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People, Technology, and Usability:
An Ergonomic Perspective

In this chapter we exemplify and discuss a macro-perspective of people in nature and people and technology. We emphasize the need for service design to strive toward a model of harmony or balance between people-activity and the natural world. We feel this is a reasonable proposal. After all, nature itself is founded on a system in balance. Ancient so-called primitive societies lived, to a large extent, in balance with nature and its ecology. In our own understanding of the concept of ergonomics, we look simultaneously at ecology in nature and its inherent balance. The science of ergonomics focuses on human intervention often to the detriment of a natural balance. This is ergonomics from a macro-perspective. A more general understanding of ergonomics aims to create a balance between people as individuals or as groups on one side and on the other, technology from simple work tools to complex large technological systems. We take ergonomic theories and concepts as our springboard for service design.

Ergonomics: A Brief Overview

Ergonomics is a cross- and interdisciplinary science covering all different areas of human sciences, including some aspects of social science, as well as different areas of technology and technological applications.[1] Ergonomics can be subdivided into many different areas. We focus on four distinct areas: power ergonomics, informational ergonomics, environmental ergonomics, and organizational ergonomics. Power ergonomics deals with humans as an energy/power resource. From this point of view, ergonomics is related to the design of simple tools, for example, knives and forks, hammers, saws, screwdrivers, hand drills, and axes. In this category, we also include simple electromechanical hand tools, such as electrical hand drills, and household tools, such as vacuum cleaners and dish washers. Informational ergonomics is related to psychology, pedagogics, and sociology. But we emphasize that here there is only a relationship, and informational ergonomics is not a direct part of the overall discipline (as, for example, a university department of psychology). Practitioners of informational ergonomics (called ergonomists)

need a good scientific understanding of humans as information processors, and different types of cognitive processes. They also need knowledge of the development and deterioration of these different types of processes in different types of work situations. In this context work can be both paid employment in industrial or office settings and related to human activities in the context of consumption (for example, at home) or leisure (for example, in outside venues, as when attending a concert). An information ergonomist needs to understand the interrelationship between human information processing and cognition in relation to information processing in technologically controlled processes. An example here would be a computer or different types of micro-computers and related embedded control systems.

Environmental ergonomics deals with the wide field of creating a kind of micro- or macro-climate around human beings to create comfort and physical balance in relation to the surrounding environment. In practice this relates to different types of clothing, air conditioning and ventilation systems, acoustical protections, and physical enclosures, such as buildings. Environmental ergonomics aims to create a balance in relation to the thermal environment and different forms of movement (for example, vibrations). Another feature relating to environmental ergonomics is the provision of the support systems for resting and working, for example, tables, chairs, and beds.

Organizational ergonomics is related to areas of information processing between groups of people (including the use of information processing devices such as mobile devices, desktop computers, and handheld computers) combined with multifunctional devices to function as a handheld computer terminal interlinking to centrally located computers. Included as part of this system are control rooms interacting with other control rooms in local, national, or international computer systems and all parts of the system capable of interacting with each other part. Sometimes these are a part of Internet systems or special purpose computer systems for long-distance information technology (IT) and information and communications technology (ICT) (for example, via satellite systems). These perspectives of informational ergonomics are developing at a rapid pace. This development is closely interlinked to an understanding of individual cognition and interaction with very large technological information processing components and very large supercomputers. From this perspective the context of organizational ergonomics is still in an early phase. Ripe for future development is advanced interaction on the Internet. This form of activity in a local society or on a global scale is an area of ergonomics. The human ability to handle, for example, large economic systems and the highs and lows of global economic systems is, to a large extent, dependent on this understanding of the human aspect of ergonomics and an understanding of technological systems of information handling (for example, as needed in processes of trading). Today, with interconnected macro-information systems, small errors in information handling can have enormous ramifications. On the other hand, information handling in a modern motor vehicle with many

built-in electronic service systems (different types of embedded control systems) can also give rise to disturbances and accidents due to a lack of organizational ergonomics (i.e., a lack of understanding between the local service system and its coordination with the cognition of the human operator). These micro- and macro-ergonomic perspectives have many parallels to our understanding about overpopulation of our planet and the roles of human activity in building up macro-technological systems such as energy supply (e.g., nuclear power, wind power, water power) related to new types of energy-related consumption for heating, air conditioning, and transport (whether public or private). Seemingly, humankind currently lacks a good understanding of the ways in which human activities are affecting the balance in nature.

