increases cost and constrains the range of solution options. Access to a service is not simply a question of terminal design, the infrastructure to support alternative access methods must be implicit in the conceptual organisation of the service or application design.

2.1.5.2. Scope

It is not intended that this area of work should concern itself with the development of new technologies or devices or with the development of new methodologies. Rather it is concerned with the adaptation of existing technologies and approaches and the piloting of new and innovative services and applications.

Two sub areas have been defined in area 3, these are:

- Access to services and communications
- Innovative applications.

The scope of an application or service considered within this area should be taken to include the organisational issues associated with introduction, training and support to deliver a solution to users. This includes consideration of issues such as tariffs and billing: disabled or elderly people may be excluded from services if they are not able to understand or handle billing procedures. Tasks in this area should not be regarded as technology led but as user

centred. Work in this area should be complementary to that described in area 1 which deals with aspects of physical interaction, control and access.

2.1.5.3. Anticipated impact of the action

The main impacts sought from activities in this area are:

- Improved understanding of the needs of disabled users and the appropriate methods to address them.
- Pilot services and applications which demonstrate benefits for all classes of user.
- Improved submissions to relevant standards bodies and industry wide take-up.

2.1.5.4. Non R&D actions required in this work area

Standardisation in a number of areas relevant to this part of the TIDE work plan must take the needs of disabled people into account and this is viewed as the main non-R&D activity associated with this action line.

2.2. Control Technologies

2.2.1. Overview of Control Technologies for the elderly and people with disabilities

Technology is needed to enable users to control their immediate environments; control and operate common household and workplace appliances; and acquire greater personal control of their own mobility. To these ends, priority is given, here, to research and development aimed at producing effective, usable, attractive and affordable control technologies: *user and system interfaces for control*; *robotics*; and *mobility and transport*. Note , however, that the R & D on control systems ought to be carried out with an awareness of the need for fully integrated, standardised and open systems. Note, too, that due attention should be paid to related projects in other Action Lines.

2.2.2. Rationale for inclusion in TIDE

As the number and relative proportion of people with disabilities and elderly people is increasing in Europe, the aim of helping people to live independently (e.g. at home rather than in an institution) is increasing the demands for control technologies to enable them to do so. The Finnish National Board of Social Welfare, for example, in 1988 undertook a survey of the needs for assistance of disabled and elderly people. The main findings were:

- 14% (275,400) of households included a sick, disabled or elderly person who needed assistance with daily life
- About half of these people (52%) were living alone
- Help was needed, especially, with:
- daily living (15%) e.g. dressing, washing and eating
- light activities (17%) e.g. cooking
- heavier work (55%) e.g. housecleaning
- moving outside (9%).

Projected onto the entire European population, this constitutes a potentially huge market for aids to everyday living. RACE project TUDOR (R1088), to quote a second example, estimated that these were in the order of 18.7 million people with lower limb disabilities and 6.1 million people with upper limb disorders. Many of these will have difficulty with the sorts of activities mentioned in the Finnish survey as well as with common workplace, social and leisure activities. As a final example, a conservative estimate suggests that over 2 million people with severe special needs within the EEC could benefit from a viable "intelligent" wheelchair and many more could benefit from a technically superior wheelchair even if it is not "intelligent".

This Action Line is intended to meet these everyday but vital needs. Giving people direct control over their immediate surroundings and better mobility will significantly improve the quality of lives of themselves, their immediate carers and the able-bodied population more generally. It is included in TIDE, however, not only because there is an obvious European-wide human need but also because technologies, provision, knowledge and skills are not spread evenly throughout the Community. Pan-European, collaborative R & D is needed to stimulate technology transfer, to stimulate development of appropriate standards and to stimulate the industry to rise to the demands of the market for appropriate technologies. In the areas of control technologies much of the R & D is likely to be undertaken by SMEs (Small and Medium Enterprises).

2.2.3. User and System Interfaces for Control

2.2.3.1. Issues

People with various forms of handicap are recognised now more than ever to be a group requiring special assistance in order to cope with areas of their lives such as education, vocational training and independent living. Integration of the individual into the mainstream of activities is considered important, not just for the persons themselves, but also for society as a whole. Institutions are focusing on those with greater levels of handicap requiring more specialised care, which means that schools, colleges, workplaces and homes must be able to accommodate the special needs some people have. Legislation is also likely to be introduced to reinforce the above, within Europe, in the wake of such significant measures as the Americans with Disability Act (1990).

Disabled people and the elderly will, increasingly, demand to be able to lead normal lives. In the longer term, this need can be met by ensuring that all new facilities are designed to meet the full range of users with particular attention paid to showing that products are usable by the least capable users. In the shorter term, existing products can be adapted and improved. Note, however, that the need is not merely to enhance the usability of physical devices (e.g. by overcoming psycho-motor difficulties in using standard keyboards and other input devices) but, also, to improve the quality of information available to the users so as to make the facilities more effective and acceptable because they are made more understandable. This is as true for the design of control systems as it is for all other facilities.

The lives of all people rely more and more on the use of technologically based devices. The use of more complex telecommunication systems, televisions, video recorders and electrical appliances make the home a more technical place to be in. The workplace relies extensively on computers and various forms of automation more than ever, as do activities of everyday living like banking and information retrieval. The TIDE Action Line on Integrated Systems will deal with the combining of these into a coherent whole. This section, however, addresses the design of sub-systems for environmental control.

The modern trend is to increase the level of integration of handicapped people which lends impetus to work in this area. Fortunately, the sophistication of the available technology and the cost of such systems are able to work to the advantage of the disabled and elderly.

Legislation may be enacted in the near future placing an onus on employers and manufacturers of equipment to ensure maximum accessibility for persons with disabilities, or those who are elderly. This, too, is a reason for rapid action.

Experience has taught, that control and access equipment must be prescribed for the individual at an appropriate level. Funding is limited, and demands on the financing agencies are likely to rise. It will be important for research findings to be made available to equipment producers and providers to ensure maximum benefit to the users. It will be important, too, to emphasise the relevance of good design. Such an approach will serve to promote the better development and application of equipment, but will also show where existing technology falls short of the needs of the target groups.

The tasks described here complement those of the TIDE Action Line on Communications and Information systems. The separate activities must be coordinated.

2.2.3.2. Scope

Development of tools and procedures to assess the suitability of specific environmental control systems for different individuals. (related task 201)

This part of the R & D work is designed to cover examination of the various factors influencing the choice of environmental control equipment by/for a specific individual. Included will be a consideration of the user's desired lifestyle pattern, and their physical and mental abilities. The possibility should be considered of utilising, to some degree, other equipment being used by the individual. An example would be to use equipment provided for communication purposes as an environmental controller thus avoiding unnecessary duplication.

Commercial input will be required to ensure that the tools and procedures cover the full state-of-the-art of the available technology, and that the designs themselves, reflect accurately the needs of the end users. Manufacturers must be aware of the need for tools to allow for accurate independent assessments and provide equipment for this purpose. This may take the form of a special assessment simulator or even an expert system.

The tools should provide guidelines to manufacturers, clearly indicating the need for flexibility in the design of systems to allow clinicians to arrive at the appropriate mode and configuration best suited to the client.

Development of improved user interfaces and environmental control systems bearing in mind the need for compatibility between different interconnecting technologies (related task T202)

The standard of comfort in European homes is now potentially very high. Domestic electrical wiring and appliance standards within the EEC are good. The market for electrical "white goods" is already very large and crosses all EEC borders with some exports to non EEC/EFTA countries. The market is maintained by users (accustomed to high standards) replacing items with improved models. Existing products for the mass markets are not designed, however, with the needs of physically disabled and mentally handicapped users as a consideration.

Potential users should have their needs identified and these should be listed. The needs could be initially defined in general terms such as requirements to turn on lights, control TVs, radios and telephones, control cookers, vending machines, money automats, prepare food, clean the home, control road crossings, etc. For instance transducers could be placed in cookers, refrigerators, and water supplies to monitor temperature and contents, or in road crossings to monitor elderly and disabled users as necessary. Monitored parameters could be displayed in a suitable form (e.g. audio, visual and tactile). These transducers and controllers for the appliances, lights and heating could be linked to a controller which could be operated by various means (direct touch, infra-red link, etc). It is essential that these transducers and controllers are effective and usable by the full range of users.

There are a number of commercially available environmental controllers based on different technologies. Efforts should be made to develop systems permitting compatibility between these technologies. Also, innovations in transmission of the signal should be considered. The trend towards standardisation of usability procedures should be encouraged, to facilitate the integration and or use of different control devices in different environments.

2.2.3.3. Anticipated Impact

Two major impacts are anticipated. First, improved usability and effectiveness of environmental and domestic control systems will lead to an improved normalisation and quality of life for the users - the benefits to people with special needs are obvious, but the resulting benefits to the wider population from better control systems should not be ignored. Second, the improved accessibility of the disabled and elderly to appliances and control systems would open up a substantial extra commercial market. Even a small increase in the turnover of the existing huge market would be commercially attractive to manufacturers and suppliers.

2.2.3.4. Non R & D Actions

The guidelines to suitability of equipments for people with specific needs ought to be maintained publicly and available widely.

2.2.4. Robotics

2.2.4.1. Issues

The rapid development of robot technology, directed towards less expensive solutions, improvements in control interfaces, end-effectors and sensors, and more functional robots, may enable people with severe disabilities to perform everyday functions more independently.

The technology can offer a powerful means of integration to people with severe disabilities such as tetraplegia, upper arm diplegia, muscular dystrophy and cerebral palsy. To these people the use of a robot will give improved opportunities to perform independently common household tasks and activities necessary in daily living. At the workplace, it will assist their use of computers and other equipment, paper handling and other tasks.

Robots can be defined in terms of performance (for example, joint acceleration and end-effector positioning accuracy) and specification (for example, size and weight). The performance and specification of robots for personal use will differ from the properties needed for most industrial tasks. Methods of programming and control will also impose different design constraints. Safety is of prime importance for any application in which the user interacts with the robot in the same or adjacent living or working space and is influenced by performance, specification and the method of control.

The following issues should also be considered:

- The design of safe robot systems to meet the specific functional requirements of disabled users
- The design of end-effectors and integrated sensors appropriate to the needs of the user
- Integration of control functions with other systems, especially wheelchairs
- Commonality of control techniques among different working environments
- Availability of the full functionality of controls to users with severe disability
- Concepts of human-machine interactions in relation to the levels of control accessible to the user
- Cost-effectiveness and the level of independence that can be provided by a robot system
- Reliability of the robot and the associated control systems
- Integration of the complete system into its environment both functionally and aesthetically
- Psychological barriers to the acceptance of the technology
- Assessment of user, environment and system to match the capabilities and needs.
- Methods of teaching and programming new robotic operations by the user, the user's family or caring staff, rather than solely by programmers and engineers
- The development and transfer of advanced robotic technologies to *all* member states of the EC.

2.2.4.2. Scope

Integration of robotic aids with wheelchair. (related task T203)

Powered wheelchairs are widely used to provide mobility for people with lower limb disabilities who cannot drive a manual wheelchair. Many people, with, for example, upper arm diplegia or tetraplegia, have restricted ability in the use of their arms and hands to pick up and move objects or to operate environmental control systems. For these people, an integrated mobility and handling system would open new opportunities in a large number of situations of personal care, vocational tasks and control of devices in their environment.

Robot systems for assistance with common household and workplace tasks. (related task T204)

Related to, but separate from, the previous task of placing robots on wheelchairs is a need to develop static and mobile robots for the home and workplace. Robot arms adapted from industrial applications, or purpose-designed, could be fixed to working surfaces, walls, floors or ceilings to carry out a range of specific, limited functions. Examples are picking up and placing objects, food preparation, opening books and handling documents. In addition, special-purpose or adapted industrial mobile robots could be used for cleaning tasks, access to storage units, etc.

2.2.4.3. Anticipated impact

All of these developments give increased control over the user's environment and access to additional systems and appliances, offering an improvement in the user's quality of life, a greater ability to live independently at home and a greater ability to be involved in gainful employment.

Commercially the market for domestic and workplace robotic tools is limited by cost. The market is potentially large since each person may need several robots. Within the workplace, the emphasis is on increasing opportunities for employment, as opposed to the replacement of people by robots. The challenge is to design effective and safe robots appropriate to a range of tasks within the home and workplace at a price which enables them to be used by a large number of people.

In the European Community, the rehabilitation services of the group of people with lower limb disabilities (about 18.7 million individuals) forms a large actual market within each member country (e.g. for wheelchair support). There are about 6.1 million people with upper limb disabilities (e.g. needing prosthetics, orthotics and robotics support). The market for rehabilitation robotics, however, is mainly related to the smaller group of people with severe upper limb disability and combined upper and lower limb disabilities. The single European Market opens the opportunity for cost-effective development, production and service, whereas national markets are too small.

2.2.4.4. Non R & D actions

Technology training and technology transfer must be considered in depth in view of the unequal distribution of knowledge in robot technology throughout the EC.

A well-developed scheme for device maintenance and access to technical assistance is a necessary consequence of developments in the use of this technology.

2.2.5. Mobility and Transport

2.2.5.1. Issues

Three separate but related problems need to be highlighted: problems of improving the mobility of people by improving wheelchair technology; problems of improving the mobility of people using public and private transport and problems of improving the mobility of people by better "transfer systems" (e.g. facilities to lift people out of chairs; in and out of baths; onto and off WCs; up and down stairs). These are discussed below.

The number and proportion of people who need "easier" *wheelchair mobility* is increasing as a result of longer life expectancy due to better medical care, inter alia. This applies both to the ageing population as well as to accident survivors and people with various types of paralysis or spastic impairments due to congenital and perinatal, acquired conditions or evolutive diseases. A conservative estimate indicates that over 2 million people with severe special needs within the EEC could benefit from a viable intelligent wheelchair. Although powered wheelchairs have improved considerably over the past few years, their control and navigation systems are not available to all people and are still largely inaccessible to people with severe physical disabilities and mental handicaps. There is considerable evidence to show that self-initiated wheelchair mobility can engender self-confidence which is a crucial component of the user's quality of life. Most experts agree that the sooner self-initiated control can start in terms of age the better. However, the type of wheelchair envisaged is not simply a vehicle with a variety of controls. The "intelligent" wheelchair is a carefully selected, adjusted and matched system designed to suit each individual. A crucial feature of this process is that the electronic, electrical and mechanical compatibility of each component must be certain if the end product is to work efficiently and be capable of extension. An intelligent system would ensure not only that user needs are met, but also that certain impairments are compensated for.

The concern with intelligent wheelchairs should not detract from the more everyday requirement that wheelchairs have to be designed to give proper physical support for the user. The improved design of seating and posture support remains an important area for research.

Outside the home, there is a need in general to make public transport more accessible for elderly and disabled people, and specifically to integrate wheelchairs with other forms of transport (e.g. cars, taxis, buses, trains) as well as a need to further adapt vehicles and driving controls to accommodate disabled users. Special vehicles will continue to be needed, but there is considerable room for adapting standard vehicles and for designing vehicles from the onset so that they can be adapted for special users.

Presently there is considerable emphasis and effort put into the design of lightweight wheelchairs. The technological foundation for this effort is a direct result of innovations in "sports chairs". Despite these positive innovations efforts into designing wheelchairs which give appropriate *postural support*, particularly to those with severe disability have not been commensurate. The maintenance of proper and comfortable posture in a wheelchair can be crucial to an individual's quality of life. Good posture has a direct bearing on the user's ability to control or "handle" a wheelchair which in turn affects the users independence and self confidence. Two features of a good postural support are the feeling of being safe and the prevention of pressure sores. Various medical studies which have advanced our knowledge of the factors involved in the formation of pressure sores emphasise the tailoring of seating to individuals. Present methods of using advanced manufacturing technology can enable this tailoring to take place both for seating and other forms of wheelchair postural support.

For a disabled or elderly person, independent living at home is often complicated by obstacles and lack of space in the dwellings. This can make the use of necessary *transfer devices* difficult or impossible. On the other hand current transfer devices are generally designed to be used in hospitals or institutions and often even there they are avoided because of poor ergonomic design and inconvenience of use. The devices are designed mostly for specific functions and seldom integrate into other close functions or into other environments. New materials and

mechanical solutions which are based on new ergonomic ideas can enable the design of products which operate in limited space (e.g. old homes). This design, complemented with interfaces and adaptable control input devices for different disabilities, can produce transfer solutions which increase independence of a disabled user. Essential issues in this context are: the concept of self-help; safety of the user; the occupational safety, health and comfort of the nursing staff and other carers; and the difficulties of solving the problems arising from the variety of environments and user needs. There is a related need to design buildings to accommodate transfer systems. Initially, there is a need to modify existing buildings but, eventually, all new buildings should be designed with the requirements of special users as a consideration from the outset (this extends beyond transfer systems and includes wheelchair access, environmental control and other facilities).

2.2.5.2. Scope

Intelligent control of powered wheelchairs for severely physically disabled and mentally handicapped people. (related task T205)

The key area of concern is to re-examine all the elements that facilitate interaction between users and wheelchairs. Microelectronics and associated developments clearly represent important options for bringing the two closer together. The diversity of skills of the target population would require that the powered wheelchair is capable of being controlled by a wide range of different devices. A modular approach would be an essential feature of the design and performance requirements. Such an approach would eliminate "ad hoc" solutions and prove to be cost-effective in the long term. It could also allow for means of controlling environmental components. Given the severity of user impairments an "intelligent systems" approach would ensure navigational accuracy, occupant safety through the use of collision sensors and enable the wheelchair to compensate for specific handicaps. Such an intelligent wheelchair would, for example adjust and dampen the controls to suit varying tremors or become "familiar" with regular routes or surroundings for someone with a mental handicap.

The result of the work will accelerate the general integration of a largely isolated group and provide an industrial platform for European SMEs.

Much of the work will consist of consolidating the results from other intelligent systems experiments. Preparatory work will be required to provide a framework for this consolidation.

An automated system for designing the seat of a wheelchair. (related task T206)

The baseline of this project is a clear understanding of the user groups and their generic and individual requirements. Particular attention needs to be paid to the various postural problems encountered in different impairments. Another area crucial to the project is an understanding of the medical aspects of pressure sore formation. This links in with the type and range of activities undertaken by the wheelchair user. For instance, the requirements of a wheelchair netball player are significantly different from those of someone participating in a more passive activity. Whatever the activity, appropriate body positioning and support can also alleviate certain clinical problems such as extensor spasm and skeletal deformities.

The use of CAD/CAM techniques is a major development that can help in "tailoring" postural supports to specific individuals. These, alongside machine tool and sensor technology and the wide range of new materials available hold much promise. Much of the work consists of consolidating knowledge from a range of inter-related fields. The results of this effort could potentially benefit over two million wheelchair users in Europe and provide a wide industrial base for European SMEs.

