Gerontechnology : matching the technological environment to the needs and capacities of the elderly

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GERONTECHNOLOGY, MATCHING THE TECHNOLOGICAL ENVIRONMENT TO THE NEEDS AND CAPACITIES OF THE ELDERLY*

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ABSTRACT

The new professional area 'Gerontechnology' includes the development of techniques and products, based on the knowledge of aging processes, for the benefit of an optimal living environment and adapted medical care for the elderly. In this new professional area, needs must be identified. This requires increased knowledge regarding activities of the elderly, problems engendered by these activities and the use of technology by the elderly to solve these problems. Demographic and epidemiologic data are required. In the interaction of the human being with the technical environment, the processes of perception, cognition and motor action are determined by the qualifications and skills of the individual person. The possible communication of the individual with the environment, which exists of products and services is determined by the quality of the motor, cognitive and perceptual interface. Here, an increasing gap arises between the range of suitable products and services and the skills of the elderly. To bridge this gap, is the challenge and basis for the fundamental and applied research projects as they are developed at the Eindhoven University of Technology. The paper highlights projects dealing with mobility, communication, housing and health care for the elderly. A short description of the post graduate course is given. The intention of this paper is to create openings for international collaboration in research and training in the field of Gerontechnology.

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INTRODUCTION

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.

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 life 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 Crystal Display technology (make reference to environmental conditions)

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.(The Dutch 'snorfiets' is a good example, but we can be more creative)

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.
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-centred 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 concomitant medical problems that complicate treatment and recovery.

WHAT IS THE GOAL OF GERONTECHNOLOGY?

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 the same five ways as human factors and ergonomics do in the way as described by Fozard in his paper. Gerontechnology also plays a role in:

- prevention
- compensation
- enhancement
- aid to caregivers
- improve research on aging

Gerontechnology basically covers the same field as human factors or ergonomics and aging, but it is restricted to that research and those applications were technology plays a role. On the other hand it is broader than human factors and ergonomics if we look at the crossroads of medical technology and aging in for example diagnostics, treatment and care support in the case of chronic diseases, many of which come with age. Gerontechnology also adds the economical factor since it aims at affordable technology and last but not least it adds the psychosocial factor by looking into the preferences rather than the needs of the elderly. If the in-depth analysis of man-product-environment interaction is characteristic for human factors and ergonomics then gerontechnology distinguishes from human factors by focusing on:

- technological support in aging research and
- synthesis of results of research in design

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).
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.

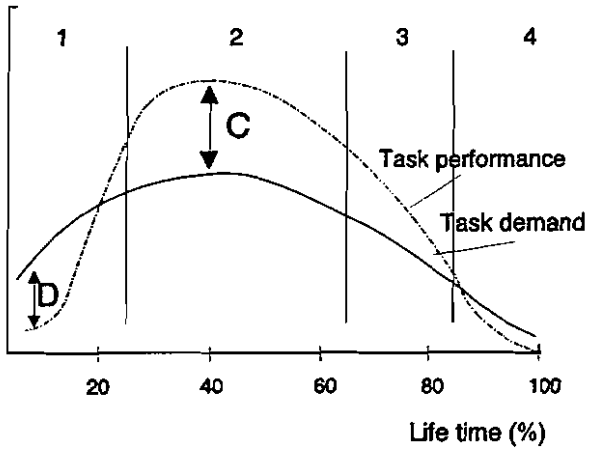
THE CONCEPTUAL BASIS OF GERONTECHNOLOGY.

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.

These concepts fit very well in the dynamic systems model as introduced by Fozard in his paper.



Relation between task performance, task demand, comfort and demand during human life

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.

- 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, kinaesthesis, 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.

	time elapsed	
input-mode	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

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.

During the 1993-94 year, an independent Institute for Gerontechnology Research will be 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 holds the co-chair in COST-A5, which is a European network on 'Ageing and Technology'. Fourteen European countries (EC & EFTA) participate in this network

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. Dr. J.L. Fozard, director of the National Institute on Aging Baltimore Longitudinal Study on Aging, is spending this academic year at the university. He 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.

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. A related topic of research is the thermal comfort of the elderly.

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.

Neurophysiological and psychophysical effects of general anaesthesia on cognitive functioning in the elderly

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 regretted 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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