



MODULE 4

AGE-FRIENDLY BUILT ENVIRONMENT
- INTERIOR

UNIT

1

COMPLEX COMFORT AND AGE- FRIENDLY
INTERIOR DESIGN

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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 1 – COMPLEX COMFORT AND AGE-FRIENDLY INTERIOR DESIGN

1.1 HUMAN-CENTERED SPATIAL DESIGN AND BIOPHILIC DESIGN

IN A NUTSHELL

Prevention of civilization diseases- reduction of environmental stress and dynamisation of environment/more spontaneous and intentional movement and supporting of socialisation in combination with providing privacy and individualisation adaptable to the current situation; are the most important principles of well-being in the built

environment. They should be reflected in the spatial arrangement and equipment of housing spaces. The space for older adults should offer alcoves and shelter corners with a view into the space. In older age lifetime is this need of controlling own space is extremely important.

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A crucial role here has the application of biophilic principles, where belongs also the application of natural materials, especially wood.

Wood with its natural and emotional impact through visual, tactile, and olfactory interaction also has positive objective properties of the healthy microclimate, such as great contact comfort, improvement of room acoustics, the regulation of air humidity in a space, reduction of VOC (volatile organic compound) emissions (“sink effect”), and

antimicrobial properties due to the absence of surface treatment with all kinds of surface finishing, e.g., oil, wax, or varnish. Unfortunately, without them, wood is sensible in a more extensive way to surface defect, irregular patina due to wear and obsolesce, and maintenance in a wet way is crucial. The standard use of cleaning disinfecting agents guarantees that surfaces are visually clean and without microorganisms. In the case of a “naked wooden surface”, it is not simple, but it is possible to find alternative solutions (Kotradyová, Vavrinsky, 2019).

Our behavior, life prospects and general well-being, and everyday social interactions are directly tied to the natural and built environment. How spaces and their structures control our everyday use has consequences, which are far-reaching – potentially impacting our long-term mental and physical health and at the same time they can directly influence the process of aging.

Homo sapiens has lived in buildings for only thousands of years, but 6 million years ago he lived in wild nature surrounded by all sorts of natural dangers that forced him to look for supportive natural and later built environments for survival. The nervous system was developed according to these conditions, and it has remained almost the same also in contemporary human beings (Hildebrand, 1999).

Why did Homo sapiens prefer certain places and avoid others? The earliest human beings need food, water, and protection to survive, but also new challenges to develop further.

The basic human preferences caused by seeking spatial arrangement supporting survival and further development are expressed by the five archetypal characteristics of a supportive environment by the American architect Grant Hildebrand (1999), based on knowledge from evolutionary biology and his own research, and they are prospect refuge, attraction, peril and complex order).

The built environment influences human behaviour, well-being, and health in the long-term interaction. Space arrangement, furnishing and program of space can help to prevent or to diminish behaviour and phenomena in society with a negative impact on public health, including social exclusion and isolation, one of the most crucial problems of older adults.

Older adults had in the past stable and respected roles in the family, living in bigger multigenerational families, neighbourhoods, and communities, based on unity, solidarity and belonging – related to traditional socio-cultural values. By increasing individualism, modern nomadism of productive population and by practicing self-optimization and hedonism in societies with advanced economies, traditional family systems are endangered. It is reflected in the space organisation.

Human beings can perform in an “autopilot” regime thanks to cultural stereotypes and habituation/somatisation (Kaščák, 2005; Hall, 1968; Kotradyová, 2015). Instinctive behaviour comes into conflict with western cultural habits. Habits and stereotypes are becoming more important or relevant in the 3rd and 4th ages, whereas the 3rd age is an active part of mature life, and the 4th age is the part of life when older adults need daily health and social care. We use these terms to distinguish between two different life situations.

Built environments for long-term stays should be supportive and stimulating in an appropriate way, preventing environmental and social stress – helping us to be in a state of complex comfort or well-being. We set the assumption that the body-conscious designing or design for well-being applied consciously in public and private spaces for long-term stays can help not only improve public health but also foster better relations to social and natural environments.

We can state that at least 3rd age older adults of the upcoming digital future will want and have to work (due aging is prolonged working age and leaving for being retired) with computers and other digital equipment used for work and entertainment thus we have to speak also about the supportive built environment for working of older adults. In the 4th age, more health care and social life issues are relevant.

For staying healthy and active up to the 3rd and 4th age the prevention of civilization diseases is extremely important. By exploring those in the research project within BCDlab.

To handle the topic of aging properly it is necessary to speak about the prevention of civilization diseases already in youth and middle age. By exploring this topic, we have found out two most critical issues related to most civilization diseases – **a lot of environmental stress and lack of movement**. Thus, dynamisation of the environment and reduction of environmental stress can lead to the prevention and healing of civilization diseases (Fig. 4.1.1 and 4.1.2). Bringing into living, working and public spaces appropriate volume of natural physical activity and freedom of choosing body positions, including preventing the sedentary culture and reduction of too intensive environmental stimuli in the long term stay spaces can contribute to public health. In the projects of BCDlab there were elaborated also recommendations for preventing and healing the single diseases (Kotradyová, 2014).



Figure 4.1.1 Dynamisation of the environment, including more physical activity in daily life, can prevent and positively influence most of the civilization diseases (Kotradyová, Petelen, Žúžiová, 2013)

Understanding of comfort – well-being in the western culture relates to many stereotypes that we are questioning and re-evaluating with our research studies. Ergonomics/human factors in our research are understood in a broader context and relation and it is enriched by knowledge from other sciences dealing with the human body and behaviour in relation to the environment. So, the summarized knowledge

from studies from anthropology, ethnology, environmental, cognitive, social and cultural psychology, neuroergonomics, environmental ergonomics, physiology, and own experimental research has led to the formulation of 11 principles of spatial design for well-being (Kotradyová, 2018, 2019). These principles are now being here specially reconsidered from an older adults' needs point of view.