Fundamentals and Criteria of Ergonomics and Usability

Ergonomics focuses on the interrelation between humans and complex technological systems. The overall purpose of ergonomics is to contribute to a balance between people and technology. Figure 5.1 illustrates the relationship between people and technology in low and high levels of automation.

Although the sum of people and technology is the same in (a) and (b), levels of production output are likely to be higher in (b) to reflect the higher employment of technology in the work process. However, production in (a) may be related to a specialized human skill or craft, such as handcrafted embroidery, where the input of human expertise is high and limited use is made of technology to support the human labor. Figure 5.2 illustrates the relationship between people and technology where automation is at a very high level and where automation is nonexistent.

People	Technology

(a). Low level of automation*

People	Technology

(b). High level of automation*
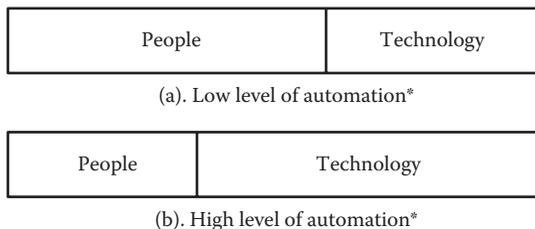
* In each instance the sum of people + technology is the same.

FIGURE 5.1
People and technology in automation. (From Toni Ivergård and Brian Hunt (2010), New Approaches in the Design of Future Control Rooms, invited plenary paper for the International Control Room Design Conference (ICOCO), Paris, October 25–26.)

People

(c). High human labor, no automation*

People	Technology

(d). High automation, low human labor*

* In each instance the sum of people + technology is the same.
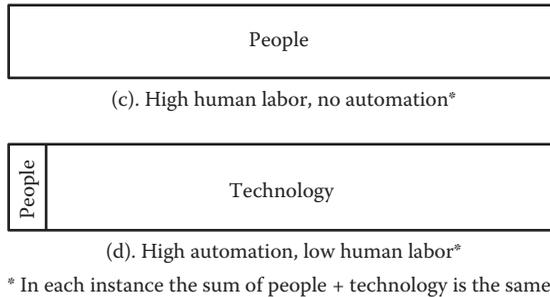
FIGURE 5.2
People with and without technology. (From Toni Ivergård and Brian Hunt (2010), New Approaches in the Design of Future Control Rooms, invited plenary paper for the International Control Room Design Conference (ICOCO), Paris, October 25–26.)

The work environment represented in (c) has highly intensive use of human labor and no technology to support this labor. Nowadays, there are very few examples of work that use no technology whatsoever. Even a simple farm implement is a form of technology. The work environment represented in (d) employs technology to a large extent and has very low human labor input, although the human input is likely to be highly skilled to manage and maintain the high levels of technology in the work process. Modern production lines resemble this format. On a guided tour of a vehicle manufacturing plant the visitor sees many robots and robotic-guided processes (such as transporting parts to the production line). The robots (nicknamed steel-collar workers) are employed in work traditionally done by technicians and craftspeople, such as welding, riveting, and installing components to construct the finished vehicle.

Ergonomics: Aiming for Balance

Ergonomics deals with micro-perspectives from one person and one work tool up to complex organizations, whether these are national or international. The key aims of ergonomic investigation in this area are to create balance and avoid unwanted disturbances, and in the worst case, accidents or catastrophes. The ergonomic component and its approach provide a key to success in realizing this process of balance. Balance is, for example, critical in helping humankind solve the problem of climate change and global warming. The lack of a systematic approach, as suggested by the use of ergonomics, frequently results in suboptimizations. The problems of global warming or climate change cannot alone be solved by one individual science, such as, for example, meteorology. The problem of global warming can only be

handled with sound, concerted, interdisciplinary efforts. Nor will ergonomics per se fully resolve issues of global warming. But ergonomics is an example of an interdisciplinary approach that can handle human technology problems that require an interdisciplinary approach.

The reason for the current lack of success in the application of ergonomics in the macro-area is attributable to the fact that traditional research institutions and universities are in essence disciplinary in an old-fashioned way. The old division of science into different faculties is completely outmoded. Understanding complex problems can never be understood in a good way within a single science. Professor Albert Einstein reminded us that problems cannot be solved with the same thinking that created them. Invariably, whether it is the detail or a macro-perspective view of a problem, better results can be achieved by using broad interdisciplinary methods and involving people from diverse disciplines and perspectives. (We belabor this point as we feel that there are lessons here for the management of service.)

