MODULE 5

AGE-FRIENDLY PRODUCT DESIGN

UNIT 3

ERGONOMIC PRODUCT DESIGN FOR OLDER ADULTS

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DESIRE

DESIGN FOR ALL METHODS TO CREATE AGE-FRIENDLY HOUSING

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DESIRE will provide professionals in the building industry and home furnishings sector with the tools and skills to apply Design4All methods as an integral part of the design process, with the aim to create or adapt age friendly housing as a solution for the wellbeing, comfort and autonomy of the older adults or dependents at home.

The DESIRE training platform consists of six modules and 21 units.

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UNIT 3 – ERGONOMIC PRODUCT DESIGN FOR OLDER ADULTS

The unit provides an overview of ergonomics, specifically its meaning, related domains, and relevance across various scientific fields. Ergonomics supports an understanding of human variability in terms of performance, stress or tiredness in correlation with environment and product. Method of simulation illustrates its importance in design processes in order to achieve better ergonomic solutions. Various health conditions and needs focused on people with higher age are described. Special aids and assistive technology are presented.

5.1 INTRODUCTION

The term **ergonomics** originates from Greek, comprising the words **ergon** which means work and **nomos** which means law.

Ergonomics or human factors are terms which are used interchangeably or as a unit – Human Factors and Ergonomics (HFE or EFH).

The International Ergonomics Association (IEA) (2000) defines ergonomics as a scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance.

In addition to the IEA exists the Federation of European Ergonomics Societies (FEES) which is a network of various ergonomic societies mostly in Europe.

Experts hold a variety of views on the term ergonomics. Wojciech Bogumił Jastrzębowski presented the first definition of ergonomics in his work An outline of Ergonomics, or the Science of Work based upon the truths drawn from the Science of Nature in 1857.

Lubor Chundela (2001) states that ergonomics is an interdisciplinary systemic field that comprehensively deals with human activity and its links with technology and the environment, with the aim of optimizing its psychophysical load and ensuring the development of its personality.

Miroslav Šmíd (1977) understands ergonomics as a combination or integration of scientific knowledge from biology and scientific technical knowledge or intent to create harmony between man and his biology with the technical world. Šmíd collected definitions of ergonomics from several experts: According to professor Hywel Murell it is a scientific relationship between man and the environment. He understands the term in a broader sense (e.g. machines, tools, organization of work, etc.). Lawrence H. Fogel defines ergonomics as an interdisciplinary science which deals with man and machine systems. Wesley E. Woodson sees ergonomics as an approach to resource creation and design aimed at achieving greater performance, reducing errors and mistakes in use to achieve comfort and reduce fatigue. Alphonse Chapanis considers ergonomics to be an applied field of modern technology, dealing with the construction and design of machinery, work operations and work environments to adapt to human capacity and constraints (Šmíd, 1977).

Étienne Grandjean (1988) defines ergonomics as the adaptation of work to a person.

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At the dawn of industrialization, manufacturers changed to factory production methods that lacked proper tools for the workers, leading to generalised approaches that worsened the ergonomic man-machine relationship. Chief engineer Frederick Winslow Taylor noticed that worker's performance was low because little attention was paid to their skills required for the job. He was searching for a scientific approach to increase the effectiveness of work. Taylor summarized his findings in the book The Principles of Scientific Management. Therefore, his system of scientific management is called Taylorism.

5.1.1 The meaning of care in the design profession

IN A NUTSHELL

Designers should “design for people's needs rather than their wants.”
(Papanek, 1984, 219)

Designers, regardless of focus (product, graphic or interior) operate prolifically within the commercial sphere, in new media, advertising, and marketing, typically mainly focused on graphic design. They are hired to develop advertising and promotional campaigns – sometimes in contrast with values that speak of humanity and care. Design education often does not prioritise or value the benefit of the end user. Society itself is still not at the stage of development when people are naturally considerate to one other. Legislative and social norms are insufficient to present conditions for the development and integration of care for the disadvantaged fellow citizens. Developed countries offer examples of transformations towards a caring populace illustrated in the transition from a careless person to a caring person, from care to universal care, as claims Jiang Ying from Hong Kong Polytechnic University of China (Ying et al., 2018). Designers are often perceived as care professionals as they meet needs through design and user expectations. Therefore, they should pay attention to the principles of human-centric creation, which are also enshrined in the ISO 9241-21036 standard.

According to Ying (2018) an example of an ideal relationship between designer and user can be summarized in 4 points which are the basis of a quality design approach capable of producing meaningful outcomes for people:

1. Designers have to know the meaning of care and cultivate themselves as caring people.
2. Designers convey care to users through design practice.
3. Users perceive and receive care.
4. Users react on care. They may care for themselves and others as a response.

