Gerontechnology as a field of endeavour

Herman Bouma PhD
Vessem, the Netherlands
E: h.bouma@gerontechnology.info

James L. Fozard PhD
School of Aging Studies
University of South Florida, Tampa, Fl 33612, USA
E: fozard@tampabay.rr.com

Johanna E.M.H. van Bronswijk PhD
Performance Engineering for Built Environments,
Department of Architecture, Building and Planning,
Eindhoven University of Technology, Eindhoven, The Netherlands
E: j.e.m.h.v.bronswijk@tue.nl

H. Bouma, J.L. Fozard, J.E.M.H. van Bronswijk. Gerontechnology as a field of endeavour. Gerontechnology 2009; 8(2):68-75; doi: 10.4017/gt.2009.08.02.004.00. Our technological environment is the silent basis for the many activities that implement the goals of daily life. Yet, in our daily environment, technology is taken for granted; so much so that the purposes of later life, such as optimal health and independence, may seem distant from technology. But if we wish to enhance the quality of later life, we must direct our efforts also toward improving and extending products, services, and infrastructure of the rapidly changing technological society in which we are aging. Human ageing is the scientific domain of gerontology and geriatrics (GG). Using innovative technology to prevent or repair the challenges of aging requires collaboration between the disciplines of human ageing and the disciplines of technology. An earlier matrix representation of this gerontechnology (GT) shows what methodology and insights are already available in such cross-fertilization. An example is the concept of 'technology generation', a combined fruit of sociology and technology. The classic approach of disciplines is to focus on the own development with less attention to the environment in society in which fruits are to be reaped. But already there is enormous advancement in available technology options for supporting health, compensating for functional and social restrictions, and supporting care. Examples include multiple applications of distance communication through the Internet, most of which are recent and still extending. In order to accelerate advantages and diminish mismatches, advances should be controlled rather than left to chance. An impact matrix will illuminate innovative technologies that serve well-defined purposes in the domains of daily life. The combined efforts of GG and innovative technology have immense promise for our ageing society.

Key words: gerontology, geriatrics, technology, health, prevention, innovation

The Gerontechnology (GT) symposium at the IAGG 2009 Paris conference shows once more that progress in Gerontology and Geriatrics (GG) as well as GT accelerates through enthusiastic collaboration with carefully selected fellow disciplines[1]. GG are concerned with ageing people, their ageing processes, their ailing or maintaining health, their multiple diseases, their activities of daily life, their wisdom, and, most important, their remaining quality of life. The practical goal is invariably the keeping up of quality of life and the slowing down of unavoidable loss. The scientific goal is to understand processes of human ageing, the diversity of ageing life itself, and age-related diseases as to aetiology, diagnosis, treatment, and cure.

The environment in which older people age is generally recognized as important, in particular the social and living environment. In this paper, the technological environment is considered and proposed as a determinant of the life of ageing persons. Though not unrecognized[2,3], it has remained somewhat hidden in the mainstream of GG. Among the reasons are: a focus on ageing people rather than their environment, on disease countering rather than proactive prevention, on social policy rather than active participation by ageing persons themselves as agents for change in the ageing process. Surely, these are valuable focuses. But for all interventions, the basis both individually and socially is the daily environment in which people age. Technology is the driving force behind changes in the daily environment. Therefore, the environment in which people age cannot be taken for granted as a constant. It is an ever changing creation, not a given one. It is an accelerating dynamic, not a static one. It provides ever changing opportunities and challenges. It is basic for GG as well.

Let us just consider some recent changes in the technological environment. The home computer started about 30 years ago, the laptop some 10 years ago. The Internet came less than 20 years ago, its massive use about 10 years ago with applications still rising if not exploding: for example, Facebook and twitter are recent additions. Cell phones, again with ever more functionality, and digital photography came about 10 years ago, as did massive cheap air transport. Telemedicine and telecare started slowly about 10 years ago and are nowadays very much on the rise. The hybrid electric bike came 5 years ago. Smart housing including passive alarms and several types of automatic monitoring is around the corner. So, in a few decades, part of the environment in which people live has changed almost beyond recognition. Ageing people experience this happening as well and have to deal with it somehow. Obviously this has consequences for GG, some of which we will consider here.