On a micro-level ergonomics has proven to be very useful. When we look at problems of power ergonomics or information ergonomics, we use different types of criteria to evaluate and support the design work. Examples of criteria used include factors that affect quality of life at work and leisure. A typical list of criteria is:

1. Health, safety, and security
2. Functional, durable, easy to use
3. Comfortable versus cozy
4. Aesthetic, i.e., has a good appearance from a subjective/objective/normative perspective
5. Simplistic versus complex
6. Pleasurable and stimulating (including sexuality)
7. Passion, desire, and craving
8. Motivation (i.e., a driving force for behavior)

Sometimes the word *usability* is used in a meaning similar to *ergonomics*. Most commonly *usability* is used in the meaning of ease of use of ICT products. A more formal definition can be found in the work of Brian Shackel, which encompasses the goals of effectiveness, learnability, flexibility, and attitude.[2] These attributes are encompassed in a short question: Will the users be able to work the technology successfully? There are also a number of techniques that have been developed in the field of ergonomics. The physical bodily dimensions of people presented in computer databases or in the former human scale is one example of the design of workplaces. Another important tool for ergonomic design work is the allocation of functions. Figure 5.3 shows the use of allocation of functions.
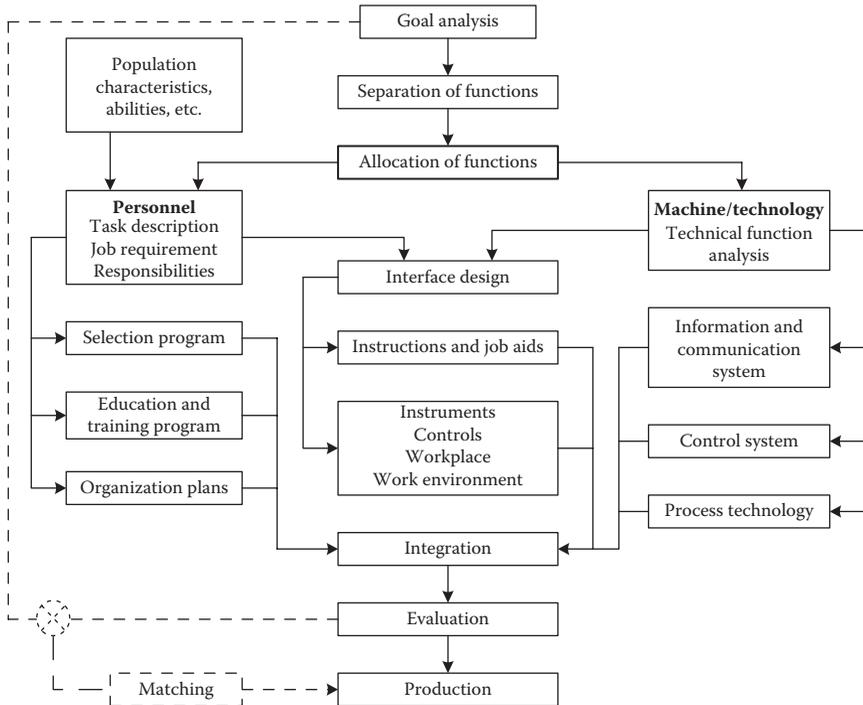
FIGURE 5.3
Allocation of functions. (From Toni Ivergård (1981), *Information Ergonomics*, Lund, Sweden: Studentlitteratur.)

Allocation of functions can vary from different users and designers. The methodology was created during the 1960s by ergonomists in the UK and the United States. Singleton (1974) made an elegant description of the use of allocation of functions.[3] In his unpublished doctoral thesis Toni Ivergård (1972) described retailing from the development perspective of allocation of functions and predicted the move from manually orientated retailing (shop assistants serving behind counters) to highly automated retailing (bar code scanning and automated readers of customers' purchases). In his predictions of the roles and purposes of technology, he came very close to what today is referred to as Internet shopping.