5.1.2 The Ten Principles of Good Design

The goal of designers is the good of humanity; it is their duty to create products that do not endanger people in any way nor harm them. In the early 1980s Dieter Rams set out 10 principles of good design, also called the 10 commandments. He stated that:

1. good design is innovative – innovative design develops in cooperation with innovative technology, but should never be an end in itself;
2. good design makes a product useful – design emphasises the usefulness of a product whilst disregarding anything that could possibly detract from it;
3. good design is aesthetic – the aesthetic quality of a product is integral to its usefulness;
4. good design makes a product understandable – it clarifies the product's structure, at best, it is self-explanatory;
5. good design is unobtrusive – the design should be both neutral and restrained, to leave room for the user's self-expression;
6. good design is honest – does not make a product more innovative, powerful or valuable than it really is;
7. good design is long-lasting – it avoids being fashionable and therefore never appears antiquated;
8. good design is thorough down to the last detail;
9. good design is environmentally-friendly;
10. good design is as little design as possible – less but better.

In the study An Exploration of Designer-to-User Relationship from a Care-Oriented Perspective the designer argues that people can change if they come into contact with good design. Good design evokes a better state of mind in people and provokes changes through experience. Gradually, this can affect their mood and can affect their dealings with other people (Ying et al.,2018).

5.2 CORRELATION BETWEEN HUMAN, PRODUCT, AND ENVIRONMENT

The main goal of ergonomics is to optimise the system of relationships between humans, products and the environment. The most important part of this system is the human being. Ergonomics exists to ensure that the system's affects on humans is positive.

The **Human element** is characterized by physical (dimensions, weight, force) and neuropsychic (intelligence, memory, velocity of reaction) properties.

Product (or machine in the context of industrial ergonomics), is defined as any tool with which we achieve a desired result.

Environment is characterized as a summary of working conditions that affect the person and that results in his neuropsychological and physiological state and consequently, his performance.

DO YOU WANT TO KNOW MORE ABOUT...

To learn more about the environment we recommend that readers refer to Module 4.

Users of any devices should not be divided into capable (healthy) and incapable (with health impairment) because their level of capability is not dichotomic but continual as stressed by Pia Hannukainen a Katja Hölttä-Otto (2006). Their principle is that even a healthy person can be seriously impaired in non-friendly environment.

5.2.1 Physiological and psychological human variability

IN A NUTSHELL

Human performance is not a constant value. It is influenced by several factors: qualification, motivation, relationship to work, quality of work tools, suitability of the environment, etc.). Performance can change during the day, week, month, or a year. It can be also influenced by biorhythm or levels of stress.

At the beginning of every design project, it is very important to understand the target group as well as possible. Many human factors are influential and help us create a better result.

During the week our peak performance is typically in the middle (Wednesday). On Monday our performance tends to be subdued as a result of recovering from the weekend. On Friday tiredness can occur, and as a result we are less focused as we prepare for the weekend. Peak performance during the day occurs usually between 9 – 12:00 and 15 – 17:00. There are two types of people based on their maximum performance period during the day: "early birds" and "night owls". Early birds can easily wake up early and their performance period is moved approx. 1 – 2 hours prior to the majority of people. They are active between the hourse of 5 – 6:00 in the morning. Conversely, night owls remain awake until late at night and become active later in the morning – around 9 – 10:00. Summer months are associated with higher physical performance, while in winter we see increased mental performance.

Biorhythm works as our inner clock. We should understand it and make the most of it. The better we understand it, the more effective we can be and our performance would be more optimised too. We should not fight it because it is an authentic reflection of who we are. Biorhythm does not relate only to the function of the body cells, tissues, organs but it relates also to the psychic – attention, memory, and thinking. The most important element of biorhythm is 24-hour circadian rhythm.

As people get older they tend to be more tired. Tiredness can affect our daily life and behaviour. Two types of tiredness are distinguished: acute tiredness and chronic tiredness. Exhaustion is an extreme case of chronic tiredness. The most common symptoms of tiredness can occur in poorer movement coordination (speed and accuracy of movements), decreased perception by senses (vision worsens) and emotional deterioration associated with growing tension (agitation, anger). We need to take this into account when designing furniture, electronic devices, infographics, displays, control panels, etc. to avoid errors.

Stress occurs in our lives more than we would like to admit. Various factors can contribute to a certain level of stress. The aim of the body's stress response is to mobilize its protective forces to prevent possible damage and to restore physical and mental balance.

DO YOU WANT TO KNOW MORE ABOUT...

There are 3 stages of stress response:

1. **resilience** – a person is still exposed to a stressful situation. The production of substances that help to adapt to stress increases.
2. **exhaustion** – the state of adaptation cannot be maintained, the ways in which the organism copes with stress have been exhausted. It is manifested by fatigue, anxiety and depression.
3. **alarm** – the organism is in a state of increased alertness, the defence against excessive load is mobilized. Physiological reactions are a warning but also a caution.

Stress can be manifested in various ways:

Physical – accelerated pulse and heart activity, higher blood pressure, accelerated and deepened breathing, sweating, slower intestinal activity, increased mental alertness, higher muscle tension, feeling tired, headaches. Hair loss or unreasonable itching of the skin can appear.

Psychological – irritability, nervousness, tension, anger, dissatisfaction, despondency, feeling of inferiority, feeling of hopelessness, helplessness, reduced ability to correctly assess the present situation.

Behaviour – sleep disorders, aggression, distraction, inability to rest, loss of sense of humour, nervous and exaggerated reactions to noise, reduced ability to deal with daily responsibilities, overeating, appetite, increased consumption (alcohol, cigarettes or coffee), insufficient concentration.

