Gerontechnology®: Translating knowledge of aging processes into products and services to benefit the aging

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Eindhoven University of Technology.

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Overview

Imagine yourself when you are 60 or 80 years old. Will you be able to do the things you do now, for example your favourite hobby or even simple things such as reading the paper, taking a bath, turning on the stereo, driving a car or taking money from a cash dispenser? Where will you live, in what kind of house? Will you be able to enjoy new freedom from a life of work? *For those of us who are still young (and who is not), will we go from mastering the high technology multi media systems coming on the market and making them our center of home entertainment and personal telecommunication, go into an old age incapable of dealing with anything beyond this last great accomplishment. Or will we find ways to comfortably and continually adjust to the "next generation of innovations" in our world and be able to competently program the VCR's or what-have-you of the future as well as our grandchildren.* (Make also reference to biggest merger ever in the USA between Atlantic Bell, MCI and others in the area of multimedial communication)

(SLIDE 2)

When asked, old people say that maintaining their independence is very important to them as they grow older. Indeed, independence is a quality of adult life in our society that we cherish at any age. To be able to live independently and to be able to do what you want depends

partly on your health and abilities but also on the relevant social and physical environment. A supportive environment can help people continue doing what they are accustomed to and want to do even though they may perhaps see or hear less, move with more difficulty or have somewhat poorer memories. The social part of a supportive environment consists of people (family, friends or professional care givers) who provide help. The physical part includes technology that makes living easier and more enjoyable.

Throughout life, technology helps people with products (hardware, software and services) that provide a larger range of possibilities in perception, communication, information processing and/or mobility and helps maintaining health. Technology is acquired to meet daily needs when it is useful and available at a reasonable cost.

We believe that there is a gap between the needs for technology by the elderly and the range of suitable products and services available for them. The gap between the needs of the elderly for technology and existing technology itself has two parts.

First, many existing technologies have to be adapted for use by the elderly because perceptual, cognitive and mobility limitations that often occur with aging make today's technology difficult to use effectively. The problem that must be addressed here is not the function of the technology but the interface between the technology and its user. *A good example here might be the Liquid Cristal Display technology*

Second, most existing technology does not specifically address the unique challenges (illnesses and limitations of activity) or the opportunities (time for new activities and interests) of the elderly of today and in the coming years. The problem that must be addressed here is the challenge of adapting new technology specially oriented towards the interests and special needs of the elderly in the coming years. *We might want to think here about total new concepts of private transport that can use both gasoline and metabolic energy*

There are two major influences on the gap. First, there is the ongoing demographic change in the age distribution of the population. The relative number of older people will continue to increase through the middle of the next century. At the same time, particularly since the post World War II "baby boom" there has been a relative decrease in the number of teenagers. The percentage of people older than 65 years in the Netherlands was 6% in 1900, 13% in 1989, and in 2030 it will be approximately 21%.

What influences the gap as well is the ever increasing pace of the density and speed of technology development itself. The current increase in the complexity and speed of information processing and communication technology and the increased sophistication of automobiles and other modes of transportation illustrate these changes. This means that

adults of all ages will be confronted with an ever more rapidly changing technological environment that will continue.

Closing the gap between elderly and technology is the goal for the program that is under development at the Eindhoven University of Technology. We call the program Gerontechnology®; technology for the aging. Our goal is to support and encourage education and research in this area throughout this university and to promote research and development activities in other educational, industrial and health care facilities in the Netherlands and other countries.

The gerontechnology program is a natural outgrowth of ongoing educational and research activities at the Eindhoven University of Technology. Both within specific departments and in interdisciplinary centres that cut across these departments there are several ongoing projects that provide a basis for the new development. Specifically, the interdisciplinary Centre for Biomedical and Healthcare Technology is the setting in which the gerontechnology program is being developed. This centre supports and connects research within a variety of technical programs in human perception, healthy buildings, electrical engineering applications in medicine, biophysics, biochemistry and other areas, all in collaboration with the specific faculties of the university. The centre has conducted an international conference on gerontechnology, developed a post graduate course on the topic which will be given for the first time in November this year, and is supporting several research projects in collaboration with specific faculties. Current developments include the creation of the Institute for Gerontechnology Research at the Eindhoven University of Technology with a full scale graduate level education and research program.