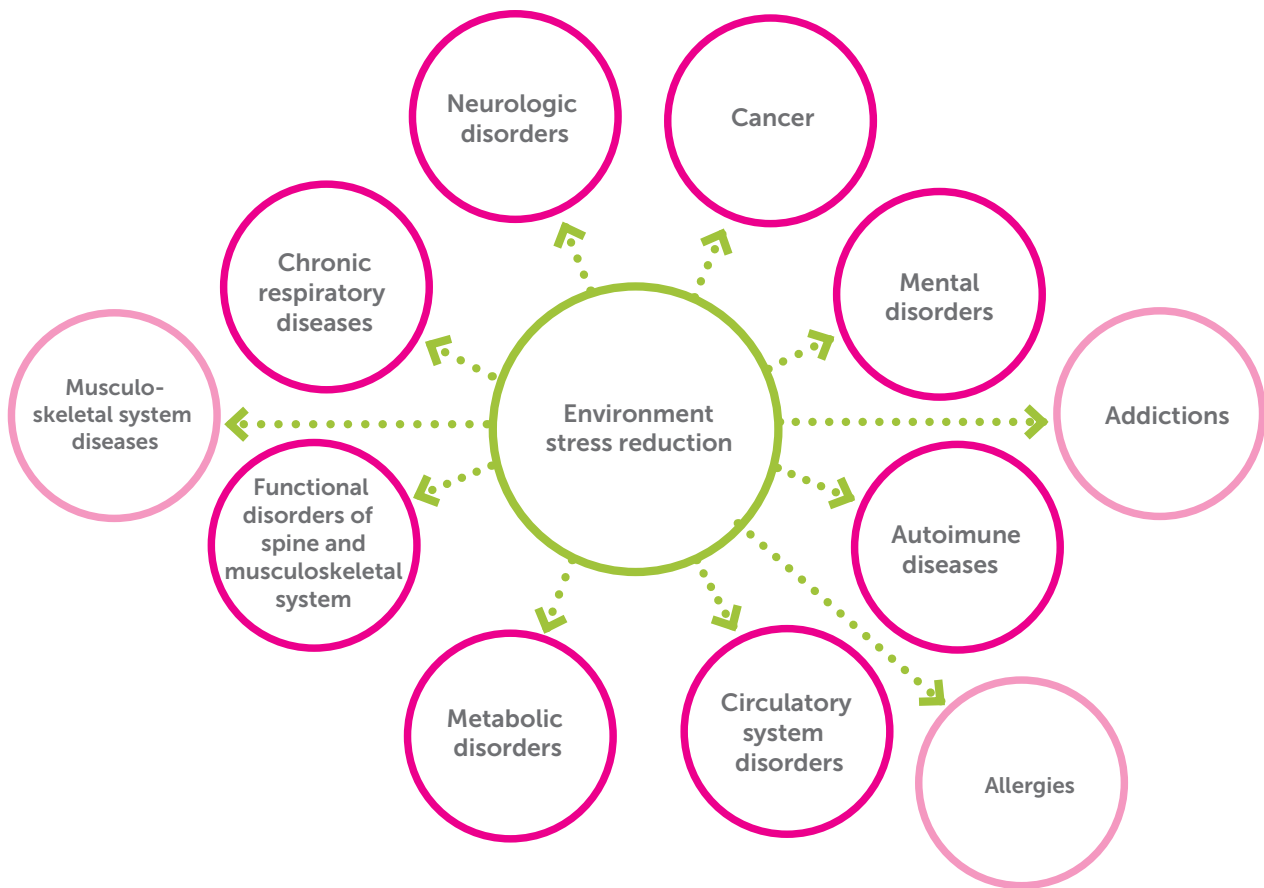


Figure 4.1.2 Relation of civilization diseases with environmental stress (caused by (e.g., noise, inappropriate space arrangement and choice of materials, etc.), its reduction can contribute to public health (Kotradyová, Petelen, Žúžiová, 2013)

1.1.1 Eleven principles of spatial age-friendly design

First, it is a feeling of safety, combined with the competence to manage risks and attractions, this need is also about seeing and being seen, whereas humans need to have this status under control and this need is strongly culturally related.

A feeling of safety is a basic condition for a feeling of well-being. In terms of safety in the macro-environment, it means e.g., being away from endangerment from nature elements or being in a safe quarter of a city with low crime. In terms of the microenvironment, it means being safe at home – with less endangering of privacy and territory or feeling safe from any mechanical or technical /static endangering – like unstable objects. Even though in western

cultures, vision is the dominant sense especially by entering a space (Hall, 1968, Palaasma, 2005), safety is a matter of all senses. Our visual culture precludes stimuli from other senses, but nonetheless, they are more connected to human unconsciousness, where instincts initiate an intuition that can give us “warnings” in risky situations which lead us to change our behaviour.

This topic is related to our ability to be oriented in space while disorientation can cause people to feel stressed and unsafe, which can lead to potential aggressive or psychotic behaviour. It is closely related to the topic of wayfinding, analysed in Module 3, Unit 2.

The feeling of safety is supported by these features:

- the ability to protect one's own private space,
- the presence of a physical barrier behind one's back – e. g., in the form of a wall, screen, or piece of furniture that unconsciously grants protection from attack from the back,
- visual contact with (overview) the entrance to the space and control over territory,
- horizontal structuring of space,
- lower ceiling,
- panoramic outlook over surroundings,
- presence of limits and barriers that are flexible and adaptable due to the situation.

In this relation, it is important to have the competence to manage risks and attractions where it is possible (Fig. 4.1.3).



Figure 4.1.3 Different arrangements of risk management in one house in Bratislava, Photo: V. Kotradýová, 2008

The feeling of safety is also connected with the second principle is **an appropriate ratio of prospect and refuge** and the possibilities of their combining according to the individual needs and the actual situation. The combining of prospect and refuge is a very basic need of Homo sapiens. It is connected with an instinctive search for situations and environmental settings where a person has a protected back and at the same time an overview of the actions and events in the space. It is about the possibility to see and be seen that is controlled while being culturally conditioned. It is essential for a person to alternate between staying in a safe controlled place (with socialization possibilities or searching for resources perspectives) –

alternating between privacy, socialization, and challenges. The space for older adults should offer alcoves and shelter-like corners with a view into space.

A 3rd important feature of spatial design for well-being is **contact with the outdoors**, at least visually supports to set and maintain healthy biorhythm and the saccadic movement of eyes, during the day and the possibility to control it – which is in many working environments still strongly undervalued.

Another critical issue, 4th principle is the need for **personal and intimate space**, one's own territory, and the competence to occupy and

control it. In older age, this means respecting someone's territorial borders with higher empathy.

This is very much related to the 5th principle: the **need to switch between privacy and socialisation** according to the current situation. It very much depends on a space arrangement supporting or postponing communication, about which a lot of knowledge is found in proxemics and anthropology. For older adults, it is very much appreciated if they live in a mixed heterogeneous community considering age and social status. This state provides the feeling of inclusiveness.¹

A sixth principle is an **appropriate scale and harmonised proportions** of buildings and their indoor housing and working environment – spaces for a long-term stay of humans whereas the need for appropriate scale for housing and its furnishing is becoming even more relevant in terms of age-friendliness where it is counted with an appropriate volume of living space, whereas two little personal space connected with high density can stress, but at the same time too big space to occupy can increase the feeling of loneliness and the discomfort is even supported by the rational reasons connected with higher energy costs and maintenance demands.

A 7th principle and important characteristic is the possibility (or competence) to allow **attachment** – be attached to a place or products, to have the competence to adapt, personalize, to mirror, extend the Self into the occupied space where a human lives, and thus gain a state of self-identification. This feature is important for the human as a cultural creature, but also as an animal that needs its own marked habitat.

This is strongly connected with the 8th feature – respect and foster cultural sustainability through giving the local identity to the built environment.²

Securing identity in private and public spaces and preventing loss of **local identity** mostly because of globalization and especially in the environment for older adults.

This means applying local materials, principles, concepts, and stories into the material culture – architecture, housing, and product design that are connected also with a lifestyle.

For older adults, it is highly appreciated when being in an environment that reminds them of and supports local culture and place of origin, in the level of own private space, but also community and public space. If it is not possible to do on a general level, it is at least possible within own territory – a micro-environment that is under own control as was mentioned in the previous principle.

Another need of older adults is to be a valid part of participatory and activities and projects in the local community. Older adults can share their wisdom, experiences, and deeper cultural values, especially with younger generations thus to support socio-cultural sustainability. They are the best source of information for ethnological and anthropological research, “heroes” of oral history stories. This can secure identity in private and public spaces and prevent loss of local identity often caused by globalization.