5.2.2 Interdisciplinarity of ergonomics

IN A NUTSHELL

An important feature of ergonomics is interdisciplinarity. It uses and applies knowledge from various scientific fields and disciplines, the combination of which can create a product or solution that approaches the ideal.

HFE takes into account physical, cognitive, sociotechnical, organizational, environmental and other relevant factors, as well as the complex interactions between the human and other humans, the environment, tools, products, equipment, and technology.

Examples of professions contributing to the design phase are: anthropology, psychology, sociology, typography, construction, statistics, cybernetics, materials science, production technology, prototyping, medicine (orthopaedics, ophthalmology, neurology, etc.).

DO YOU WANT TO KNOW MORE ABOUT...

If you want to learn more about anthropology we recommend that readers reference Module 1 Unit 2 Ageing and environment through the lens of anthropology.

5.3 DOMAINS OF ERGONOMICS

5.3.1 Cognitive, organisational, and physical ergonomics

Practitioners working in the field of ergonomics often work in specific sectors, industries or application areas. As described by the International Ergonomic Association (n.d), we can divide ergonomics into three main areas: physical, cognitive and organisational ergonomics .

Cognitive ergonomics deals with mental processes such as perception, memory, thinking and motor responses that affect interactions between people and other elements of a system. Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-systems design.

Organisational ergonomics is concerned with the optimisation of socio-technical systems, including their organisational structures, policies and processes. Relevant topics include communication, crew resource management, work design, working time design, teamwork, participative design, community ergonomics, cooperative work, new work paradigms, virtual organisations, telework and quality management.

Physical ergonomics deals with the anatomical, anthropometric, physiological and biomechanical characteristics of humans in relation to physical activity. Relevant topics include working postures, material handling, repetitive movements, work-related musculoskeletal disorders, workplace design, physical safety and health.

Although we divide ergonomics into different areas the science and practice of ergonomics is not sector-specific, but a multidisciplinary, user-centred, integrated science. Ergonomics uses a holistic, systems approach to apply theories, principles and data from many relevant disciplines to the design and evaluation of tasks, workplaces, products, environments and systems. Ergonomics considers physical, cognitive, socio-technical, organisational, environmental and other relevant factors, as well as the complex interactions between people, the environment, tools, products, equipment, and technology.

5.3.2 Microergonomics and macroergonomics

The International Ergonomics Association distinguishes three broad categories of ergonomic specialisation described above. These three categories can be further divided into microergonomics and macroergonomics.

Microergonomics encompasses physical and cognitive ergonomics, which have traditionally focused on human-machine interactions. Activities on work or worker posture analysis, productivity estimation, work equipment design, work physiology, work biomechanics, physical environment, anthropometry, standard time and other topics fall within the scope of microergonomics (Panjaitan et al., 2019).

In contrast, **macroergonomics**, also known as organisational ergonomics, refers to sociotechnical systems theory and is concerned with the design of larger sociotechnical systems (Karsh et al., 2014; Waterson, 2013). Macroergonomics focuses on the design of overall work systems by providing the knowledge and methods needed to improve work systems and thus develop organisational effectiveness and performance.

In 2014 Karsh et al. (2014) proposed a model for the development of cross-level ergonomics studies that clarifies the inclusion of micro-, macro- and meso-level factors in any organisational study. So-called **mesoergonomics** is defined as an open systems approach to ergonomics theory and research in which the relationship between variables is examined at a minimum of two different system levels and in which the dependent variables are human factors and ergonomic constructs (Karsh et al., 2014).

Although ergonomics is usually associated with optimising workplaces, it is not limited to correcting seating in the workplace. When designing the built environment, ergonomics takes into account individual strengths, sensory abilities and other physical limitations that can play a crucial role in making life easier and safer – including for older people. Whether it is to mitigate the impact of a limited coordination ability or a visual impairment, senior-friendly ergonomics can help older people use household appliances or move around the house. For example, an ergonomically designed chair can help seniors relieve back pain. While there are many reasons for slips and falls in older adults, messy homes and inappropriate height of steps are one of them. Therefore, an ergonomically designed home, which considers all domains of ergonomics, can help prevent injuries and possible hospitalisation of older people.

5.4 ANTHROPOMETRY IN ERGONOMICS AND PRODUCT DESIGN

Anthropometry can be classified as part of physical ergonomics. The word **anthropometry** comes from the Greek language, where **anthropos** means man and **metrikos** means measurement. Today, anthropometry is defined as the scientific discipline concerned with measuring the size and mass of the human body, as well as body shape and composition. Anthropometry is broadly divided into static and dynamic anthropometry. Static anthropometry refers to static measurements of anthropometric variables when the body is at rest (standing, sitting, lying down). We can measure skeletal dimensions (length between two joints), soft tissue contours (e.g. waist circumference, fat, skin) and the naked body at rest. Dynamic anthropometry measures distances when the body is in motion. We can measure the reach of the body in space, the manoeuvring space that allows the required movement and the movement space that a person can reach in space.