What is gerontechnology?

The term, gerontechnology is a composite of two words: "gerontology"; the scientific study of aging, and "technology"; research and development of techniques and products. Gerontology is concerned with research on the biological, psychological, social and medical aspects of aging. Technology includes both research and development derived from chemical, civil, construction, electrical, industrial, information, mechanical and physical engineering. Gerontechnology refers to research and development of various techniques and products based on a scientific knowledge of the aging process. Gerontechnology includes technology that supports basic and applied research into aging processes, for example imaging techniques, or signal processing of brain activity. *More formally, gerontechnology is defined as the study of technology and aging for the benefit of a preferred*

living and working environment and adapted medical care for elderly.(**SLIDE 3**)

The word gerontechnology was introduced for the first time by your speaker of today who is more than happy to observe that the term is adopted by many research groups all over Europe and the USA, not because the word in itself is such a beauty but because of the fact that it covers an arena of interdisciplinary scientific activities that deserve and demand for our attention. If we are self-centered enough we will invest in our own future.

In gerontechnology as in gerontology, we recognize that the difference between normal aging and falling ill is important. The starting point for gerontechnology is technology developed for or adapted for the elderly. Aging may well be accompanied by illness so consideration of the illnesses of the elderly is part of the research needed for gerontechnology, especially when a sickness occurs mostly in the elderly or when it has special effects on them. For example when a young and old adult have the same medical problem such as a broken hipbone or pneumonia, the recovery period is often longer, the symptoms are usually more severe and the older person is more likely to have concommitant medical problems that complicate treatment and recovery.

What is the goal of gerontechnology? (SLIDE 4)

Designers of products, systems or processes must be aware that human performance changes with age and must adapt their design to elderly user characteristics. This is a simple goal to state but it is not an easy one to reach. Knowledge concerning aging must be translated into products that must then be produced. Gerontechnology encourages designers and engineers to join in translating the multidimensional needs of the older consumer through research programs into product development and the market. The results of gerontechnology will include better communication and interaction between elderly persons and their environment and assistance in maintaining control over it.

Gerontechnology can address aging in five ways.

First, the effects of technology will play a role in **preventing** or slowing of the declines in strength, flexibility, and endurance that are commonly associated with age. The role of technology includes measurements of compliance with training regimen goals, monitoring of physiological functioning and assessment of progress. The importance of preventive measures relative to activity, nutrition, and substance abuse as related to aging have only recently become recognized. As intervention programs are developed and implemented, the need for technological support of the programs will increase.

Second, technology aids the elderly indirectly by **improving** the quality of research on

aging. Technology relates to imaging organs and tissues, signal processing of neurological events, and measuring and monitoring blood flow. Further, making noninvasive biochemical measures is revolutionizing the scientific study of biological and physiological processes of aging.

Third, gerontechnology can provide technology to **enhance** the performance of new roles (the opportunities) provided by aging. The new roles include changed work, leisure, living and social situations. The potential for technology in these areas has not been developed to a significant degree at present.

Fourth, it provides technology to **compensate** for declining capacities (the challenges) of aging. This is the most developed aspect of gerontechnology and includes products and techniques to compensate for sensory and perceptual losses, task redesign that speeds response time, and technologies that compensate for loss of strength and ability.

Fifth, gerontechnology provides technical support that **assists caregivers** who care for impaired elderly persons, for example technology for lifting and transporting persons who are incapable of moving themselves. Many products have been developed for use in hospitals and rehabilitation facilities and some of this technology is currently or potentially available for the elderly.**(SLIDE 5)**