CROSS-FERTILIZATION

As an application-oriented endeavour, GT combines a scientific research approach and an application directed approach. By definition, scientific research is directed at new understanding and insight; in the case of GT it is directed at learning to match ambitions and needs of ageing people in their actual environments with suitable innovative and existing technology. It follows that such research is interdisciplinary between disciplines of ageing (physiology, psychology[4], sociology, GG,.....) and disciplines of innovative technology (physics, chemistry, building[5], mechatronics, robotics, design,....). The search is for methods and theories that help understand what specific purposes may be served by what specific technologies. Examples: what memory problems at old age can be eased by what compensatory image and speech technology? What changing living situations of what ageing people are met by what requirements of building and building environment? Although the final purpose of such research may be directed at useful applications, the direct goal is the understanding of ambitions and needs of ageing people in relation to technology that may help realizing such ambitions and answer such needs. Formulated this way, it becomes clear that it belongs to the fields of GG as well.

Cross-fertilization between scientific disciplines of ageing and scientific disciplines of innovative technology have resulted in certain gains in insight, as have been worked out in a recent paper[6] of which we reproduce here a summarizing matrix (*Table 1*). The matrix cells are filled with methods and theories that represent such understanding.

For example, there is the new concept of 'technology generation', as taken from sociology indicating that earlier life experience of technology in the formative years puts a lasting mark on people; consequently people in their seventies still bear certain marks of their technology environment some 50 years ago. The methodology of 'inclusive design' acknowledges the active participation of older

Table 1. Interdiscipline matrix of gerontechnology (GT), indicating in the four rows the main discipline groups of ageing processes and in the six columns the main discipline groups of technology products and services. The matrix cells contain a selection of concepts, insights, and methodology considered relevant for gerontechnology[6].

		Technology discipline					
		Chemistry Biochemistry	*Architecture Building*	*Information Communication*	*Mechatronics Robotics*	*Ergonomics Design*	*Business management*
Ageing discipline	*Physiology Nutrition*	- Preventive nutrition	- Experimental housing - Healthy indoor environment	- Telecare	- Biorobotics - Resource sharing (man-vehicle)	- Individual differences - User participation - Inclusive design - Standardization	- Care management innovation
	Psychology Social psychology		- Experimental housing - Domotics	- Situated learning - Temporal discount & benefits - Technology acceptance - Persuasive technology - Domotics - Navigation tools		- Individual differences - User participation - Inclusive design - Standardization	- Technology acceptance - Persuasive technology - Targeted marketing
	Sociology Demography			- Technology generation (protocols)	- Technology generation (protocols)	- Technology generation (user interface)	- Targeted marketing
	Medicine Rehabilitation	- Preventive drugs - Perceptual implants (materials)	- Healthy indoor environment	- Perceptual implants (signal processing) - Modelling restrictions - Telecare	- Biorobotics - Resource sharing (man-vehicle)	- Self medication - Telecare	- Care management innovation

people themselves in the design process, the necessity of robust design, and the notion that a wide range of individual differences has to be served by new technology. Specific information can be found in the review article.

IMPACTS ON DAILY LIFE

In essence, useful applications are the very purpose of any technology discipline including GT. Understanding and insight are indispensable, but the actual fruits for ageing people are to be reaped in improving their daily technological environment. So we have to consider what type of fruits for ageing people exist or are to be expected:

products, services, infrastructures and environments that can improve their lives.

The general notion of lifestyle and life improvement for ageing people has to be worked out. For this, we have to realize that the diversity of people increases with age and this is true for a great many life dimensions among which health, education, financial options, interests, work background, family and friends, hobbies, and travel experience. Consequently, we have to abstain from broad generalities and concentrate on specifics. Building on earlier literature, we start by distinguishing four categories of goals

of ageing people and five categories of their daily lives[7-9]. A key question is how to advance living an independent and active life of one's own choosing, despite decreased health prospects, activity restrictions, and losses that tend to come with advanced age.

Restrictions and disease may acquire such a dominant place in the lives of ageing people that dealing with these may become their most prominent goal. Abatement can be divided in three categories: (i) preventing or postponing such restrictions or disease to occur (ii) compensating restrictions that have materialized and (iii) supporting the types of care and treatment that have become necessary. An unfortunate side effect of disease, pain, and restrictions is the extra attention that it attracts or requires from the side of the patients themselves and from their family and friends. Such attention to one's suffering and to one-self distracts from activities and interests that one would have pursued otherwise. This may cause disease even to dominate one's life. Technology may have partial answers to this by supplying motivating options to other activities such as games and communications[10-12].

Important as health restrictions may be, the primary purpose of ageing people is taken to be a different one: to carry on with whatever one wants to do, to give meaning to one's life, and reach a high personal level of satisfaction. Therefore, we start with this first goal, while acknowledging that health restrictions have to be dealt with actively as a precondition for freedom of choice.