5.4.1 Anthropometry and design

Anthropometry in design aims to make a space, furniture or any other product convenient for the user. The goal is to produce a design that suits the human body instead of the people adapting to the design.

To ensure that the built environment and products fit the user's body measurements, we must first define the user's body dimensions. In ergonomics, the results of body measurements are often presented using percentiles, where percentiles are whole numbers that divide the distribution of values into 100 equal parts. Each part therefore covers 1 % of the distribution. In ergonomics, anthropometry-based product design usually uses the 5^{th} and 95^{th} percentiles of measurements. The ergonomic design of a room or a product must take into account the minimum and the maximum dimensions of the user. The measurements of the largest user are used when designing door heights, determining legroom between seats, etc. The dimensions of the smallest user are used in designing reach, handle heights, etc. If we are talking about range of motion, we opt for the 95^{th} percentile, if we are talking about reach, we opt for the 5^{th} percentile. If we want to set upper and lower values for adjustable aids, we can use the 5^{th} and 95^{th} percentiles as thresholds. If the complexity of the task requires an extremely customised design, we use the 1^{st} and 99^{th} percentiles. When measuring users' measurements, we can refer to the anthropometric points proposed by the International Society for the Advancement of Kinanthropometry (ISAK). Commonly used anthropometric points are for example:

- Dactylion: tip of the ball of the third toe (the nail is not considered).
- Glabella: the part of the forehead in the middle between the eyebrow arches.
- Acromion: a bony projection on the shoulder blade.
- Pternion: the rearmost part of the heel bone when the person is standing.
- Vertex: the uppermost point of the skull when the head is in the Frankfurt horizontal.

The use of anthropometry in design is intended to ensure that people feel as comfortable as possible. In practise, this means that dimensions must be appropriate (kitchen sink at the appropriate height, doorways and corridors wide enough, chairs sufficiently tall and wide, etc.). Anthropometry plays an important role also when designing products and built environment for older adults.

5.4.2 Anthropometry for older adults in product design

Designers, architects and engineers who create built environments have a responsibility to ensure that the built environment is safe, comfortable, and accessible to everyone. This also applies to anyone with limited mobility, including older adults.

Anthropometric measurements are the first step when we want to make ergonomic products. A specially adapted environment and appropriate aids are required when the user has special needs, e.g. when designing for older adults, disabled people, etc. Hence, anthropometric standards derived from the adult population may not be suitable for older adults because body composition changes as we age. Before designing products for older adults, we need to analyse specific anthropometric databases. In addition, the anthropometric characteristics of older adults can differ significantly between men and women and between older adults with different medical conditions. For example, frail older adults often have lower body mass, or people with heart failure may have edema that increases the circumference of their limbs. Based on the anthropometric data specific to the end- user, we can design the built environment, interior design or assistive devices to specifically meet their needs.

As the proportion of older people around the world continues to increase, it is becoming even more important to create ergonomically designed living environments to ensure safe and comfortable independent living for older people. When designing such living environments, consideration of the anthropometric characteristics of older people is crucial.

5.5 SPECIFIC ERGONOMIC DESIGNS AND AIDS

IN A NUTSHELL

The market provides us with more assistive products and technologies than ever before. But this does not mean that every tool or aid can actually help people. Some products tend to be ageistic, are cheaply constructed, or on the other hand are too expensive because of use modern technology or specific materials. Such products do not improve people's lives but exclude them even more.

We can divide aids into multiple groups: **tools which help with movement** – e.g. handles, crutches, walkers, canes, wheelchairs; **tools for daily routines** – e.g. hair-brushes, grabbers, device for putting on socks, writing aids, medicine dispensers, indicators for visually impaired; **kitchen tools** – e.g. cups, knives or cutlery for people with grasp problems, plates which cannot be spilled, water level measurements.

We have new possibilities, new materials, and we have more knowledge. This could lead us to thinking that every problem in this field has its solution. But the reality is different. Not every aid is useful and even can harm a person when using. Another issue is aesthetics. One might question why aesthetics have such importance for these people. We have to keep in mind that people use their aids daily and they are part of their everyday life, even part of how they dress. In fact many people do not use their aids or prosthetics because they are ashamed of how they look. They may even be more indicative of their disability and/or of limited utility, which can lead to psychological problems or isolation. These problems are the focus of professionals such as anaplastologists, who create personalised prosthetics for missing limbs or other body parts.

In an ideal case, every person would have personalised aids that are fitted precisely to suit their needs. 3D printers or moulds enable us to achieve that, but the associated costs may be prohibitive. If we want to create products which are ergonomically and anatomically correct and are not that expensive, we have to design aids which can fit more than one person and can be customized according to their needs.

Liftware products demonstrate positive combinations of function, ergonomics and aesthetics. Liftware created cutlery for people with tremor or grasp problems. Sufferers can find it difficult holding a spoon without spilling the contents. This may lead to them feeling ashamed about visiting restaurants and socializing because they spill their food, eventually resulting in isolation. Liftware's Level product connects cutlery to a handle with motors and via a flexible joint keep the cutlery in the right position. Meanwhile, Liftware Steady connects cutlery to a larger handle with gyroscopic motors which moves counter the tremor and prevents spilling.