Home transfer for disabled users. (related task T207)

The key problem is how to help with the transfer problems in the home environment. This will create new methods of assessing the needs and abilities of the disabled users in connection

with transfer operations as a part of daily functions. Another important element is the need to assess and decrease the work load of the home carers. Based on these analyses, the work should produce an operating concept for systems to be integrated into or adapted to the home environment (beds, chairs, work spaces, bath rooms, stairs, entrances, exits, etc). This concept should aim to shift the transfer work and operations, at least a part of them, to be controlled by the disabled user and hence to increase the possibilities for independence in mobility. A modular design should allow control by users with different disabilities and it should support the compatibility of the components of the system. A comprehensive view should also include user requirements, design of new buildings and the modification of old buildings in the transfer concept.

Integrated cars and wheelchairs. (related task T208)

People who use wheelchairs for mobility can increase their independent if they are able to enter and drive a car. A wide range of equipment is already available both for the transfer from wheelchair to car and for help with driving. Even so, problems remain (e.g. people who can move themselves from wheelchair to car often need help with the lifting and stowing of the chair, while those with more severe disability who rely on a powered chair may need a lift to enter the car and extensive adaption of the driving controls). The main areas in which work is needed are the development of guidelines for the design of wheelchair transfer systems, safety investigations into the restraints needed for wheelchairs used as the driving seat and integration between wheelchair controllers and driving controls. Many of the difficulties in adapting cars so that they can be driven by wheelchair users could be alleviated by quite small changes in the car design. The design of special cars is one approach but there may be attractions, to the users and their families in having the option of using more standard vehicles.

2.2.5.3. Anticipated Impact

The common result of all this work will be to improve the mobility of users both inside and outside the home.

The commercial market for wheelchairs, cars and transfer systems is potentially big. The research will provide openings, especially for European SMEs.

2.2.5.4. Non R & D Actions

The R & D proposals should be complemented by user surveys to establish the range and size of the potential markets.

2.3. Restoration and Enhancement of Function

2.3.1. Overview of Restoration and Enhancement of Function

This area covers the application of advanced information and micro-electronic technology to the restoration and enhancement of function, including assessment and training for people experiencing motor, communications and cognitive dysfunction.

It is necessary to make a distinction between technological support oriented purely towards the medical aspects of restoration and enhancement of function, which is covered by other programmes, and rehabilitation technology targeted on the means to enable the disabled and/or elderly to acquire and maintain the ability to achieve independent living within the community. In the latter case, which is the field covered by this work area, the primary users of such technology are elderly and disabled people, but secondary users could also include physio and occupational therapists, designers/manufacturers of custom built and generic prosthetic and orthotic devices, as well as the medical profession. However, it should be noted that the primary users of all the devices and technologically based services to be developed under the TIDE programme are elderly and disabled people. (This is a criterion for acceptance of projects for funding.)

Applicable technology includes the following :

- systems providing assessment of the scope and level of dysfunction
- information systems supporting the planning of rehabilitation and maintenance procedures for individuals.
- systems to support restoration and maintenance of individual mobility, particularly ambulation.
- systems providing for restoration, maintenance and enhancement of motor, communications and cognitive function.
- improved prosthetic and orthotic devices and systems supporting their design, manufacture and assembly.

2.3.2. Rationale for pan European Action in the Restoration and Enhancement of Function

Motor dysfunction is one of the prime impediments to maintaining independent living of the disabled and/or elderly, with all the consequential socio-economic benefits.

Information technology and modern control methods can make a substantial contribution to rehabilitation technology aimed at restoration, maintenance and enhancement of function but pan European action is required to stimulate a market for these systems.

The European industrial base in the area of Rehabilitation Technology for Motor Function is dominated by very small (less than 10 employees) low technology companies. In some countries, prices are often pegged at an artificially low level by National Health Authorities. Profit margins are low, leading to a lack of funds to re-invest in R&D. Most of the high technology systems are imported.

Much interesting work is being done in European Research Institutions, but all too often this fails to reach fruition, either because it does not meet the real needs of users and/or because of lack of funds in the industrial sector to exploit the new technology.

There is an urgent need to stimulate the industrial sector to collaborate on a pan European basis to achieve economies of scale in the sharing of scarce R&D resources and the management of technology transfer from research institutions. Pan European consensus needs to gained on a common approach to rehabilitation procedures, particularly function assessment criteria, to create a Single Market for rehabilitation technology. Pan European collaboration of user groups could help to achieve the necessary momentum to identify and stimulate the market requirements.

Europe is currently losing ground to Japan and the US in this field and concerted action is needed to reverse this trend.

2.3.3. Functional Assessment and Training (related tasks T301,T302,T310,T311)

2.3.3.1. Issues

Dysfunction needs to be clearly defined to enable appropriate equipment and services to be provided to the elderly and handicapped on a cost effective basis. Assessment is required of both functional capabilities within the home/community setting and in terms of the implications of the dysfunctions

More effective assessment systems are needed to :

- reduce waste of treatment resource in an area which is expanding rapidly within Europe
- permit provision of equipment and services which more appropriately address the needs of elderly and disabled people.
- encourage pan European provision of equipment which in turn will permit competition on a global scale.

The socio-economic implications of effective assessment of function are to enhance the provision of appropriate equipment and services to enable an individual to increase, or prolong, independence and to maximize the effectiveness of scarce resources.

The issues which need to be addressed by the TIDE programme include :

- the variability of assessment standards which are applicable throughout Europe.
- the degree to which there is a pan European market for commercial provision of assessment systems
- the relevance and acceptability of existing equipment (much of it used mainly in research environments) to users in the area of rehabilitation.
- the validity and reliability of assessment techniques and equipment demonstrating these attributes

2.3.3.2. Scope

The scope of the R&D work should cover assessment of pan European market requirements for proposed Function Assessment equipment in terms of the market size, applicability, acceptability to the rehabilitation team and elderly and disabled people.

The development and acceptance of standardised function assessment criteria needs to be tackled and consensus sought both within the TIDE programme and externally.

The R&D work can cover the adaption of existing systems and/or the development of new prototype systems which are capable of commercial exploitation. Particular attention should be paid to demonstrating the reliability of equipment (both hardware and software) and its ease of use in a non-research environment.

The scope of assessment systems should range from monitoring functional ability within the community, to evaluation of bio-mechanics. Such systems should be applicable to community or rehabilitation settings and permit analysis of data in a verifiable manner to test validity and repeatability. Where appropriate, assessment should be established within the framework of Impairment, Disability and Handicap, as identified by the World Health Organisation.

2.3.3.3. Anticipated impact of the action

The anticipated impact of more effective monitoring instrumentation and methods of assessment, both within a home/community or rehabilitation environment would be to improve the effectiveness of available treatment, permit the development of new rehabilitation strategies and promote more reliable and standardised therapy regimes. In addition to supporting a more rational approach to the rehabilitation of handicapping conditions, a market for successful equipment will develop within Europe as the impact of effective systems becomes recognised.

By more clearly identifying Impairment and Disability, effective assessment systems can reduce the degree to which Handicap results and so permit elderly and disabled people to be more independent and contribute to society to a much greater degree. Economic and sociological benefits will thereby accrue.

2.3.3.4 Non R&D actions identified

A number of issues not directly related to the research and development elements of projects in the Assessment of Function need to be addressed. These include training, legal and infrastructure requirements.

When new equipment is to be produced, the overall skills required to operate the associated Information Technology may exceed those which the group who would operate the system would normally be expected to have achieved. (This issue is likely to be common amongst all TIDE projects and is therefore a factor which may need to be addressed as the programme evolves).

New instrumentation or methodologies may demand novel skills from those that are required to operate the system. Although that may not be an immediate concern in the development phase, the marketing plans should propose means of providing and funding training which is vital to the successful application of a new system.

Where networking is envisaged, the degree to which an appropriate telecommunication infrastructure exists throughout Europe needs consideration. This is an issue which may need to be addressed at a level higher than that of a single project. Within a specific project, the potential financial implications of establishing data links to support the newly developed methodologies or instrumentation must be indicated.

In assessment of function, there are two main legal concerns. The requirements of data protection legislation must be satisfied by any scheme which involves data exchange. When developing new equipment, the implications of product liability legislation must be addressed not only at the design stage but also in evolving marketing strategies.

2.3.4. IT for Individualised Plans for Rehabilitation and Maintenance within the Community (Related tasks T303,T304)

2.3.4.1. Issues

Independent living outside health care centres is not only important from an economical point of view but also, and primarily, for maximizing the quality of life of disabled people.

In addition to the large range of aids, ranging from simple devices capable of solving the more basic problems of independent every day living to sophisticated mechanical and electronic aids, Information Systems can play a major part in the rehabilitation of motor functions for the disabled.

As a supplement to the present utilization of information processing systems for :

- storing and retrieving data on therapy tests,
- networking of rehabilitation centres,

Information systems can also be viewed as means for supporting the planning and evaluation of programmes for maintenance, enhancement and restoration of function. They can provide plans for the rehabilitation of individual elderly and disabled people.

In this context, the issues to be addressed are :

- the requirement for novel information system methodologies and tools capable of investigating the effect of particular solutions on the rehabilitation of dysfunction and generating indications of possible modifications in the planning of rehabilitative procedures
- the need for knowledge bases to support the planning of rehabilitation procedures

2.3.4.2. Scope

Work in this area should cover the development of information systems directed towards the optimization of care and treatment of people with an impairment of their functions , or who are at risk of developing such an impairment, with the goal of maintaining these people in their home environment. Such information systems should take into account the specific circumstances of individuals, e.g. motor properties and social circumstances.

Possible information systems to be considered could be :

- Simulation systems which comprise those tools capable of predicting the effect of particular rehabilitation systems. Special purpose active instrumented devices worn by the handicapped person in addition to simulation software could be considered. Their function is that of predicting the effect of the use of a prosthetic or orthotic device, as well as other particular rehabilitative or training procedures, on the real behaviour of the person's impaired functioning.
- Knowledge based or expert systems devoted to delivering support for the diagnosis and planning of the rehabilitative actions, and possibly including systems providing for data capture from a disabled or elderly person in the home environment to enable monitoring of function.

Close collaboration will be needed between developers and potential users to establish the user requirements and market potential of such systems.

The development of advanced information systems in this work area will only be considered for funding under TIDE in so far as their primary purpose is the planning of rehabilitation and maintenance for individuals, and their primary output is an individualised rehabilitation and maintenance plan.

2.3.4.3. Anticipated impact of the action

The use of simulation systems to predict the effect of the application of a particular prosthetic/orthotic device or treatment regime, prior to any clinical evaluation, can play a significant role in enhancing an individual rehabilitation and/or training programme by improving the cost effectiveness of the procedure and its acceptability to the recipient.

Additionally, simulation systems can be expected to benefit the development of new devices. The phase of elaborate experimental testing of different prototypes can be reduced by preceding this with a phase of pre-clinical evaluation using simulation systems, leading to a quicker release of new designs to the market place.

2.3.4.4. Non R&D actions identified

The following related actions should be considered:

- educational and training programmes for operators in the field of rehabilitation technology
- establishment of specialised information and consultancy centres in Europe charged with the role of gathering and disseminating information on rehabilitation procedures and technology. Telematic links should be established between each of these information centres and to rehabilitation centres.
- The establishment of access to shared knowledge bases, both on rehabilitation procedures and available products, can be anticipated to improve the standardisation of procedures throughout Europe and enhance the establishment of a pan European market for the available products.

2.3.5. Technology for Rehabilitation and Maintenance of Motor Function (related tasks T305,T306)

2.3.5.1. Issues

There is a tendency for elderly people, especially disabled ones, to progressively reduce their motor activities with the passage of time, often subsequently accompanied by a reduction in other functions. This, in consequence, leads to weakness of the muscio-skeletal system, restrictions of the mobility range of the joints, and an overall diminution of activity. These factors can combine to form a positive feedback loop reinforcing the deterioration process.

The objective of this work area is the development of technology allowing disabled and elderly people to remain part of the community by directly improving and maintaining their voluntarily controlled motor functions and, by this means, reversing or preventing the dysfunction.

In the field of "maintenance of motor function" there are three main areas :

- The first concerns rehabilitation aimed at achieving restoration of a temporary functional waste of the joint due to injury or as a result of surgery. The rehabilitation programme starts from an assessment of the functional deficits. Later on, the programme is managed according to the progress made in recovery.

- The second concerns mainly elderly and disabled people where rehabilitation aims at preserving motor control by means of a training programme.

- The third concerns permanently disabled people where the aims are to optimize available motor function.

Modern rehabilitation technology is basically well placed to prevent reinforcement or to break the above mentioned loop, but it is still neglecting the opportunities offered by advanced information and control systems technology to improve this process.

In particular, there are shortcomings in the reactivation of severely decayed functions and in the means to encourage the active participation of people in their home. The latter is essential for continuation of the improvement and for the maintenance of the state of the elderly and disabled in their daily environment.

In addition, the level of knowledge and application of effective rehabilitation procedures varies widely throughout the European Community, and even within national boundaries.

The rehabilitation process may be subdivided into the following stages :

i modifying the dysfunctions of severe disorders of the neuromuscular and skeletal system (currently often difficult to approach) to such an extent that the disabled person becomes accessible to therapy and an improvement in his condition

ii training the muscles to prepare them for stage 3)

iii enhancing the muscle force and the capability for voluntary control of the muscles to normal access level

iv training of the coordination and voluntary control of movements for normal use, with special attention to the functional aspects

v improving and maintaining this capability in the home

Currently the methods associated with stages 1) and 5) do not yet provide satisfactory solutions, while those associated with stages 2)-4) could be improved, especially in the functional domain.

The means to incorporate the active participation of the disabled or elderly person in the training of his ability for self control and self assessment are not yet sufficiently well advanced, and the possibility of the client operating his rehabilitation and training programme in his home, on a daily basis, does not yet exist.

2.3.5.2. Scope

R&D activities in this area should be focussed on technological innovations aimed at enhancing and maintaining motor function capabilities of elderly and/or disabled people in their daily environment by means of the retraining of diminishing muscle force and the voluntary control of movement.

To ensure achievement of the objectives, the active involvement of all interested parties in specifying the requirements and assessing the results of such systems is necessary.

The new technology should be applicable to one or more of the following areas :

- Force and coordination training, with the disabled or elderly person as an active participant, with the objective of restoring normal functional movement capabilities

- Activation of the muscles by Electrical Stimulation, including Functional Electrical Stimulation, allowing the controlled activation of every muscle.

- Reflex inhibition of the muscles, allowing the inhibition of involuntary movements.

For subjective and objective control of the effectiveness of treatment, the equipment must be capable of conducting adequate measurements, which might be graded or scaled. Wherever appropriate, the measurements should be used to provide biofeedback and/or technical feedback to the operator.

The therapeutic concepts applied need to be consistent and controllable by the therapist.

The apparatus itself has to be controllable by the therapist and the client, and should give warnings or automatic shut down, for example, in situations of muscle fatigue or in emergency situations.

Prototype developments should have the potential for successful commercial exploitation.

Aspects which need to be taken into account in the specification and design of new systems include :

- The acceptability of the apparatus to the therapist and the client e.g. the ease of mounting and operating the equipment

- Legal requirements on product safety

- Effectiveness of the apparatus

- Usability by the disabled or elderly person at home

- The need to provide biofeedback and self assessment information

- Ease of maintenance

- Low cost manufacture

2.3.5.3. Anticipated impact of the action

R&D work in this area is expected to contribute towards :

- Creating an awareness of the socio-economical importance of effective Physical Rehabilitation throughout the EC.

- The adoption of the best practices of Physical Rehabilitation throughout the EC.

- Improving the procedures of Physical Rehabilitation ie making them easier and more accessible to an individual client.

- Focussing the development of the required technology in the appropriate direction.

- Creating a pan European industrial base and market, which can subsequently radiate abroad.

2.3.5.4. Non R&D actions identified

In conjunction with the R&D projects, the following need to be considered :

- Education and training of therapists in:

- The use of the methods.

- The education and training of the disabled and elderly person in their use in his home environment.

- Technical support services for the introduction of new rehabilitation technology.

As a follow up programme, the following points might support the dissemination and exploitation of the results of the TIDE Main Phase Programme :

- Studies of the applicability of new technology to a number of different aspects of cases.

- A Community wide, broad based control of the impact and success of the action from which measures of improvement might be derived.

- Institution of a Community wide exchange of experience in this field for a defined period of time.

2.3.6. Substitution Devices for Motor Function (related tasks T307,T308,T309)

2.3.6.1. Issues

Prostheses and orthoses have been created throughout recorded history, but there are still many knowledge gaps which reduce the likelihood of a high quality outcome. Whatever the complexity of the substitution device, the characteristics of the interface between the human body and the device are vital to the function and acceptability of the result. Devices which are inadequately matched to the human body system cause discomfort or pain and poor function; leading to failure of rehabilitation with serious social and economic consequences.

Whether the achievement of the primary function depends largely upon an information flow across the body-device interface, or upon the character of the mechanical coupling, adequate knowledge of the interface requirements and its implications must strongly influence technical design. This is readily apparent in situations such as upper-extremity prosthetics where attention given to sophisticated electronic and mechanical assemblies can produce a poor functional result if the human is improperly matched to the feedback and control required by the device. Technological advances in sensors and computing are allowing the application of novel control systems and artificial neural network strategies to increase the potential for multiple channel electro-mechanical prostheses and orthoses. Hybrid devices can combine conventional designs providing body support, with information technology approaches to provide substitute power, command and control. the nature of the human-machine interface is critical to the acceptability of such developments and providing very simple voluntary command interfaces is a challenge.

Inadequate matching is a problem of interface design for prosthetic sockets, where arbitrary and pragmatic solutions to the force transmission requirements have evolved. The techniques of socket design in current practice are generally not based on an adequate knowledge of body tissue behaviour under dynamic load. Even though these techniques can work well in skilled hands, it is also clear that such skills are not widely available, are difficult and costly to acquire and elusive in form. Orthotic devices to manage such problems as muscle imbalance or control of progression of deformity are similarly based on incomplete knowledge and their long term effectiveness is often difficult to predict.

2.3.6.2. Scope

Work is required to address body property measurement and all aspects of body/device matching. The findings should be embodied in control solutions and in new CAD systems

which are based on sound biomechanical understanding or are designed to assist in acquiring it. Such developments should recognise and take advantage of relevant trends and emerging standards in computing, materials and manufacturing technology and permit opportunities for the channelling or redistribution of resources not possible with conventional hand-based techniques.

Attention is required to apply technology which provides rapid, direct manufacture of the custom device and any associated cosmetic cover.

2.3.6.3. Anticipated impact of the action

The effectiveness of any substitution device, whether technologically simple or complex, depends upon the nature of the interface it provides with the body. This action tackles the problem of how to best create such interfaces. With devices where the mechanical coupling with the body is key to success, the deployment of appropriate computer-aided methods of measurement, design and manufacture will provide the means to efficiently deliver devices with consistent quality throughout Europe and, for the first time, allow the communication and exchange of techniques and expertise to take place without ambiguity. Technically sophisticated prostheses and orthoses are rejected if they are not adopted as natural extensions by the recipient. The human aspect of the rehabilitation problems is common throughout Europe and a shared approach to their solution, provided through this action, will allow market segmentation for development to reflect this broad need and increase the attractiveness of product development.

