Societal aspects and individual preconditions of technological development

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H. Mollenkopf. Societal aspects and individual preconditions of technological development. Gerontechnology 2016;15(4):216-226 doi:10.4017/gt.2016.15.4.011.00 The meaning that technology's progressive infiltration of the environment has for older adults hardly needs to be emphasized. With the increasing prevalence of health impairments, waning physical power and increasing sensory loss on the one hand, and the loss of close friends and relatives caused by old age on the other, the importance of adequate technological appliances and systems is particularly rising. Until now, however, older persons' access to modern technologies depends strongly on socio-structural conditions like income and education. Among cultural requirements, societal stereotypes and aspects of design and stigmatisation influence the acceptance and use of technical devices and systems. And whether older persons benefit from the options technology offers for maintaining independence and social participation in old age depends largely on their earlier experience with technology and individual aspects of acceptance or rejection. In this article, the socio-structural, cultural, and individual prerequisites for the productive use of technical devices and systems are regarded from a long-term perspective. Furthermore, the ambivalent societal consequences related to technology implementation are discussed.

Keywords: Technology use, acceptance, older persons, stigmatization

A salient characteristic of modern industrialized societies is the high degree to which technology has proliferated into all domains of life. This statement pertains not only to the domain of industrial manufacturing and the organization of work, but also to the private everyday world in which each member of society lives.

Societal aspects

The impact of technology on the private everyday world in which aging individuals live is also growing constantly. Ongoing advances in technology have enormous potential for improving how people age at any point in their lives. In the domestic environment, the application of technology has made dealing with tiresome everyday tasks easier for persons of all ages. Transportation technologies facilitate mobility, and information and communication technologies (ICT) give remote access to information, strengthen contact with family and friends, and help create online communities. ICT is also suited to pursue leisure activities, online learning for individual development, gaming for pleasure or exercising mental abilities, and artistic self-expression[1].

With the increasing prevalence of health impairments, waning physical power and increasing sensory loss on the one hand, and the loss of close friends and relatives caused by old age on the other, the importance of adequate technological appliances and systems is particularly rising. With regards to health, prevention and care, ICT in combination with assistive devices, electronic medical screening and monitoring help provide integrated care for those with health impairments and allow early diagnosis without a personal consultation.

The meaning of technology's progressive infiltration of the environment for people in old age has been addressed for more than three decades. The options that 'low' technologies and 'high' technologies offer for the autonomous living of older people was probably first stressed in the Office of Technology Assessment's 1984 report on 'Technology and Aging in America'[2]. Since then a wealth of empirical studies have dealt with the topic; predominantly problem centred and relating to specific areas of technology. For example, researchers are looking for ways in which technology can help overcome socio-structural difficulties such as raising pension and health costs, stemming from the population's growing share of elderly people, particularly the very old.

The development and use of technical aids is being studied largely with an eye to reducing such costs by e.g., giving out-patient care rather than hospitalizing the individual. Other major subjects of inquiry are home furnishings designed for persons with special needs, home adaptation, and the use of technical aids to help elderly people run their homes independently; the general accessibility of the dwelling's immediate vicinity,

means of transportation and the infrastructure as a whole; and the use of computers and 'new media'. Another focus in recent years has been on user-friendly technological design, on older persons' competencies and needs, on the ergonomic context, and on the acceptance and use of modern technologies and integrated systems.

The increased availability and use of technologies widens ageing persons' scope of action significantly, but it can also lead to new dependencies and unintended consequences, depending on both an older individual's personal, social, and economic resources, and the traditions, prosperity, welfare policies, health system, and level of mechanization of the country in which she/he lives. This may result in new social inequalities which can result from different chances to afford, accept, access and use technological devices. When we started our research in ageing and technology in the early nineties of the last century, we found that whether older persons benefit from the options technology offers for preserving their independent living and social participation into a ripe old age depends on a whole string of preconditions. Apart from their individual resources and attitudes, on the one hand, and the shape and easy handling of the devices, on the other, structural and cultural conditions played a role as well. Therefore, it is necessary to take the social embeddedness of aging and technology into account and, consequently, to employ a social-cultural view when technology development is the focus.