Figure 5.3.1 Liftware Level and Liftware Steady (Liftware)

Figure 5.3.2 Liftware Level in use (Liftware)

Figure 5.3.3 Liftware Steady in use (Liftware)

Unfortunately, many ergonomically correct and aesthetically pleasing products are costly to purchase. Seniors or people with disabilities often cannot afford them. Many people are unaware that special products designed for their needs even exist. Establishing a connection between doctors and medical social workers can be a solution. Doctors themselves are frequently unaware of products or services designed for those with special needs or impairments. Connecting doctors with informed medical social workers, who can directly help people, would be a significant improvement.

5.6 VISUAL ERGONOMICS IN PRODUCT DESIGN

IN A NUTSHELL

Humans perceive most information via their visual sense. Visual impairments require particular approaches when designing and specific rules must be applied in order to communicate information as clearly as possible.

Vision is very important because it is known that sight is of great importance in human life. We perceive 70 – 80 % of the information about the surrounding world through our visual sense, which does not mean that the loss of vision or its significant weakening leads to changed living conditions, which have an impact on further development and overall functioning of the personality and the social environment in which a visually impaired person lives with a disability (Požár, 2012) . The most common vision problems are trouble focusing on close or distance objects and are a normal part of the process of ageing. These problems can be solved by using dioptric glasses, contact lenses, permanent artificial lenses or surgical correction. In higher age groups various causes of vision loss could appear, including injury or progression of a disease.

5.6.1 Age-related vision diseases

IN A NUTSHELL

Any visual impairment has significant influence on daily life. Some people are born blind, some people lose their vision during life, some visual impairments occur as a results of untreated health issue or they can be caused by injury. As people get older various visual impairments can occur.

Age-related macular degeneration –affects the central part of the retina (macula). It results in a loss of a person's central vision, therefore reducing the ability to see fine details. The most common symptoms are blurry or fuzzy vision, straight lines appear wavy, empty areas or blind spot appearing in the centre of vision. Those that suffer from this condition can lose the ability to operate vehicles, see faces or read smaller print.

Cataract – clouding of lens of the eye which is normally clear. It is caused by breaking down of the proteins and fibres in the lens which clump together. The progress is slow and can develop in both eyes but not at the same stage. The most common symptoms are faded colours, blurry or double vision, halos around light sources, trouble with bright lights or difficulties seeing at night. People may have problems with driving, reading and recognizing faces. This disease can be easily surgically fixed.

Glaucoma – eye condition that damages the optic nerve. It is often caused by an abnormally high eye pressure. After the age of 60 it is one of the leading causes of blindness. Unfortunately, the progression of disease is such that one may not notice until the condition is at an advanced stage. Vision loss by glaucoma cannot be recovered. The most common symptoms are patchy blind spots in one's peripheral vision, and in advanced stages this can progress to even tunnel vision.

Diabetic retinopathy – pathological retinal changes in prolonged (5 – 20 years) Diabetes mellitus disease. It begins as a non-proliferative form (microaneurisms, hemorrhage, capillary depletion), continues as a preproliferative form causing the growth of new and abnormal blood vessels in the retina (leading to secondary retinal detachment and complete loss of vision).

5.6.2 Ergonomic principles and aids for people with visual impairment

IN A NUTSHELL

In order to help people with visual impairment precise rules should be applied. They concern font selection, colour combinations, contrast or tactile graphics. By respecting the requirements, we create quality design products which make people's lives easier and better.

FONT

When creating text or graphics for people with vision impairment, we should choose a proper font to communicate the information as comprehensibly as possible. Italic, cursive and decorative fonts are typically not suitable. One should preferably aim to use Tiresias family of TrueType sans-serif typefaces, or as an alternative from sans-serif group Calibri, Arial, Helvetica, Verdana or Tahoma. Tiresias is a font family which was designed considering the needs of visually impaired people at the Scientific Research Unit of the Royal National Institute of Blind People in the UK.

The European Blind Union suggests the use of a minimum font size of 12 points for standard documents, potentially even up to 16 – 20 points font size. They also recommend against the use of all-caps for continuous text.

Braille font is used by blind people. It is a special font created by Louis Braille, French educator and inventor. It consists of 6 points divided into a grid of 3 points each in 2 columns, called the braille cell. This is the size of the fingertip of regular index finger.

COLOUR COMBINATIONS

The vast majority of aids (digital magnifiers, computer software) have accessibility pre-sets for the most suitable colour combinations according to the characteristics of vision diseases. These combinations are:

- blue background with yellow;
- black background with yellow;
- white background with black;
- black background with white.