2.4. Integrated Systems Technologies

2.4.1. Overview of Integrated Systems for elderly and disabled people

This action line focuses on the challenges and opportunities that relate to the integration of technologies in order to:

i Adapt and integrate available technology (including the relevant methodological, organisational and technological dimensions) into disabled and elderly persons' everyday environments to enable independent living at home as well as remote care and supported living and to deal with the many issues associated with navigation and transport, the work-place, leisure and self-realisation.

ii Ensure that systems facilitate the realisation of individual aspirations in order to promote independence and self-realisation and not just compensate for impairment.

iii Encourage the use of a multi-disciplinary, market-oriented, systemic framework in the development of technological systems which incorporate user needs and requirements in good ergonomic solutions which also integrate organisational, architectural and construction, sociological and economic issues.

iv Prevent the isolation and alienation of elderly and disabled people through their inability to cope with the effects of the increasing complexity of ongoing technological development in society.

2.4.2. Rationale for Pan European action on Integrated Systems for elderly and disabled people

The demographic changes which will occur in the next twenty to thirty years mean that there will be an increasing number of disabled and elderly people who require support in order to take a full and active role in society. At the same time, there is an increasing trend to decentralise care and support services. The consequence of this is that many of the functions formerly provided by specialised centres in order to satisfy the requirements and needs of disabled and elderly people will have to be more widely available. Whilst individual difficulties can be supported by independent technological solutions, the fact that the majority of disabled and elderly people will be living in the community and will need to fully integrate into their environment means that there will be an increasing requirement for multifunctional devices, systems and services. Such capabilities can only be effectively provided through the integration of technological solutions with each other, within the socio-economic infrastructure in which they are found and used.

The provision of support through integrated systems technologies can reduce the dependence of disabled and elderly individuals on social care services. In turn, the social services are then freed to concentrate on helping the individual to develop emotionally and socially towards a better quality of life and hence to increase the contribution they make to the productivity of the community.

Work in this area is strategic to Europe because the effective deployment of integrated systems will have positive economic effects not only because they provide a means to combat the rising cost of care but also because they have the potential for widening the tax base. There is a need to defend and increase the competitiveness of European industry on the world market. The creation of an efficient Single Market in Rehabilitation Technology in Europe and the development of integrated systems would provide opportunities for significant economies of scale and the expansion of markets for the IT&T and consumer goods industries as well as the many SMEs already working in the area. Creating appropriate industrial partnerships is a way of achieving this goal.

Pan European collaboration in this field will help ensure that the support systems and approaches developed are applicable to the wide variety of client groups with differing cultural backgrounds and languages. It is also the case that different member states have addressed different problems and developed different solutions to similar problems. This action line presents an opportunity for the best of those solutions to be gathered together and integrated. Knowledge of the problems faced by individuals with various disabilities is scattered and is also weakly represented in main-stream industry, and this area will aim to bring together the interested parties and experts to address, in detail, the issues relating to the use of integrated systems technologies to support the disabled and elderly and to help them to live more independently. One key benefit of this new, greatly enhanced level of cooperation would be that it is likely to achieve a common basis for working and hence the foundation of a Europe-wide basis for integrated systems, which will gradually evolve into standards.

2.4.3. Smart Environments and Systems

2.4.3.1. Issues

The smart home environment concept is becoming more mature and various prototypes exist or are in the process of development. In addition, there are several products for smart home systems already on the market. These systems offer many benefits to disabled and elderly people through the provision of support services in the home, via telecommunications and internal bus architectures to control domestic appliances and the environment. The market for consumer electronics and home systems will develop very rapidly in the next decade with the risk that this type of technology will not be accessible by disabled and elderly people. In order to prevent their further isolation, these products have to be adapted, adaptable or properly designed for these groups.

The basic issue is to increase the usability of smart home environments in order to improve the quality of life of disabled and elderly people by helping them to integrate into society, giving them access to new technology, improving their security and increasing their independence. Independence should be in accordance with the wishes of the individual and should not result in increased isolation. The notion of independence includes a variety of aspects which can be illustrated by various keywords: independent decision making; self control; access to resources which allow for self determination; the ability to cope with the functional tasks involved in daily living.

The integrated technologies developed should be accessible to everyone but should also be adaptable to individual needs. In addition, these environments must make everyday technologies accessible to disabled and elderly people and any aids must be adaptable to everyday technologies. As social acceptance is necessary, such systems must be formed around the concept of a base system which is expandable when necessary.

The trend towards community care of disabled and elderly people is likely to continue in Europe. While it is generally considered to be desirable to maintain independent living in the home environment when possible and for as long as possible, this is not always an option for a variety of reasons. Accordingly, there is also a demand for a variety of different types of living accommodation and institutional contexts which can support the needs of elderly and disabled people and their carers.

Integrated systems in these contexts have an important role in supporting independence and dignity, social integration with the wider community and in supporting the integration of formal and informal services. At the same time, it is important to be aware of the ethical issues in order not to affect individual integrity.

The R&D tasks for this work area should identify user needs and user requirements to enable the development of solutions that will facilitate self-management and independent living in a home environment and the support of those receiving care in both sheltered and institutional contexts, and their carers. The tasks encompass the definition of an open systems architecture, adaptation and redesign of existing consumer products, development of special problem-solving systems and devices, smart sensors and software programs, and health monitoring systems as parts of integrated support systems for use in a variety of contexts.

The user-machine interface should reflect the functional potentials of different user groups. The elements and devices should be based on standard interfacing to ensure modular design, thus accommodating different needs, as well as local social and cultural variations.

Target groups include those who may be impaired, physically, perceptually, cognitively (with problems relating to temporal, quantitative or qualitative reasoning and structuring) and who may also be multiply impaired, or those who have disabilities or handicaps through illness.

Projects within this area should reflect both the systems and the organisational models of the context in which the solutions should be integrated.

Medical, functional and problem-oriented solutions should facilitate for home based care as well as higher degrees of independent living and better safety for the individual user. This should result in cost effective support services.

The challenges will, however, be to tailor solutions to individual users, to integrate the solutions into a service system, to introduce the system to the user and to provide the necessary follow up. There is also a challenge in paving the way for an acceptance of those parties being responsible for the purchase of such systems. This will only result from a change in the attitudes and roles tied to old traditions within health and social care services.

The familiarity with, acceptance and availability of technology depends on the degree to which smart elements are built in to everyday devices. The more this is the case, the more familiar, available and cheaper will be the systems and the easier it will be to create smart homes and environments.

2.4.3.2. Scope

The R&D work undertaken must use a multi-disciplinary systematic approach covering technological, user, organisational, architectural, sociological and ergonomic issues. In order to achieve a real smart home system architecture, R&D work should be planned to:

- Adapt existing technology.
- Develop new technology.
- Develop specialised user-machine interfaces.
- Involve:
    - Consumer goods.
    - Smart home systems.
    - Services providers.
- Potential solutions can be:
    - An integrated part of other solutions (as with consumer goods).

- Part of more global systems:
    - within the home.
    - local professional services.
    - medical emergency or alarm systems and larger hospital/local health and social services systems.
    - Self-contained.

The proposed applications should address the needs, with regard to key domestic tasks, of clients and client groups who have cognitive, perceptual or physical impairments or who are frail or forgetful due to old age. Technological solutions should aim to promote the self-sufficiency of the individual by supplementing skill deficiencies with technological support and will therefore need to deal with the functions of daily life including such activities as: hygiene/toilet functions; mobility; clothing; nutrition and the kitchen; bedroom and sleep; spare time and social activities (shopping, banking, transport, information etc.) and cognitive functions.

Interfaces should be designed to be ergonomic, clear and easy to understand and safe to use. Applications should aim to be accessible to the individual and should take advantage of existing technology where feasible.

It is expected that work will result in advanced prototypes which can demonstrate the application of technology to specific areas. Prototypes should serve the needs of real individuals and should exhibit potential for commercial exploitation in the long term. All work in this area should be based on a review and consolidation of the existing results such as those from DRIVE and PROMETHEUS.

2.4.3.3. Anticipated impact of the action

The provision of an architecture and the identification, specification and development of components for smart homes and environments would stimulate the creation of a Single Market in Rehabilitation Technology due to the demonstration of the possibilities of such an approach in addressing the following issues:

- The high cost of institutional care and traditional personal care.
- The higher priority being given to community based care for reasons of keeping costs within limits and the resulting higher quality of life for the individual.
- The rapid increase in the number of old elderly people in society calls for alternative measures to cope with the needs for services and care.

One of the key issues in smart homes and environments is the cost, and the stimulation of a market will create economies of scale.

2.4.3.4. Non R&D actions required

In the health and social sector, as well as in other sectors (education, work etc.) it is traditional to provide medical and other special services, as well as care, to handicapped and elderly people. It is not traditional, however, to provide solutions which facilitate independent living. Many member states do not have an organisational infrastructure that can handle this, nor financial systems which can cater for the provision of this type of solution, but are very interested in the issues of independent living.

There are five actions of importance:

- The establishment of provision systems and infrastructures that can handle this field in a professional manner.
- The education of professionals and the informing of users about engineered solutions and provision methods.
- The creation of public awareness of the potential of smart homes and environments and the opportunities for hands-on experience.
- The carrying out of cost-benefit analyses.
- The establishing of appropriate financing procurement and promotional activities.

In addition, there is a general need to collect together and make available, to any interested parties, all of the information concerning research, products, evaluation etc. of relevance to this area.

2.4.4. Orientation and Navigation Systems

2.4.4.2. Issues

Many disabled and elderly people have problems of orientation and navigation in an unfamiliar environment. Intellectually impaired persons may require appropriate information on how to get to their destination in a complex environment (e.g. a multi-level shopping centre). Wheelchair users may require information about routes which are usable by a wheelchair to reach their destinations. Deaf persons might need auditory information displayed in a visual form. Visually disabled persons may want to avoid obstacles, orientate themselves, find machines (e.g. a ticket selling machine) and use machines (e.g. automatic gates) to facilitate independent travel on public transport.

2.4.4.2. Scope

The system should assist disabled or elderly persons in orientation and navigation in a public place. It could also be beneficial if the system assisted in the location of machines and could request the machine to modify its mode of operation to meet the needs of the user.

2.4.4.3. Anticipated impact of the action

The system should make it easier for a disabled or elderly person to travel independently and use self-service machines. This will therefore increase the access to facilities for elderly and disabled people.

2.4.4.4. Non R&D actions required

There will need to be agreement on the allocation of a spectrum for the transmission system (e.g. radio frequency) and on the coding of this signal.

In addition, there is a general need to collect together and make available, to any interested parties, all of the information concerning research, products, evaluation etc. of relevance to this area.

2.4.5. Education and Training

2.4.5.1. Issues

Training is seen to be of major importance in this area. Not only will there be a requirement that users be trained in the use of new technology and devices, but it is also the case that elderly and disabled people would benefit from life skills training. It is necessary that individuals possess, to varying degrees, a range of living skills in order to support their independent lifestyle. Projects in this area should approach the work from a user perspective, analysing the nature of the impairment and the skills required for performing everyday tasks. The work should involve the specification and development of solutions based on the premise that such disabilities can be overcome by technological intervention. The technology should provide support for the individual in the short term and training in the necessary skills in the long term. Likely application areas include kitchen management (e.g. cooking, larder maintenance, budget control, menu planning etc.), electronic equipment operation (e.g. washing machines, cookers, TV's, videos etc.) and the use of Information Technology in social, domestic and work environments.

There are different groups of people with differing combinations of impairments and, therefore, with different skills and experiences. An important task should be to define these groups, their needs and the different goals for their training.

Any hardware or software developed must be as flexible as possible. The ideal is to have core systems which only require a certain amount of adaptation for use with a particular group. This will ease the burden on trainers being required to manipulate different systems. It should also ease the economic cost of development as the potential user group is substantial. It needs to be recognised, however, that techniques appropriate for one country may not be usable in another, and work in this area should attempt to overcome this difficulty.

The work should take account of the issues related to improved independence. Independence should be in accordance with the wishes of the individual and should not result in increased isolation. Applications should also address the issues associated with skill transfer and not merely skill supplementation. Problems here will include the often varying needs of the individual, including obstacles relating to attention span and forgetfulness. It is critical that the proposed work addresses issues relating to safety including hazards of daily living and conformance with international safety standards.

Work should also consider the technical issues relating to the use of multimedia including full motion video, sound and graphics. The mixture of these elements used will have implications for the development time and cost and therefore on the final cost of the resulting application to the user.

2.4.5.2. Scope

The proposed training applications should address the needs, with regard to living skills, of clients and client groups who have an intellectual impairment or who are frail or forgetful due to old age. Technological solutions should aim to initially promote the self-sufficiency of the individual by supplementing skill deficiencies with technological support. In the long run, the aim of the application should be to support the impaired individual in acquiring the additional skills, thus enabling them to achieve a greater degree of independence. Applications should aim to be accessible to the individual and should take advantage of existing technology, where feasible.

2.4.5.3. Anticipated impact of the action

Applications in this area will contribute to the broadening of the market for IT systems by helping those who normally have difficulty in learning the necessary skills to use IT effectively. By facilitating the learning of these skills, those who might otherwise be barred from operating

effectively in IT contexts at work or in everyday life will be helped to gain access to services and employment possibilities from which they might otherwise be excluded.

Pan European collaboration in this field will help ensure that the support systems and approaches developed are applicable to the wide variety of client groups with differing cultural backgrounds and languages. Particularly important is the design of user interfaces that have application for broad categories of mentally and physically impaired and elderly people. These should, in the long term, increase the accessibility of such technology to the general population.

2.4.5.4. Non R&D actions required

In order to increase the potential of technology based training systems, there need to be a number of coordination activities, notably the integration of pedagogic approaches in order to provide a common basis and integration with professional educational activities.

In addition, there is a general need to collect together and make available, to any interested parties, all of the information concerning research, products, evaluation etc. of relevance to this area.

2.4.6. Working Environments for Disabled and Elderly People

2.4.6.1. Issues

The integration of disabled and elderly people in the normal life of society should be one of the primary objectives of any social policy. It is particularly important to enable them to be gainfully employed, not only for their own social well-being, but also for the economic value of the resulting growth in demand for goods and services of interest to disabled and elderly people. Employment opportunities should be developed not only for disabled people but also for elderly people, whose potential is often still valuable. New technology often creates obstacles to the employment of elderly and disabled people and specific initiatives for process and product innovation are needed to overcome them. New technologies themselves can help achieve this goal. In addition, new technologies can provide new job opportunities.

2.4.6.2. Scope

This work area aims to determine which new systems technologies, subprocesses and interfaces are needed to enable the employment of elderly and disabled people.

Work in this area will concern methods, organisation, protocols and so forth, whereby advanced technologies can be applied to create new jobs or to redesign activities, that would otherwise be fated to disappear, that can be carried out by disabled people. The purpose of this action is also to identify new roles and types of jobs which new technologies give rise to, and to see how they fit in to real productive processes. Also of concern is the retention of individuals in employment after, for instance, an accident that causes disability or handicap.

The goals of R&D activities are to use new technology to define new kinds of jobs and to develop and apply new instruments and systems in support of existing jobs.

The fields of application concern both intellectual and manual types of work. The goals may be either economic or essentially therapeutic.

2.4.6.3. Anticipated impact of the action

If the TIDE integrated system technology project is carried out through application initiatives or, better still, through demonstrations involving end users, it can determine the acceptance of standard methods, technologies, subprocesses or products and help augment the job market.

Demonstrations accelerate the diffusion of new technology. Analysed with appropriate methods of assessment and accompanied by adequate promotion, they give potential manufacturers key information for decisions on investing heavily in areas where technology has not yet been standardised. It is important to bear in mind that besides manufacturers and end users, an important role is played in these decisions by parties, such as the public administrations, which have no direct knowledge of the problems experienced by elderly and disabled people or of the opportunities offered by new technologies. Demonstrations are particularly important in obtaining authorisations or financing from these bodies.

Demonstrations also give manufacturers the chance to devise, together with international partners, standard systems compatible or integratable with technologies applied in other sectors. This approach is especially valuable in expanding a market that might otherwise be thought too small to be attractive.

2.4.6.4. Non R&D actions required

Information and training play a key role in the diffusion of any integrated system, but are most significant in the area of employment, where innovation is hindered by the difficulty of introducing changes in job organisation and by resistance to the use of unfamiliar tools and procedures.

Considering that a large proportion of orders will be placed by public bodies, specific methods and terms of diffusion will have to be established to:

Heighten awareness at the various levels of the decision-making processes in public bodies concerned with providing care and services for elderly and disabled people.

Influence changes in standards or legislation that unjustifiably hinder innovation or uptake in this sector.

More generally, there is a need to:

- Obtain involvement of organisations to enable the choice of economically significant matches of jobs and disabilities.
- Make information about job opportunities widely available through the use of publicly available information systems.
- Provide special training for technicians, analysts, systems experts and other employees of companies that intend to supply new telematic systems and services for disabled and elderly people, as well as technical assistance to companies that employ them.

In addition, there is a general need to collect together and make available, to any interested parties, all of the information concerning research, products, evaluation etc. of relevance to this area.

3. R&D TASK DESCRIPTIONS

ACCESS TO COMMUNICATIONS AND INFORMATION TECHNOLOGY AND SUPPORT FOR INTERPERSONAL COMMUNICATION.

T101 Input and output devices and transduction systems

Background

Input and output devices represent the means by which information passes between the user and a system; specific channels of information flow represent different modes and media of communication. A transduction system provides the capability for translating the information flow between channels or media of communications, for example, the transformation of Bliss symbols into text or text into artificial speech.

The interfaces to today's systems are dominated by the keyboard, the graphics screen, pointing devices and the telephone handset. Many new devices and technologies are emerging, however, including facial and body movement detectors, enhanced visual presentation such as 3-D and multi channel, multi media presentation systems.

This potentially very rich set of capabilities and options provides the means for addressing many needs of people with disabilities by maximising the exploitation of residual perceptual and motor functions and providing new adaptations of existing interfaces.

Objectives

The interface devices represent the first barrier to access of systems and services by disabled and elderly people. The objective of this task is to reduce or remove (if possible) that barrier by appropriate design approaches, flexible and appropriate device selection, appropriate media selection, and powerful mode and media transduction systems.

Technical approach

This task must be driven by user need and market considerations on the one hand and the availability of technologies and devices on the other. The primary focus of this task will be on the development of new architectural, design and integration approaches to flexible interfaces for disabled users. New and improved existing devices may figure in this but the key criterion for TIDE is that real results must be achieved within the time-frame of the programme.

The task must create and validate a framework for all aspects of the design and implementation of such interfaces including:

- The characterisation of user need and capability
- The characterisation of application context and purpose
- The selection and integration of interaction and transduction devices with the target application and system
- The criteria by which the acceptability and performance of the resulting systems my be evaluated.

Extensive trials and evaluations of the overall framework and of the set of solution components proposed within this task must be undertaken. This could be based on the development of a prototyping and evaluation environment which incorporate performance monitoring and evaluation functions.