In the following, I will draw on the findings of our research of the nineties of the last and the beginning of the 21st century in Germany, quote from the respective publications[1,3-5], and compare them with developments we can observe nowadays[6-9]. In the first part, I will deal with cultural conditions such as the social shaping of technologies, societal stereotypes and aspects of design and stigmatisation.

The focus of the second part will be the structural conditions which constitute the prerequisites in particular for the provision with assistive devices. Individual aspects with regards to acceptance and use of technical devices will be discussed in the third part. In each part I will try to detect major changes or remaining similarities. And finally, I will discuss some challenges regarding future relations between ageing and technology.

Cultural conditions

Social shaping of technologies

The construction and design of technical artefacts, the course of their diffusion and acquisition, as well as the positive or negative consequences resulting from their usage – support for a variety of actions, on the one hand, and new dependencies, on the other – are largely determined through the social and technical circumstances of their genesis. The decisions on which options will be generated, eliminated or selected and implemented depend on the societal and cultural context into which the crucial actors are tied[10,11].

This assumption holds also for the development of technical devices and age-specific offerings. In Germany, for instance, the consequences of World War II and the necessity of adjusting foreign products to German conditions were an initial cause for the production of special mobility and communication aids[4,12]. Compared to this, the development of technical aids for specific losses of function in the early nineties took place predominantly in small specialized firms. The motive mentioned most often by the owners of those companies was being afflicted oneself or having personal experiences with a problem case in the family or circle of friends[3]. The demographic change, including the increasing share of the old and very old people and their special needs and interests, was just beginning to receive attention.

About the same time, the possibilities offered by new assistive and adaptive technologies (AT) and information and communication technologies (ICT) came to the fore in scientific and funding programmes (e.g., the European TIDE and IST programmes)[13,14]. Compensating for impairments, increasing independence and quality of life, improving safety and reducing the burdens of care have been formulated for AT[15,16]. In 1988, the field of Gerontechnology was created by researchers at the Eindhoven University of Technology, aiming at the interdisciplinary collaboration between all professionals concerned with an ageing society for the benefit of ageing people. Among the major features of this approach was its focus on all day-to-day life domains of older people, not exclusively on illness and chronic conditions, as was the case with more traditional rehabilitation and assistive technology approaches[17,18]. *"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"*[19p21].

Thirty years later, the perception of the older generation as a promising consumer market has risen and the production of adequate technologies, technical systems and services is seen as

an economic opportunity and response to the challenges of an ageing society[20,21]. National and international programmes have been launched or further developed (e.g., the European Horizon 2020 R&D Programme[22] and the AAL Joint Programme[23]), and substantial funding for joint European Projects has led to a definite increase in research and development activity, resulting in vast numbers of new technical products and related services.

This development shows both the changing societal conditions and ways of looking at the relation between technology and ageing and the growing significance thereof. However, whether older persons actually accept, acquire and use – and, by this, benefit from the options all the new technical devices and systems offer–, depends not only on their availability and functioning, but on further cultural and structural aspects.

Symbolic meaning of technical artefacts

In addition to the historical emergence and development of technologies, their symbolic meaning and significance for individual identity and social differentiation[24] is an argument for looking at technology from a socio-cultural perspective. As with all objects with which people surround themselves, technical objects are neither inevitable nor neutral artefacts. Like home furnishings and clothing, technical appliances convey to an actual or imaginary interlocutor a visible expression of who the user is or would like to be seen as.

Socio-cultural constructions of this sort are also important when it comes to age and older adults, for certain images of age are conveyed via certain technologies, and vice versa. This becomes particularly salient when a certain technology or technology user is associated with aspects that are societally desirable or undesirable. Thus, to attain old age is considered to be societally and individually worth striving for; being old, on the other hand, is often equated with being no longer young, of being frail, lonely, and physically and mentally incompetent. Similarly, technology is positively associated with modernity and progress, but can also be considered as an expression of human inadequacy, as a symbol for the loss of competencies.