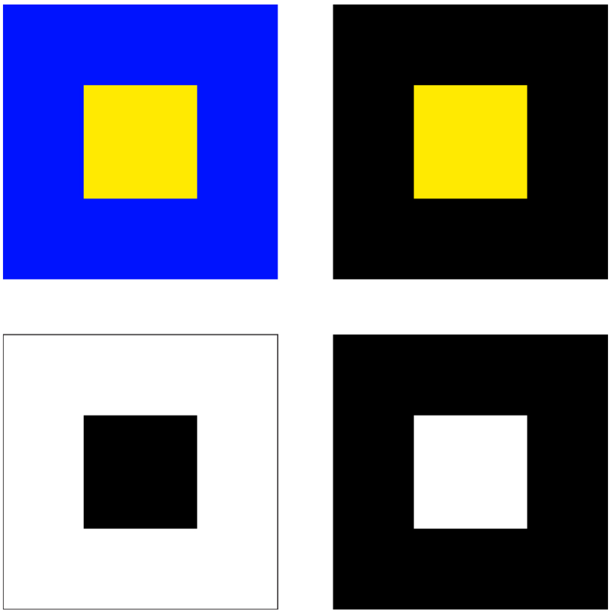

Figure 5.3.4 Most suitable colour combinations (Šimková)

Apart from colours, the next most important thing is contrast. When creating a graphic it is recommended to convert it into shades of grey in order to determine whether the contrast is sufficient or not.

TACTILE GRAPHICS

Tactile graphics deals with relief graphics for the visually impaired. This includes graphic editing of texts (segmentation, line skipping, framing, underlining, highlighting, dividing paragraphs), textbooks (displaying geometric shapes, graphs, parts of the human body) and images (illustrations).

When creating images some specific rules should be applied. For example, objects, animals, or people must be presented anterior or from the side. One should avoid the use of perspective effects because this leads to comprehension challenges for visually impaired people. For example, when one creates a relief image of a chair in perspective, a visually impaired person may “read” it with their hands and discover that two legs of the chair appear shorter. But when they touch the real chair, they discover that all the legs are the same length, resulting in confusion.

PRODUCTS

The first product to be widely available for use by people with visual impairments are magnifiers. The most basic examples are analogue devices which come in various formats and level of zoom. Beyond this are electronic or digital magnifiers, typically around the size of a smartphone. A user can set an exact level of zoom, change colour combinations or even make photos of documents. The lens is accompanied by a light diode. There are also desktop/table video magnifiers. These consist of a display, camera and control panel and can provide magnification to a whole book or magazine . Their usage can extend beyond simply reading – they can also facilitate knitting, the completion of crossword puzzles, painting, and writing, etc.

Figure 5.3.6 Desktop electronic magnifier Optelec ClearView (YouTube)

Figure 5.3.5 Portable electronic magnifier Zoomax Luna S (Tyflocomp)

When using computers people can use a braille keyboard or have access to a range of accessibility various software. Software features include text to speech tools which are able to read out loud text documents and electronic books and assist with desktop and Internet navigation. Unfortunately, synthesised voices can be difficult to understand for novice users but experienced users have fewer difficulties. Software can also zoom the screen or change it to a desired colour combination. Examples of the most common software include Jaws, Fusion and ZoomText.

For orientation in space, white canes are often used. Newer technologies offers additional functionality, including the use of radar and vibrations to detect and assist people to avoid obstacles. In some public spaces or buildings acoustic beacons are installed which can help with orientation via acoustic information and instructions.

To help with daily living various aids have been developed. For example, water level measuring tools help people to pour correct volumes of liquids into cups or pots. Various measuring tools for kitchen are in use. Colour identifiers help with task such as getting dressed or searching for specific items. Money dividers or identifiers helps to differentiate denominations of coins or bank notes. To assist with telling the time there are 2 types of watches – analogue ones which have tactile points on the watch face or digital with synthesised voices that speak the time information out loud.

Figure 5.3.7 Tactile and speaking watches (Tyflocomp)

For writing in Braille special typewriters are used. The most widely used mechanical writer is the Perkins Brailler. It is easy to use, durable and multipurpose for any kind of document.

Since the modern technology era, electronic writers and displays are available – we can speak of a form of alternative keyboards. For example, the Braille Display Focus 40 Blue can be connected via Bluetooth to 5 devices (iOS and Android smartphones and tablets or computer). It contains similar keys as a mechanical writer for writing and a Braille line for reading text.

Figure 5.3.8 Perkins Brailler (Perkins)

Figure 5.3.9 Focus 40 Blue (Freedom Scientific)

DO YOU WANT TO KNOW MORE ABOUT...

Specific principles for designing graphics for visually impaired in architectural space can be found in Module 3 Unit 2 Multisensory environment and wayfinding in subunit 2.7 Signage and graphic symbols.

5.7 CONTACT COMFORT AND HAPTICS IN PRODUCT DESIGN

Tactile interaction between people and elements of the built environment, such as furniture, is often deprioritised, with visual aesthetics often taking precedence over tactile interaction between people and elements of the environment. However, contact with different materials can have an impact on personal comfort and thus on physical and mental well-being.

Comfort is by definition a subjective perception. There are different definitions of comfort and discomfort. Some authors see comfort and discomfort as antonyms, while Zhang et al. (1996) point out that discomfort is primarily associated with physiological and biomechanical factors that cause feelings of pain, soreness, numbness and stiffness, while comfort is primarily associated with aesthetics, feelings of relaxation and well-being. When we talk about contact comfort, we usually also refer to haptics, which is the science of transmitting and understanding information through touch.