N.B. Explain PxA, Td, Tp, C and D and the contribution of Gerontechnology to the understanding of these curves and the possible effects of interventions
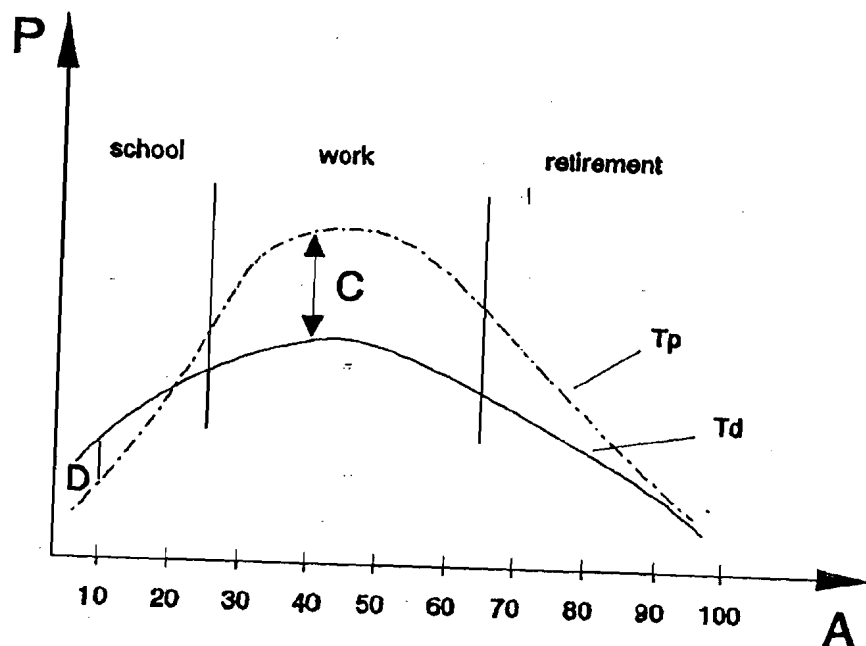
Gerontechnology's target groups: the aging and the aged

People of all ages use technology to make it easier to carry out their activities. Over a period of generation the design and technology of the home for example might support a new family with adults, children, and perhaps grandparents. Later it will be an empty nest for parents whose children left home, and still later frail elderly parents with impaired mobility, sensory function etcetera will prefer to find a comfortable shelter in that place. At the same time secular developments in technology itself may profoundly affect the ways in which the home as such may be used and what devices people might wish to use in their home.

The scenario just outlined calls for a lifespan approach to design which would emphasize flexibility and adaptability of the architecture and technological environment of the house to meet the changing needs of the occupants. The adaptability would be reflected in the structural characteristics of the house (such as removable or movable interior walls) as well as the interface between the user and the furnishing and appliances (such as the placement of cabinets and the controls of appliances). **(SLIDE 6)**

What about technology for the present elderly? Sharing a common chronological age does not make for homogeneity among the elderly; indeed the opposite is true. Differences in genetic background plus differences in life experiences, exposure to diseases and differences in lifestyle make for relatively greater heterogeneity among elderly persons than younger ones. Note that is not stated here that there exists a genetic difference between young and old persons. Even though there is no single elderly group, some age-graded classification of the elderly is useful. One subgroup would contain persons up through about 75 years and containing about 90% of the elderly that is general healthy. They would benefit from adequate consumer products and services that enhance work and new technology that would improve performance of leisure, work and family activities that are unique to this period of life. A second subgroup can be distinguished between 75 and 85 years, that may need some assisted care to remain independent, which could be met by technology. A third subgroup over age 85 would typically need more assisted living and medical care, for which some of the technology would derive from existing medical technology.

In summary, the target groups for gerontechnology define a need for a developmental or sustainable approach to technology, as well as adaptation of existing technology and development of new technology targeted toward the interests and special needs of older persons. The adjective 'sustainable' refers to the economical and ecological criteria for technological developments, as mentioned in the report of the World Commission on Environment and Development: Our Common Future (Brundtland report); Oxford University

Press. (1987). The Eindhoven University of Technology has adopted these criteria in its mission statements for the coming decade.

The conceptual bases of gerontechnology(SLIDE 7)

Three concepts are central to gerontechnology:

* The first is that age-associated differences in functioning are modifiable by technical modifications in the environment. A task that may seem very difficult to an elderly person in one situation may be easily accomplished with suitable environmental modifications. Thus the very idea of age-grading of abilities should not be considered independently of the technical environment.

* The second is that the level of human abilities relatively to most task demands changes over the lifespan: increasing from childhood to adulthood, remaining stable over most of the adult years and then declining in old age.