Therefore, technical aids that can make life easier for elderly people whose strength or physical competence is declining are frequently rejected because their very shape evokes associations of handicap and disease, stigmatizing the user and undermining self-esteem. In our first studies on ageing and technology[4], we met older persons who went out only when it was dark because they were ashamed to be recognized as wheelchair-dependent, as 'handicapped' persons. Others did not wear their safety alarm system because they did not want to 'look old'. On the other hand, older individuals who were able to use modern information and communication technologies (ICT) e.g., for being able to read the newspaper despite vision loss, were proud to be up-to-date.

Hence, we expected a positive change for future generations of older adults, who would have different experiences and attitudes, and when new electronic devices could be associated with the image of modernity and youth. Based on a recent literature review of studies dealing with older adults' acceptance of technology, Merkel et al[8] assumed similar developments. Indeed, meanwhile wheelchairs and rollators (walkers) have become natural means of assistive transport modes in the streets; safety alarm systems are well recognized devices and ICT applications have moved into the households of many older people – of those needing support as well as of those using it just for information, leisure and communication.

And yet, there still exist reservations because of some devices' appearance. In a recent qualitative study investigating older people's views with regard to new assistive technologies and services[6], especially older ladies gave answers like the following: *"It's like those little gifts that you receive from somebody and that you can't put away but that you find terribly ugly."* (Female, 87 years old, Antwerp). Another older lady who used a device to monitor her weight stated that she does not like it because *"it is a bit too big for my taste and I actually find it getting on my way"*. (Female, 91 years old, Antwerp).

Consequently, technologies should not only be functional devices, compensating for any physical, sensory or mental deficit of its users. Instead, they should also fulfil the criteria of social or cultural functionality, respectively, and contain aesthetic qualities and attractive features[3,12]. One could ask, for instance, how a hearing aid could be designed so that – in addition to its technical function – it would also constitute a fashionable attribute. Or what a 'feminine' wheelchair could look like, which in addition to mobility would also give its user a little attractiveness.

Structural conditions

With respect to macro-structural requirements such as national regulations, institutional differentiation between access channels played a major role in particular for the provision with assistive devices. Important in regard of funding possibilities for assistive technologies was above all the institutional differentiation between ambula-

tory and stationary care – in Germany between 'Pflegebedürftigkeit' (the need for nursing care) and 'Behandlungsbedürftigkeit' (the need for medical treatment). If a person became acutely ill, then a treatment was financed by his or her health insurance, either ambulatory through their physicians or stationary in the hospital. When they were not in need of medical treatment, but of social and/or nursing care, this was far from the responsibility of the health insurance. Up to the nineties, the alternative was then between moving to a nursing home or domiciliary care from relatives or friends and/or professional social services[3].

Although the general income level, including that of retired persons, had slowly increased in the decades after the war, there were still many older people – especially women – whose income was not enough to afford technical aids. Besides, there were not only older people in need of care who were disadvantaged with regard to acquiring technical assistance in order to perform their daily routines and maintain social participation. The results of a survey with a sample of 1,417 persons aged 55+ conducted in Germany in 1999 as part of the interdisciplinary research project 'sentha'[5,25] showed that also older people who were not heavily impaired but felt serious difficulties when doing everyday tasks owned on average less of the ICT devices asked for, while persons who had no or only minor difficulties possessed more of them (7.5% vs. 6.6%). Moreover, those who were impaired reported significantly higher amounts of bad experiences and fears, as well as a higher need for simplification of devices. This holds true for both the domestic and the ICT domains and – what is particularly important in the case of impairments – also in the field of assistive technologies[5].

Thus, the access to technology can be considered as a new dimension of social inequalities[26,27]: Apart from socio-structural aspects like income and education, a country's macro-structural framework constitutes an important precondition for the equipment with and use of technical devices. As especially ICT appliances have become ever more important tools for the maintenance of an autonomous and participatory lifestyle, older persons who are not able to acquire and use those technologies run the risk of being excluded from important social domains.