Especially important for providing healthy physical built environment is the 9th principle: **body consciousness** by creating solutions for furnishing objects and in-built elements as well. Characteristic is the possibility to prevent pain and body deformation due to using of inappropriate products and environmental settings; freedom in choice of body position and using of body conscious products are needed here. The most important agenda is preventing of long-term sitting and sedentary culture also by healthy people.³

¹ This topic is further analyzed in the chapter 1.2.2 Encouraging social interaction with building/interior design, prevention of social isolation

² This topic is further analyzed in the chapter 1.2.3 Individualisation and personalisation of spaces, allowing attachment

³ This topic is described further in detail in chapter 1.3 Solutions for active ageing, prevention of sedentary culture and support of motor skills



Figure 4.1.4 Concept for living room with freedom to choose body position, concept of sociologist and body conscious design advocate Galen Cranz, (Galen Cranz, 2000)

The tenth feature is the **appropriate environmental stimulation** – selection of adequate sensual stimuli- not too stimulating an environment in spaces of long-term stay. By older adults it is a providing of right ratio of stimulating and relaxing special arrangements, that are very much connected also with the 11th principle – using **natural materials more often**. The last is the choice of appropriate materials, where natural materials are priority and can also influence the measurable parameters of well-being.

In general, it is possible to declare that the more natural materials in their authentic form and more nature-evoking solutions present in the immediate surrounding environment of a human being during his long-term stay, the better. The explanation comes from evolutionary biology and psychology. Natural materials are beneficial to the nervous system, which responds to something well known to it, which does not need to be constantly “scanned”. A nervous system that is linked to our unconscious and genetic memory responds to natural materials, is gently stimulated, and can easily be recovered.⁴ Natural materials are part of our archetypes in our traditional material culture. Their use significantly contributes to the creation of a supportive environment and an environment

for well-being. However, in order to have an ecological meaning, it is necessary to apply natural materials from renewable raw materials from sustainable forestry or agriculture.

First, we examined wood as the most used natural, domestic, and renewable material for interior design. In the project APVV 0594-12 Interaction of man and wood⁵, we examined wood itself and its application as a phenomenon of a supportive environment and a “healthy interior”. The benefits of wood were in last year investigated by several scientists (Burnard, Kutnar, 2014, 2015, Fell, 2010). Its positive properties for the comfort and health of the human, for the internal environment, and its microclimates can be formulated as follows:

- enhances and softens the overall atmosphere of the space, supports cosiness,
 - is aesthetically attractive – its shape and surface properties – the colour of the wood is warm to earthy, but not “hot” like red or orange; its colour, texture, structure, tone can also soften and “warm” otherwise cold lighting in space,
 - excellent haptic properties – contact comfort, especially with softwoods,
- wood-based materials are well-formable and adaptable to the shape of the human body, thanks to the comfort features, they allow good control over the body's positions and the possibilities for their variation,
- maintenance is possible through renewability – e.g., weaker wet-wise maintenance can be compensated, for example, by surface sanding,
 - has antibacterial properties, especially pine, larch and oak (Kotradyova, Vavrinsky at al.,2019),
 - produces a pleasant sound in human interaction, and wood-based materials can enhance acoustic interaction when used on acoustic panels,
 - regulates air humidity and emissions,
 - smell (particularly coniferous species) and “taste”, in direct and indirect interaction –

⁴ This topic is further analyzed in the next chapter 1.1.2 Principles of Biophilic Design.

⁵ On behalf of the project was held Koloquim Interaction of man and wood, 2016, we were presented most of the project outputs, Proceeding book is available at http://bcdlab.eu/udalosti/pdf_kolokvium_clovek_drevo_19_07.pdf

- e.g., when food is served on it,
- is part of our culture, collective unconscious, and is in genetic memory.

Most of these strengths of wood are effective when the wood is free from any surface treatment. The weakest aspect of natural materials, just in connection with their surface treatment, is their maintenance by wet methods (water and strong detergents).

The application of wood significantly supports the regenerative effect of the built environment

on the nervous system of humans and can contribute to recovery in healthcare facilities. Anyway, there are many stereotypes that are again using natural materials in their authentic form in the healthcare environment because of their maintenance.

But there are many examples e.g., in Austria or Swiss where natural authentic wood or clay are used at least in less exposed zones of health care facilities (Fig. 4.1.5, 4.1.6 and Fig. 4.1.7). This principle is connected with the biophilic design.



Figure 4.1.6 Hospital in Feldkirch, Vorarlberg, where clay is used for main bearing wall., photo: Veronika Kotradyová



Figure 4.1.5 Exposition about Home health care in Frauenmuseum in Hittisau, with using of natural wood and solutions more reminding "home" environment, Vorarlberg, photo: V. Kotradyová



Figure 4.1.7 Addition of Hospice in St. Gotthard pass in Swiss, where the authentic Swiss pine is used for interior furnishings, architects Miller&Marantamc (Ignant)

1.1.2 Principles of biophilic design

IN A NUTSHELL

Humans evolved in a natural environment, and so even today contact with nature is essential to the health and wellbeing of our species. Most people have little contact with nature because they live in cities and spend most of their time indoors. We can bring them closer to nature through biophilic design – design that aims to connect people and nature in the built environment. Biophilic design advises connecting people to nature using three approaches: direct experience of nature, indirect experience of nature, and experience of space and place. Direct

experience of nature means bringing people into direct contact with various elements of nature, such as plants and water. Indirect experience of nature refers to bringing people into contact with representations of nature, including natural materials and natural shapes and forms. Experience of space and place relates to experiencing spatial features characteristic of the natural environment that have improved human wellbeing; for example, creating a space that gives people a sense of security while allowing them to view the surroundings.

The modern human -- homo sapiens – has existed for about 200000 years, and the evolutionary roots of the species go back even further into the past, connecting to earlier human species and other animal species. Considering the hundreds of thousands of years of human evolution, most of what consider normal today is a relatively recent occurrence in the history of our species. Food has been grown on a large scale for only 12000 years, the city has been invented only 6000 years ago, mass production of goods and services has begun only 400 years ago, and electronic technology exists only since the 19th century. Our bodies and minds evolved in the natural world, not in the artificial world that we have recently invented (Kellert & Calabrese, 2015). Perhaps the easiest way to understand this is to look at how people react to pictures depicting different dangerous situations. They tend to have strong aversive reactions to dangers coming from nature, such as snakes and spiders, and much milder reactions to dangers coming from the modern environment, such as electric wires and handguns (Ohman, 1986). On the other side of the coin, we see positive reactions and outcomes when people are exposed to favourable aspects of nature.

People consistently rate the natural environment as preferred to the built environment, and after spending time in nature, they generally feel and function better. Their emotions tend to become more pleasant, their cognitive performance improves, and their physiological activation decreases, indicating less stress. The tendency of people to connect with natural systems and processes is called biophilia. It is thought that this inclination has become biologically encoded because it has benefited people throughout the long history of human evolution, which has largely occurred in a world dominated by natural features such as sunlight, water, vegetation, and animals. Less natural environments, with industrial production, technologies, and modern cities, have been present for only a small part of human history. As a result, most of our emotional characteristics and problem-solving capacities are still closely tied to the natural systems in which humans evolved as a species.



Figure 4.1.8 People evolved in natural environments – environments dominated by sunlight, water, vegetation, and animals (Pexels)

We sometimes view our separation from nature as a sign of progress and civilization, but we tend to forget that people's physical and mental wellbeing importantly depends on the contact with the natural environment even in the modern times. People were in contact with nature by default throughout most of the human evolutionary history, and we should view contact with nature as a necessity, not a luxury (Kellert, 2008). The distance between people and nature is especially problematic nowadays, as more and more people live in cities and spend most of their time in indoor spaces, with little contact with nature.