* The third is that greater exposure and hence familiarity with particular display/control configurations that may occur with aging increases adaptation to those configurations and reduces the ability to adapt to different configurations....*It is harder to unlearn than to learn*

The first concept (that age associated differences in functioning are modifiable by technological change) is illustrated in the diagram below **(SLIDE 8)** which is adapted from standard system models used to describe person/environment relationships. At any point in time the transaction between a person and his technical environment may be characterized by the basic two-dimensional diagram: starting at the middle left and reading upwards, information is received from the environment (displays) by the person (perception). Events in the person result in motor actions which may adjust or modify controls of the technical operating system which may be a vehicle, or a device at work or at home. With aging, changes in the internal environment (centre box) affect sensitivity to the external environment (visual, auditory and climatic) in ways that change significantly over time. The display/control relationships as well as the environment may require changes to accommodate the abilities and needs of older persons.

The dynamic, "geron" part of gerontechnology is represented along the third dimension of the figure. Personal aging and the time period when personal aging occurs both interact with technology, because technology is not static over time. The social and educational characteristics of a person as well as health status is part of personal aging and affects how a person interacts with his or her technical environment. The characteristics of the interaction between an individual and the technical environment at present ("0" on the time dimension)
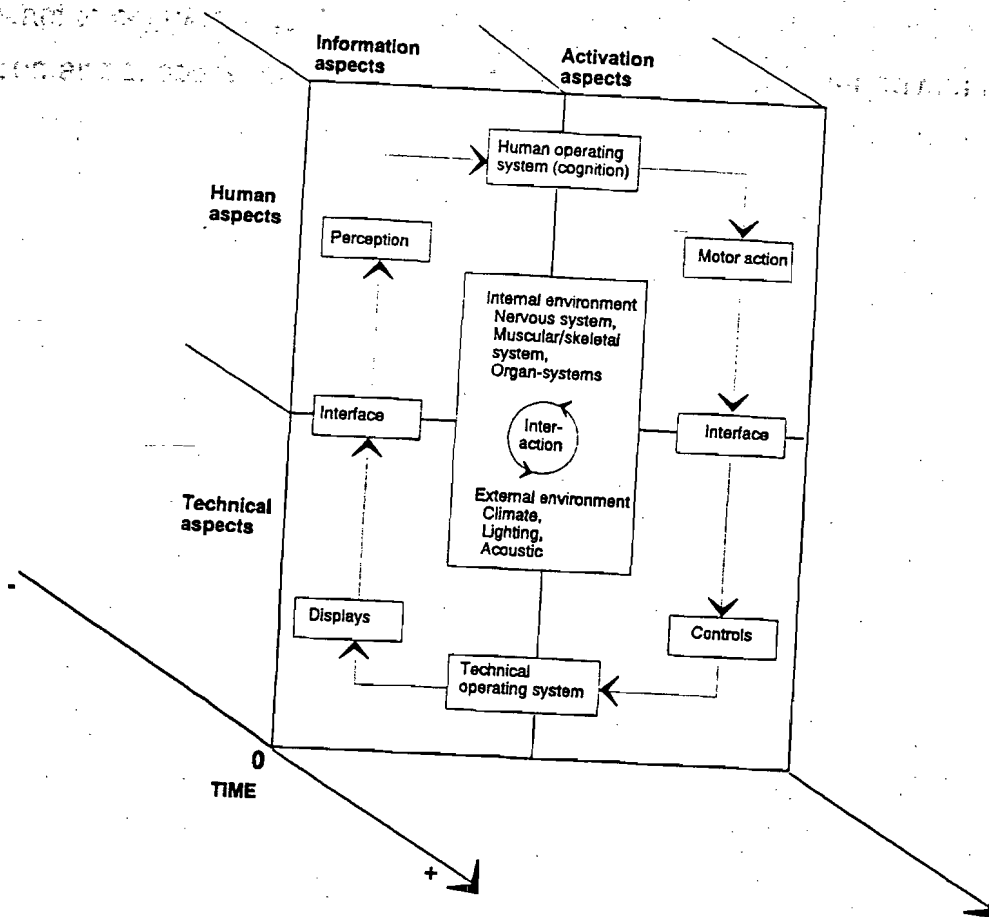
is determined in part by past history ("-" to "0") on the time dimension, just as the quality of the past and present person/environment interaction will determine the future interactions ("0" to "+" on the time dimension).