Key results and milestones

- Publication of requirements, markets and technology availability studies and also production of feasibility assessments
- Publication of flexible device and media architecture to meet the needs of disabled and elderly people
- Demonstration of innovative, flexible interface systems.

T102 Structuring the multi media dialogue

Background

How people are going to interact with a multimedia environment has to be analysed and suitable adaptations for elderly and disabled people have to be developed. This is a new issue, but will have a special impact on the situation of elderly and disabled people.

Interaction methods and techniques, dialogue design, the separation of the application or service from the user interface management functions, the efficient and flexible handling of media and devices are all issues which have an impact on user interface design.

Many approaches for managing and structuring user dialogues exist and some de facto and de jure standards have emerged. As far as the needs of disabled users are concerned, approaches to adaptation of these interfaces have been fragmentary and address only small segments of the problem. For example, there are many aids for blind users to access text based interactive systems but an increasing number of applications are now based on graphical presentation and manipulation. The current emphasis on screen, keyboard and mouse excludes a number of groups of disabled users and renders existing adaptations and aids useless.

The scope of this task, therefore, includes:

- The development of interaction methods and techniques which support the handling of special input and output devices and support interaction with additional media and information types such as speech, sounds, braille, symbols, gestures and signs, etc.
- The investigation of current dialogue systems and user interface management systems and development of appropriate adaptations for different categories of people with special needs, where necessary and possible.
- The definition, development and validation of multi media dialogues architectures which enable easy and quick adaptations and support flexible media dialogues for the benefit of elderly and disabled people.
- The development of dialogue systems which are adaptable to the conceptual models and mental abilities of disabled and elderly users with particular reference to cognitively and linguistically impaired users.

Objectives

The main achievements expected of activities addressing this sub-task are:

- The identification and documentation of market trends in user interface design, dialogue structure and control.
- The specification and validation of architectures for flexible-media dialogue systems integrating new methods and approaches with existing devices and designs.
- The development of new interaction methods and dialogue techniques that facilitate user (with special needs) interaction with alternative media and enable user handling of alternative input and output devices.
- The development of mechanisms for integrated multimedia dialogues which support concurrent handling of devices and consistent combination of media.

- The development of draft specifications that application developers and user interface designers should follow for dialogue structure and control, so that adaptations for the benefit of disabled and elderly users can be easily incorporated into newly developed applications and user interfaces.

- The identification and specification of the usability criteria which should be applied in the certification and acceptance testing of devices, interfaces and applications for elderly and disabled people.

Technical Approach

It is obvious from the above description of the objectives of this task that both theoretical and practical demonstrations are called for. The techniques of human factors, ergonomics and psychology must be integrated with hardware and software engineering skills. Wherever possible the technical approach should emphasise the adaptation of existing dialogue systems and architectures, however where it is necessary to meet the requirements of elderly and disabled user groups new techniques and architectures may be investigated.

Investigation of the market is also required in order to analyse the current and potential future trends for graphical and multimedia user interfaces and dialogue management architectures, and to promote the development of general purpose solutions and the provision of some standards for user interface designers.

The general approach to be followed is:

i Characterisation of the user need and problems and the market characteristics and potential.

ii Definition of the criteria for success and the method for demonstrating its achievement.

iii Specification the key technical aspects and interfaces of the proposed solution components in a form which may be published and thus ensure openness and dissemination.

iv Demonstration and evaluation of the results with users, testing realistic models and prototypes.

The central theme of flexible and adaptable interaction media in this task implies an overall architecture within which different strands of technical development may be positioned.

Key Results and milestones

- Publication of draft flexible media architecture

- Publication of user interface design recommendations

- Demonstration of the architecture in an evaluation pilot

- Development of tools for the design and adaptation of user interfaces.

T103 Intelligent human - machine interfaces and dialogues

Background

Hopefully in the near future performances of systems will be such as to allow possibilities of devoting resources to support the user with the introduction of "intelligence" in the control of input and output and in the management of dialogues, allowing them to adapt to the characteristics of users, by employing real-time learning procedures.

The development of user interface techniques and methods, particularly those associated with multimedia represents a significant area of research world wide with the objective of improving communications performance and effectiveness. Similarly great effort is being devoted to the improvement of the effectiveness and appropriateness of user interfaces and dialogues by the introduction of intelligent capabilities such as adaptation to the user, predictive behaviour, guidance and active assistance in user interface implementation and management. The special needs, difficulties and opportunities for disabled people associated with these developments have not received sufficient attention.

Objectives

- To establish and disseminate information on the potential for improved access and benefit to disabled and elderly users through intelligent and knowledge based user interface systems.
- To pilot particular exemplar systems, applications and services.

Technical approach

Developments which are undertaken within this task must be based on a comprehensive review of the relevant state of the art in both user interface, multimedia and Knowledge Based Systems. There are many possibilities and the developments which are selected must be well justified in terms of industrial exploitation and user benefit.

As with the other tasks in this work area, the development of new techniques and technologies is not regarded as the primary objective rather, emphasis must be placed on the selection, adaptation and integration of the appropriate components. Possible examples are:

- Systems which analyse user behaviour in order to model user familiarity with the system, physical and or cognitive capabilities and preferences and adapt their characteristics accordingly
- Systems for user control of presentation and interaction media
- Active user assistance

The task is expected to produce demonstrations and pilots with detailed evaluations of effectiveness and benefit and with clear potential for exploitation and commercialisation.

Key results and milestones

- Publication of state of the art analysis and definition of priorities
- Demonstration of intelligent interface systems for disabled people
- Detailed evaluation of developments
- Development of exploitation strategies for specific systems and components.

T104 Interactive interpersonal and group communication

Background

The current market for aids for people with communication impairment is fragmented and would greatly benefit from co-ordination and cross fertilisation between the producers and developers of devices and the expertise in different language groups.

As far as the devices and systems themselves are concerned, increased speed and facility of output is required in conversational modes as well as improved facilities for the access to and manipulation of stored material in databases. Portability also represents a key ergonomic factor.

Devices in this area require improved responsiveness to the expression of user mood and personality and there is a need to integrate gesture and residual speech effectively.

Speech synthesis techniques are well advanced in most but not all the languages used by the people of Europe, there is still a need for to provide facilities for personalisation to individual user requirements.

Work in the area of visual and pictographic based systems is fragmented with some effort being addressed to translation between symbol sets but this does not benefit from the sort of co-ordination which language translation systems have at the European level.

In face to face, conversational modes, production rate remains the fundamental problem together with the effective support of the pragmatics of two person or group interaction.

Handicaps other than those directly related to speech production may also feed requirements into the work of this task including the problems resulting from language dysfunction, special learning difficulties, developmental disabilities, autism and various motor impairments.

Non-technological disciplines including socio-linguistic approaches, speech and occupational therapy and the discourse analysis, conversation analysis and social psychology have significant contributions to make to this area of work. Many aspects of the provision of support for interpersonal interaction will be exploratory in nature owing to the lack of a well established theoretical base for understanding the complexity of social intercourse.

Objectives

The objective of this task is to develop and evaluate devices and methods which aid disabled users to engage effectively in face to face conversations considering:

- Ease and effectiveness of use
- Responsiveness to individual differences and intellectual growth of users
- Integration with other modalities (e.g. gesture or residual speech)
- Addressing the needs and cognitive capabilities of the user
- Portability and social acceptability

- Scope of use including social, recreational and employment contexts
- Addressing the problems of multiply impaired users.

Technical approach

The work of this task concerning the development of aids and systems to support social interaction for disabled people should commence with a detailed review of:

- The development of a multi-disciplinary framework for the identification and analysis of user needs
- A review of relevant current approaches, technologies and devices
- A review of technical developments in related areas such as human computer interaction, computer supported co-operative work and communications.

Of particular importance will be an improvement in communication rate, in the effectiveness of communication at slow rates and the integration of non-language communication methods.

There should be an emphasis on investigating solutions to the fundamental problem with aids for people with impaired speech; the restriction on speed of output due to the low data rates attainable with existing input interface modalities.

Working pilots and prototypes will form the basis of these evaluations and should also provide a basis for the development of realistic commercialisation and introduction plans.

Key results and milestones

Publication of analysis of need and guide-lines for solutions

Demonstration of systems for face to face communication support which shows improved performance in speed and effectiveness

Publication of studies on market information, manufacturing, distribution and support feasibility and competitive advantage over current technologies and products.

T105 Support for Non interactive communication

Background

The concept of non-interactive communication is associated with message storage in the form of text or some other medium and the absences of the time constraints of conversation. The capabilities which are essential for effective participation in this form of communication are those of writing and reading.

Many common impairments of perception and motor function result in disability in this form of communication. Although there is a large body of research and development activity associated with reading and writing and the means for supporting them with information technology and systems, the needs of disabled users receive relatively little attention.

Objectives

This task covers a wide area of problems and potential solutions. The objectives are to make demonstrable progress in the following areas.

- Aids for writing both in the context of document creation and note taking based on conventional character sets and language, symbols and pictures.
- The development of front end systems which incorporate knowledge of the syntactic, semantic and pragmatic aspects of application domains and exploits them to improve the speed and effectiveness of users with disabilities which impair their ability to write.
- Similar devices to aid people with impaired reading ability.

The results of the task must be in a form which is appropriate for industrialisation and dissemination.

Technical Approach

Many aspects of the technical approach of task T104 (interactive communications support) apply equally to this task. The emphasis must be placed on:

- Comprehensive analysis of available technologies and systems together with detailed modelling of needs and achievable benefits.
- The selection and execution of appropriate pilots and demonstrators with detailed, quantitative evaluation of the benefits and costs.
- Publication of results and identification of commercial developments and exploitations.

Key results and milestones

- Publication of review and analysis of needs and potential solutions
- Demonstration of pilot systems and applications
- Development of plans for technology transfer and exploitation.

T106 Support for distant interaction and group communication

Background

Telephone services represent a major means of communication and social intercourse as well a commercial interaction which is not accessible to individuals who are deaf or speech impaired. Many developments are under investigation or have limited introduction but the problems are by no means fully solved. Current approaches include different aspects and applications of speech technology, signal processing and visualisation and display techniques.

Objectives

The objective of actions under this task is to bring together the disparate developments in aids associated with telephone services for disabled people and to formulate a concerted approach and priorities in the following areas:

- Systems which allow communication by speech impaired individuals to use the telephone effectively.
- Systems which support the effective use of the telephone by individuals with different levels and types of hearing impairment.
- Text and picture systems for use with the telephone including the augmentation of speech with images and symbols for group communication.

Technical approach

In addition to the careful and comprehensive review of requirements and capabilities on the part of the user and also of the available technologies and systems, the issues of standards and the relationship with the communications service provider are most significant in the execution of this task.

The prototyping and evaluation approach which has been outlined for the preceding tasks is appropriate here with the additional consideration that the communications service providers' view on the impact and consequences of proposed solutions must be represented very clearly.

Key results and milestones

- Publication of review and analysis of need, options and suggested priorities
- Presentation and evaluation of pilots and prototypes
- Development of plans for exploitation and material for consideration by appropriate European standardisation bodies.

T107 Speech to text transformation in real time

Background

The production of a written transcription of spoken material represents the key to communication for many people with hearing disability. The real time transcription of speech to text is a highly commercial area and much effort has been devoted to the development of effective dictation support systems. The progress which has been made in this area has yet to be turned to the advantage of disabled people. It is not acceptable that they should wait many years for the spin off of these developments: their needs may be met by using the latest technologies in specific ways. The TIDE programme represents an opportunity to achieve this technology transfer and to create a new market for these developments.

Chord keyboards have proved successful in providing verbatim transcriptions of speech at meetings where deaf people participate and for sub-titling of broadcast material. This is, however, a narrow and highly specialised area which leaves the majority of potential users without the possibility of accessing such facilities. There is also a marked difference in the level of development of these techniques for the different language groups.

Real time transcription services are not, for example, available as a mediation service between communicating parties.

The work to be considered here may include addressing the problems of combining computer technologies such as recognition systems with human operator capabilities to provide cost-effective relay services for deaf people. It may also include the development of computer - based shorthand systems covering general and profession specific language. Any work undertaken in this area should be aimed at providing cost effective solutions for hearing impaired users and should seek to adapt available technology.

This task is concerned with the definition of the technological and systems means for achieving cost effective transcription. It has a clear relationship with T110 which concentrates on the service structure and delivery aspects of mediation services of which speech transcription is an example.

Objectives

- To investigate the means of combining current speech recognition technologies and operator transcription approaches to provide efficient speech to text transformation in real time.
- To determine the usability and utility of transcription services in a range of business, social and leisure / entertainment contexts.
- To develop computer-based shorthand systems covering general and profession specific languages.
- To demonstrate the enhancement of current rapid keying devices by the incorporation of intelligent, language systems.
- To investigate the training of operators for transcription services.

Technical approach

A detailed and comprehensive analysis of requirements is required which covers not only the need of the users and operators of the system but also considers service management, market issues. Non-functional requirements such as confidentiality and dependability must be made explicit. A particularly important aspect of this phase of the activity is the definition of a set of acceptability and performance criteria against which the pilot may be evaluated.

The piloting approach may be based on a prototyping environment but should include special facilities for collecting and analysing user and system performance.

Key results and milestones

- Publication of recommended methods for combining speech recognition techniques with operator based transcription systems
- Demonstration of pilots systems and publication of user evaluations
- Realisation of pilot training courses for speech to text transcription operators.

T108 Enhancing interpersonal human speech communication

Background

Speech and hearing dominate human conversational communication. A significant proportion of the population experience problems with aspects of audible communication at some stage in their life. These problems may be associated with either

i The ability to perceive and interpret speech, or

ii The ability to produce speech which is understandable and acceptable.

These problems may be associated with disability at cognitive, language, motor or sensory functions resulting in an area of high complexity where success in the provision of devices and aids depends on careful and comprehensive assessment as well as effective training and support of the client.

This task focuses on the two issues of perception and production of speech and addresses the problems of sensory augmentation and compensation and those of motor function and production. In the case of speech perception, systems for the increased stimulation of the auditory system by electrical and acoustic means and the use of tactile simulation will be considered.

Problems associated with speech production, may be associated with the loss of organs or loss of motor control or co-ordination due to neural or muscular defects. Approaches to the provision of aids and prosthetics may be concerned with the exploitation of residual abilities in the case, for example, of low level of production or stuttering, or the creation of devices to replace function for those suffering loss. Many commercial devices suffer from computer like sound and poor prosody, which requires a high level of concentration and adaptation by the hearing partner.

Speech and hearing impairment often occur together and in such a case an integrated solution might be sought.

Objectives

- To deliver improved benefit from amplification with particular reference to hearing aid performance in noisy environments and other difficult listening conditions.
- To develop means for auditory stimulation or creation of awareness of the acoustic environment through electrical and tactile systems.
- To improve methods of assessment by the incorporation of computer based interactive tools.
- To create the means for integrating hearing aids and other assistive devices into a range of user - system interfaces e.g. to telephones.
- To develop systems and tools for analysing and measuring speech production.
- To develop prosthetic systems for speech augmentation and enhancement and also systems to aid training and rehabilitation in this area.

Technical Approach

In the case of speech perception, the approach to be taken in this task must concentrate on making the most appropriate and effective use of newly available technology in overcoming disability.

The task must determine which forms of digital signal processing yield the greatest potential benefits to severely-impaired people and develop circuits and systems which have more general applicability so that they can be used in other communication devices, such as telephone handsets.

The task must also address the need for standardisation of interfaces between wearable hearing aids and desk-bound evaluation and control units. The European market is sufficiently large to support such standardisation of both functional architecture and control parameters - essential if deaf people are to derive maximum benefit.

For the area of speech production, the task must make the most effective use of current knowledge of the speech sciences in the evaluation of current technologies.

Technologies, devices and areas of application must be selected which will provide the greatest impact on speech support aids, products and services and design pilot demonstration and evaluation activities.

The task must address the problems of achieving technology transfer, production and introduction plans.

Key results and milestones

- Analysis of the requirements, available technology and market evaluation for speech related aids and systems
- Demonstrations and field trials of selected systems and technologies
- Technology transfer and introduction plans.

T109 Information Retrieval Applications

Background

When the problems of the physical access to a service or application has been solved, new issues arise concerning the service or application itself. The functionality available in multimedia systems allows complex and diverse services to be designed and implemented. The accessibility of these services is critically dependent on the design of the user / service interface. Attention in this area is particularly important in information access services where navigation and presentation approaches dictate the cognitive load and demands on memory which is placed on the user.

The special needs of users with disabilities have received little attention in this area and, as a consequence, many new services which have been made possible by technological advance fail to reach potential markets such as the elderly.

Objectives

- To identify and demonstrate accessible navigation and search techniques to meet the needs of users which cognitive, perceptual or other disability.
- To identify and demonstrate presentation techniques and procedures of multimedia information which address the needs of these users.
- To identify and demonstrate approaches to multimedia information structuring to support the various access and presentation methods which have been developed.
- The development of proposed standards in the area of database and document structure on which a common approach to the development of services for disabled users may be based.

Technical Approach

Any approach to the execution of this task must be based on a detailed and comprehensive study on the user-needs and market segmentation. Current and emerging standards for multimedia document structure and data-base structures must also be evaluated.

A study of existing interaction techniques and protocols would result in proposals for general interaction protocols for the elderly and disabled persons.

Study of existing information retrieval, reading and interaction techniques and protocols and develop proposals for general information retrieval protocols for the elderly and disabled persons. This task must also undertake active promotion of the use of this protocol.

Technology verification with users, using field trails and scenarios.

Key results and milestones

- Publication of the state of the art and critical technology review
- Preparation of submissions to appropriate standardisation bodies
- Demonstration and evaluation of pilot services.

T110 Access to relay / mediation services

Background

Relay and mediation services provide the means and mechanisms for translating a message from one mode of communication to another. Examples of such services are remote reading centres which produce spoken recordings from written or other textual material or the real time translation between spoken material and signing.

Objectives

- The objective of this task is to investigate, through realistic demonstrations and field trials, a range of specific mediation and relay services and to evaluate their acceptability, effectiveness and cost in relation to different implementation strategies.

Technical Approach

The most direct approach is the establishment of staffed services centres to provide relay and mediation service to deaf, hard of hearing, deaf-blind and speech impaired persons.

In one approach, ordinary telephones may be used together with text transmission services. At the relaying sites tests should be made of chord key boards and prediction systems in order to speed up the manned, real time conversation services. Systems should also be developed which provide direct speech communication in one direction and relay facilities in the other.

Research is required to develop and test wholly automatic means of relay service provision based on speech recognition and synthesis and also into the possibility of augmenting human operator effectiveness and efficiency by use of these technologies. In the case of sign language conversion, fundamental issues in behavioural sciences and communication must be emphasised.

Key Results and milestones

In all the above cases, the key result is improved communication or information access for the groups in question. The successive replacement of human assistance will decrease the cost and, thus, make these services more widely available.

In the case of sign language relay services, the result will be a pilot demonstration of a telematics based interpreter service for deaf people, with a demonstrated potential for commercial introduction.