Contact with nature gives people more than just momentary good feelings, lower stress, and improved ability to perform cognitively. People living close to open natural spaces report fewer health and social problems, regardless of whether they live in rural or urban areas, their level of education, or their income. Both direct contact with elements of nature, such as exposure to vegetation,

and indirect contact, such as viewing images of the natural environment, can enhance healing and recovery from illness and surgery. Communities with higher-quality environments report superior quality of life and greater neighbourliness. Importantly, people tend to feel and function better even when nature is brought to indoor spaces. For example, people working in offices with natural lighting, natural ventilation, and other natural features tend to perform better, experience less stress, and feel more motivated (Kellert, 2008).

Contact with nature can be beneficial especially when it becomes a repeated experience. Unfortunately, most common designs of the modern built environment tend to alienate people from nature. We often see nature merely as a resource to be exploited or as an enjoyable but not essential recreational amenity (Kellert & Calabrese, 2015). Separation from nature is evident in most aspects of modern human life, including manufacturing, education, healthcare, urban development,

and architecture. The built environment has deprived people of beneficial contact with sunlight, fresh air, vegetation, scenic views, and other elements of nature. Some believe that much of the modern built environment is so depriving it reminds of the barren cages of the old-fashioned zoos, which we now avoid because we consider them inhumane (Kellert & Calabrese, 2015). This is not an inevitable by-product of modern city life, but rather a flaw in design. We can choose to act on our innate inclination to connect with nature or we can choose to disconnect from the natural world: just as we have chosen to design the built environment in a way that distances us from nature, we can also choose to design it in a way that brings us closer to it. We can bring people and nature closer together with biophilic design – design that fosters beneficial contact between people and nature in the built environment (Kellert, 2008).

Biophilic design aims to address the shortcomings of the modern built environment. Its goal is to create a habitat for people that considers the needs of people as biological organisms. This is meant to enhance people's health and wellbeing, including physical outcomes, such as lower blood pressure and fewer illness symptoms; mental outcomes, such as increased satisfaction and motivation; and positive behavioural outcomes, such as improved social interaction. The goal is to achieve that while taking care of the natural environment – to support an ecologically robust and sustainable natural community.

Biophilic designs adheres to several principles (Kellert & Calabrese, 2015):

- it requires repeated and sustained engagement with nature,
- it focuses on the evolutionary adaptations to the natural world that have advanced people's health and wellbeing,
- it encourages emotional attachment to particular places,
- it promotes positive interactions between people and nature to improve the people's

relationship and responsibility for the human and natural communities,

- it encourages architectural solutions that are mutually reinforcing, interconnected, and integrated.

We will explore how to apply biophilic design through three categories: direct experience of nature, indirect experience of nature, and experience of space and place. Direct experience of nature refers to actual contact with natural features, such as sunlight, plants, and water. Indirect experience of nature refers to a representation or image of nature, a transformation of nature, or patterns and processes characteristic of the natural world. Examples include photographs, artwork, natural materials such as wood and wool, and ornaments inspired by natural shapes, forms, and processes. The experience of space and place refers to spatial features characteristic of the natural environment that support health and wellbeing of people, such as the integration of parts into a whole.

Features of biophilic design are experienced through many human senses, with the visual sense being the dominant sense through which people perceive and function. The mere sight of natural features such as plants triggers a variety of cognitive, emotional, and physiological responses in people. Despite the dominance of the visual sense in people, other senses are still important – nature can be experienced by hearing water, touching plants, and smelling flowers, for example. Spaces should ideally be designed to provide multisensory stimulation.

DIRECT EXPERIENCE OF NATURE

- **Water** is a very basic human need and usually evokes strong positive reactions in people. It is particularly attractive when it is in motion and stimulates multiple senses, when it can be seen, heard and touched. Contact with water in the built environment can occur through views of bodies of water, fountains, aquariums, artificial wetlands, and other approaches.
- **Sunlight** is consistently cited by people as a preferred feature. This is not only because people rely heavily on their vision and need adequate lighting to function normally, but also because the special characteristics of daylight are usually more liked than those of typical artificial lighting. Natural light can be brought into indoor spaces through large windows, glass walls, reflective colours and materials, and other design elements.
- **Plants** are essential to people because they provide food and shelter, and people find plants aesthetically pleasing. Plants are one of the easiest ways to directly experience nature in the built environment. Although a single plant can go a long way, vegetation should ideally be abundant. Green walls, roofs, and facades are design approaches that feature plants prominently.
- **Animals**, like plants, have been an essential part of human existence, providing food, resources, protection, and companionship (though occasionally they have been also sources of fear and danger). Integrating animals into the built environment can be challenging, but there are ways to do so. Design strategies that provide positive contact with animals include feeding stations, green roofs, gardens, aquariums, aviaries, and creative use of modern technologies such as webcams, video, binoculars, and spotting scopes. Another approach is to incorporate animals into the built environment in representational form, for example, through art and decoration.
- **Natural landscapes and ecosystems** consist of interconnected plants, animals, water, soils, rocks, and geological forms. People tend to prefer a savannah-like

environments, which have been important in human evolution and include landscapes with spreading trees, an open understory, the presence of water, and forested edges. Self-sustaining ecosystems that are rich in biological diversity can be particularly satisfying. Examples include artificial wetlands, forest glades and grasslands, green roofs, and simulated aquatic environments. Still, even other types of natural environments tend to be preferred to artificial scenes. The built environment can bring people into contact with the natural environment through views, observation platforms, and direct interaction.

- **Fire** has enabled people to harness energy and transform objects from one state to another. The satisfying experience of fire in the built environment can be achieved through fireplaces and hearths, and also through simulation, by creatively using light, colour, movement, and materials.



Figure 4.1.9 Plants are one of the easiest ways to connect people with nature in indoor spaces (Pexels)

INDIRECT EXPERIENCE OF NATURE

- **Representations** of nature can be made through the use of photographs, paintings, sculptures, murals, videos, computer simulations, and other means, which can depict plants, animals, landscapes, water, and other natural features.
- **Natural materials** tend to be preferred over human-made materials. Natural building and decorative materials include wood, stone, wool, cotton, and leather, which can be used for a variety of objects and furnishings, both indoors and outdoors.
- **Colour** has long been important for survival of people-it enhanced the ability to find food, resources, and water, detect danger, improve mobility, and more. People tend to be attracted to flowering colours, sunsets, water, sky, and other colourful features of the natural world. Artificial colours, especially bright ones, should generally be avoided in favour of muted, “earth” tones characteristic of soil, rock, and plants. Bright colours should be applied cautiously and limited to emphasising appealing environmental forms such as flowers.
- **Natural light and air can be simulated** in the built environment. Artificial light can be designed to mimic the qualities of natural light, and air in interior spaces can simulate the qualities of natural ventilation through variations in airflow, temperature, humidity, and air pressure.
- **Natural shapes and forms** can be reflected in, for example, leaf- or tree-like patterns on columns, shapes of plants on building facades, and botanical motifs used as decoration. Even the animal kingdom can provide inspiration – honeycombs are a particularly common example. Sometimes plants, animals, or other aspects of nature cannot be directly represented by shapes and forms, but it can be enough to create atmosphere just by avoiding straight lines and right angles and instead using oval or curved elements, for example, with arches, vaults, and domes.
- **Variability and information richness** that characterize the natural environment

can positively stimulate human senses, and this can be implemented in the built environment by providing many options and opportunities. One way to achieve this diversity is to represent nature's ability to respond adaptively to changing conditions, for example, by using materials that change over time. Another way is to use natural geometries, such as fractals, in which a basic shape repeats itself in different but predictable ways.