With a study carried out ten years later[28], we found that still, the main structural barriers to broader dissemination of assistive (AT) and information and communication technologies (ICT) in older people's homes were the differentiation between the health and care sectors, the segregation of competences, the diversity of authorities in charge of care and the reimbursement conditions. With the establishment of the Social Long-term Care Insurance that was enacted in Germany in 1995 - with several modifications and additions over the years -, home care has been strongly encouraged. However, health insurances continue to pay in cases of illness, and only for a short period if home-care is needed. If a person is in need of care for more than six months, the Long-term Care Insurance is responsible. The payment is based on three levels of need of care. People who just need some help or minor care are not entitled to this support.

The segregation of responsibilities between healthcare and long-term care results in confusion about competences and responsibilities and consequently in uncertainty about entitlement, reimbursement and legal possibilities for receiving support for technological equipment when needing assistance.

Surprisingly, technology does not play a major role yet in this context. Particularly in home care, the diffusion of assistive technologies has been relatively limited so far. The same holds for ICT-based information systems suited to empowering and supporting informal caregivers. Although it is possible to get some reimbursement for assistive devices within the German Long-term Care Insurance, this insurance covers devices only for people in need of care according to 'Pflegebedürftigkeit' grades 0 to III, depending on the person's ability to perform basic activities of daily living, self reliance, and their need of care, supervision, and guidance[29]. Moreover, the subsidy is limited to the applications listed in the official catalogue of assistive devices. For telecare devices and services people in need have to pay privately[28].

This deficit is not limited to Germany, though. In spite of a relatively well-developed market supply, very limited deployment of ICT-based solutions to support the persons cared for can be observed in other European countries as well. The only assistive solution deployed widely is the first generation of tele-alarm systems and only in the United Kingdom one can find at present a strategic initiative to mainstream ICT use in long-term care. Barriers such as the separation of health and social care services nevertheless still limit the wider and more effective ICT deployment also in the UK[7].

Individual prerequisites

Socio-demographic aspects

Beside the great heterogeneity of individual life courses the historically new phenomenon of old

age as a particular life phase includes highly diverging living conditions. The results of the interdisciplinary research project 'sentha' already mentioned[1,5,25,30] showed that whether older people can profit from the benefits of technological devices and systems depends strongly on such living circumstances[31].

With regard to the domain of household technologies, age showed the most important negative impact and gender the most important positive one, followed by income, household composition, and parenthood. In the ICT domain as well, socio-demographic aspects contributed substantially to the explanation of the older respondents' equipment. Again, age showed the greatest negative impact. Household composition had the highest positive impact, followed by income, the level of education, and parenthood. Surprisingly, gender had no impact on the equipment and use of information and communications technologies.

Psychological variables like general and domain specific attitudes towards and earlier experience with technology as well as perceived obsolescence were also important predictors, though. This will be shown in the following section.

Attitude and experience

In terms of attitudes of older adults toward technology, data from the 'sentha' project showed that older adults are neither 'enemies' of technology nor uncritical users of technological innovations. By combining two dimensions of 'general technology acceptance' - one with regard to cognitive-rational aspects of technology evaluation (e.g., *"Technological progress is necessary and therefore one has to accept some inevitable disadvantages"*), and a second dimension representing emotional-affective aspects of technology reception (e.g., *"Technology is more a threat than a benefit to people"*), four groups of respondents differing in their person-technology relations could be distinguished. They were roughly equally distributed across the sample. In detail, these were (i) the positive advocates of technology (29%), (ii) the rationally adapting (26%), (iii) the sceptical and ambivalent (23%), and (iv) those critical and reserved with respect to technology (22%)[32].