The ultimate objective is the availability of a range of services which exploit the capabilities of fixed and mobile video-telephony to provide flexible interpretation services for deaf people.

T111 Access to alarm services

Background

In order to be maintained in a community rather than an institutional setting, some individuals will require support services to deal effectively and reliably with emergency or crisis situations. Disabled and elderly persons must be able to understand and operate appropriate alarm systems and services if effective and efficient protection is to be afforded them. Different types of disability present different problems in the area of alarm services: this task must examine the problems and opportunities all of them and consider the functionalities and dependability of the total alarm system and service. This includes both the technological, economic and human dimensions.

The increasing availability of mobile communications technologies and services provide the potential for delivering effective alarm services which are not restricted to controlled environments.

The recognition of alarm activation and warning signals is a key issue for access to this type of service. Deaf people are particularly disadvantaged by the reliance on conventional telephone services for emergency communication.

Objectives

- To identify and characterise the requirements for alarm services, devices and technologies and to define the functional and non functional requirements from both the clients' and the carers' viewpoints.
- To adopt, develop or adapt a comprehensive set of components and sub-systems together with interfaces to the communications infrastructure, with which cost effective solutions to the whole range of alarm service requirements can be met.
- Improve access for elderly and disabled people to both public and private alarm services.
- To validate the solution set with realistic pilots and evaluation exercises.
- To publish proposed standards and recommendations for good practice in the area of alarm services for protected environments for disabled and elderly people.

Technical approach

Any approach to this task must co-ordinate market and commercial analysis with user needs. In the case of alarm services and technology, the requirement of both the beneficiary and the emergency service provider or caring agency must be considered. Clear and explicit definitions of requirements and policy options are required against which technical solutions may be validated.

With respect to requirements, non-functional issues such as privacy, intrusiveness and reliability can be expected to be significant as well as functional requirements of usability.

Activities in this area must include appropriate analysis of the dependability of existing and proposed systems with particular reference to the interests of elderly and disabled people.

Key results and milestones

- Publication of needs and market analysis and technology review
- Specification, prototyping and evaluation of innovative alarm service mechanisms and approaches
- Publication of recommended approaches to the evaluation of the dependability and acceptability of alarm services for disabled and elderly people.

T112 Services for people with difficulties in document access

Background

Many handicaps result in problems with access to documentary information of all types, printed matter, hand written text, diagrams or pictures. Technologies which are now available offer a variety of options for overcoming these difficulties both with and without human assistance.

Many of the traditional printed forms are now available in digital form, as a result of the document production process or can be easily converted into it through optical character recognition. This opens new possibilities for people with some reading disability in accessing information sources likes newspapers, magazines, books, forms and official information and personal correspondence. First explorations of these new possibilities have been done through a number of isolated local projects in different EC countries; most have concentrated on digital newspaper projects.

To come to a larger scale use of these new possibilities there are a number of obstacles to be overcome such as:

- The legal aspects particularly those relating to copy-right
- The lack of standardisation on the level of document structure
- The need for standard general interaction protocol
- The need for a standard information retrieval protocol
- The lack of harmonisation of government funding techniques in different EC countries resulting in totally different cost-effectiveness figures for the same solution in different EC countries
- Compatibility problems on a national and European scale between the transmission systems used for services to people with difficulties in document access. The issues associated wit ISDN services and, eventually, broadband communications must be considered.

Objectives

- To identify and demonstrate services for people with difficulties in document access
- Develop a generic approach which supports the possibility of access to any such service, regardless of disability, on a Europe wide scale
- To contribute to the conditions which will result in a single market for services for people with difficulties in document access
- Promote favourable interpretations of legal and regulatory aspects of such services particularly with respect to copy-right.

Technical Approach

A study on the user-needs and market segmentation including the world-wide legal aspects and the technologies and devices which may have application in this area. As a result, recommendations for legislative work should become available.

Development of a prototype trans-national network of services for people who's reading abilities are impaired and the publication of a set of guide-lines for the creation of such services. These guide-lines should guarantee compatibility between services and a common approach to access appropriate to the widest range of disability.

The services and technology must be verified with users, using realistic field trials and scenarios.

The developments associated with this task must be integrated with those of T110. Development of conversion software to make existing services compatible with the proposed new standards.

Key results and milestones

Publication of market and requirements analysis including studies of the regulatory and funding regimens within the EC and the impact on the cost-effectiveness of the possible solutions.

- Publication of state of the art and technology review
- Demonstration and evaluation of pilot services
- Publication of guide-line documents for service creation
- Publication of recommendations for the legislative framework which will favour disabled users and promote services.

T113 Access to audio/visual services

Background

We are seeing increasing application of the audio/visual media in all facets of life. This trend seems set to accelerate in the future with the introduction of such services as interactive TV applications, e.g. museum guides.

Tele-sales and catalogue browsing as elements of tele-shopping and the development of new audio/visual presentation methods (e.g. virtual reality and real time simulations).

The audio / visual media combination, supported by appropriate technologies, could provide powerful opportunities for innovative services to meet the needs of elderly and disabled people. For this potential to be realised, however, work is required on the analysis of the precise needs and preferences of the different user groups in order to be able to specify both the functional and operational requirements of appropriate audio visual services.

Contexts and applications which could be considered are:

- Personal and business related information systems
- Tele-shopping
- Training and education
- Orientation and guidance.

The sorts of innovative technologies which could be evaluated include:

- Virtual reality
- Simulation
- Interactive techniques.

Objectives

- To identify requirements for innovative services employing audio / visual media.
- To create pilot services which demonstrate user benefit and commercial potential.

Technical Approach

This task seeks to apply available technologies in a way that will benefit elderly and disabled users and to stimulate the application of the latest techniques for the benefit of this group.

In some cases the approach would follow the strategy of:

- Identification of service needs and opportunities, e.g. the specific needs of intellectually impaired students in the area of open learning and remote training
- Identify technological options

- Develop demonstration system and evaluation programme.

In some cases, more fundamental work may be required to apply developments from basic research and would include the following steps:

- The attributes of new technologies and methods must be examined to identify operational limitations and possibilities.
- The match between the new possibilities and unsolved needs of disabled or elderly users in the area of audio/visual services must be analysed.
- Testing and evaluation of laboratory prototypes must be undertaken.
- Detailed analysis of the production feasibility, distribution and support of development must be undertaken.

Key results and milestones

- Market and user need survey and analysis identifying application domains for audio-visual services for elderly and disabled people
- Identification of appropriate technological options
- Demonstration and evaluation of prototype developments
- Analysis of social impact and acceptability of the proposed services.

T114 Multimedia possibilities

Background

Mono media communication has been available for a long time. The range of different media becoming available from different sources and various forms of distribution is increasing, for example: B-ISDN promises simultaneous availability of more than one medium with simultaneous, real time interaction with information. This will be accompanied by equipment able to handle and make available multiple media.

The control procedures required to access and manipulate the multiple media will be more complex than current systems and the record to date of engineering and commercialisation applied to media access has not been always good resulting in multiple competing standards and approaches.

Not enough is known, in practice about peoples' ability to handle multiple media and there is a need for an element of basic research as well as engineering and piloting activities in this area.

Particular care is required in the design of interfaces and services for elderly people, many of whom may be overwhelmed by the complexity and the apparent demands made on the user of multi media interfaces and reject them in panic.

Objectives

The objective of this task is to demonstrate new and more effective ways of combining media and modes of presentation and interaction to meet the needs of different classes of disabled users. On the one hand, the simultaneous use of more than one medium could be a problem for the elderly and those with cognitive processing decay or impairment, on the other, it could provide sufficient information flow to make communication feasible for the first time for multiply impaired users.

Then task must produce and publish clear and useful guide-lines for the use, management and presentation of various media in given applications. These guides must address the following areas:

- The particular needs of visual and hearing disability, motor impairment and cognitive impairment.
- Media redundancy issues and the problems of timing and sequence of presentation.
- Interpretation issues concerning the presentation of the same information in different media.
- Adaptation where the system can take into account the capabilities and preferences of the user in order to promote a feeling of comfort and safety.

Technical Approach

Three phases are envisaged for this task:

i A review of technology and market issues to identify opportunities and to propose priorities.

ii The design, execution and evaluation of pilots and prototypes.

iii The development of exploitation and technology transfer actions and materials.

Key Results and Milestones

- Publication of state of the art and market survey
- Presentation of demonstrator systems and services
- Publication and presentation of technology transfer materials.

T115 Social interaction services

Background

Telecommunications services have become an essential means for preserving social contact and interaction for people with restricted mobility. The increasing functionality and capacity of telecommunications together with the increasing cost effectiveness of terminal equipment provides an opportunity for telecommunications to provide a basis for building, expanding and supporting social contact for disabled users.

The possibilities which emerge include:

- Networked communities
- Special interest and support groups
- formal and informal social communications based "events"
- Tele-working.

Objectives

To identify opportunities and approaches to the use of advanced communications services to support social and cultural interaction amongst those with restricted mobility in order to promote:

- Psychological and social well being
- Afford preventative and therapeutic benefits in mental health
- Reduce the effects of isolation and alienation
- Higher functioning of the disabled person leading to their increased social and economic impact.

Technical Approach

Three phases are envisaged for this task:

i A review of technology and market issues to identify opportunities and to propose priorities.

ii The design, execution and evaluation of pilots and prototypes.

iii The development of exploitation and technology transfer actions and materials.

Key Results and milestones

- Publication of state of the art and market survey
- Presentation of demonstrator systems and services
- Publication and presentation of technology transfer materials.

CONTROL TECHNOLOGIES

T201 Development of tools and procedures for the selection of suitable systems of environmental control.

Background

There are many ways in which a disabled individual may be given a degree of control over devices within their immediate environment. The precise system used will depend upon the degree of handicap, the nature of the difficulties experienced, the activities which they wish to control, and whether they are already users of other technology oriented systems such as communication aids, or specially designed, computer-based work tools.

A need exists for tools and procedures to enable those concerned with assessment of disabled people to be able to suggest the most appropriate system. Clients' needs must be balanced and combined, then matched with commercially available equipment from throughout the single market. This approach may also serve to identify needs not yet addressed.

People directly concerned with the assessment of clients and recommendation of equipment are required to collaborate closely with commercial developers to arrive at the most effective configuration.

Objectives

- To produce tools and procedures allowing for the selection of the most appropriate system to control identified devices, within specified price ranges.

Technical Approach

Establish working groups comprising representatives from industries, user groups and rehabilitation staff to form a consensus on the user needs and market requirements. Procedures can be formulated to permit eventual formation of standards.

Produce versions of commercial equipment designed to be used in the assessment of individual need. Form a set of procedures to be followed in this assessment to produce the most suitable system for a disabled person.

Develop an advice system (possibly an expert system) from inputs provided by the working groups or other experts, to aid in the appropriate provision of equipment.

Identify test procedures and criteria to quantify how well the users needs are met by various possible combinations of equipment, and verify the validity of the tools and assessment procedures.

Key Results and Milestones

A check list to identify the needs of an individual and pin-point areas where equipment may be used in a multifunctional way.

Production of a proven set of tools and procedures for the cross matching of equipment functions with individual needs and the quantification of equipment suitability.

Recommendations for consultative arrangements between manufacturers and end users to ensure relevancy of design and public awareness of available products, throughout the whole community.

A user-friendly database giving comprehensive details of pan-European and other equipment together with strengths and weaknesses, the range of possible modes of operation, and hence the range of potential users.

T202 Development of improved and compatible user interfaces and environmental control systems

Background

The need exists for disabled people to be able to control a wide range of different devices both at home, work in education and training and in the public domain. To function effectively, control systems need mechanisms that allow remote control, mobility of the users and compatibility between devices.

Manufacturers need to work within defined standards to allow their products to form parts of overall systems. The production of a range of compatible products, distributed throughout the single market can be assisted by the definition of specifications for interface protocols. The opportunity should be taken, too, to incorporate alarm systems to enable the user to seek help remotely.

The standard of domestic appliances and fittings is high within the EEC where user demand has resulted in a large market. The disabled and elderly people have a need to have independent control of these appliances and systems.

The electronic technology for programmable controllers and monitoring transducers is readily available and low cost. However, adaption to use by the disabled and elderly requires much work. Field trials have been performed on some equipment but full general assessment within the EEC is lacking.

Objectives

- To produce technical specifications to remotely controlled devices using the wide range of available technologies.
- To develop interfaces between the above and emerging standard bus systems.
- To develop or modify existing transducer, feedback and programmable controller technology for domestic use by the disabled and elderly.

Technical Approach

Potential users should have their needs identified and listed in the different environmental contexts. The needs could be initially defined in general terms such as requirements to turn lights on and off, control cookers, prepare food, clean the home, use vending machines, etc.

Identify and test available receivers, transmitters, activators, effectors and other component parts with a view to their employment in a modular environmental control and bus interface system.

Within individual or group houses, transducers should be placed in cookers, refrigerators, water supplies, etc to monitor temperature, contents, position and other parameters as deemed necessary in the survey. Monitored parameters should be displayed in audio, visual and tactile form as appropriate to the users. These transducers and effectors for the appliances, lights and heating should be linked to a controller which can be operated by various means (direct touch, infra red link etc). Similar principles could also be utilised to control such things as vending machines and road crossings.

Develop the serial and/or parallel interface components necessary to allow connection to commercially available computers.

The effectiveness and usability of the facilities should be proven by user testing and automated monitoring of the devices (e.g. failure rates, accuracy and speed of response of the control systems). Where facilities are critical the applicability of standards on fail-safe operation should be considered.

Key Results and Milestones

- Report on user requirements for environmental control systems in smart houses and of appliances.
- Report on the expected market in the light of initial user survey (revised in light of later testing). Review of expected mechanical and electrical safety standards to be met when producing the interfaces.
- Demonstration of working prototypes.
- Report on usefulness of the systems as revealed by the user testing.
- Report on system accuracy, reliability, etc.

T203 Integration of robotic aids with wheelchairs

Background

Powered wheelchairs are in widespread use as aids to mobility for people who have difficulty with or cannot operate a manual wheelchair. Many of the people using a powered wheelchair, for example those with upper arm diplegia or tetraplegia, also have limited use of their hands and arms and are not able to handle objects or control devices in their environment. For powered wheelchair users with upper limb motor dysfunction, a wheelchair-mounted robot with integrated control function could be of value for a large number of activities including personal care, environmental control and vocational tasks.

A fully-integrated, combination wheelchair-manipulator system will have significant advantages. The influence on the wheelchair specification will be especially in the area of control systems. The performance specification of the robot manipulator will emphasise safety, attractive design, compactness and high-level control at the expense of high acceleration, speed, accuracy and repeatibility.

Commercially available robots may form a basis for the manipulator but will have to be carefully modified and adapted for integration into this particular application. The development of novel robot mechanics and control systems may offer a more satisfactory solution. The integration of the human-controller interface allowing access to mobility and handling, and possibly also communication and environmental control, will further improve the ease of operation of the complete system.

Objectives

- To identify the special requirements of the user group addressed.
- To specify an integrated design of wheelchair, robotic aid and controls, where high level control functions and human machine interfacing for mobility handling and environmental control are included.
- To develop and demonstrate a control system in combination with a special robotic arm and a wheelchair for the enhancement and restoration of mobility and handling capabilities of disabled people. Special attention has to be paid to safety and human machine interaction.

Technical Approach

- User needs analysis:
  - elaborate typical handling tasks, which are essential for independent living
  - consideration of user's mental, sensory, perceptual and motor capabilities.
- Analysis of market requirements:
  - legal constraints
  - influence of social systems of member countries

- consideration of existing standards.

- Technical requirement specification:
  - transfer of user requirements to system requirements
  - system breakdown and interface specification
  - choice of methods and technology with regard to the state of the art and on-going research and development activities (e.g. EC projects, US activities). Make a clear distinction between what is existing or adapted or innovative new technology.
- Prototyping:
  - choice and adaption of a state of the art powered wheelchair for integration
  - development of suitable integrated prototypes.
- Technology verification:
  - provide a technical system specification
  - user evaluation concept (test scenarios, field test studies)
  - practical user evaluation.

Key Results and Milestones

- Report of elaborated user needs and market requirements
- Report on specifications for an integrated wheelchair and robotic aid and describing interface and possible standards
- Demonstration of a prototype realisation of a wheelchair with robotic aids and supporting documentation
- Report on the evaluations.

T204 Robot systems for assistance with common household and workplace tasks

Background

In a variety of homes and at the workplace, robot technology can offer a powerful method of integration for people with severe disabilities such as tetraplegia, upper arm diplegia, muscular dystrophy and cerebral palsy. A few attempts have already been undertaken to use robotics to give the person with disabilities improved opportunities to perform common household tasks and the activities necessary in the everyday life. More attempts have been made to use robotics at the workplace to assist the user in the use of computers and other equipment for handling papers and other tasks. It is of great importance that an effort is made to make these solutions more effective and economical for the user, before a market breakthrough can be achieved.

Performance requirements for the use of robots by disabled people are different from the industrial type (e.g. there is no need for high speed, acceleration, accuracy and repeatibility: there is a need but for a carefully planned safety system, aesthetically pleasing machines, attractive design and high level control).

Commercially available robots may be take into consideration, but have to be carefully modified and adapted for the integration with respect to this particular application. On the other hand the development of new robot mechanics (e.g. light-weight, dexterous kinematic construction) may be suitable. In addition the integration of controls and human machine interfacing for handling of objects and environmental control will further benefit the easy user operation of the aid system.

Objectives

- The objectives of this task are to develop and demonstrate a robot system which is able to carry out various functions within the common household and/or the workplace environment, in the situations where it would be suitable to carry out the functions with a robot. The robot system is integrated into the environment functionally and aesthetically.

Technical Approach

- User needs analysis:
  - describe the functions in a common household and/or office in which the robot function can be of optimum use.
  - describe the qualifications which the user, family and staff need, to adjust the robot to new pre-defined functions (semiautomatic and automatic mode).
  - describe and discuss the uses of direct control (manipulation mode) and semiautomatic/automatic mode, in relation to the user's capabilities and the specific tasks.
- Analysis of market requirements:
  - employment possibilities
  - cost effectiveness of the solutions

- legal constraints
- consideration of existing standards.

- Technical requirements specification:
  - transfer of the requirements in common household and/or office to system requirements
  - transfer of user requirements to system requirements
  - system (breakdown i.e. modular decomposition and interface specification)
  - choice of methods and technology with regard to the state of the art, and on-going research and development activities (e.g. EC projects, US activities). Make clear distinction between what is existing, adapted, and innovative or new technology.
- Prototyping:
  - develop suitable prototypes.

Technology verification:

- user evaluation concept (test scenarios, field test studies)
- practical user evaluation
- evaluation and adjustment of system and the environment
- provide a technical system specification.

Key Results and Milestones

- Systematic functional and technical evaluation of existing robot solutions for people with disabilities (common household and workplace use) with respect to the adopted technologies, implementation methods, user acceptability, design and cost effectiveness.
- Report describing end-user requirements.
- Report describing the tasks in common household and workplace being optimum for the use of a robot.
- Report describing proven functionality and usability of the robot for common household and/or workplace use for the agreed target population and/or office use.
- Report reassessing the markets in the light of product testing.
- Report giving draft specifications for input to standards bodies.