Figure 4.1.10 Nature can be experienced indirectly through arched openings with patterned decoration in earth color (Pexels)

EXPERIENCE OF SPACE AND PLACE

- People like the option of **prospect and refuge**. Prospect refers to revealing views of surroundings that allow people to identify both opportunities and threats, while refuge refers to place that provide safety. Design features that support this include providing views to the outside and to other interior spaces and places where people feel secure and sheltered.⁶
- The environment should strive for **organized complexity**—it should be variable and diverse but contain elements that are connected in a coherent way. The parts of the built environment should form an **integrated whole**. This can be achieved through sequential linking of spaces as well as clear boundaries and is reinforced by a central focal point. Spaces should relate to clear and recognizable transitions, such as corridors and doorways, and areas that link indoor and outdoor spaces, such as porches or patios. Clearly identifiable pathways promote mobility and a sense of security, while unclear pathways can lead to confusion and anxiety.
- Humans have evolved as territorial beings to have better control over resources and more security. This territoriality is reflected in an **affinity for familiar places** and can be reinforced through cultural and environmental means. Designing the built environment to incorporate local culture and ecological features (e.g., native plants) can make residents feel more connected to place.



Figure 4.1.11 Transparent windows can give people a sense of security while still allowing them to see their surroundings (Pexels)

⁶ this theory is also included in the chapter 1.1.1 Eleven principles of spatial age friendly design under principles 1.+2. FEELING OF SAFETY; PROSPECT AND REFUGE.

1.2 SOCIAL INTERACTION AND PRIVACY

IN A NUTSHELL

The feeling of privacy in a housing space is possible to create not only with dividing walls with doors but also through appropriate space arrangement – with furniture and interior elements, e. g. a piece of storage furniture, a drawing curtain in a space, bigger indoor flowers, lighting, etc.

On the other hand, encouraging social interaction with the building/interior design can be a tool for the prevention of social isolation. First of all, it is a sociopetal space arrangement – supporting socialization and communication, like offering small corners or protected areas where it is possible to sit together face to face or at least in 90 degrees turning position. Offering interfaces between privacy/intimacy and being seen and socialize, between private and public or semi-public space, like e.g. bench at the front door.

Important for preventing social isolation is if visitors feel welcomed and well in the facility, there arises bigger physiological and social comfort during visits and a higher frequency of visits.

Concerning individualisation and personalisation of spaces, allowing attachment, the need to adapt and decorate own private space is important for self-integrity and self-identity. It helps to feel at home and not like in a hotel or “institution”.

Individualisation according to anthropometry (the individual body measures) and to the contemporary physical and mental state and the adjustability or availability of different sizes of chairs, stools and other equipment are convenient.

As it was already mentioned in chapter 1.1.1 by the 11 principles of spatial age-friendly design, the need for **personal and intimate space**, one's own territory, and competence to occupy and control it and at the same time in older age there is strengthened the **need to switch between privacy and socialisation** according to the current life and event situation.



microspaces for older adult

1.2.1 Enabling feeling of safety, privacy, and zoning

Controllable entry to the space is the first condition for the feeling of safety and intimacy. Naturally, the best tool to create privacy is to have own door that is possible to close and have under control. Having protection behind own back is particularly important for feeling

safe, it is possible to provide it with a small furniture element that has a certain protective effect, at the same time it is good to allow socialisation by having others sitting face to face (Fig. 4.1.12).

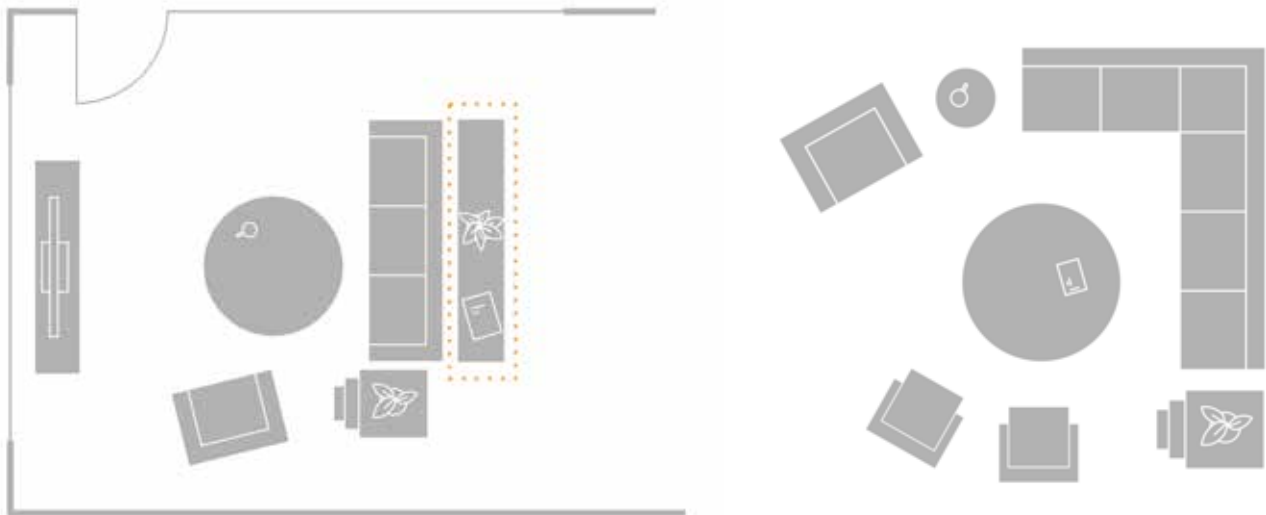


Figure 4.1.12 Having protection behind own back is particularly important for feeling safe, with a small furniture element that has a certain protective effect, at the same time it is good to allow socialisation by having others sitting face to face (Kotradyová, 2019)

It very much depends on a space arrangement supporting or postponing communication, about which a lot of knowledge is found in proxemics and anthropology.

How to support the feeling of inclusiveness in interior spaces? For older adults, it is very much appreciated if they live in a mixed heterogeneous community. The ideal setting is a feeling of safety, feeling of belonging and privacy with a prospect and in the common space to have the possibility to meet spontaneously the other members of family or community in the transitional or social spaces. Also here, there is a strong need to create protected spaces, corners, alcoves (Fig. 4.1.13), creating cosy atmosphere, where can be set own proportion of privacy and socialisation,

or the setting “to see and being seen” or its variations. In ideal state these cosy corners have a pleasant view or contact with greenery – “practicing biophilia”, with good access to window with natural light and sitting near window. Modern minimalistic architecture often lacks these kinds of settings. It offers full panorama views, but less protected areas. That is why in the post-occupancy phase there are spontaneously created little interventions by users, to create the protected areas and cosiness with different kind of furnishing, that authors do not always appreciate. It is better to count with it in advance already by the architectural and interior designs and to find solutions how to offer different spatial solutions that are adaptable to the individual need for privacy and socialisation.



Figure 4.1.13 Housing and public spaces with protected coves or corners, window seats or so-called bay windows provide a feeling of home and cosiness, intimacy, and contemplation, ideally combined with the possibility of prospect-with views outside (Kotradyová, Simonton)

ZONING NECESSARY

Due to saving living and energy cost many older adult live in a minimal living space, in own or rented apartment, or in a room in some daycare facilities where is a minimal living space – very often one room, shared with adult child, partner, friend, roommate or caregiver. By all these cases, in general, it is convenient to divide the only living space for private and social zone or for day and night zone, or for active and passive zone, if there is available one room that must be universal.