Goals of ageing people
Enhancement and satisfaction. This is what GT wants to achieve most: to enhance daily life by answering and supporting active and dormant ambitions and needs of ageing people. This will make them feel in control over their own lives in their preferred environments, where they take an active part in social activities, in their families and in communities of their choice everywhere from locally to globally, and feel satisfied

about it. In terms of the Maslow triangle[10], it represents the higher level of existence: self-actualization. Since Maslow's original work, we now know that these goals remain relevant when health restrictions and adverse circumstances occur.

Prevention and engagement. During the ageing process, functional restrictions tend to increase such as in general vitality, in mobility and motor skills, in vision and hearing, and in memory. Such restrictions stem from specific processes and diseases related to old age. We want to prevent this from happening as far as possible by taking action already earlier in life, since we know that many of such shortcomings may be related to risky habits, unhealthy environments or genetic dispositions that should be dealt with as early in life as possible[13]. We want to reach this goal proactively, thus engaging ageing people with active control over the preventive measures, for example by turning to healthy food, avoiding specific risks, having regular physical exercise, or whatever other measures are available. The active role of aging people themselves will also increase their independence and autonomy in adverse circumstances.

Compensation and assistance. Despite overlooked (exercise) or scarce (vision) preventive options, functional restrictions do occur. Accordingly, we wish to direct technology to the compensation or substitution of such shortcomings, such as with mobility aids, vision and hearing aids, memory aids, and pain alleviators. Also the private and in particular the public environment should be geared to support ailing functions. Note that technology-tools to go beyond unaided human performance have always been a decisive factor for the human species at large. Present general examples are spectacles and binoculars for an extended range of vision, radio, MP3, televisions and DVD for extended hearing and seeing; cell phones for immediate distance communication; bicycles, cars, trains and planes for higher speed mobility; books, photography and palmtops for increased memory, the Internet for access to

digital information. The compensations and assistances intended here are specific ones for age-related restrictions with the purpose of bringing ageing people closer in line with the general adult population.

Care support and care organization. If professional or other carers become a necessity, we wish to direct technology toward making their work easier and better organized, such as by lifting-supports, passive and active alarms, video links, GPS connected tags, by other telecare, and by improved logistics. This should contribute to maximum efficacy and minimum privacy invasion. It applies to self-care as well. Apart from its intrinsic value, this also will help to diminish the growing gap in society between the increasing numbers of ageing people in need of care and the decreasing availability of carers.

Domains of life

For increased insight into actual situations of ageing people in which the above goals are to be achieved, five main domains of daily life are distinguished here.

Health and self-esteem. A good health is a first condition for the realization of many ambitions of daily life. It is something of a paradox that being healthy goes almost unnoticed when achieved. On the other hand, a poor health may stand in the way of quite a few daily occupations, be it directly by the accompanying functional limitations or indirectly by diverting attention away from more fruitful and satisfying pursuits. Because of this importance and because of the general age-related decline, health deserves the first position as a domain of life. We add to this self-esteem as a second important parameter in freely pursuing one's ambitions, resisting prevailing prejudice in society, and in particular if autonomy is endangered by the necessary help of others[14]. The account of the importance of the environment in health and aging provided by GT theory encompasses those of other conceptual schemes that link the social and manmade environment to ageing[14].

Housing and daily living. One's home is one's castle: the place where most time is passed and where most daily activities are being performed. This is the more true for ageing people who have retired from their jobs. A special category has been recognized as ADL (activities of daily life) and IADL (instrumental activities of daily life, instrumental referring to the use of technological tools), because these activities are a daily necessity and thus an indicator of the degree of independence and the need for help. The domain of the house as a potent support for independent living has also been targeted from the point of view of technology[15,16] ('smart housing'). Technology will be indispensable for realizing the concept of 'ageing in place'.

Mobility and transport. Mobility is a requirement for independence in pursuing one's ambitions and activities. Also it is an active domain of technology both for the many types of vehicle and for the extensive infrastructure: even for walking an infrastructure of sidewalks is welcome. A great many private and public means of transport are being utilized each with their own static and dynamic information necessities. All of these have to be robust and geared to ageing people as well. Therefore, the special perceptual, motor, mental, and endurance requirements of ageing people are defining this domain of life.