One might assume that gender impacts these attitudes because women are usually said to be less interested in technology. The findings of the 'sentha' study confirmed this assumption to some degree: About two thirds of the older women had not had much to do with technology in the course of their lives (men: 25%), 27% had avoided the use of technology if possible (men: 9%), and 52% felt uncertain when confronted with complicated devices (men: 20%). 28% of the women compared to 39% of the men have or would have liked to learn the use of a computer. However, within the four types of technology acceptance there were no significant gender differences. Age differences didn't show either in the 'rationally adapting' and 'sceptical/ambivalent' types, but among the positive advocates the share of the 'young old' was significantly higher than the share of the older and old-old. The critical group consisted mainly of men and women aged 65 and older. Persons of higher education were found significantly more often among the positive advocates of technology and persons of lower education most often were classified as rationally adapting.

With respect to domain specific attitudes towards technology (e.g., *"Information and communication technology to me means a major support of independence"*), the findings were even more positive. To the vast majority (72%) of the older adults in Germany, household technology meant a major support of independence. About two thirds (67 %) of them felt the same with regards to ICT. As could be expected, respondents who envisaged their remaining life-time to be rather short, less often considered buying new ICT devices as worth the effort.

To answer the question of what best predicts the equipment and use of domestic and ICT appliances in the households of older adults, a multiple regression analysis was carried out (since the availability of a device does not necessarily mean that it is used, the criteria has been controlled for unused equipment in this analysis). In addition to the objective socio-demographic variables age, gender, parenthood, household composition, education, and income, experiences with technology and subjective attitudes towards both technology in general and domain-specific technologies were included as potential subjective predictors for technology equipment[5,30].

In addition, we included an instrument assessing the personal perspective on one's future life time and perceived obsolescence of one's competence to get along with modern life, two subscales of older individuals' future time perspective developed by Brandtstädter and colleagues[33,34] (e.g., 'I feel more and more unease with today's lifestyle').

In concordance with our expectations, experience with technology (*"I always had a lot to do with technology in my life"*.) turned out to be a significant predictor. Domain-specific attitudes were found to be of predictive value, too: persons who always had preferred to keep

the use of domestic and ICT devices at a minimum were less likely to be well equipped also in old age than those who had always liked to use household technologies and ICT during their life course. Perceived obsolescence, both in its domain-specific connotation and the general feeling of obsolescence, was found to determine the ICT equipment of the households as well. Its relevance in the ICT domain was even higher than in the domain of domestic technologies, the impact of age, household composition, income, and parenthood, and the domain specific attitude towards ICT technologies (*Table 1*).

Meanwhile, these findings have been confirmed through many studies. Further determinants that proved influential in the technology acceptance of older adults were: perceived usefulness and perceived ease of use, cognitive abilities, social influences, self-efficacy, and facilitating conditions such as training[8]. Interviews conducted in a qualitative study[6] mirror directly the views of older adults and show that the individual preconditions did not change over time. The answers given revealed that a lack of financial resources remains one of the most important reasons of parting with the products and services offered during the lifetime of the project, and one can assume that this will apply also to real life situations.

Examples
Ms. Garcia, a 70 years old widow, has completed primary education and was neither interested nor had previous experience in technologies. She will not miss the devices. *"I cannot wait to take them out"*, she said, since there are *"many obstacles, many cables, many devices and in any case I don't use them"*. She is not willing to pay for the devices. *"Of course not. I am a pensioner. I would not pay for them"*, she argued. Ms. Morales, 72 years old and widowed as well, is not willing to keep them either, nor to pay for the service. *"I think they are so complicated"*, she said. She nevertheless thinks that technology is the future. *"I am very happy with new technologies"*, she underlined[6].

The costs for the basic equipment, for installation, maintenance, internet access and energy consumption, the emergency support and further services are barriers to the uptake of technologies.

Example:
Mr. Marques, 83 years old and single, has completed secondary education, has a professional background with technological experience and a high interest in technology. He can be regarded as a typical example of a person provided with favourable conditions for technology acceptance and use. Thus, it was not a surprise that Mr. Marques would like to keep the devices offered in the project. However, he added: *"If I had to pay, I would not participate, because I have more appliances and these (from the project) are not necessary for me at all"*. Hence, costs were not the reason for his voting out. Instead, he thinks that technology is the future. His argument was: *"The devices could be more modern"* [6].