Motives for Physical Design as a Part of Excellence in Design and Practice

Ergonomics as a science seeks to adapt technology to fit people. This fundamental theme pervades our thinking throughout this book. In this
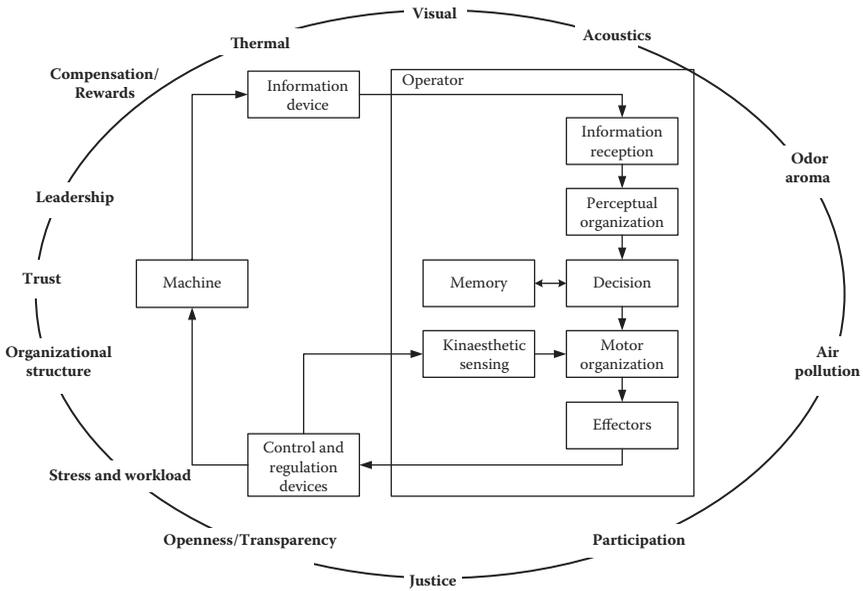
FIGURE 5.4

Environment: physical and psychological/social. (From Toni Ivergård (1981), *Information Ergonomics*, Lund, Sweden: Studentlitteratur.)

current chapter we place excellence of service in a context of macro- and micro-perspectives. This helps in comparing these two perspectives and aids analysis of their strengths and weaknesses. In other sections of this book we discuss in more detail how to obtain a good ergonomic design in order to achieve a high level of service excellence. By definition, good ergonomic design fits all different types of people. Furthermore, ergonomics deals with all different aspects of people-related perspectives. For example, ergonomics considers the characteristics of people, such as their physiological dimensions, their physical strength, and also their psychological and mental perspectives. In terms of context, environmental factors such as lighting, acoustics, and air pollution are also of relevance. Another critical factor to consider is workload. Other important issues relate to the quality of work and levels of experience of employees. Figure 5.4 shows an example of people-technology interaction in relation to information ergonomics with the addition of a number of environmental factors to illustrate the inclusion of environmental ergonomics.

In using ergonomics in the design for people at work, at leisure, or as consumers, a number of criteria are relevant. To ensure good design, these criteria should be adhered to and fulfilled either wholly or to varying degrees. Criteria vary according to context and situation, and can also vary depending on the objective. The following criteria need to be highlighted: health and safety, well-being and comfort, durability and sustainability, and

pleasure and happiness.[4] Sometimes, and particularly in service for leisure and pleasure pursuits, other factors of relevance might be passion, lust, and addiction.[5]

Safety and health are paramount in a number of industry sectors. Transportations systems (airlines, railways, bus services) make a point of emphasizing passenger safety. Airlines are legally obligated to demonstrate safety features of the aircraft before takeoff. Cabin crew announce that all passengers (including frequent fliers) should pay attention to their safety demonstration as safety features (such as the location of emergency exits) vary on different aircraft. Frequent fliers consider certain seats in the aircraft to be safer than others and when booking and at check-in, request their preferred seat (aisle seat, near the exit, over the wing, near the front). Air travel is acknowledged statistically to be the safest form of travel. It is said that airline passengers are most at risk in the taxi ride to the airport. The hospitality industry also emphasizes health and safety of customers as a duty of care. Arguably, in some establishments health and safety of employees may be secondary to other concerns, and in others practically nonexistent. We've seen some kitchens and back stairs (customer-free) areas on several continents where work environments seem positively dangerous. It is said that the kitchen is the location of 90 percent of accidents in the home. In industrial and professional kitchens the accident risk is greater, and there tend to be more people present and involved in a greater number of work tasks simultaneously and under time pressure. Management tends to set strict rules and routines in an effort to prevent accidents in these workplaces.

Somewhat related to health and safety are well-being and comfort. Unlike in transportation systems, failures in well-being and comfort are unlikely to be life threatening, but nonetheless, breaches in levels of well-being and comfort can raise the emotions of users and, in some cases, lead to accidents. And, surprising as it may seem, issues of health and safety and well-being bring public relations crises of almost equal importance. Health and safety influences the operations of many industries, including those that serve food (hotels, restaurants, cafés, clubs, universities and schools, public transportation services). When food causes illness or worse, various governmental agencies and public bodies mobilize resources to address public concerns. For the companies involved, declining public confidence forces them to take steps to manage the crisis.[6] In a range of industries and settings a critical success factor (CSF) is safety of the customer.