T205 Intelligent control of powered wheelchairs for users who are severely physically or mentally impaired.

Background

There is considerable evidence to show that self-initiated wheelchair mobility can engender self-confidence which is a crucial component of the user's quality of life. Most experts agree that the sooner self-initiated control can start in terms of age the better.

Recent developments in interface design technology in combination with microelectronics offer tremendous scope for wheelchair innovations. These not only offer advanced solutions to powered wheelchair control by disabled users but also the flexibility to "individualise" these vehicles with ease.

The application in particular of AI developments to wheelchair design offers hope to people with severe physical disabilities and those with mental handicap. A number of technological paradigms already exist within the motor industry which could be harnessed for the purpose. Various other transport industries have also developed advanced transducers and sensors which could be modified for use in intelligent wheelchairs.

Objectives

- To identify generic application scenarios with particular reference to user characteristics.
- To design working prototypes of the intelligent control interface and carry out systematic tests with mentally handicapped and severely disabled people.

Technical Approach

A substantial amount of the work consists of consolidating the results from various other related fields using intelligent systems experiments. It would be necessary to carry out a survey of potential users in order to establish a baseline of requirements.

Identify both human and technology related requirements for the specifications of an intelligent wheelchair interface. This involves analysing mental and physical impairments which impinge on the interface design as well as their ergonomic and human factors attributes. It is necessary to identify individual 'intelligent' control modes and the possibility of using different control modes simultaneously. Interface adaptability to varying user needs has to be established alongside issues such as sensor reliability, overall safety and feedback mechanism. The latter includes responding to different terrains. Incorporate environmental control functions, pre-programmed routing, obstacle avoidance, positioning, environment sensing and navigation.

It would be essential to include user testing of the prototype wheelchair in the proposal. The testing would have to be in a variety of conditions and contexts to be valid.

Key Results and Milestones

- Report giving a description and justification of scenarios and the resulting special needs requirements
- Report on common functional specifications for intelligent based wheelchairs
- Report identifying the attributes contributing to user-to-system match
- Report giving a compilation of potential usage patterns across types of users
- Report on the market sector analysis
- Report on strategies to be employed in order to be competitive in the face of similar initiatives from outside Europe
- Demonstration of working prototype
- Report on user testing of prototype in a mixture of critical conditions
- Report identifying issues on which standardisation is required
- Report giving a compilation of final specifications
- Report suggesting strategies for exploitation.

T206 Development of an automated system for the design of postural supports for wheelchairs

Background

Efforts into designing wheelchairs which provide appropriate postural support to the user lag behind emphasis on lighter metal frames, better electronic control or better wheel arrangement. Yet the maintenance of proper and comfortable postural support can be more important to the user's quality of life, independence and self-confidence. The ability to maintain a good posture has a direct bearing on the user's ability to control or 'handle' a wheelchair. Feeling secure and safe, and the prevention of pressure sores are the other positive attributes of a properly designed and "tailored" postural support.

The baseline of the project is a clear understanding of the user groups and their generic and individual requirements. Particular attention would need to focus on the differing needs of various impairments that impinge on wheelchair use. Whatever the activity, particular attention would need to focus on appropriate body positioning and support. Use of CAD/CAM and other advanced manufacturing techniques alongside the development of new materials offers enormous possibilities for "tailoring" postural supports to specific individual needs.

Objectives

- Definition and detailed characterisation of wheelchair user groups in terms of their generic medical conditions and postural characteristics
- Analysis of problems associated with wheelchair seating and support
- Development of specifications for an automated design and fabrication process for "tailoring".

Technical Approach

It would be crucial to identify the generic medical conditions and postural characteristics of wheelchair users. An analysis of seating and support problems would be integral to the project. As no design of seating is totally satisfactory in preventing tissue trauma without the patient contributing through movement it would be essential to identify the type of activities that contribute to pressure sores. The latter could be seen in terms of pressure related categories and would entail some understanding of the medical aspects of pressure sore formation. The variables could include such factors as: pressure, shear loading, general metabolic conditions of the person, age, local tissue integrity, repeated pressure, sensation, psychological factors, etc.

It would be necessary to understand the relationship between seating and the elements that contribute to postural support. For instance, it would be essential to target pelvic stability when designing any form of support. This implies an integrated approach to the design of seating and the various types of supports as opposed to the present "add on" practices.

A close examination of CAD/CAM and materials technology is at the centre of any efforts to provide individualised supports. Computer modelling techniques could be an important tool for this purpose. An important consideration is cost-effectiveness if this process is to be fully implemented. Aside from cost some thought should be given to such features as:

- assessment and criteria of 'fit'
- the measure of feeling secure
- accessories, upholstery and aesthetics
- environmental and climatic factors.

User testing of a number of tailored supports in a variety of critical conditions would be important.

Key results and milestones

- Report identifying wheelchair user groups in terms of their generic medical and postural characteristics
- Report on the analysis of problems associated with wheelchair seating and support
- Demonstration of a computer simulation of seating and support mechanisms
- Report and demonstration of a methodology for the use of CAD/CAM and other design and manufacturing techniques
- Report on the analysis of seating and support materials
- Demonstration of an automated design and fabrication system
- Report on the user testing of "tailored" postural supports and seating
- Report on market sector study and strategies for exploitation.

T207 Home transfer systems for disabled users

Background

A general way of helping transfer functions at home is to treat them separately. The transfers between e.g. beds, wheelchairs, bath chair, bath, work site, at the stairs, etc are often performed by different and incompatible devices. This applies also to the transfers to and from home: to cars, lifts, etc. The devices are designed to be used by the nursing staff with little possibilities for the self-help of the disabled users, furthermore they are difficult to operate in narrow home environments.

A new systematic approach is required to produce integrated transfer system which are adaptable into different environments and which could increase the independence of users with different disabilities. Besides the new solutions for devices, this approach has to include the aspects related to the work load and ergonomic conditions of the home carers as well as the adaptation of the buildings.

Objectives

- To develop and test new integrated transfer systems
- To develop design rules for integrating transfer systems into buildings

Technical Approach

Analyse the market of home transfer devices: approximations of the size of the market sector, evaluation of the devices available in terms of functionality, safety, ergonomics and performance.

Analyse the transfer functions and needs in different home environments related to the daily activities and disabilities: user characteristics, functional procedures and needs, possibilities of self-help, the function and requirements of nursing staff, problems and obstacles, environmental aspects, safety, ergonomics, etc.

Develop a comprehensive transfer system based on the analyses.

Implement the concept into novel modular prototype devices which can be integrated into the daily functions using new design and material solutions, develop modular control systems for users with different disabilities, develop strategies and methods for adaptation of old buildings as a part of these systems.

Test and evaluate the prototypes in practical environments.

Produce guidelines and specifications for design of environment for transferring functions, transfer devices and systems and transfer strategies for limited home environment.

Outline the strategies for exploitation of the systems in the Single Market.

Key results and milestones

- Report of market analysis: identification of gaps in the product selection.
- Report on systematic methods for analysing daily transfer functions.
- Demonstration of prototypes of new integrated transfer systems.
- Demonstration of prototypes of modular control devices for transfer systems.
- Report on user testing and evaluation.
- Report on guidelines for design and adaptation of transfer systems in limited home environments.
- Report of transfer requirements for different physical handicaps in home environment.
- Report on outline for exploitation strategy.

T208 Integrated Cars and Wheelchairs

Background

Disabled people who depend on wheelchairs are able to be independent car drivers with the help of various technical aids. Manual wheelchairs can be loaded into the driver's compartment of small cars if the transfer method is right and the wheelchair is suitable. A small powered wheelchair can be loaded into the luggage compartment of an estate car by a disabled person but the user then has to be capable of moving along the car and into the driver's seat. Aesthetic and practical aspects (e.g. the time needed - important during bad weather conditions) may lead the disabled person to the use of a somewhat bigger car and a lift/hoist to get faster in and out. The category of cars named "Multi Purpose Vehicles" (MPV) or "Minivans" is growing more and more popular, but if the demands are even greater, only a larger "Van" or "Minibus" will do.

Once inside the car the function status of the disabled person will decide the next step. If possible the person transfers to the drivers seat. The empty wheelchair has to be secured at a suitable spot inside the car. If this solution will not work, the disabled person has to move the wheelchair up to the driver's location and then lock the chair in that position. Most of the disabled persons using manual chairs manage to transfer to the driver's seat but fresh crashtests show that if the driver is properly belted, the wheelchair will manage the strength of a collision. Safety, nevertheless, has to be an important element in the research.

Concerning more severely disabled persons, the use of an electric wheelchair will be the normal situation. The issues here are how to transfer the controls of the wheelchair to the steering unit of the car through connections made by the locking device and of course, the wheelchair batteries should be charged from the car engine.

Objectives

- To produce tested demonstrations of integrated solutions which enable wheelchair users to drive cars.
- To produce guidelines for the design and build of integrated wheelchair/car combinations which enable disabled people more easily to use private transport.

Technical approach

- Identify user requirements:
    - Wheelchair users (both current drivers and potential drivers) and, if appropriate, their helpers, should be interviewed to ascertain what are their requirements in terms of fully using a car for mobility. Other experts associated with the design and provision of mobility aids including car conversions and adaptations should be surveyed and a description of wheelchair users' requirements produced. There is also a considerable amount of information in the literature and this should be reviewed. The user requirements should then be classified in terms of the criteria relevant for potential solutions.
- Conduct market analysis:

- Market analysis will identify what products and systems are currently available to meet the requirements of various groups of wheelchair users.

- Evaluate existing solutions:

  - The current solutions should be evaluated in terms of their ability to meet the actual needs of the various categories of wheelchair users. The evaluations should take into account the needs and abilities of the potential user population safety and reliability, as well as the existing construction, use and licensing regulations.

- Develop integrated solutions:

  - It is extremely likely that the current solutions will be only partial solutions and not integrated in such a way as to enable the users to carry out all the tasks associated with driving. Hence the approach to be taken next is to specify and develop integrated solutions which will effectively enable the various categories of wheelchair users to carry out all the tasks associated with driving. Integrated solutions will include existing solutions which have been shown to be useful and newly developed solutions.

- Test integrated solutions:

  - The newly integrated solutions should be tested in terms of their ability to meet the actual needs of the various categories of wheelchair users. The tests should take into account the needs and abilities of the potential user populations, safety and reliability, as well as the existing construction, use and licensing regulations.

Key Results and Milestones

- Description of wheelchair users' mobility problems and requirements for wheelchair/car integrated solutions.

- Review and evaluation of existing products providing potential solutions.

- Specification of integrated solutions.

- Demonstration(s) of integrated prototypes and user evaluations.

- Specifications for input to standards authorities.

- Design guidelines for integrated solutions.

RESTORATION AND ENHANCEMENT OF FUNCTION

T301 Bio-mechanical assessment of normal and abnormal motor function.

Related section 2.3.3

Background

A wide range of instrumentation and methodologies exist for the assessment of motor function. Although ostensibly intended for clinical evaluation, much of this equipment is used primarily for research purposes because it is either designed to cope with a narrow band of parameters, it is difficult to use routinely, or because common standards of interpretation do not exist between centres.

Objectives

- The objectives of a TIDE project should be to evolve new technology to simplify the process of bio-mechanical assessment of motor function, to generate quantifiable results, to widen its availability in a rehabilitation context and to promote agreement on the implications of the results and standardisation of their presentation. Specific aspects of motor function which are addressed by techniques being developed need to be identified.

- The groups of disabled and/or elderly people within Europe who may benefit from a new or improved procedure must be identified as part of a project, as should the potential cost effectiveness of its application in a rehabilitation context.

Technical Approach

The specific area of motor function to be addressed by bio-mechanical assessment instrumentation or techniques to be evolved under the TIDE programme must be clearly defined.

Where necessary, new prototype systems should be developed to satisfy assessment requirements in a European context through consortia of clinical, technical, research and production groupings. This work would need to be supported by market research to establish both the direct assessment requirement and the commercial potential on a European and World market basis. The proportion and/or number of people to whom individual assessment methods may be applicable and the likely cost implications should be identified.

A further approach may be to adapt existing technology, when it exists, and to generate a market by demonstrating its applicability and, where appropriate, by setting standards for interpretation.

New systems should have a design rationale and a series of development stages with key objectives identified and timetabled for prototype production.

When adaptations of existing technology are considered, the key changes should be identified and the stages required to ensure routine commercial production should be timetabled.

In evolving standards, a rationale for their production should include an identification of their current disparity, together with a description of the specific areas to be covered and the means and timetable for their development.

Key Results and Milestones

The equipment and processes which may be developed can have a great diversity, ranging from, for example, simple goniometric devices to fully automatic three dimensional movement analysis systems. In all cases, there must be an IT element within the system and projects will be expected to fall within one or more of the following categories :

- Direct Monitoring Devices
- Harmonisation of Protocols
- Methodologies of Assessment
- Standardisation of Interpretation
- Information Networking

For device development, milestones in the development programme must be clearly identified within the stages of design, prototype production, design verification, and production development being clearly indicated against specific objectives and date targets.

In other areas of work, the parameters and range of data being considered must be specified and the stages in the progress of the project must be identified against key factors e.g. specific protocol development, means of data collection and/or distribution, validation of data, technical verification of results, establishment of common procedures within the consortium membership, and the timetable of the required stages must be identified against the key aims.

T302 Home and Community assessment of normal and abnormal motor function.

Related section 2.3.3

Background

Sixty to eighty million people in the European Community today are estimated to be old and/or disabled and these numbers are predicted to increase. Maintenance and improvement of daily motor function and minimalisation of dysfunction is a fundamental objective in prolonging the ability of this population to live at home. Assessment of motor function ability within clinical settings provides only a partial assessment, as important environmental issues are often not taken into account.

To complement the motor function assessment technology used by clinicians, information systems are required to support the assessment of an individual person's ability to maintain independent living within the home/community environment.

In addition to providing assessment of individual circumstances, aggregate information on the actual rather than presumed extent of motor dysfunction in the elderly and/or disabled can provide input to the identification of new/improved products and services targeted at supporting independent living in the community.

Current systems of assessment in rehabilitation suffer from the absence of an agreed framework. Within the generally accepted conceptual classification of disablement of the WHO International Classification of Impairment, Disability, and Handicap (1980), better taxonomies and criteria are required to enable effective assessment, both objective and subjective, observed and self-reported, of the degree to which independent living can be achieved by the elderly and/or disabled. Consensus on better methods of assessment needs to be a necessary precursor to any implementation of information technology support.

Objectives

- The objective is the development of reliable information systems providing assessment of motor function to determine the degree to which daily living can be achieved independently within the home and community

Technical Approach

The work should include :

- identification of user requirements and the market potential for such systems. Consideration needs to be given to how such systems might be utilised e.g. the need for remote access, the need for disaster recovery procedures

- identification of the taxonomy and criteria to be used to provide the method of assessment. Close collaboration between home/community motor function assessment professionals and the developers is required to achieve this end. Consensus should be gained on the assessment criteria and, where appropriate, contributions made to any emerging standards

- development of prototypes of user-friendly information systems conforming to existing legislation on product safety and data protection
- field trials of the use of such systems.

Key results and Milestones

The key result is the development and dissemination of better methods of home/community assessment of motor function.

T303 Simulation systems for the planning of rehabilitation of motor function.

Related section 2.3.4

Background

Knowledge of the effect of prosthetic and orthotic devices (including Functional Electrical Stimulation) on different kinds of movement pattern and overall mobility restoration largely depends upon experimental research, giving only limited insight into the factors influencing the level of mobility restoration with these devices. This limited insight hinders the selection of, based on a quantitative assessment of motor functions, the optimal prosthetic or orthotic device in individual circumstances. Simulation software and hardware, taking into account the motor characteristics of the individual user as well as the technical characteristics of prosthetic and orthotic devices will be of a great help in the optimal rehabilitative process.

Additionally, the development of new prosthetic and orthotic devices will benefit considerably from the availability of simulation systems. The phase of elaborate experimental testing of different prototypes can be reduced by preceding this phase by pre-clinical testing using simulation systems, leading to a more rapid selection of the most promising inventions and a quicker release of new designs to the market.

Training programs to enhance or restore mobility are also up to now mainly based upon knowledge derived from experience. Muscular-skeletal simulation models can provide substantial support to training programs, especially when combined with simulation models for device supported movements. By this means, a training program and the provision of a prosthetic device can be closely interrelated and tuned to the abilities of the individual person.

Simulation systems can be considered an extremely useful tool for the determination of the functional conditions and effectiveness of rehabilitative methods. Simulation systems must be conceived according to the general meaning of "simulation" as primarily referred to systems capable of reproducing, directly on the person, or in a graphical computer model, the requested motor function. According to this broad definition, simulation systems can be intended as both hardware components, capable of mimicking the behaviour of a prosthesis or orthosis on the human limbs, or as powerful software programs generating realistic video representations of the behaviour of motor functions or dysfunctions.

At present, several simulation systems are available for specific rehabilitative tasks, such as gait analysis or simulation of human limb kinematics or dynamics. Most of these tools have, up to now, only been used for research purposes, and there is a need to evolve these systems to provide effective support in rehabilitation environments.

Objectives

- The objective of this task is to develop simulation systems in support of restoration and enhancement of motor function.
- The development of advanced information systems in this work area will only be considered for funding under TIDE in so far as their primary purpose is the planning of rehabilitation and maintenance for individuals, and their primary output is an individualised rehabilitation and maintenance plan.

Technical Approach

The work must include identification of the usage and field of application of any simulation system, preferably by means of a close collaboration between developers and potential users.

Particular attention should be paid to the choice of appropriate algorithms and parameters for modelling of specific behaviour. This choice is fundamental to the effectiveness of any simulation system.

The simulation system should fall into one or both of the following categories :

- simulation of the effect of equipment on the motor function of an individual person before the actual application of a technical device
- simulation of the effect of a specific training programme on the enhancement and restoration of motor function.

The work must include user driven assessment of the effectiveness of the simulation system, preferably involving a field trial in a non-research environment.

Key Results and Milestones

Results should include reports detailing :

- the scope and field of application of the simulation system
- the potential market for such systems
- user assessments of the effectiveness and relevance of such systems in daily rehabilitative practice.

T304 Information systems for the planning of rehabilitation of motor function.

Related section 2.3.4

Background

Motor function assessment, as well as rehabilitative procedures, is largely based on experience, with little attempt to capture and compile this experience into a set of well defined procedures. This lack of definition hinders the exchange of experience between centres and the quick dissemination of valuable new assessment and treatment procedures.

By using expert systems and knowledge bases, more coherence in the assessment of motor impairment and the planning of rehabilitation programmes can be achieved.

Prevention of the development of severe motor impairment, in particular for elderly people, can contribute much to a reduction of medical and hospital treatment. Information systems directed to the surveillance of high risk groups and planning support to the rehabilitation team should be developed.