On the Fig. 4.1.14 are examples of the room setup that is like the one needed as a student room, especially in the upcoming generation of older adults that will use the online environment and work in home offices.

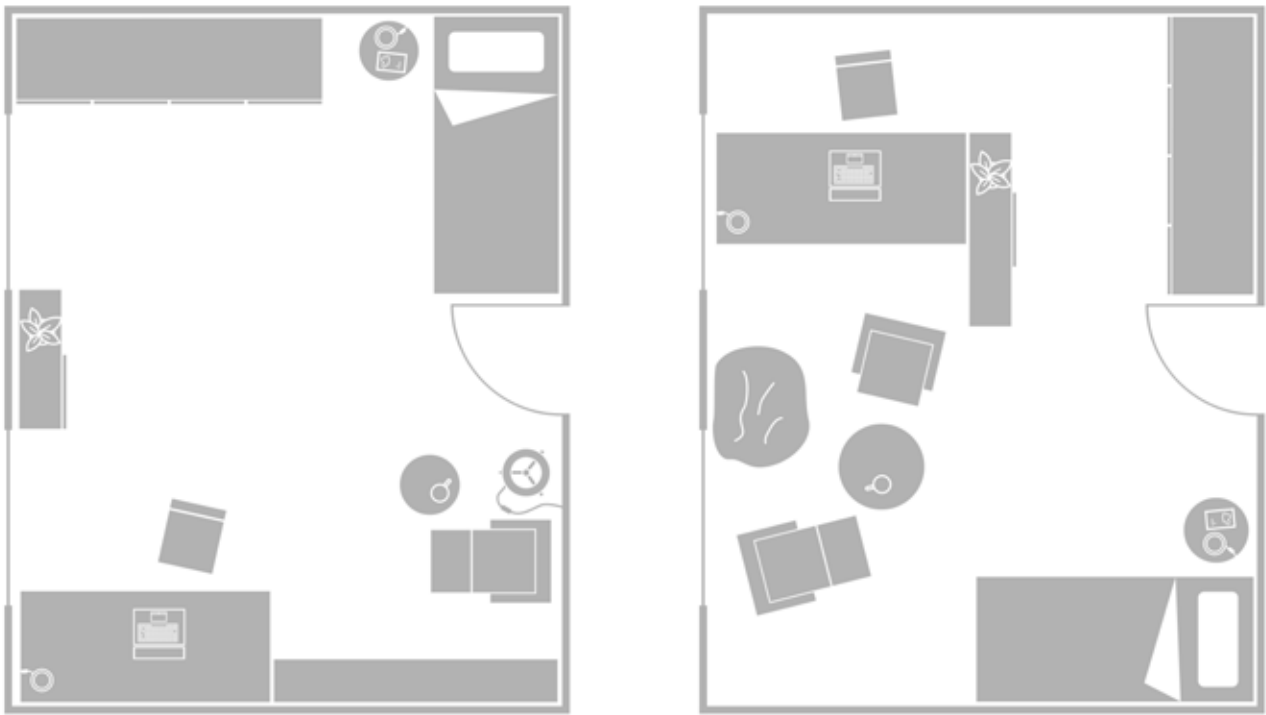


Figure 4.1.14 Space arrangement where is put a value to the working place- a home office, is equivalent of student/scholar room, left example is a more introvert setting, the right one is more extrovert (Kučerová, Kotradyová, 2019)

In the day care centres with common social areas, it is good to have active zones where any kind of interaction and communication is tolerated and then the silence zones where it

is possible to be in quiet and to concentrate on some silent activity or just being with Self and to practice contemplation or meditation.

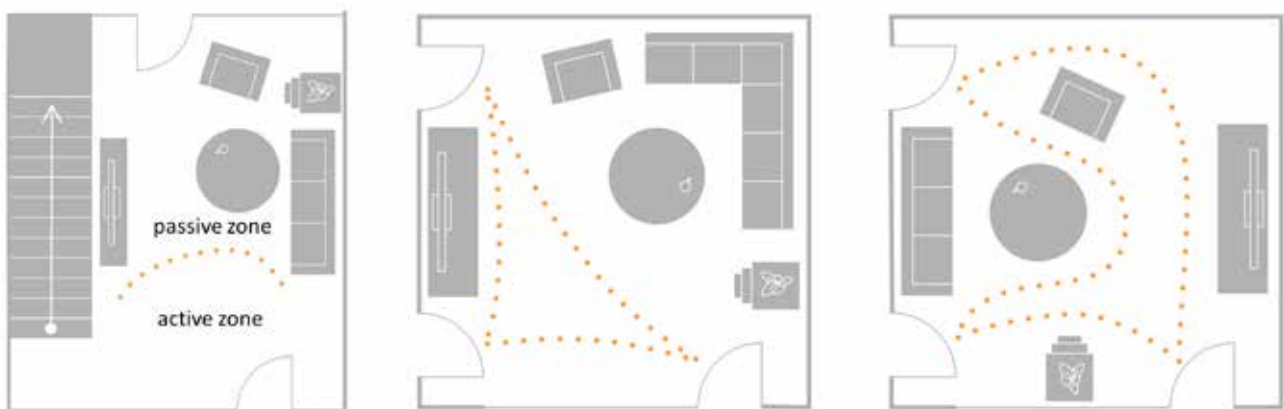


Figure 4.1.15 In a living room it is good to have active (transitional) area and the passive zone where the sitting elements, tables, small storage furniture and accessories are places so that moving around the single pieces of furniture does not means to go through the obstacles, (Kučerová, Kotradyova, 2019)

In the same time, it is necessary to maintain for each human being living in the space possibility to occupy and to control own territory and to

have elements to adapt and to separate or to join for socialisation, easy movable and adaptable furnishings (sociopethal arrangement).

So, the need of privacy and intimacy works on more levels/scales of space. In the interior space in general it means choice of room or corner to stay in, but in the micro-space (the space that surrounds human bodies) it is occupying a favourite chair or couch in a favourite place, and especially comfortable bed that provides subjective satisfaction that increase the quality of sleep.

To work with these personal needs, people can use all available elements to mark their territory, but it can help to have easy movable and resettable elements like easy shelves, caravans or moving hangers, stands, home flowers, or even chairs that create an indirect barrier. The light barrier is created by the possibility to draw the curtain, just for this reason there has to be already railing on the ceiling prepared (Fig. 4.1.16).



Figure 4.1.16 Sliding curtain in a space like a dividing element is one of the solutions how to create zoning in a room where must be many distinct functions at the same time (Homeedit)

Naturally, the choice or presence of a co-living person is crucial for creating comfort/wellbeing in the living space of any housing system, especially the one predestined for day care. By creating good combination of personalities living in one space with individual space preferences and especially the need of privacy and socialisation. This means coming to consensus or agreement by being quite or loud, comforting physiological needs concerning temperature and air quality, opening, or closing windows etc. Here the spatial needs can be similar, complementary, or opposite/in conflict, so a very smart and empathetic approach and “social engineering” is needed. Also, the stage of physiological signs of ageing is here the decisive fact, if to combine people with special needs and healthy one that can assist or combine people with similar diagnosis that have understanding to each other but need more assistance from other person.