Future technologies and ageing

Changing technologies, changing societies?

For some years now we have witnessed the development of new technologies which will greatly affect all domains of private and public life and

Table 1. Predicting availability and use of Information and Communication Technology (ICT) in old age; from the data base of The sentha Survey 1999[5]; n=1417; r^2=0.46; adjusted r^2=0.45; *=p<0.05; **=p<0.01; ***=p<0.001; *pr>|t|=level of probability/ significance; stb=standard beta; stb=standard beta; semi-partial r2=the unique contribution of an independent variable; partial r2=partial correlation of determination for the variable of interest*

Predictor	pr>|t|	stb	semi-partial r^2, %	partial r^2, %
Socio-demographic				
Age	***	-0.18	2.7	4.8
Gender	-	-0.02	<0.1	<0.1
Parenthood (no/yes)	**	0.06	0.4	0.7
Household Composition	***	0.31	6.7	11,0
net income per person	***	0.24	4.4	7.5
Education				
Completed 10. Class	***	0.11	1,0	1.8
Completed 12. Class	***	0.08	0.5	0.9
Attitude towards ICT				
Use				
I 'always liked to use ICT'	-	0.05	0.1	0.2
II 'prefer to minimize the use of ICT'	***	-0.09	0.6	1.1
Acceptance				
I 'ICT is a major support'	-	0.06	0.2	0.3
II 'ICT is a risk'	-	0.04	0.2	0.3
Technology-related obsolescence				
'it's not worth buying new ICT anymore'	***	-0.11	0.9	1.6
General technology-related attitude and experience				
Acceptance				
I 'use'	-	<-0.01	<0.1	<0.1
II 'threat'	-	-0.02	<0.1	<0.1
Experience				
I 'had much to do with technology'	***	0.16	1.3	2.3
II 'always avoided to use technology'	*	0.07	0.3	0.5
Sub-score perceived obsolescence	***	-0.09	0.6	1.1

hence, the living conditions of the ageing population. The potential of the new technologies, in particular information and communication technology (ICT) applications, integrated systems and ambient assisted living environments (AAL), robotics and converging technologies (CTs, i.e. the synergistic convergence of previously separated scientific disciplines and technologies[9,35]), exceeds by far the possibilities of conventional technical aids.

Cognitive sciences are considered to be one of the scientifically most interesting areas of technological convergence which promise innovative applications with high relevance for the ageing population[36]. The combination of ICT, bionics, nano- and cognitive sciences, especially, offers much more than just prevention of early decline, compensation for functional or sensory impairments, and assistance in case of illness and needing care. In line with the wider gerontechnology approach, it opens up nearly unlimited possibilities with regards to enhancing, mending, repairing, or improving corporal and mental capabilities, on the one hand, and to shaping ambient environments capable to adapt to any and anybody's needs, on the other. And what has for long time been a vision for the future but has already become an unquestionable tool in manufacturing industry, a familiar toy for children, and a rather popular character in movies and science fiction, is now moving into the lives of aging or disabled people too: automatons, robots, robotics, and manipulators. The next generation of robots performing assistive tasks for older people will probably largely rely on progress in cognition.

From a socio-cultural perspective one can rightly assume that advances in technological development and proliferation are pushed or damped down by current political and/or economic forces. Technologies do not develop autonomously from social life, but are *"the product of the human project"*[11] . Whether ageing men and women in fact profit from the outcomes might rank second among the conflicting interests. Thus, considering the processes at work in technology's pervasion of society must include both the question of the specific utility that each technological development has for its developers', providers', and users' objectives and the specific forms of social organization implied by its use.

Altogether, the progressing integration of technological systems and the convergence of science and technology result in dissolving frontiers between spheres that have traditionally been regarded as distinct. With advancing technological development there is an increasing overlap between the different fields of application. But the emergence of converging technologies means much more than blurring frontiers between technology domains. The home, for instance, is becoming a multifunctional and multidimensional space and the distinction between the 'inside' and 'outside' world gets blurred – a development that can change older people's living in dramatic ways.