Ergonomics as a philosophy is related to humankind's understanding of ecology and the harmony found in the cyclical processes of nature. Nature's processes are in balance. Human production and consumption intervene in this natural balance. The enormous and relatively recent population increase on our planet strongly threatens nature's balance and harmony. From a limited perspective, ergonomics attempts to learn from the balance and harmony that are found in nature. When considering ergonomics of systems for individuals, it is conventional to refer to micro- or

macro-ergonomics. Macro-ergonomics relates to groups of people in relation to a larger system/organization. A macro-perspective of ergonomics deals with a group of people interrelated with some kind of complex technological system. Ergonomics in a micro-perspective deals with one or a few individuals interacting with a specific part of a technology.

Usability/Ergonomics Related to Different User Groups

The ultimate *aim* of any type of ergonomics is to include all different types of user groups. The ultimate *vision* is to make designs to fit all. If possible, we should include all human beings irrespective of age, physical abilities or disabilities, races or nationalities, gender and lifestyle preferences. An important starting point is to use basic anthropometrics (physical measurements of the human body). Other types of data of humans are the function and capabilities of our sense organs and strength and mobility of our muscles. Obviously, consideration should also be given to features of human cognition and learning abilities and restrictions. The ergonomic designer will on this basis define a need to use technology to supplement human restrictions. This is a role of the allocation of functions. People with low or restricted personal mobility need a safe and functional design of streets, stairways, and other access routes in order to facilitate accessibility irrespective of the individual's difficulty in moving around. For example, a city and a building should be designed to facilitate the use of wheelchairs and have handrails to aid access for people who have physical difficulties in personal mobility. People with visual impairments should be facilitated in the environment with suitable aids. These aids could be in the form of tactile sensors or modern equipment, for example, in the form of acoustic or electronic signals or built-in radar equipment that the individual can perceive through the use of other senses, such as touch or hearing. Hearing aids have over recent years been greatly developed to supplement impaired hearing. These are just a few examples relating to allocation of functions and how technology combined with innovations can supplement people at leisure and work.

Rapidly aging societies need a completely new approach. Many parts of the world have seen a very rapid increase in the numbers of aging people, while at the same time there are apparent reductions in the numbers of people who comprise the productive age group (the workforce). This is an incongruous situation that is potentially unsustainable. Over time this situation can lead to economic stagnation and undue social and financial burdens on society. The productive proportion of people between the ages of twenty-five and fifty-five cannot be expected to teach and train the group below the age of twenty-five while at the same time shouldering the responsibility for caring for the ill, infirm, diseased, and elderly who are unable to manage on their

own. In this scenario very few people will remain to provide the means of production for the society. If steps are not taken to rectify this, it will be the actual situation in a number of countries within the next half century.[7] A new approach to designing our living environment can make it possible to a much larger extent for the elderly and the infirm to take care of themselves.

Self-care will also provide and give provisions for a healthier type of aging. This is the basic concept behind prevention of illness and disease and is superior to the concept of curing. Of course, this is not to say that sometimes curing is valuable and necessary. But many times the progression from illness to cure becomes a vicious circle. In the near future people above 100 years old will comprise quite a large group. However, it would be naïve to expect too much productivity from this 100+ age group, especially as they most likely feel that they have contributed to their societies earlier in their lives.

Information and communications technologies (ICTs) will be a useful tool to facilitate usability for inclusion of more or less all people in a rather natural way of living. But sadly enough, new technologies in the form of mobile devices seem mainly to focus on cognition and learning of the young. Compared with older generations (people aged twenty-five years and above), young people have an extremely good short-term memory and related learning abilities and seem able to retain these attributes even in stressful and noisy conditions. The elderly (those over the age of forty-five) are very strong on long-term memories and can make references of lifelong experiences stored deep in the brain. But when attempting to learn new things, elderly people tend to need more time for processing and adapting, part of which is spent on time-consuming trial-and-error processes. In general, older people have slower reaction times and lower levels of dexterity. Their use of keyboards and the positions and speed of finger movements are less precise. Posture and balance deteriorates with age. Elderly people with an active physical life can often compensate and reeducate their physical impairments and deteriorations, in essence retraining muscle memory. Impaired vision and hearing is a natural part of aging. As long as these impairments are not too severe, these two impairments can be overcome with devices such as spectacles and hearing aids. The new world of ICT must include the aging population and their cognition. In this way, the elderly can remain fit and physically active up to much higher ages. Even mental abilities can be developed. The elderly can then continue to contribute to the production of their society. They can also increase their quality of life such that life becomes more pleasurable and fun for society as a whole.