As far as expert systems are concerned, at present, the use of Artificial Intelligence techniques in the field of motor function rehabilitation is not an established technology. Different approaches have been demonstrated but problems arise because an effective objective analysis is still not possible.

Inductive methods, rather than deductive, since these are intrinsically concerned with a single specific motor dysfunction, seems more promising for direct application.

This approach, though limited in application, represents state of the art technology and commercially viable results could be achieved within the framework of the TIDE programme.

The use of information systems for evaluating rehabilitative procedures enabling the disabled and elderly to remain in their homes are still at a very preliminary stage. Action should be taken to develop new tools for planning and evaluating rehabilitative procedures and, where appropriate, improving communication between rehabilitation centres and the clients' homes.

The lack of access to information about existing rehabilitation technology, in particular about existing products for disabled people, acts as a deterrent to the exploitation of the use of this technology. Centres devoted to collecting and disseminating information are already active in some European Countries, but effort is needed to stimulate pan European collaboration in this area. Such information should also be directly accessible by the disabled person.

Objective

- The objective of this task is to develop information systems in support of motor function rehabilitation assessment, planning and/or training programmes.
- The development of advanced information systems in this work area will only be considered for funding under TIDE in so far as their primary purpose is the planning of rehabilitation and maintenance for individuals, and their primary output is an individualised rehabilitation and maintenance plan.

Technical Approach

The work must include identification of the usage and field of application of any information system, preferably by means of a close collaboration between developers and potential users.

Market studies will be needed to assess the potential for commercial exploitation of a prototype system.

The role of an expert system should be that of generating a defined knowledge process capable of translating the quantitative data obtained from measurements of the impairment and/or disability into a form/language capable of being utilized by rehabilitation staff in order to generate the correct rehabilitation procedure.

Where appropriate, effort should be devoted to obtaining a general tool to be used in different rehabilitative approaches.

The work must include user driven assessment of the effectiveness of the information system, preferably involving a field trial in a non-research environment.

Key Results and Milestones

Results should include reports detailing :

- the scope and field of application of the information system
- the potential market for such systems
- user assessments of the effectiveness and relevance of such systems.

T305 Technology for maintenance of motor function.

Related section 2.3.5

Background

In the field of maintenance of motor function it is possible to identify three main areas of application, i.e.:

i temporary functional loss due to an injury or surgery

ii permanent loss like paraplegia

iii preservation of motor control (in particular aimed at elderly people).

In the first and second application, equipment such as EMG plays a major role and is in widespread use. However, improvements could be made to this range of equipment, such as development of a whole telemetric system that is able to work in adverse environments (e.g. water).

Dynamic/kinematic equipment has been in use for many years and contributes towards a reduction in time taken for rehabilitation. There are objections to the use of this range of equipment, however, because they work on a single rotational axis and produce isolated and artificial activities and movements which do not emulate real life. It is possible to conceive of adaptations of existing equipment to overcome these objections by providing multiple rotational axes equipment for a better functionality of rehabilitation activities and movements.

In the second application, the use of Electrical Stimulation (ES), including Functional Electrical Stimulation (FES) is currently being evaluated. FES is used in hybrid devices, comprising mechanical orthoses with manually or otherwise controlled electrical stimulation, and stand-alone FES with no mechanical orthosis. The main problems in the current use of FES are muscle fatigue and inadequate control of stimulation parameters.

In the third application, mechanical weight equipment is used and the new generation of this equipment has programmable control with feedback to the operator. However, this equipment still isolates single joint working on a single activity and improvements could be make to encompass the totality of movement.

Objectives

- The objective is to develop new or adapt existing rehabilitation equipment applicable to the enhancement and maintenance of motor function.

Technical Approach

The work might include adaptations of existing rehabilitation technology, e.g.

- EMG
- Dynamic/Kinetic equipment

- ES, including FES
- Mechanical weight equipment

to increase their functionality/applicability and/or to enhance the feedback and control aspects of the equipment.

One field of interest would be the development of a prototype closed-loop system utilising ES and biological or technical feedback to achieve controlled muscle activation.

A market study should be undertaken to establish user requirements and assess the market potential for any proposed system. This study might address, for example, the number of accidents in Europe subdivided into categories according to the consequent pathologies.

Attention should be paid to innovative ideas for reducing the cost of equipment.

Potential users of the equipment should be involved in specifying requirements for the equipment and in assessing the validity of the approach.

Key Results and Milestones

Key results of the project should include :

- descriptions of prototype equipment
- analysis of market potential
- usability assessments

T306 Restoration of motor function.

Related section 2.3.5

Background

At the present time, a variety of measuring equipment and rehabilitation devices are available for those disabled with motor dysfunction e.g. after a stroke, spinal cord injury, amputation, nerve injury or because of cerebral palsy or multiple sclerosis. Special attention is needed for novel and innovative ways of incorporating the use of existing, including newly developed, equipment and devices into the rehabilitation process.

Objectives

- The objectives of the R&D project should be to develop systems supporting procedures and methods which are applicable to the training of people disabled with motor dysfunction, e.g. pareses, spasticity, dyscoordination, balance problems.

Technical Approach

Work should include development of software and the necessary hardware devices to integrate available measurement equipment and devices into improved systems for motor dysfunction rehabilitation:

- muscle strength, e.g. paresis/paralysis
- spasticity
- dyscoordination
- range of movement, in joints, neck or back
- balance.

The systems should include the appropriate sensors and devices, e.g.

- force and torque transducers
- muscle testing equipment (e.g. EMG)
- goniometers
- balance control devices.
- Electrical Stimulation, including Functional Electrical Stimulation devices

The systems should include appropriate command, control and feedback mechanisms providing the operator with immediate results.

Special attention needs to be paid to the design of this "user interface" and of particular interest would be any innovation which would allow suitable training equipment to be safely operated by the disabled person in his home environment.

Potential users should be involved in the specification of requirements and in the validation of the use of any prototype systems.

Key Results and Milestones

Key results should include details of systems, incorporating available technology in an innovative way, which improve rehabilitation programmes for people with motor dysfunction.

T307 Human/machine interface and control systems.

Related section 2.3.6

Background

In using a prosthetic device to replace a body segment or an orthotic device to assist it, it is necessary to take into account the crucial problem of the control of the substitution device by the person wearing the device.

The human being is a very sophisticated system, controlled by a person completely ignorant regarding the technical aspects of mobility and, as a result, it is necessary to consider the control in the brain of motor function as being accomplished on two levels. The first is a **decision level** with a very simple and global language, allowing command and achievement of very complex tasks such as grasping an object, walking or climbing. The second is an **execution level** of motor programmes with an analytical language and a very complex circuitry with many automatic feedback control mechanisms, needing approximately 80% of the brain motor structures. That explains why an apparent impression of facility is always linked in people's mind to the execution of movements or tasks, which when reproduced by machines or robots require a high level of technology. Therefore to replace a body segment or function, many technical prosthetic solutions can be conceived, from the very simple and purely mechanical device, to the very sophisticated poly-articulated system utilising many actuators. If the control interface with the user is too complex, requiring an analytical procedure, a need to identify many sites of command and a long training process, (particularly in the case of unilateral substitution of a symmetrical pair of organs as in hand amputations), the rejection of the device becomes very high. It is impossible to replace complex motor functions by simple functional equipment. In all cases it is imperative to be as close to the normal organisation of the motor system as possible, which implies the provision of very simple voluntary command interfaces and very complex control systems, to guarantee reliability and safety of motor command task execution.

It is also important to recognise that the direct introduction of an artificial device cannot be physiologically included into the body scheme. Many failures in prosthetics and orthotics relate to these problems of command interface and control systems. It is appropriate to consider, in this particular task, not only the practical applications, but also the more basic scientific aspects.

The acceptance of a device is also largely influenced by its cosmetic appearance and with the quality of the movement achieved. For example, assistive devices for walking restoration will be more easily accepted by paralysed persons if the movements achieved by the controlled lower limbs are as smooth and elegant as normal movements. The same situation applies with hand amputation in which the cosmetic aspect of hand prostheses has an important psychological impact; according of course to the various cultural, socio-professional, and ethnological profiles. These particular technical constraints have to be taken into account in the device design.

Objectives

- The objectives of this task are to make recommendations on the resolution of problems related to the interface between orthotic or prosthetic devices of varying complexity in motor function restoration related to amputation, paralysis, osteoarthropathies and muscular dystropies. This will also involve prototype development for motor substitution and their related evaluation.

Technical Approach

These objectives are to be achieved through investigation and experimentation of the following :

- interfacing using body movements with mechanical transmission to the device
- interfacing using biological signals coming from muscles or the nervous system
- study of conditioning processes of biological signals (amplifying, filtering techniques)
- study of the electrode interface for biological signal collection
- analysis of various command and control modes for mono and poly articulated externally powered substitution devices
- conception and design of relevant transducers to be introduced in regulation loops
- modality of use of artificial intelligence and neural network architectures for pattern recognition and conception of motor programmes for complex closed-loop control systems
- basic analysis of the user/equipment command interaction
- modality of use of Artificial Intelligence methods and Neural Network based architectures for multi-pattern recognition applicable to the design of motor rehabilitation programmes and to the control of complex closed-loop systems.

Key Results and Milestones

Key results of the project should include the following:

- determination of the current state of the art in command and control interfaces for mono and poly-articulated motorized systems
- analysis of existing biological command signal conditioning and processing techniques
- identification of suitable technical characteristics of command/control interfaces according to the types of motor pathologies concerned, levels of dysfunction and disabled persons' control potentialities
- development of models, simulators and prototypes for the prediction and analysis of user/equipment interaction
- design of interface prototypes and their assessment in a rehabilitation environment.

T308 Computer aided design/computer aided manufacture of substitution devices.

Related section 2.3.6

Background

Although a number of standardised components may be required to complete a device, the critical body-device interface is usually custom made. It has always proved difficult to provide such custom devices both quickly and with high quality. In traditional practice, the shaping or design of the interface is commonly carried out by modifying the shapes of a model obtained by hand casting the body part with plaster of Paris. A positive produced from this cast is shaped by adding or removing plaster from critical areas. Such modifications must not only reflect the surface contours of the body but also the practical know-how required to achieve effective, pain free coupling of the device with tissues which can permit load transmission under dynamic conditions. Such traditional methods work well in skilled hands but such skills are often in short supply and are difficult to communicate to others. This process provides few opportunities for the efficient supply of devices in widespread or remote communities and results in a wide variation in the acceptability of the results from place to place.

Despite the diversity of prosthetic and orthotic devices and the need for custom shaping of the interface, information technology can provide a common strategic approach and result in efficient means of measuring the body part, interpreting measurements to influence a design strategy, then controlling the design and its manufacture. Solutions to prosthetic and orthotic body-device matching are now increasingly being applied through the medium of computer aided design (CAD) systems. Such developments offer **potential** advantages with respect to :

- the speed of device provision; allowing custom device manufacture without sacrificing productivity
- the achievement of consistent quality and standards of provision independent of location
- communication of techniques and data across geographic boundaries
- creating a quantitative tool to investigate methods of creating body device interfaces.

Early work on CAD systems has evolved systems which do not yet match these needs and may perpetuate the arbitrary solutions of hand based practice. There is no adequate model of prosthetic/orthotic interface design expertise and therefore a satisfactory representation within the computer is problematic. Techniques of knowledge elicitation and representation can be combined in software with the design function to create the ability for computer-based design methodologies to evolve or learn with experience. High performance interactive 3D graphics are essential to provide the designer with quality visualisation and productivity and the computer interface should allow natural manipulation of the graphical objects during design. Design software should permit the rapid performance of all consistent aspects of a design yet not constrain the user to an unverified philosophy.

Current CAD approaches frequently require rapid and precise three dimensional shape measurements of a body part but future design methods may require additional measures of body tissues and their properties. A number of orthotic applications such as custom seating and orthopaedic footwear may require the tissue loading and body position at the time of shape measurement to be identified or controlled as a part of the measurement exercise.

Current generations of CAD/CAM systems require the provision of an intermediate model as the "former" for the custom design. CAD/CAM system effectiveness is currently limited by the lack of ability to directly manufacture and finish a device. The custom requirement of manufacture means that it is important that production strategies utilise all possible means of

ensuring that errors of machining or forming are anticipated and corrected through adequate simulation and error detection.

Cosmetic restoration is an important aspect of many devices but most CAD/CAM developments for the field have neglected this area. The full utilisation of the CAD/CAM approach will require attention to the means by which a cosmetic cover can be generated for a device along with any associated measurement and manufacturing enhancements.

Objectives

The objectives of this task are to create computer based systems for body measurement, device design and direct manufacture which are capable of tackling a broad range of such devices with appropriate variation in measurement and manufacturing subsystems. These systems should allow flexible deployment of measurement/design and manufacturing resources. The software algorithms should be influenced by identifiable biomechanical principles.

Technical Approach

These objectives are to be achieved through the following :

- identification and prediction of body-device interface characteristics through direct measurement and modelling under dynamic load situations
- identification of the relationship between the interface and other relevant characteristics of the individual to the quality of the clinical result
- examination of the nature of expertise in custom interface design and methods of knowledge elicitation and representation
- identification of the current state of the art in CAD/CAM systems and their strengths and weaknesses
- identification of approaches to measurements, design and manufacture which are capable of application to a wide range of problems
- specification of measurement and design systems and associated data representations
- examination of emerging standards for software open systems and data exchange
- generation and validation of prototypes measurement and design systems
- examination of existing approaches to direct manufacture
- generation of prototype manufacturing system
- evaluation of prototype systems

Key Results and Milestones

The following key results are to be achieved :

- Identification of the biomedical characteristics of the body-device interface necessary and sufficient to form a basis for device design
- User requirement specifications, taking account of existing state of the art and opportunities for exploiting a common strategic approach to providing new technology and the implications for its application across the Community
- Technical specifications and design of measurement, design and manufacturing systems which are sensitive to emerging standards and domain specific challenges
- Demonstration and evaluation of prototype systems.

T309 Modular systems and standards

Background

Modular systems emerged in the past in response to a desire to improve the potential for rapid supply of devices through the mass production and stocking of routine assemblies and components. Such component systems, of which there are many throughout Europe, are currently combined with the custom part of the device to create the complete system.

As new CAD/CAM technology is applied to the creation of the custom parts of devices, these techniques violate the efficiency and effectiveness of this method of assembly and component supply. There are now opportunities to re-examine the modular system concept to ensure that the customised and standardised aspects can continue to combine to best effect.

Rapid prototyping may allow the boundaries which designate custom and standard components to be redefined.

Improved ability to measure the proportions and requirements of clients can permit a community wide re-examination of the size and performance requirements for components. The application of information technology and telematics [e.g. Electronic Data Interchange (EDI)] can allow a geographic redistribution of premanufactured and assembled components as well manufacturing resources. Concepts of stock management and modular component manufacture (e.g. "just in time" principles) applied from industrial domains might allow stock holdings costs to be reduced for health care providers without detriment to the quality and speed of supply.

Objectives

- The objectives of this task are to make recommendations for a more effective use of the concept of modular components systems; against the background of technological adjustments in the means of supply and the need to improve the matching between the custom and standardised parts of devices.

Technical Approach

These objectives are to be achieved through the following :

- identification of existing standards and modular system components
- specification of requirements for components and assemblies which improve the match between custom and standardised parts of devices
- identification of stock holding and communication strategies which can allow the rapid order and supply of modular components
- creation of new standards for modular system components.

Key Results and Milestones

The development of modular component standards ensuring the interchangeability of components from suppliers throughout the community.

T 310 Technology for the assessment, rehabilitation and training of people with communications disorders.

Background

The current market for technology in this area is under-developed and lacks co-ordination. As a consequence it is difficult for both professionals and clients to acquire information regarding the availability, application and benefits of devices, equipment and products.

Without proper assessment of both the application and the effectiveness of this technology, its application remains fragmentary and inefficient. The potential benefits of technologies for assessment, rehabilitation and training for people with communications disorders are great. Among these is a more precise match of specific user needs, and the more effective take up and use of devices and aids.

A multi-disciplinary approach is required to build on the core of knowledge and experience in this area. In particular, this task is concerned with the introduction of information technology based tools and new approaches to the use of current instrumentation procedures. A consequent improvement and integration of assessment and training procedures should result due to the technology support. It may be noted that aids of this type can be operated autonomously or semi-autonomously by storing intermediate results and can thereby increase the efficiency of utilisation of teaching staff.

Objectives

The objective of this task is to develop, demonstrate and evaluate methods, devices and systems which support the assessment, rehabilitation and training of people with communication disorders in the following areas and contexts:

- Testing and assessment of impairment or residual or alternative capabilities.
- Planning and supervising rehabilitation programmes.
- Measuring and evaluating progress in rehabilitation.
- Devices for adapting and tuning general purpose aids to specific user needs.

In addressing these areas, the task must focus on the client as the main user of devices in this area rather than the therapist or medical professional. However, the issues of medical intervention and supervision must be considered.

Technical approach

This task covers an area which is potentially very wide. A thorough review of current techniques, technologies and the contexts of their supply and use is required; technologies of particular relevance are:

- Interactive learning/teaching systems
- Expert systems for assessment and planning
- Visualisation and user feed back techniques

- Automated test and evaluation systems including complex pattern processing and recognition.

Key results and milestones

- Publication of state of the art and technology review and market evaluations
- Demonstration of prototype systems
- Evaluation of social acceptability and effectiveness of the proposed systems.

T311 Technology for the assessment and training of people with cognitive and functional disabilities.

Background

This area has seen important individual initiatives; the task aims to provide a more comprehensive and systematic approach to the application of information technology to meet the assessment and training needs for this group of disabled people. The issues of standards, marketing and user acceptability has not been addressed nor has the true potential for the application of information technology been identified.

The needs to be addressed include:

- The harmonisation of devices and approaches across Europe relating to input devices, software environments, training methods and applications.
- New research and development in areas such as dedicated memory and decision aids which bring the benefits of information technology to users in real life settings, multimedia training and rehabilitation systems and sensor and control devices for monitoring whole-body co-ordination.

Objectives

- To characterise current good practice in the use of technologies for the assessment and training of people with cognitive and functional disabilities.
- To identify areas of possible harmonisation in practice and technology.
- To demonstrate and evaluate systems and applications aimed specifically at the assessment and training needs of cognitively impaired users.

Technical approach

Survey current systems, methods and devices for functional and performance assessment applied to cognitive impairment. Particular reference should be made to the appreciation and analysis of the different approaches, attitudes and policies which are pursued in different parts of Europe in order to form a consensus on the definition of type applications.

Any approach to the development of a prototype or demonstrator must take into account the issues of user support and the requirements of the carers as well as clients.

Key results and milestones

- Publication of a review of needs, social impact and performance requirements
- Publication of market, technology, method and system review with proposals for applications with a potential for Europe-wide exploitation
- Demonstration and review of prototype systems and applications.

INTEGRATED SYSTEMS TECHNOLOGIES

T401 Development of smart home and smart environment concepts and applications.