*Here, I want to give an example in order to illustrate the complexity we are facing as researchers and designers. It is known that information about the environment comes from many external and internal sources through a variety of input modes.***(SLIDE 9)**

- *visual*   *83%*
- *auditory*   *11%*
- *smell*   *3.5%*
- *touch*   *1.5%*
- *taste*   *1.0%*

Note that in this list some modes are not included such as, kinesthesis, temperature, vestibular, etc. We also know that memory retention of newly learned information depends on the mode of information input and on the time elapsed.

input-mode	time elapsed	
	3 hours	3 days
auditory	60	30
visual	70	40
audio-visual	90	70

These data originate from industries, involved in communication and information technology (audio-visual systems). However, they are an average of large populations and do not take into account variables such as:

- *age*
- *past experience (training and education)*
- *present state of body and or mind*
- *speed and density of the information process*

The current research of Bouwhuis, Brouwer and McCalley at the Institute for Perception Research of the Eindhoven University is aimed at gaining more insight about the impact of these variables on the design of products dealing with information processing. We do know that hundreds of researchers, all around the world, are engaged in the same kind of activity. However, the integration of the results of this research is as complex as in the Human Genome Project.

Gerontechnology at the Eindhoven University of Technology(SLIDE 10)

Historical background

The impact of age-related physiological and psychological changes on human functioning in the living and working environment is the common theme for the development of this program at the university: gerontechnology as a field of academic knowledge, an interdisciplinary program of research, and initiation of a process of technology and knowledge transfer between the university and industry and other institutions.

The development of gerontechnology at the Eindhoven University of Technology began in the late 1980s. The major university initiatives in gerontechnology have been organized in the Centre for Biomedical and Healthcare Technology (BMGT). The first major milestone in developing the research and educational plans for gerontechnology was the planning and convening of the first international conference on gerontechnology in August 1991, and the publication of the first book on gerontechnology.(SLIDE 11)

During the 1993-94 year, an independent Institute for Gerontechnology Research was founded. The institute is the focal point for the development of the academic discipline of gerontechnology and will provide the integrative power necessary to organize and coordinate education, research and development and knowledge transfer in gerontechnology within and outside the university. Because the university's Institute for Gerontechnology Research is the first in it's kind, it will be critical in establishing relevant cooperative programs with other universities, institutes and industry, both within the Netherlands and internationally.

The Eindhoven University of Technology is the coordinating contractor of a `Horizontal Activity' proposal under the EC TIDE program (TIDE is Technology Initiative for Disabled and Elderly people). The objective of this horizontal activity is to create a data-base with relevant cross-cultural data on the preferences and perceptions of elderly in three of the four themes on which the program of the university is also centred. The data for the data-base will be delivered by the 11 partners from eight different European countries. The established data-base will provide industries with information on the requirements for products for the Single European Market. In the project three sets of two workshops are foreseen. In the first workshop on each theme, the data from sociological, economical, behaviourial and medical disciplines will be compared and strategies for fine-tuning of the data will be discussed. During the second workshop the data will be integrated with market information, technological and design aspects. The management of the data collection and maintenance of the data will be the responsibility of the Eindhoven University.

N.B. Make also a reference to COST A5, a European network on Ageing and Technology in which 14 European(EFTA) countries participate.

Education and curriculum development.
The development of an interdisciplinary knowledge base for gerontechnology is a primary task ongoing at the university. Training of a small core of researchers and teachers of gerontechnology is a major goal of the university. In 1993, the university appointed its first visiting professor of gerontechnology. Prof J.L. Fozard, director of the National Institute on Aging Baltimore Longitudinal Study on Aging, is spending this academic year at the university. Dr. Fozard helped establish the conceptual relationships between gerontology and gerontechnology, and to develop the curriculum in gerontechnology. By the end of 1993,

a two day international postgraduate course on gerontechnology will have been organized and conducted at the university. The topics include the conceptual foundation of gerontechnology, business and economic aspects of gerontechnology, applications in cognition, perception, motor performance and anthropometry. Examples of gerontechnology applications in work, housing, and transportation are covered and a workshop on a design problem is included. A one day international workshop will follow the course to evaluate the content and organization and is aimed at recommendations for future courses and workshops throughout the European community.