In every case, universal design and adaptable housing philosophy are useful, to create an environment that can accommodate anybody and is suitable for healthy and at the same time for people with any kind of disabilities.

Very personal is intimacy in the bathroom and WC, especially if this facility is shared with more inhabitants living in more bedrooms, to have shelves or closed cabinets with intimate hygienic kits and tools needed for daycare.

Shared facilities and their maintenance is often an occasion for arguments thus every member of the household can have different imagination about the cleanliness and its order/system. The own territory like storage space or place to hang towels is good to be clearly separated for each member.

1.2.2 Encouraging social interaction with building/interior design, prevention of social isolation



Social and physical inclusion like the prevention of social exclusion and loneliness can lead to the reduction of health problems that often have mental / psychosomatic backgrounds.

Since the 2nd half of the 20th century a big transformation of approaches is happening to the older adults living and housing in modern societies it is hard to get back to the full traditional understanding of multigenerational housing. Despite it, is possible to create housing concepts for co-living of more generations – by conscious social and material environmental design that encourages a different range of behaviour leading to socialization, combined

with sufficient privacy, very much depending on the social and political system, cultural differences, and personal economic situation.

Social inclusion can be directly or indirectly supported by the built environment. On macro-environment solution, it can be found in providing a diversity of multipurpose buildings with mixed programs that are getting together people of different ages and occupations and multigenerational housing concepts as well, where switching between being at home and attractive and assessable public space in a flexible way is possible, and ration of privacy and socialization through natural meetings and gathering is adaptable.

On a microscale sociopetal space arrangement – supporting socialization and communication, with possibilities of getting together can have a positive impact on inclusion. To share and support each other on an everyday basis in common shared spaces that are easily available. The exchange of knowledge, insights, and energy flow between older adults and children/youth is a contribution for both sides. Creating and providing attractive and accessible common shared housing and public and semi-public space around housing or daycare units. Without fences or other visual and physical barriers. With the contemporary



Figure 4.1.17 Examples of sociofugal (avoiding communication) and sociopetal (supporting communication) sitting arrangements (Kučerová, Kotradyová, 2019)

trend of supporting concepts of joined smaller housing units with the possibility to have home care, it is crucial to have not only shared space to meet and socialize naturally by passing through and getting to some point of everyday use but also a private room with a size that accommodates also visitors where intimacy is a must but in the same time it supports socialization and communication, including meeting family that can feel comfortable and welcome during their visit. An important issue is to have good access to sanitary equipment- a safe and welcoming shower, to feel clean and to have self-confidence by socializing.

The space concepts are more successful in the prevention of social isolation if they are supported by appropriate programs – based on neighbourhood community, professional daycare and social workers and volunteers, e.g., a program of getting seniors out for a ride on special bikes adapted for pushing a wheelchair that started like a project in Netherland and is spread all over Europe already. The most critical issue here is adaptability – flexibility in housing concepts is needed, to reflect instant social and personal changes of the inhabitants of any household. At the same time, it is also necessary to count on obstacles like stereotypes and fear of change.

Social isolation can arise not only by staying at home but also in institutional care, while closer and more fruitful inter-human relationships are possible rather in smaller groups.

Small housing units within cities with infrastructure, with access to common spaces, greenery and available small gardens, provide more occasions to meet and to share. Fig. 4.1.18 is a social housing settlement in Bamberg, Germany was built on a previous brownfield, consist of more different sorts of wood structure houses with different housing programs and typology that creates a setting with common green yards, by entrance into the housing units, there is the high-quality interface between outdoor and indoor supported by possibility to sit on the wooden bench and support socialization with neighbours. With its concept, it reminds lining in the village and provides more occasions to spend free time together.



Figure 4.1.18 Social housing unit in Bamberg, Germany, small unites build from wood, mixed program and social groups, benches by the entrances, small gardens, (Kotradyová)



Figure 4.1.19 Bench at the front door provides a feeling of protection under the roof and prospect at the same time, at the interface between private and semi-public zone, is part of many traditional cultures around the world, traditional bench in front of winery houses in the Stara Hora, region Hont, Slovakia (Kotradyová)

INTERFACES



In public space, an interface between earth, air and water is the most attractive for relaxation and socialisation as well and it is particularly useful to prepare sitting elements and shades against the sun in these places. In the private and semi-private spaces in many traditional cultures exist sitting on the space in-between, which means in the roofed interface between own home and public space. “Fale” (community space) in Pacific islands, front porch in the USA with rocking chairs or traditional bench at the front door in central European cultures (in the Slovak language “lavička na priedomí”) (Fig. 4.1.19). Spontaneously this place is the most prepared by older adults, it offers prospect and refuge simultaneously and it is possible to stay in contact with neighbours and at the same time to feel the protection of own roof and own private space, especially nowadays when the contemporary housing developments are more supporting social exclusion, it is a very urgent topic.

WELCOMING ENVIRONMENT AS PREVENTION OF SOCIAL ISOLATION



Attractive and friendly space and interior design with well-being quality create a welcoming environment for visitors when visits are one of the ways to prevent social isolation. The social corners in the common spaces and in the private rooms enable private talks and nonverbal communication. The living space should count with visitors – family and friends visit with dignity and enough privacy. The welcoming environment means having small sitting furniture, or a day bed, where visitors can stay also overnight, these elements create a welcoming environment for any kind of visitor, thus having space to stay.

It can be solved also with inbuilt solutions like window seats or alcoves, a free place for the playing of children, and can be also on the floor (e.g., with the cosier and tangible full floor carpet or a rug that is not in the main transition zone). This social interaction should be considered already by creating architectural space. If visitors feel welcomed and well in the facility, there arises bigger physiological and social comfort during visits and a higher frequency of visits.

By using carpets, family and friends are longer (increased social support). Carpets also foster the feeling of safety and improved personal psychological and thermal comfort and produce a more homelike, non-institutional, ambience (Salonen et al., 2015).

1.2.3 Individualisation and personalisation of spaces, allowing attachment

According to the environmental psychologist Robert Gifford (1996), place attachment represents a deep experience of feeling part of a place. It is related to the richness of meaning and sense that is developed out of acquaintance with a place and, subsequently, when the place gets to be more familiar. This attachment can be to our homes, properties, communities or local nature sceneries and settings. Where the attachment rises, the intensity and meaning of the place and the meaning of the Self become affiliated. Then the meaning of the place can become so strong that self-identity starts to be restricted by the place.

On a smaller scale, many people are identified with their neighbourhood, quarter, village, farms, house and rooms and being separated from this bound can lead to social exclusion, at the same time coming into a new social group can be a challenge and stimulation for further personal development, especially in older age.

As it was mentioned by allowing attachment in chapter 1.1.1, as a seventh important characteristic of well-being, the ability (or competence) to allow attachment – be attached to a place or products, to have the competence to adapt them, personalize, to mirror and extend the Self /ego into the occupied space where a human lives, and thus gain a state of self-identification.

This means to have the competence to bring also own furnishing objects into social care facilities, or to adapt the existing ones according to subjective needs.

There are already many examples from projects of good practices show this concept. Something like “not finished” interior space and exterior green spaces and giving an opportunity to participate at their finishing deepens attachment to the place.