In the time of the Vikings (approximately from the eighth to the eleventh centuries) there was a practice of people committing suicide when they became too old to fulfill active roles in their society. Today, we are more sophisticated and should have other values and possibilities for the process of aging. But to a large extent this depends on what we are doing in society of today in terms of urban planning, building design, and forward planning

to provide for an active productive life of the elderly. As was concisely stated in a United Nations report on aging:

> The challenge for the future is "to ensure that people everywhere can grow old with security and dignity and that they can continue to participate in social life as citizens with full rights." At the same time "the rights of old people should not be incompatible with those of other groups, and reciprocal intergenerational relations should be encouraged."[8]

The World Is Getting Older

Toward the end of the twentieth century, the population of our planet was reported to have passed 6 billion, and by 2005 it had reached 6.5 billion.[9] In its 2005 report, the Department of Economic and Social Affairs of the United Nations Secretariat reported that global population grows at an annual rate of 1.2 percent. A twelve-year period (1987–1999) saw global population grow by another 1 billion.[10] This twelve-year period is the shortest time taken to add another 1 billion people to the population on our planet. An earlier report prepared by the Population Division of the United Nations indicated four critical indicators.[11] These are population aging is unprecedented and is without parallel in human history; population aging is pervasive—this phenomenon is global and every person on the planet will be affected; population aging is enduring—this is the future and humankind will not revert to young populations; and population aging has profound implications for many facets of human life.

Several recent official reports remind us that populations are aging fast in many countries around the world. A report by the Organization for Economic Cooperation and Development (OECD) states that by 2050 some 2 billion people will be aged over sixty years. These data have implications throughout these aging societies. The phenomenon of increasing aging populations needs decisions to be made at government levels concerning healthcare and social support and related resources, such as budgets, care facilities (specialized equipment and appropriately trained care professionals), and frameworks for social and environmental infrastructures. Some of these decisions also need to be made at regional levels, for example, acquiring land and space for the design and construction of housing and accommodation and public transport networks. At present this phenomenon is confined mainly to developed nations such as Germany, Italy, Japan, and the United States. However, countries in the developing world are not much more than one generation behind. The elderly population (generally defined as people aged sixty-five or older) occupy increasingly higher percentages of

total population. In certain developed countries this percentage of the total population is predicted to acclerate.

The population of developed countries is aging fast, and the developing world is lagging behind at most two or three decades. In OECD member countries the fastest-growing segment of the population is older adults (those aged sixty-five and over).[12] Aging represents one of the most important challenges for the OECD member countries.[13] It is projected that by 2030 around 25 percent (i.e., one in every four persons) of these countries will be aged sixty-five years or older.[14] Currently, less than 60 percent of the populations in OECD countries is in paid employment. Employed workers in the age range from twenty-five to forty-nine years of age account for around 75 percent of the OECD population. This is predicted to change rapidly over the coming decades so that by 2050 the ratio of employed to unemployed could be 1:1.[15] This gives rise to a paradox: as the proportion of elderly people in the OECD countries *increases*, the share of the working population is predicted to *decrease*.[16] Governments will therefore need to tackle some major issues and face difficult decisions, not the least of which relates to national income. Fewer persons employed in the workforce will contribute their labor production to gross domestic product (GDP). As per capita work output productivity and income tax contributions fall, there will be fewer people providing national revenue to support nonproducing members of a population (such as the infirm, the sick, and the disabled). An aging population thus represents a threefold risk to national economies at the fiscal, social infrastructure and at the level that affects the well-being of individual members of the population. The ramifications will be both political and social.

Peter Part, chairman of the Working Group on Aging Populations and Sustainability of the Economic Policy Committee (EPC) of the European Union, states:

> The ageing of the population is becoming a growing challenge to the sustainability of public finances in the EU Member States. The increase of the ratio between the number of retirees and the number of workers will amplify expenditure on public pensions and health and long-term care and thus puts a burden on maintaining a sound balance between future public expenditure and tax revenues.

Not only is a rapidly aging population predicted to put into question the possibility of sustained national economic growth, but it also threatens the financial health of the aged themselves.[17] A report by the EU captures the gravity of an aging population on economies: "An ageing population raises challenges for our societies and economies, culturally, organisationally and from an economic point of view."[18] The projected population of the EU in 2060 will be 517 million citizens (an increase of approximately 15 million from the current population). By 2060 it is predicted that about one-third of these citizens will then be aged 65 or over.