Research areas
Educational and research gerontechnology activities at the university have centred on four broad areas: housing and urban planning; mobility, transport and motor performance; perception, cognitive performance and communication; and health, health care and medical technology.
All of the research activities, that fit very well in the gerontechnology program, are carried out by research groups in most of the faculties of the EUT. The following enumeration will serve as example of the span of gerontechnology.**(SLIDE 12)**
The faculties of Building & Architecture and Philosophy & Social Science are active in the field of housing and urban planning for the elderly. They participate in a consortium of European groups that submitted a proposal under the EC TIDE program about smart house technology(domotics). The objective of this project is to integrate multi-sensing techniques and artificial intelligence in a global housing approach to help elderly to live autonomously at home. They also are developing a model of personal needs and a standard program of demands on a flexible and adaptable housing environment for the elderly. Another topic of research is the thermal comfort of the elderly.
Although we think that the research on thermal comfort is important, we ran into some unexpected problems. Here, I do suspect that research on the elderly in the Netherlands can be somewhat different than in the U.S. due to cultural differences. First of all, research on the elderly in the Netherlands is seasonal. All experiments must be scheduled around the winter vacation season when the Dutch government encourages (through a very generous social security program) all Dutch senior citizens to flock south to the beaches of Spain. Experiments from May until September are also nearly impossible as the elderly are again on vacation to the colder climates. (This makes the study of indoor climates for the elderly superfluous . There is rarely a need for either dramatic heating or airconditioning because we

just ship them to the appropriate area until things get better at home.) And when we can catch up with the elderly for serving as experimental subjects we have to contend with their active recreational schedules of 80 km bike rides, tennis matches, soccer coaching duties, and so on. I hope you do understand that I exaggerated a bit. My only intention was to illustrate some cultural differences, we have to keep in mind.

The laboratory for automotive engineering is doing research on a new concept for individual transport, based on the capacities and preferences of the elderly.

In the area perception, cognitive performance and communication several groups are doing research. The faculty of Industrial Engineering & Management Sciences introduces the age related changes in the research on task design and work schedules. The Institute for Perception Research among others is doing research on visual attention and its technical consequences. More applied research is carried out on communication aids and reading aids. One objective of the latter topic was to obtain better readable television-subtitling.

I assume that we, in the Netherlands, are in a more favorable situation than researchers in the USA. First of all, we are more familiar with subtitling but we also don't encounter the liability problems that most of our American counterparts have to deal with. Instead of panicking when one of the older subjects claimed to have gone temporarily deaf after performing a vision search task, the master's students in the research team sat down over a cup of coffee and devised various auditory experiments to perform on the unwitting subject to see if he would become temporarily blind! Unfortunately, the team leader (an American) refused to call the subject back to undergo more experiments.

The faculties of Chemical Engineering, Electrical Engineering and Mechanical Engineering are doing various research projects in the areas of health, health-care and medical technology. The development of a diagnostic method for prostate cancer, which is an age-related disease, is a project in the faculty of Chemical Engineering. The effects of nutrition on ageing are studied in a biomolecular context by the same department. Other research topics in this area are the development of a fitness profile for elderly, age-related cardiovascular diseases and the modelling of muscle and bone.

In 1993 four doctoral training projects in gerontechnology were established at the university. The projects, summarized below, illustrate again the diversity and interdisciplinary nature of gerontechnology research.

Examples

A "COPD-proof" dwelling for the senior citizen.

About 40% of the population is susceptible to allergic reactions of which approximately 25% will develop allergic symptoms. Long term exposure to allergens and years of asthma or chronic bronchitis may lead to emphysema. Reduced lung function may lead to decreases in mobility and functional independence. The aim of the project is to design, specify and maintain directives for new and renovated housing for the aging citizen. The indoor air should have a minimal load of irritating gasses and allergenic or infective aerosols. In this project the mass of known medical, chemical and biological data are reduced to key-figures for minimal development and spreading of pollution. These key-figures may then be used by the designers of houses. The key-figures will include hygienic thresholds including irritating gases and allergenic or infective aerosols, indoor air-pollution regimes, humidity management, temperature relationships and requirements for management of common pest organisms. While evaluating the published information discrepancies will be discovered that are to be resolved in new laboratory experiments.