However, how individuals age and whether and how older people are capable to profit from technological progress depends – apart from their personal resources and attitudes - on the historical time, society, and (technological) environment they live in, all of which influence each other in complex interactive processes[1]. While technical options are developing and changing at an ever faster pace, the societal conditions into which they are embedded have remained almost the same over the last decades. Social policy and structural regulations of the health and care sectors are lagging behind technological progress (see in this context Osborn's classic work on 'cultural lag'[37] and Riley and Riley's concept of 'cultural lag as the tendency of social structures and norms to lag behind people's rapidly changing lives')[38].

New technologies, new concerns

In view of the rapid proliferation of technology into all spheres of life, previous concerns related to technical devices are currently replaced by new uncertainties and fears. Sceptical attitudes toward technologies may diminish as in the future, a greater share of older people will be experienced with and open minded towards ICT – due to their lifelong use of ICT for work, leisure, information and networking. For many of them, the adaptation of ICT to the situation of being in need of care will be just a small step. However, not all older men, and probably even less older women, will be able to take advantage of such type of experiences. Therefore, the segregation between those who have technological means at their disposal, and those who do not or cannot use the latest technology, will probably continue to exist. The danger of a social and, respectively, digital divide will remain as long as there are different levels of education, income and opportunities.

Technology is losing its prosthetic nature and will no longer be viewed as a stigmatizing replacement for a missing body part or means of compensation for a particular deficiency. Instead, the more technology offers solutions to repair or enhance corporal and mental capabilities, the more expectations may occur towards ageing men and women about their performances,

health related activities, and finally, their independence from social support. Of momentous significance is, however, that by biotechnological interventions the distinction between 'natural' and 'technological' will become blurred, as will the distinctions between 'health' and 'illness', between the individual as subject, with his or her own body and identity, and technology as an object separate from the individual. As yet, the resulting effects on both individuals and society as a whole are unforeseeable.

Furthermore, the general discussion about protection of data and about surveillance and intrusion provokes the idea of loss of personality and of control associated with some of the assistive monitoring and control technologies used in care. To quote again Mr. Marques, the open-minded old man from our qualitative study: *"Look at the phone..., when I was young the phones did not exist and … now we are all under control"* [6].

The advancing integration and automation of technological systems, the convergence of sciences and technology as well as the fact that new technologies are actually used and spread, perpetuate new technological development and expand supportive infrastructure systems, the standardization of products and procedures, the mechanization of social action and automation of services. Hence, people's greater use of technical alternatives is precisely what also restricts their self-determined action and direct experience. Moreover, engineering the body, the mind, and the environment means that humans surrender more and more of their freedom and responsibility to a mechanical world that acts for them[9].

At the same time, ICT devices, ambient environments, telehealth and computer assisted service systems can protect in particular single living or sensory and mobility impaired older persons from severe isolation, and might even become capable of supporting independent living and quality of life of people with cognitive impairments. However, as it will be possible to monitor and control everything by integrative remote control systems and/or sensors, that is, without leaving one's home, the dangers of isolation in a modern hermitage increase. Fears among professional and informal carers as well as among older people in need of care relate to the possible substitution of human resources in care work and informal care giving through automation[7]. The question of whether the new electronic options are used to spend the time saved for going out and pursue activities of individual interest or to stay at home in virtual worlds and, by this, disappear from the real world remains open. In this respect, one can once again state technology's ambivalent character: On the one hand, it can be of great help – and on the other, its unreflected implementation on a massive scale might result in conditions of living that cannot be desirable neither from an individual nor a societal point of view. Therefore, Mordini et al.[11] are warning: *"Society should question itself about the use of technology to deal with ageing, whether this is ultimately ethically good, to what extent and within which limits. The risk we run is that ageing and the role of old age go in disguise and disappear from societal sight"*.