Comfort is the most important feature that should be considered when developing a new product. When analysing the comfort of a product, we can distinguish different types of comfort, such as musculoskeletal comfort, thermal comfort, contact comfort, etc. Contact with different materials can cause different physiological reactions and influence comfort. For example, contact with acrylic plastic can cause unpleasant sensations associated with a significant increase in blood pressure (Ikei et al., 2017). In general, contact with materials such as marble, tiles and stainless steel has been shown to increase feelings of coldness and discomfort, while no such effect has been found for contact with wood. We can apply these findings to design process. For example, handles in corridors made of wood have better tactile properties than handles made of aluminium. Consequently, older adults would walk down the corridors and use the handles more often. Various assistive devices for older adults, also called haptic technologies, are also based on haptic perception (Arab et al., 2015). When designing products for older adults, the decline of haptics sensitivity and the sense of touch should be taken into account.

It is important to consider the contact comfort and haptic properties of materials used in product design for older adults. To promote the well-being of older adults in the built environment the correct choice of materials and consideration of the declining haptic sensation of older adults should be part of the design process.

DO YOU WANT TO KNOW MORE ABOUT...

If you want to know more about the anatomy of a hand and tremor we recommend to reading Module 2 Unit 2 – subunit 2.4.3 Peripheral neuropathies and tremor.

5.8 METHOD OF SIMULATION AS AN IMPROVEMENT TOOL FOR DESIGN PROCESS

IN A NUTSHELL

At the beginning of every design project, it is very important to understand the target group as well as possible. Theoretical knowledge is important but sometimes insufficient. Various combinations of health impairments or age-related difficulties are difficult to account for solely theoretically. By simulating these conditions one can gain new perspective on the issue – the result of such a process are products that better reflect user requirements.

Simulation exercises have proven crucial at the beginning of every design process. When designers create products for people it is vital to understand not only the anatomy of the human body, but also human needs, difficulties and various impairments. Methods of simulation even increase levels of empathy. After such experiences designers are equipped to suggest better design solutions. The goal is to ease people's lives and assisting everyday situations. It is particularly important when designing for an impairment that the designer themself is unfamiliar with.

The use of simulation improves and accelerates the quality of the student's educational process if it is systematically integrated into the pedagogical process. Litwin (2018) of the University of Buenos Aires understands simulation as a teaching method aimed at familiarizing students with situations and features similar to those in the real world, but which are synthesized.

In our research project Importance of Simulation in Design Process (Šimková, 2017), we tried to determine if the simulation method is suitable for designers and how much the process can affect them. To determine the suitability, we chose Neil Fleming's VARK questionnaire (1987). This questionnaire determines the best learning method for a person. One can be Visual, Aural/Auditory, Read/Write and Kinesthetic learning type. Results confirmed that the simulation method is a suitable learning method for designers. To determine how much can the usageof simulation tools affect their design Emphatic Experience Design (EED) method was used. This methodology consists of five stages:

1. defining designer problem;
2. defining typical users;
3. designing of emphatic experiences/exercises;
4. simulation of emphatic experiences/exercises;
5. generating concepts.

At first participants were briefed about people with various impairments and which aids they use and based on that re-designed those existing aids. Later they were able to experience how a person with such impairment feels through simulation exercises. After this experience they were given the opportunity to change their design if necessary. Every designer made significant or minor enhancements. Most of them were surprised when they experienced new or unexpected perceptions, even gaining higher levels of empathy. One participant stated that at first the whole simulation experience was fun, but after she realized that people with such impairments could not control the manifestation of their disease she would feel pretty hopeless and embarrassed in society.

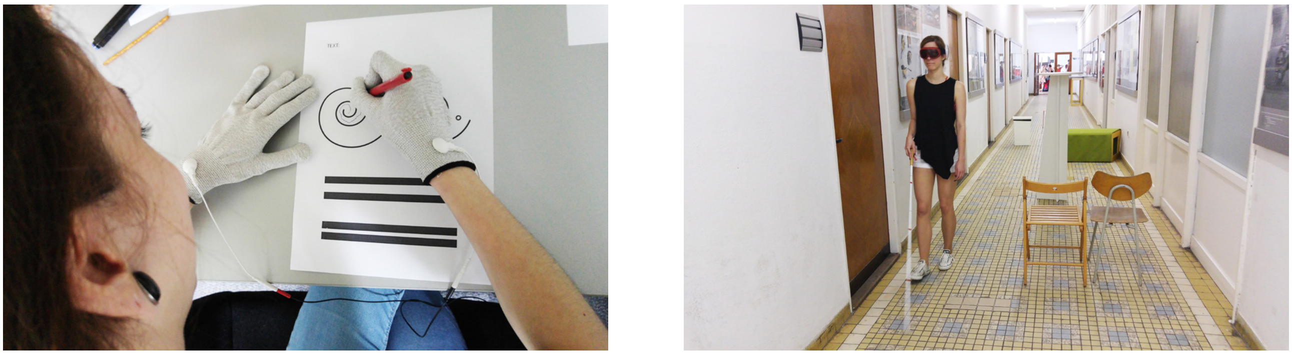

Figure 5.3.10 a, b   Simulation exercises (Šimková, 2017)

Various types of simulation tools are available. For example, simulation glasses simulate visual impairment, earphones simulate hearing impairment or tremor simulator simulates various tremors. Simulation suits were developed to combine various impairments together. By wearing them a person can instantly get a preview how their body might behave at the age of 70 and can experience difficulties connected to higher age. However, such Instant Aging methods can present those undergoing the simulation with a type of shock, which may not be shared by people whose health problems or limitations have developed over a long time period and to which they have been able to adapt.