Background

There is increasing interest in the smart home and smart environment concept, within which there is integration of the control of devices, functions, the environment and interaction with external systems, to promote independent living. Such systems are moving from an experimental phase to a stage where they promise to be extremely useful in that they can provide the facilities which are of major importance for the creation of conditions of self support and independence for elderly and disabled people in the management of the home and its surrounding environment.

Whilst there are already some products on the market which are intended to enhance the life of disabled and elderly people, the realisation of smart homes and environments is still at a very preliminary stage. Among the aspects requiring considerable research and development are:

The development of open systems architectures providing communication between items of home equipment, environmental control devices and the outside world in an integrated way. Such an architecture must define a set of components and the relationships between them, together with rules which may constrain those relationships. In addition, it will be necessary to suggest useful compositions of those components that meet particular real needs. The architecture must take into account possible future developments in market sectors, services and devices.

The development of software platforms to provide the home system with user-friendly environments and intelligent services.

The development of control devices to operate the home environment in an integrated way. Such devices should be: simple, such that simple actions only should be necessary to execute a specific device function; unique, such that a single control device should provide control for all the functions available in the system; similar, such that the user interface is consistent for all devices in the system, requiring similar commands to initiate similar operations in different devices.

Objectives

- To define overall systems architectures for smart homes and environments for disabled and elderly people.
- To define the components, interfaces and control devices which form a smart home and environment.
- To define intelligent control objectives to satisfy user needs.
- To determine the necessary socio-physical architectural design, layout and adaptation factors related to the creation of home environments which can support integrated home systems.
- To evaluate proposed system architectures with regard to the integration of existing and possible future appliances, devices and services for elderly and disabled people.

- To develop and demonstrate new concepts and applications.
- To contribute to achieving consensus agreement on architectures.
- To establish full-scale integrated pilots which could act as test-beds for results from other projects in TIDE.

Technical Approach

- Identification of user and market requirements.
- Identification of user requirements in relation to the design (including aesthetic and size considerations) and adaptation of housing which can support integrated systems.
- Identification of existing standards.
- Identification of regulatory issues.
- Identification of the high-level system architectural elements and their mutual dependencies.
- Development of usage and operational scenarios integrating the user requirements.
- Prototyping and modelling.
- Development and adaptation of enabling technology.
- Technology verification using field trials and usage scenarios.

Key Results and Milestones

- Evaluation of user requirements through the identification of specific impairment groups of people and evaluation of their problems in the home environment.
- Identification and evaluation of market segments.
- Review of appropriate architectural features.
- Evaluation of the overall architecture and the degree of consensus among key players.
- The development of models and prototypes for the systems, components and control devices and the evaluation of their functionality and usability for the target population of users.
- Contributions to relevant standardisation bodies.

T402 Smart home services.

Background

Existing and emerging new technology based systems and services are an important basis for the development of smart home living support services (e.g. teleshopping, telebanking, meals on wheels etc.) for elderly and disabled people with respect to their different needs and abilities. Specialised systems and services can increase self management capacities and meet the security needs of the increasing numbers of elderly and disabled people living alone and can also facilitate the work of their care providers. Smart systems might be installed in the home or be provided and operated as common services or through dedicated service centres, similar to those that already exist in some countries.

Objectives

- To define the different needs and requirements of elderly and disabled people with particular respect to independent living at home and the services required to facilitate this.
- To define how these services can be integrated with smart systems to support independent living at home.
- To determine whether such services should be self-managed or provided through decentralised management by service centres.
- To demonstrate and evaluate prototype smart home services.

Technical Approach

Work in this task area should be directly related to work being carried out in tasks T401 and T403.

Identification of the requirements and needs of elderly and disabled people with particular respect to independent living at home.

Identification of the services required to facilitate independent living at home.

Definition of how such services can be integrated with smart homes and environments.

Development of prototypes of integrated or decentralised (i.e. operated by service centres) systems.

Demonstration of the operation and efficiency of prototypes and the testing of the acceptance of these smart home services. This means that it will be necessary to implement smart home services in existing residential environments and, perhaps, to establish service centres to operate the systems or to connect and support the decentralised systems in homes.

Key Results and Milestones

- The requirements and needs for independent living at home for different groups of elderly and disabled people.

- A study of market segments in the member states including different means of financing home living support systems.

- Working prototypes of new systems and services, e.g. communication and information services, home help support services, home care systems, alarm systems, living support systems for elderly and disabled people and help support systems in individual homes to maintain independence.

- Experimental service centres, operating new decentralised systems and home-oriented services including systems encompassing local community professional services.

- Evaluation of the systems and support services and their acceptance by users.

T403 Elements and devices for smart homes and environments.

Background

Many consumer products are not accessible by many handicapped persons of different ages and this can result in their being unable to live independently at home. Technological advance has had a strong impact in consumer goods. Performance and price have followed nearly opposite trends with the former attaining very high degrees of sophistication and the latter falling. However, as new and improved versions of consumer goods are developed they tend to become increasingly complex to operate. In many cases, the interfaces are so complicated that many of the functions provided are rarely, if ever, used. Also, there is little commonality between the interfaces of the various devices which make up the everyday home. Elderly and disabled people have particular difficulties because of this, due to the various impairments they may suffer from.

Difficulties are experienced with: electrical appliances; the packaging of food products and drugs; instructions; books; communication and media services etc. Many handicapped people also have difficulties in controlling their environment; such as opening and closing doors and windows, managing heating, manipulating radio, TV and the telephone, the cooking of food etc. due to mobility and/or sensory impairment. Many cognitively impaired people also have difficulty in managing the activities of daily life due to lack of awareness of time and activity, lack of awareness of quality and quantity, and the lack of abilities to reason temporally, qualitatively or quantitatively, to remember and to structure.

In order for the smart home and environment to be become a useful reality, it is necessary to address the following:

The definition of appropriate elements for smart homes and environments which facilitate self-support and hence independent living. These will include:

- Consumer goods
- Environmental control devices
- Home management aids
- Problem solving systems or decision support systems

The development of smart user interfaces capable of satisfying the following requirements:

Simplification of the user interface by giving more intelligence to devices in order to make it easier to use.

Specialisation of interfaces for individuals with specific impairments in order to facilitate communication, through their available functional capabilities, between the device and the user and vice versa .

This could also include integrated alarm systems in the home, at work or in public places and could integrate devices resulting from projects in action line 1 and action line 2.

Objectives

- There are three interrelated objectives:

i The structured mapping of problem areas as experienced by elderly and disabled people living independently at home.

ii The definition of appropriate systems concepts, technical and methodological approaches.

iii The development and implementation of suggested solutions to the problems identified.

Technical Approach

Work in this task area should be directly related to work being carried out in tasks T401 and T402.

Establishing of multi-disciplinary teams with personnel from both the engineering and human sciences.

Identification of user needs and requirements as to the functional and technical characteristics of potential solutions.

Involvement of users in the design process, with particular emphasis on the user-machine interaction, aesthetics and size.

The application of smart sensor and smart interfacing technology, for example to use prediction to prompt and remind users.

The development and evaluation of prototypes.

Key Results and Milestones

- The identification of problems to be solved
- A survey of available solutions
- The specification of requirements (user, technical, systems, standards etc.)
- Prototypes of new sensors, special devices, software
- The adaptation/redesign of consumer products
- The demonstration of viability and user acceptance through the production and field trials of prototypes and their integration into systems.

T404 Remote care and health monitoring.

Background

The basic components for health and mental monitoring, as well as for the required care system are already available. For example, a video telephone system has been developed in order to facilitate the communication between personnel in a service centre and elderly and disabled people living at home. This video telephone was developed mainly as an additional feature to an alarm service to be used by the client at home in case of illness, for example. The video telephone connection is able to provide more information about the status of the client than merely voice communication and has been used in a pilot for the remote treatment of patients. There is also a lot of attention currently being paid to how to structure medical data, x-ray pictures, images and so on and how to send them between hospitals and health care centres. Also, systems have been developed for supporting remote diagnostics, treatment and medication delivery. Components for home measurements of some important physiological parameters such as heart rate, blood pressure, glucose, temperature etc. are also available.

Objectives

- To develop remote health and mental status monitoring systems for elderly and disabled people.
- To develop systems which aid elderly and disabled people in maintaining their health and in obtaining advice for self treatment.
- To develop measuring, diagnosis and dosing checkers which are easy to handle as well as medicine checkers and reminders (e.g. differentiability of medicine).
- To develop methods for remotely controlling medication delivery with the provision of appropriate feedback mechanisms.
- To integrate health systems, remote care and health monitoring systems.

Technical Approach

Development of a systematic approach to the support of elderly and disabled people. This would include details of the appropriate infrastructure, such as availability of personnel during day-time and night-time, service centre support in case of accidents etc. This systematic approach should also address questions concerned with coping with daily living activities and with leisure time activities.

Development of technical solutions for health monitoring and supporting elderly and disabled people. These solutions can serve a large user group by using time sharing and reliance on an assistance provided through support centres. Technical solutions could also include the development of devices for carers. Systems should also take into account the requirements of health care or service centres as well as defining software for automatic monitoring and the taking of appropriate actions

Development of technical solutions to enable elderly and disabled people to obtain advice about self treatment in order to maintain their health.

Development of technical solutions to enable the remote control of the delivery of medication and provide appropriate feedback.

Development of prototype systems in order to evaluate new technical solutions in real environments. Such pilots should include a sufficiently large user group in order to statistically show the benefits as well as possible drawbacks of automated systems.

Key Results and Milestones

- A systematic and evaluated view of how remote care and health monitoring systems could take maximal benefit from the possibilities offered by new technology.
- New devices and systems for sheltered home and home measurement of physiological parameters that can be used to monitor health status.
- New devices and systems for the self-maintenance of health.
- New devices and systems for remote medication delivery.
- The integration and testing of these devices and systems in real environments.

T405 Sheltered and Institutional care.

Background

The increasing emphasis on community care in the European context is leading to the establishment of a variety of forms of living accommodation and institutional contexts which can support elderly and disabled people, e.g. purpose built environments, sheltered housing, respite care, boarding out settings, day centres and nursing homes.

Integrated systems which can address the maintenance of independence and dignity, the fostering of social integration and the promotion of the integration of service delivery are required for those contexts (e.g. systems which can support continence management, social links, integration of social and health care information systems and services delivery). While many of these systems will be similar to those developed for use in the home, many will require adaptation to accommodate multiple and shared use. In addition, these new contexts will give rise to demand for new products and services. Given the likelihood of multiple transitions between home and these different contexts, integrated systems capable of use in a variety of contexts will be preferred.

Objectives

- To develop and adapt integrated systems to support the maintenance of independence and dignity, to foster social integration and to promote the integration of service delivery in a range of sheltered and institutional contexts.

Technical Approach

Identification of user requirements and the social, organisational and environmental factors associated with multiple and shared use of integrated systems in sheltered and institutional contexts.

Market studies

Development and adaptation of prototype integrated systems for use in a range of contexts.

Field trials of integrated systems in a range of environments, user and macro-institutional evaluation of systems in use.

Key Results and Milestones

- Design guide-lines for the development and adaptation of integrated products and services for use in sheltered and institutional contexts.
- A report highlighting the special requirements of different target groups and different environmental contexts.
- Prototype development and testing.
- User evaluation and feedback.
- Assessment of markets in light of evaluation and testing.

T406 Orientation and Navigation Systems.

Background

Although various systems have been developed in a number of countries, most have restricted their potential markets by being targeted at a single disabled group (often blind persons) in one geographic area. None of these systems has been adopted on a sufficiently large scale to be economically viable.

Existing appropriate technology includes tag systems (such as those used in shop security tags); these tags could be passive or pseudo-passive with coding of the reflected radio signal. A different approach could be infra-red signals modulated with stored or synthetic speech. Another possible approach is to utilise the Global Positioning System. It is important to get the right mixture of techniques to ensure appropriate and cost-effective solutions. Solutions may be active or passive or a combination of the two.

Similarly, systems can be pre-programmed or programmable by the user.

Objectives

- To develop and evaluate an economically viable system to alleviate the problems of elderly and disabled people travelling independently in an unknown environment.

Technical Approach

Identification and quantification of the unmet needs of independent disabled and elderly travellers as well as identification of the Human factors aspects of such systems.

The obtaining of agreements with appropriate organisations on the allocation of the spectrum for the transmission system and the coding of signals.

The development of prototypes and the development of systems for the training of users.

The implementation of pilot schemes.

Evaluation with a cross-section of potential users.

An assessment of the European market potential for disabled and elderly persons and for other group

Key Results and Milestones

- The specification of the needs and requirements of independent elderly and disabled travellers.
- The agreement of the allocation of the spectrum for the transmission and the coding of signals.
- Demonstration of working prototype systems.

T407 Living skills and technology training

Background

Work on training for elderly and disabled people needs to be based on research into how they can learn new skills and to what degree these skills become transferable, that is to say, to what extent education on a particular specialised skill, allows the more rapid acquisition of similar skills.

Basic research is also required:

- To determine the best ways to train intellectually impaired individuals in their interaction with technologies and especially with computers and communications systems.
- On the basic human factors and ergonomics of the home, of appliances and of information technologies.
- To identify the impairment and experiential profiles of groups of individuals and from this to state the training and support needs of the group.
- To describe a suitable mapping between training and support needs and the technological solutions which provide the training and support.

Projects should address problem areas such as:

- House-and-home management (e.g. kitchen management, the use of domestic appliances, planning etc.).
- The use of telecommunications (e.g. video telephones for skills training).
- The use of information technologies in the home, at work or socially (e.g. banking, libraries, teleshopping, automatic ticket machines, teletext systems).

Prototypes should serve the needs of real individuals and should exhibit potential for commercial exploitation in the long term.

Authoring systems will need to provide support for the development of multimedia learning environments, incorporating video, sound, graphics and text, for facilitating the skills needed to interact effectively with technology. Solutions should be based on a thorough analysis of impairments, learning difficulties and the situations in which technology is found.

Objectives

- To identify the requirements for the training of living skills and technology for the various groups of elderly and disabled people.
- To identify those factors which affect the learning of new skills and skill transfer.
- To identify appropriate means of training and supporting elderly and disabled people, together with appropriate technological solutions which provide that training and support

Technical Approach

Identification of the impairment and experiential profiles of the various groups of elderly and disabled people.

Identification of the requirements for the training of living skills and technology for the identified groups of elderly and disabled people.

Empirical studies of those factors which affect the acquisition of new skills and their subsequent transfer, including pedagogic and methodological issues.

Survey of existing technology based training aids.

Mapping between training and support needs and the technological solutions which provide training and support.

Identification, specification, demonstration and evaluation of further technology based training and support systems. Systems could be either home-based or located in community or institutional settings.

Key Results and Milestones

- Specification of the training and support requirements of the various groups of elderly and disabled people.
- Identification of how well these are met by existing technological solutions.
- Specification of new technological solutions.
- The provision of Tools for the authoring of technology based training materials.
- Advanced prototypes in terms of software and hardware which can demonstrate the application of technology to specific problem areas.

T409 Smart technologies and systems for work environments.

Background

Incorporation of disabled and elderly people into working environments has not been as widespread as hoped, because small organisations cannot easily see a payback on the necessary investment in special facilities and large organisations find it difficult to modify complex production processes and administrative procedures in order to tailor jobs for people with various impairments.

However, there are available many stand-alone devices designed to solve specific impairment problems. Work in this task should concentrate on the development of further devices and their integration into working environments. System design should give particular attention to the flexibility of subsystems and devices such as multimedia terminals for different user groups, modular human-machine interfaces to meet the needs of people with different kinds of handicaps, information presentation geared to different handicaps, especially sensory and cognitive impairments ("text to speech" and "speech to text" technology and smart robot control systems should be available for this purpose).

Objectives

- To develop integrated systems to support the work of elderly and disabled people and the retention of people in employment after , for instance, an accident which may cause a disability or handicap, through the adaptation of appropriate techniques and equipment.
- To specify and adapt workstations, including their operating and logistical features.
- To investigate the new procedures, tasks, tools and organisational aspects that would aid the incorporation of disabled and elderly people to the workforce of real world organisations.
- To identify and implement new application of new and existing technologies (CAD, CAM, multimedia and information technology, robotics, bio-process control, remote control etc.) in order to enhance the skills of elderly and disabled people.
- To create specific facilities for production by, and/or rehabilitation through work of, disabled people in working environments and centres designed to enhance the potential of elderly people.

Technical Approach

Identification of kinds of jobs appropriate for people with one or more handicaps and of the environments in which such jobs are carried out.

Identification of user and market requirements.

Identification of existing appropriate technical standards in the field.

Identification of regulatory issues.

Development of usage and operational scenarios devised to integrate user requirements for different work environments.

Development of appropriate work environments through, among other things, the education and training of fellow employees.

Prototyping and modelling.

Development and field trials of paths for integration in organised work and of appropriate training and assessment methods.

Technology verification through field trials and usage scenarios.

Key Results and Milestones

- Evaluation of user requirements with respect to work tasks and the identification of specific impairment groups and evaluation of their work problems.
- Identification and evaluation of market segments.
- Models and prototypes of appropriate support system and components.
- Application models.
- Analysis of critical success factors and constraints.
- Field trials of work environments that incorporate technology-supported logistics and functions including , technical and financial assessments.

T410 Work at a distance

Background

As technology progresses, individual contributions in administrative and production processes have become increasingly conceptual rather than manual in nature. This, together with other factors such as the problem of mobility in large cities and the isolation of communities inadequately supplied with services, has stimulated a demand for teleservices and telework enabling individuals participate in gainful employment from their own homes or remote settings.

While technology helps facilitate this style of working, organisational and social reasons still hinder general solutions. It is widely thought that this kind of work can develop only in relation to specific needs or types of jobs.

Elderly and disabled people can gain considerable benefits from the application of new technologies to enhance their own skills and to overcome obstacles to their gainful employment. Of particular interest in this task are solutions, which do not isolate them socially but enable them to work directly with other people.

Objectives

- To develop subprocesses, procedures and technologies (information, multimedia etc.) to adapt remote workstations that can be included in complex organisational functions.
- To apply new environmental control systems (guidance in structured or unstructured environments, warning and alarm systems), and technologies aimed directly at work activities (CAD, CAM, multimedia and information technologies, robotics, remote control etc.).
- To define individual or cluster-based technology aided jobs in remote or family environments and to demonstrate how they can be integrated with complex organisational processes and home environments.

Technical Approach

Analysis of services that can be delivered at a distance.

Delineation of the basic architecture of appropriate workstations and the interfaces required for their management by people with various kinds of impairment.

Identification of user requirements in relation to the design and adaptation of housing which can support home working and related activities

Identification of user training needs.

Definition of the manner in which remote workstations can be incorporated into production and administrative processes.

Cost/benefit analyses of each target market niche, based on assessment of demand for services.

Identification of alternative or competitive service providers and automated processes.

Estimates of the pace of obsolescence and need for technical upgrades.

Key Results and Milestones

- Identification of the demand for remote individual or group work by disabled or elderly people assisted by appropriate technologies.
- Creation of fixed or portable multimedia remote workstations and their integration in production or administrative processes.
- The definition of services or products that can be sold by people working at home.
- Identification of training needs and appropriate methods.