The population of Japan is aging faster (at an extraordinary rate) than that of any other OECD member country.[19] The percentage of the population over the age of sixty-five is predicted to almost double in size from around 25 percent today (2014) to around 45 percent by the year 2050.[20] Japanese law stipulates retirement at sometime between the ages of sixty and sixty-five, and because of the post-WWII baby boom, in the next few years Japan will see a large number of the elderly leaving its workforce.[21] The large number of retirees will put pressure on the Japanese healthcare industry, especially the training of healthcare professionals in sufficient numbers to cope with the large population of aged people.[22]

As various official reports affirm, different nations are at different stages of aging. Countries in the developed world (such as OECD member states) have for some time seen the onset of their aging societies and the increasingly large numbers of their citizens aged sixty-five or over. Developing countries are just beginning to see changes in their age demographic. As countries are aging at a different pace, so will the timeframe at which governments and societies prepare and adapt. For all countries, changes in their aging demographic will arrive sooner or later. Nature's biological clock does not run backward. Societies are not predicted to regress to infancy or adolescence. Countries (such as those in the developing world) whose full trajectory of aging has yet to appear will have shorter timeframes in which to design government policies and refine their social infrastructures.

Aging Populations and Sustainable Work Life

In the following section we discuss two alternative hypotheses for an active and high-quality contribution by a workforce of the age range from sixty to eighty years old. We primarily focus on the effects of ICT in relation to an aging workforce. In this area there appear to be two key issues. In essence, do new and emerging technologies (specifically ICT) *support* an aging population in an active participation in the workforce and life overall, or are these technologies setting *obstacles* for active participation by an aging population?

Over the past several decades there has been a research and development focus on ICT, and in particular its relation to issues in human factors (HFs)/ergonomics, with an emphasis on "information ergonomics."[23] The past decade has seen more work conducted on developing the concept of usability as a subsection of HFs/ergonomics to be more specific on people-ICT interactions. There has also been a very large quantity of research and literature directly or indirectly related to workplace control rooms (CRs) and command and control centers (CCCs).[24] This research can to some extent help us to understand different kinds of time-related perspectives of human employees' interactions with and usage (over time)

of different kinds of ICT. Mobile "smart" ICT as a development from mobile phones has partly had a similar process of adding artificial intelligence (AI). But the process is much more dissipated, and it would not be unfair to use the word *disparate* to describe some areas' development of smart handheld ICTs.

It is somewhat easier to track down and explain the process of development over a number of decades in the area of CR/CCC development. But this is not to suggest that this is perfect, as initial perceptions and understandings may be misleading. At first, the usage of smart handheld ICTs might be counterproductive for an aging workforce. Further research is needed in the key areas of human cognition, psychology, and neurophysiology, both in a very broad understanding and in their relation to different generations of ICT and future new possibilities for an elderly workforce. Over the past few decades and on several continents ICT has become an accepted part of daily life for vast numbers of people, particularly for the young. The spread of ICT is currently growing very fast in Asia and in many parts of Africa.[25] Arguably, a key issue related to this application is: Will the next generation of ICT be an obstacle, or will it be an opportunity for a workforce aiming to work at a higher age (60 to 70+)? Here an opportunity would include technology for work purposes (for example, technology to enable people to work more effectively). The so-called instrumental activities of daily living (IADLs) can be improved by design changes to alleviate limitations in abilities to perform some (mainly physical) activities.[26] The European Commission (EU) has carried out and initiated a large number of projects about ICT and aging.[27]

In their book *Technogenarians* Kelly Joyce and Meika Loe describe an elderly person's experiences of health, illness, science, and technology. This book presents an impressive theoretical and empirical understanding of the biomedical aspects of aging bodies, minds, and emotions, and the rise of gerontechnology industries and professions. The book combines two scholarly areas: science and technology studies and sociology of aging and health, and illness. The authors and their contributors investigate the elderly user of technology, and their findings are indirectly related and relevant to the elderly at work.[28] A similar neologism, *gerontographics*, was coined by Professor George Moschis to describe a scientific approach to analyzing and targeting the mature market.[29]

Many new technologies are already on the way to the market: for example, haptic technologies (in the hands and in the body as a whole) and ones that use auditory and odorous inputs. Large multitouch display screens (which may also be in 3D) are useful in environments for senior management and in executive boardrooms. These screens are also suitable for the display of information for education and public venues. Processes such as data warehousing and cloud technology are also interesting and relevant developments. Writer and TV presenter David Pogue describes the new superfast Windows on an iPad as an example of the "long promised world of 'thin client' computing."[30] But, this is all very new, and in general, there is a lack of

experiences (such as personal case histories) and research-based data related to the new ICTs, particularly in relation to aging users.