Figure 5.3.11   Simulation suit Genworth R70 – detail of the carousel changing of visual degenerations (Genworth)

Figure 5.3.12   Simulation suit Third Age Suit (Ford)

DO YOU WANT TO KNOW MORE ABOUT...

One of the first simulation suits was created in 1994 by the Meyer-Hentschel institute and is called AgeSimulator. Scientific results from many international research projects and interdisciplinary knowledge of for example gerontology, ergonomics, physiology and medical technology were applied when creating the suit. The manufacturer concedes that ageing is an individual multidimensional process and precise age simulation is not possible. Therefore their newest simulation suit is called AgeExplorer – a suit that explores the process of ageing. It is used in many countries and institutions (Meyer-Hentschel Institut, 2017). This suit consists of a single (overal) or two-piece (top and bottom) combination with orthoses on knees and elbows to restrict movement. Under the suit is a 10 kg vest. A shield similar to a helmet is placed on the wearer's head restricting peripheral vision and an orange visor placed over the eyes that alters the visible colour spectrum and blurs vision. Headphones reduce hearing sense by up to 30%. Gloves simulate reduced tactile sense and on the back of the hand is a specific surface to imitate arthritis.

5.9 ASSISTIVE TECHNOLOGY AND PRODUCT DESIGN

IN A NUTSHELL

Ambient assisted living (AAL) use information and communication technologies to enable older people stay active longer, socially connected, to make their life easier and more independent. In addition, they also help their family and caregivers to monitor health parameters in order to provide quick help if required. Lonely people can benefit from the possibilities of technology that helps them to communicate with friends and loved ones even if they cannot be present.

Aging is a multidimensional process that presents individual circumstances and challenges to each person. People are living longer and should have the opportunity to maintain high standards of health and quality of life for as long as possible. Additional years of life can provide opportunity for further education, starting a new hobby or returning to long-neglected passions.

Many older people live alone and have very little social contact. Some do not have many friends, and circumstances may present challenges for making new friends. Causes of social isolation can be various, such as children/family living abroad, being ashamed of their physical or mental health condition, etc.

To maintain one's independence various technologies have been developed. But the development is so fast that some people may be unfamiliar with new technologies or be unaware of their existence because older people are generally considered as late adopters. Despite the fact that many technologies have been developed to help, some people do not know how to use them, are afraid of them or are frightened of losing their privacy.

EMERGENCY SYSTEMS

Nowadays many people have a smartphone. There are many apps and gadgets which can be paired to provide essential information about people's needs. We can configure these to receive notifications if a person falls, has a low blood pressure, or low level of sugar. These parameters can be crucial if anyone is in need while away from caregivers.

All caregivers (medical facilities or family members) can be informed of noteworthy occurrences and they can provide appropriate assistance or escalate the request for help. Such technologies can be bracelets, rings, wearable devices or patches. Some garments can automatically contact emergency services in specifically defined situations.

Emergency situations can also emerge within the household. Obvious examples include outbreaks of fire, gas or water leaks, or even burglary. All these situations can be monitored via technology and one can take necessary steps in response. Even in non life-threatening situations, smart technologies may enable one to close windows, deactivate cooking devices, or lock doors, interventions that an elderly person may forget.

MEDICATION MANAGEMENT

Older people are more likely to use various medications. It is not uncommon that they may forget to take a dose or be uncertain whether they have medicated already. Automatic medicine dispensers can play a vital role in such situations. These systems dispense individual doses of medicine at a certain time and activate alarm sounds to attract the attention of the person taking the medication. If a person fails to take the dose a caregiver can be notified via a corresponding app.

Figure 5.3.13 Breyslet – bracelet which monitors person's vitals and has integrated button for emergency situations (Breyslet)

ASSISTIVE ROBOTS

Personal robots can be very helpful. They can provide a useful solution for people who do not get along with others and cannot be placed in caring facilities. Other people want to maintain an independent life without requiring dedicated care. Robots can provide 24-hour companionship, but many people are uncertain, anxious or scared of them or understand them only as a piece of technology. Designers are trying to find a balance between how a robot should look to be more appealing and trustworthy to older people but at the same time not making them too real to confuse people.

Robots can help in situations such as assisting mobility, retrieving dropped objects, detection, personal grooming, shopping, etc. Specially programmed robots can even help with food preparation. Others are used for telepresence or monitoring when relatives or caregivers are not present.

Some robots were created to be only a person's companion and take part on emotional well-being. They usually look like pets or toys. For example robot PARO was created in Japan to use in hospitals or in nursing homes and looks like a baby harp seal. It has various sensors capable of perceiving human presence and its environment.

Figure 5.3.14 PARO – therapeutic robot (Robots)

Figure 5.3.15 PARO used in therapy (PARO Robots USA)

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