Communication and governance. Communication between humans has been essential for our species long before our technological era. This applies to ageing people just as well. The recent extension of technological options for immediate communication at any distance and at any time, both in speech and in images, makes it a mandatory domain for GT. Since ambitions, needs and options of ageing people may be specific, so will their skills in mastering the ever new functionalities. Learning or extending such skills toward specific new purposes is an important issue for GT. A special position is given here to governance that is communi-

Table 2. Impact matrix of gerontechnology (GT); cells are filled with existing or emerging products and services, as present in the early nineties

Goal		Life domain				
		Health Self-esteem	*Housing Daily living*	*Mobility Transport*	*Communication Governance*	*Work Leisure*
	Enrichment Satisfaction	- Self care - Self assessment	- Remote control	- Timetables	- House phone - Surface mail - Ticket machines - Fax machines - Alpha-numeric keyboards	- Mechanical miniature camera - TV-remote control - CD - Menu style UI
	Prevention Engagement	- Home trainer - Accelerometer - anti-oxydative stress supplements - Strength training programme	- Sheltered housing - Natural ventilation - Safety illumination - Thermostat	- Handrails - Sturdy grip	- Noise abatement	
	Compensation Assistance	- Active alarms	- Jar openers - Barrier-free design	- Rollator-walker - Wheelchair - Elevator	- Hearing aids - Antiglare spectacles - Telephone with number memory - Cordless phone - Speech output	- Power tools - Focused lighting - Virtual dolls - Easy opening cans
	Care support Care organization			- Powered lifting devices	- Active alarms	

cation within the public domain, such as between the various branches of government interacting with the individual ageing citizen or communicating with the general public. Here, organizations of ageing people may act as a mediator. If communication technology such as via the Internet is being utilized by governing (or other) bodies without proper regard of the actual options available to their senior citizens, the independence of the older population is being thwarted as is the equal treatment of their citizens. It is a straight interest of governments at any level to enable every one of their citizens to make use of their communication channels.

Work and leisure. In terms of public administration, retirement marks the end of working life; consequently ageing people are considered not to work by definition. Silently, the concept of 'work' is equated with 'paid work'. Obviously, this narrow concept of 'work' is invalid since quite a few retired people are still performing paid functions in society. But, more importantly, the narrow, economically-inspired definition of work should be discarded because a lot of very useful, even essential work in society is being done without financial rewards. Ageing people take their share of such activities. From the point of view of ageing people themselves, technology should support all their activities, irrespective of payment. This brings about a fluid boundary between work and leisure activities, such as in do-it-yourself and in care for family and friends. Adjustment of the organization of work belongs to the domain as well.

Table 3. Impact matrix of gerontechnology (GT), the cells filled with existing or emerging products and services, as compared to the situation in the early nineties

		Life domain				
		Health Self-esteem	*Housing Daily living*	*Mobility Transport*	*Communication Governance*	*Work Leisure*
Goal	*Enrichment Satisfaction*	- Self care - Software personalization	- Interactive controls - Teleservices - E-shopping - Adaptive control	- Electric bicycles - Navigation tools - Info public transport	- Mobile phone - E-mail - E-info - Multimedia - E-learning - Touch screens - Mouse	- Digital camera - Tele-games - Social computing - Cash dispensers - Telebanking - DVD
	Prevention Engagement	- Healthy diet - Hip protectors - Health monitoring - E-health info	- Smart ventilation - Safety illumination	- Car automation	- Noise abatement - Automated messages	- Work simulator
	Compensation Assistance	- Passive alarms - Medication reminders - Tele-rehabilitation - Viagra	- Cleaning robots	- Scoot-mobile - Smart walker - Navigation tools	- Accommodative lens implants - Cochlear implants - Retinal implants - Delayed speech	- Garden robots - Robot pets
	Care support Care organization	- Control PDA - Carer training system - Clinical GT	- Electronic keys	- Navigation tools	- Video links	- Telecare

IMPACT MATRIX

Technology should serve the goals of the ageing population in the main domains of their daily lives. The combination of four goals and five life domains defines an impact matrix, the cells of which can be filled by technologically bound products and services including their infrastructure, which may have a positive impact for many ageing people. We first plot an impact matrix for the situation around 1990, when the first international congress of GT widened the then existing activities on 'technology and ageing' (*Table 2*). At that time the main efforts of 'technology and ageing' were ergonomics for ageing people and assistive technology. Both themes have remained as active as before[17-19]. But the scope of GT is a wider one, as has been set out in the present paper, and

also reflects the ever more important role of technology because of the many innovations. To illustrate this, an impact matrix has also been plotted for the present situation (*Table 3*). Apart from reflecting a certain personal estimate of what technology is presently promising, it is obvious that the content of the impact matrix will change with time.