An Aging Workforce and Technology

It is a fact of life that normal aging processes affect human abilities and functions. There is a marked deterioration in physical attributes, for example, strength, speed, precision, and tactile (manual) dexterity. Also, there are reductions in one's mental abilities, such as different forms of cognition and short-term memory and sensory abilities such as vision, hearing, and touch. In addition, aging tends also to lead to reduced health in general. To a certain extent this trend is being reversed.[31] In terms of technology use, a key issue is: Will an average sixty-five-year-old person be supported by the new generation of ICT (e.g., multitouch and haptic facilities), or will technological development be an additional impediment in the natural process of aging? Obviously, there are many potential obstacles, some of which are evident even now. There are likely to be a number of conflicts and contested issues. Reduced short-term memory might be compensated by motoric memories/abilities. Given the speed with which some societies are aging, there is an urgent need for cross-disciplinary research into the changes of human skill and abilities experienced by aging and the technological development of the new generations of ICT. Most likely there will be a need for personalized solutions and supplementary aids.

Managing and Assuring Ergonomics and Usability

The approach of a modern understanding of ergonomics can bring enormous value for the development of our society. As we have described in this current chapter, ergonomics defines a new approach for how technology can contribute to human life and the survival of the natural world. Science and research need to be based on interdisciplinary understandings and work methods. The old division and segmentation of research and science is outdated. In ergonomics we often talk about systems ergonomics and a systems approach to ergonomics. One of the current authors (TI) applied an ergonomic approach to labor economics during his time as a labor director of the Swedish Labor Administration. This ergonomic approach successfully defined new ways of achieving a good match between supply and demand of work competencies and skills.[32]

In systems ergonomics, there has developed a very good understanding of information to prevent accident and catastrophes. For further development, there needs to be many more audits and other types of follow-up in ergonomics activities. Recently we have been involved in the evaluation control rooms in a very large petrochemical industry complex in Thailand. We note the rapid increases in the design of control rooms and control centers. But a continued, and major, problem seems to be the reluctance to engage in incorporating in the design relevant processes and systems of evaluation and follow-ups. This reluctance inhibits progress. Many large organizations are today using ergonomics in the design of their control rooms for business processes and logistics. However, ergonomics is only being used in a very limited sense in relation to display, design, furniture design, and such. A systems approach tends not to be included.

In the service industry, we can see a trend of making increased use of ICT in its broadest sense. But currently, the usage is at a rather primitive stage, even if there has been an explosion in the number of applications. While customers use mobile technologies, the industry seems to focus on using available technologies (e.g., the Internet) for marketing, sales, and booking. This is widely used for hotels and accommodations, and in ticketing for airlines, buses, and railways. For some time customers have used mobile devices to make reservations, booking, and payment. However, the technology is still very limited in its use for the purposes of organizational integration and usage within the real core business activities. There are noteworthy exceptions. At Gyros, a Greek restaurant recently opened in Doha, customers order from menus displayed on iPad computers. Waiting staff take customers' order on their iPhones. Orders placed by the customers go straight to the kitchen team, thus speeding up the process of getting prepared food to the tables. Aloft hotels in New York and California offer keyless check-in facilities that allow guests to access their rooms without being processed at the reception desk. After a trial period of three months, the technology is planned for all Aloft and W hotels, which are part of the Starwood Hotel and Resort group.[33]

New technologies may present problems because many of the potential users, such as the elderly (the 35+ age group), will have difficulties in using these multipurpose systems designed mainly to meet the needs of a younger generation of users. But at the same time, the elderly are one of the main target groups for this form of usage, and financially, they are often more than able to pay for this type of service if it provides a high level of usability. Currently middle and top managers in organizations tend to rely on their younger assistants and secretaries to interface with technologies on their behalf. Better-designed technology (from a usability point of view) will have the potential to provide better service and increased sales revenues for the service provider (hotels, airlines, intermediaries, ticketing and travel agents, etc.).

The oncoming new facilities in this area will have the potential of a much higher level of usability also suited to elderly users and the very old.

Mobile communication tools can be very useful service equipment for the very old (the 70+ age group), especially those who are physically immobile. Mobile devices can improve comfort and daily security and also provide safety communications in case of accidents. A future extensive use of these handheld mobile devices will require some kind of standardization, and also in-built facilities for living in organizations in hospitals and in general in the town planning. To achieve this in a good way there is a need for a new type of technical-human ergonomical planning in relation to building infrastructure design.

Endnotes

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