An examination of the reasoning processes of elderly persons encountering new technology.
The goal of this project is to study the reasoning and thinking processes used by elderly when they encounter new technologies. The major objective is to provide a generalizable basis of understanding from which responses of the elderly to new technology in their working and living environment can be predicted. The assumption is that people are not too old to learn to use new technologies when the concepts that underlie the design of these new products are closely mapped to their reasoning processes and match their life style and experiences. In order to accomplish such a mapping, we have to know how the elderly reason and think about these technologies. The aim is to develop methodologies for studying the cognitive processes of the healthy ageing population.

Development, design and management of adaptable housing for independent living elderly.
Elderly persons prefer to remain in their homes and familiar environments as long as possible. Ideally, their housing is based on knowledge of the changing mental and physical capabilities of the elderly as they age. The research question is: `What kind of adaptable housing environment do the elderly need in order to continue living independently in a house as their abilities and needs change?' The study aims to develop a model of personal needs, a standard building programme of demands and a collection of design patterns on a flexible and adaptable housing environment for the aging and the aged. The information is expected to be used by organisations that develop, design and manage housing.

<u>Neurophysiological and psychophysical effects of general anaesthesia on cognitive functioning in the elderly.</u>

The aim of the research project is to evaluate preoperative and postoperative neurophysiological and psychophysiological signals for early detection of neurological or cognitive damage in elderly patients during surgery. Neurophysiological signals such as EEG and evoked response measurements reflect the cortical and sensory pathway functioning and therefore allow detection of several types of brain damage. Psychophysiological techniques enable acquisition of objective and quantitative data about pre and postoperative cognitive functions. The emphasis of the study will be on the development of a set of neurophysiological parameters that allow intraoperative monitoring of neurological and cognitive functions. Application of advanced signal processing and incorporating available physiological knowledge about the clinical importance is needed to enable success of such a study.

Design.

The Eindhoven University of Technology does not have a design department. Knowledge transfer and implementation are accomplished through cooperation with industry and industrial design institutes. The university has close ties with several industries, particularly Philips Corporate Research through its Institute for Perception Research and with Philips Corporate Design. For example, designers from Philips and the European Design Centre will contribute to the first international postgraduate course in gerontechnology described above.

Coordination.

The university, through the Centre for Biomedical and Healthcare Technology and now the Institute for Gerontechnology Research has played a central role in establishing and encouraging collaborative efforts in gerontechnology within the Netherlands and internationally. It will host the first international postgraduate course in gerontechnology, and is the coordinating centre for a proposed multinational effort to create a European data base in gerontechnology. It has established collaborations in gerontechnology with other universities in the Netherlands. The coordination efforts are critical for the successful development of gerontechnology, because the required expertise is not all available in one setting. For example, the university has no activities in technology related to leisure activities, few in nutrition, and it depends on collaborative arrangements with medical schools for the

medical and health care research and training activities.

In summary the gerontechnology program of the Eindhoven University of Technology is establishing curriculum and research activities both within the university and in collaboration with other institutions within and outside the Netherlands. It is cooperating with other organizations to establish data bases appropriate to gerontechnology and to encourage industrial design projects that reflect the goals of gerontechnology.

I want to end my presentation with an anecdotical warning for future researchers in gerontechnology.Some examples of specific problematic instances in getting older subjects to show up for experiments that one of our researchers has encountered include the time one elderly gentleman complained of minor injuries in his volunteer job as the bouncer for the local tennis club bar.

Another time another elderly gentleman, in his mid seventies, was detained by the police for illegally taking photos of the prostitutes that work from picturesque house boats in the city of Utrecht. He was doing this at the request of his American friend who regetted his adventure when the prostitutes decided to take the law into their own hands and chased these two fellows by car through the streets of the city. But there was a happy ending to this story as one of the ladies made the mistake of hitting our hero over the head with her umbrella when he was stopped for traffic so he was obliged to get out of the car and smack her in the face which enabled him to drive off unpursued. By the time the police were called in the photos were safely on their way to Minneapolis along with the happy memories of an American senior citizen's adventures in the Netherlands. When our subject returned to continue with the experiments he told how worried he had been that "the old guy", his American friend, was going to have a heart attack during this encounter. The "old guy" is ten years younger than our subject.

The morale of this warning is that researchers, engineers and designers are very likely to have a complete different image of the elderly and their lifestyles than the one the elderly have of themselves!

Address

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Acknowledgement

References

All our subjects