There are also ethical issues associated with monitoring, invasion of privacy, and virtual worlds. Many new systems in the homes of older people, such as devices monitoring the environment, sensors transmitting their health and activity data to external service providers and databases, will maximize access to the ageing individuals' behaviour and enable the identification of potential dangers in the interests of greater safety and security, while at the same time involving both environmental and personal intrusion. Such supervision measures may lead to unjustified control such as the infringement of an individual's rights of privacy and self-determination. Even more ethical questions must be raised concerning the application of computerized devices for assisting people with severe cognitive impairments or with dementia-related disorders. When considering the application of technological products to assist people with this kind of illnesses, it is crucial to take into account the extent to which they are able to give their consent to its implementation and/or to control the equipment.

New ethical concerns may emerge if through the high potential provided by the convergence of ICT, bionics, and nano- and cognitive sciences, the frontier between compensating for declining functions or repairing diseased body functions, and 'enhancing' or 'improving' human capabilities gets blurred. Intensified by the options of various identities in virtual social networks, such developments may put into question ageing individuals' integrity and identity[39].

Conclusions

Technological possibilities will emerge, develop, and advance further in the future. New electronic devices and systems can offer considerable benefits especially with regard to ageing individuals and to people with physical disabilities, and sooner or later they may also be capable of improving the quality of life of people with cognitive impairments. The progressively wider use of technology means increasing breadth in the freedom of action and problem-solving alterna-

tives in everyday practice. At the same time, the continual escalation of technology's dissemination can lead to new experiences of deficiency and constraints and create new dependencies upon technology and technological experts as well as the dangers of isolation and supervision.

Hence, the obviously ambivalent nature of technology – its capacity to either enhance active ageing and compensate for declining functions or to constrain older people's opportunities, depending on cultural, structural and individual preconditions – will continue and, on and on, create both positive options as well as social risks for the coming generations of older adults. In all likelihood, the older people of tomorrow will possess increasing competencies with respect to using technological advances. However, future cohorts of older technology users will continue to have their particular technology experiences during their life course, which will be different from younger cohorts. Therefore, the segregation between those who have technological means at their disposal, and those who do not or cannot use the latest technology, will probably continue to exist. As a result, elderly non-users run the risk of being excluded from important social domains. Thus, technology may well create even larger rifts between the rich and the poor, the young and the old.

The comprehensive 'sentha' project, although already 17 years old and based on German older adults only, provided opportunities for studying complex person-technology-relationships that go far beyond usual – and quickly obsolete – dissemination studies. The findings showed that both aspects of social structure as well as personality aspects, individual attitudes and lifelong habits constitute important preconditions for the equipment with and use of technical devices. These conditions are not equally distributed among older persons. Until now, access to modern technologies depends strongly on income, educational background and household composition[6,8,31]. Including more sophisticated aspects of personality, biographical experience, and appraisal adds to a better understanding of the underlying mediating mechanisms.

Furthermore, it must be emphasized that how men and women age depends not only on their personal resources and attitudes, but also on the historical time, society, and (technological) environment they live in, all of which influence each other in complex interactive processes[1]. Confronting the findings of the German studies of the nineties of the last and the beginning of the 21st century with some selected new studies[6-9] suggests that while technology has developed further, macro-structural, cultural and personal aspects continue to interfere with the uptake of the available products and systems. Therefore, to ensure that elderly people will be equally able to use the positive opportunities of technical products and at the same time retain control over their destiny, it is necessary to take the social shaping of ageing and technology into account. Micro-level perspectives must always consider the macro-structural and cultural conditions, the social policy and legislative regulations, as well as the stocks of technological artefacts and knowledge prevailing in a particular society at a historical time. Both ageing individuals and the technological products and systems they can or cannot use are embedded in societal and technological modernization processes[1,32].

The same is true for the societal consequences involved. The rapid pace and proliferation of technological development, in particular the advancing integration and automation of technological systems and their implementation on a massive scale can contribute to meet the societal challenges of demographic change. At the same time, it might result in conditions of ageing that cannot be desirable neither from an individual nor a societal point of view. Research into the relation between ageing and technology has to consider this larger context.

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