CONCLUSION

The increased importance of innovative technology in the daily lives of ageing people as in society at large makes it mandatory for GG to consider its impact. Technology offers both new opportunities or options and new challenges as compared to earlier situations and earlier generations. Since these are becoming part of the private and social life of ageing people, it is only natural

to be taken into account by the disciplines that are dealing with human ageing. Since technology does not belong to their natural curriculum, collaboration between the two types of discipline (GG and GT) is advocated here as the promising route[20]. The purpose of such collaboration is to increase insight and understanding of the real life and environment of ageing persons, and to ascertain that most is made of technology options to increase their quality of life and to combat occurrence and negative effects of age-related disease. Interdisciplinary collaboration is not an easy task and will require from both sides a rather wide view and a good deal of perseverance as well. The reward will be a better understanding of the ageing of people in our society and a better adapted environment leading to a higher quality of life for so many ageing persons.

References

1. Franco A, Bouma H, Cornet G, Mallea P. Gerontechnology at IAGG 2009 for optimal health in a multidisciplinary context. Gerontechnology 2009;8(2):63-67; doi: 10.4017/gt.2009.08.02.001.00
2. Lawton MP. Future society and technology. In: Graafmans J, Taipale V, Charness N, editors. Gerontechnology. A sustainable investment in our future. Amsterdam: IOS Press; 1998; pp 12-22
3. Charness N, Schaie KW, editors. Impact of technology on successful aging. New York: Springer; 2003
4. Oppenauer C. Motivation and needs for technology use in old age. Gerontechnology 2009;8(2):82-87; doi: 10.4017/gt.2009.08.02.006.00
5. Franchimon F, Brink M. Matching home automation, robotics, assistive technology, geriatric telecare and telemedicine. Gerontechnology 2009;8(2):88-93; doi: 10.4017/gt.2009.08.02.007.00
6. Bouma H., Fozard JL, Bouwhuis DG, Taipale V. Gerontechnology in perspective. Gerontechnology 2007;6(4):190-216; doi:10.4017/gt.2007.06.04.003.00
7. Fozard JL, Graafmans JAM, Rietsema J, Berlo GMW, Bouma H. Gerontechnology. Technology to improve health, functioning, and quality of life for aging and aged adults. Korean Journal of Gerontology 1997;7(1);229-255
8. Bronswijk JEMH van, Bouma H, Fozard JL. Technology for quality of life: an enriched taxonomy. Gerontechnology 2002;2(2):169-172; doi:10.4017/gt.2002.02.02.001.00
9. Bronswijk JEMH van, Bouma H, Fozard JL, Kearns WD, Davison GC, Tuan P-C. Defining gerontechnology for R&D purposes. Gerontechnology 2009;8(1):3-10; doi: 10.4017/gt.2009.08.01.002.00
10. Bronswijk JEMH van. Gerontechnology motivation. Gerontechnology 2006;5(2):65-67; doi: 10.4017/gt.2006.05.02.002.00
11. Midden CJM. Motivation is a process. Gerontechnology 2006;5(4):253-254; doi: 10.4017/gt.2006.05.04.012.00
12. Bouwhuis DG. Not care but leisure. Gerontechnology 2006;5(2):63-65; doi: 10.4017/gt.2006.05.02.001.00
13. Bronswijk, JEMH van, Kearns WD. Preventive health engineering in earlier and later life. Gerontechnology 2009;8(2):76-81; doi: 10.4017/gt.2009.08.02.005.00
14. Fozard JL. Impact of technology intervention on health and self-esteem. Gerontechnology 2005;4(2):63-76; doi:10.4017/gt.2005.04.02.002.00
15. Berlo A, van. Smart home technology: have older people paved the way? Gerontechnology 2002;2(1):77-87; doi: 10.4017/gt.2002.02.01.010.00
16. Melenhorst A-S, Rogers WA, Fisk AD. When will technology in the home improve the quality of life for older adults? In: Wahl H-W, Tesch-Römer C, Hoff A, editors. New dynamics in old age. Individual, environmental and societal perspectives. Amittyville: Bay-wood; 2007; pp 253-269
17. Bouma H, Graafmans JAM, editors. Gerontechnology. Amsterdam: IOS Press; 1992
18. Fisk AD, Rogers WA, Charness N, Czaja SJ, Sharit J. Designing for older adults. Principles and creative human factors. Boca Raton: CRC Press; 2004
19. Ellis RD. Ergonomics, human factors engineering, and gerontechnology: From accommodation to robust design. Gerontechnology 2005;4(2):61-62; doi:10.4017/gt.2005.04.02.001.00
20. Bouma H. Geriatrics and gerontechnology. Gerontechnology 2008; 7(3):330; doi:10.4017/gt.2008.07.03.010.00