Figure 4.1.20 Oude Dijk apartment building #1, Belgium, older adults housing in a monumental monastery complex, in the rooms there is an option to furnish it with occupant's own furniture and other interior elements which allows attachment to the new place easier (Shift-au)



Figure 4.1.21 Nursing Home Passivhaus / CSO Arquitectura, Camarzana de Tera, Zamora, Spain, wood structure with high-quality interfaces between outdoor and indoor, where interiors are furnished by facility providers with fewer possibilities of individualisation (Frutos)

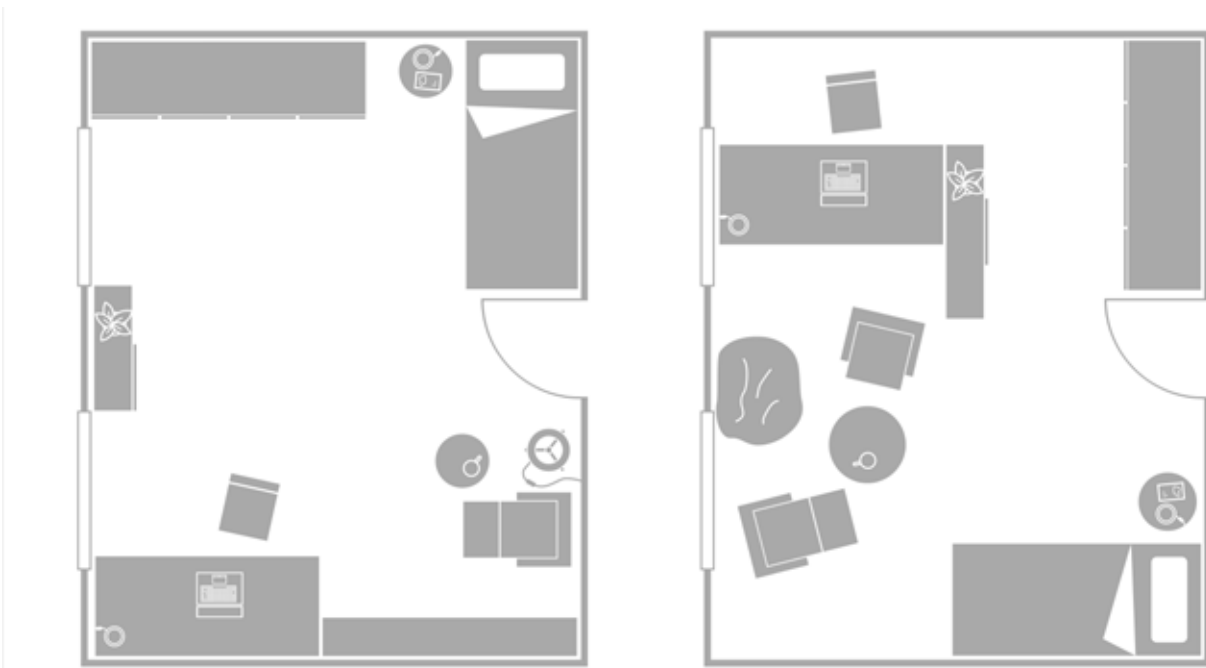


Figure 4.1.22 Common big kitchen unit that accommodates all kinds of approaches to cooking, Senior Cohousing/arqbag, Spain (Archdaily)

A good socialising point in the daycare centre of family or community-type facilities is a kitchen⁷ and eating together, where also biggest conflicts arise in terms of the organisation of space and the maintenance/cleaning, in case it is in charge of inhabitants of the house. It is good to dimension the common kitchen in a way that more people can cook together at the same time and have enough space for storing their own food and utensils.

⁷ The organisation and equipment of the kitchen is further analyzed in the chapter 1.4 and in the Module 5

1.3 SOLUTIONS FOR ACTIVE AGEING, PREVENTION OF SEDENTARY CULTURE AND SUPPORT OF MOTOR SKILLS

IN A NUTSHELL

To allow physical activity in the space by its arrangement, equipment and choice of appropriate materials inviting to move within space and change body positions and postures. The best natural and spontaneous

movement is maintaining self-sufficiency through everyday physical activities (cooking, shopping, and cleaning), including social inclusion and active life.

1.3.1 Gross motor skills and physical activity

With higher age, various limitations may occur. They are mostly age-related or are the result of an injury or accident caused by instability and problems with walking, whereas priority is having stability and self-sufficiency. The most common issues related to degenerative changes in the joints (fingers, knees, hips), overall fragility, dizziness caused by instable walk accompanied by fear of mobility and risk of falling. People are not willing to get out and to socialize.

Basic physical activity within age friendly environment consists in accessibility and motivation for mobility within household – private, semiprivate, and semi-public places with support of self-sufficiency that provides feeling of satisfaction. In this context the age friendly built environment should first invite, motivate, and challenge to natural movement in the daily routine, e. g gardening, using stairs as an option, and by multigenerational housing or mixed program housing also an interaction with young people and children. Important is space arrangement suitable for home exercises and equipment that is designed to suit into limited space and match into housing environment, made preferably of natural materials with high contact comfort by maintaining hygiene standards.



Figure 4.1.23 Hand Railings made of hardwood, pleasant to touch, as walking support are marked in the family housing for older adults, but not “sticky”, an example of a different approach and prevention of ageism in interior design, Housing for older adults, family type in Rača, Bratislava, design: P. Grošíková (Grošíková)

The risk of falling may increase with ageing. Although many falls do not cause significant injury, falls remain the cause of all hip fractures and the most common cause of traumatic brain injuries. Still, almost half of the adults who fall do not tell their doctor or family, fearing a loss of independence or a potential move to an assisted living facility (CDC, 2021).



Figure 4.1.24 Ensuring safety in the bathroom by using rails and handles supports also socialization thus it is easier to maintain hygienic standards in personal hygiene and maintenance of housing spaces that are connected also with bigger self/confidence by interaction with other people in public spaces and at home as well (Valábeková, Kira)

SUFFICIENT PHYSICAL SUPPORT AND PREVENTION OF FALLS

The simplest way to prevent falls is to keep up regular physical activity appropriate to age and health situation to maintain core muscle and leg strength. Natural movement and physical activity are strategic not only from many health aspects, but thanks to the strengthening of the muscular-skeletal system, it helps also as the prevention of falls, introducing and maintaining independence and support socialization.

To prevent social isolation sufficient body strength is needed. This can be reached by space arrangement furnishing or having enough mobility support utensils at home. For space arrangement and interior design, it means creating barrier-free space, enough space for movement and for manipulation also in case of access to emergency service, support in any form everywhere at home (for example handles can be incorporated in furniture or wall panelling), (Fig. 4.1.23) importance of chosen flooring material whereas soft floors are more inviting and pleasant to walk. Soft and warm flooring materials are suitable (carpets, soft wooden floors made of spruce or pine, cork, natural linoleum etc.), by avoiding slippery materials, especially in wet areas like bathrooms. At the same time, soft rigid floor materials have lower durability and the obsolesce appear sooner when than the hard ones. So here a question arises: Is the use of soft flooring in conflict with maintenance in the facility? It is a decision between having a more inviting to move floor that is also cosier and a more domestic and welcoming atmosphere thanks to the soft floors or is the maintenance a priority.



Figure 4.1.25 Soft tangible floor invites floor-based interactions and spontaneous movement and changing body position and playing with children on the floor as well (Valábeková)

SPONTANEOUS MOVEMENT BY EVERYDAY ACTIVITIES

First of all, everyday tasks to care about the household and self are natural physical activities.

But in addition, when having soft floors with high contact comfort, it is inviting for using much more body movement and postures like crawling, squatting, lotus seat etc., with grandchildren that spend on the floor quite a lot of time. Moreover, interaction with children creates spontaneous and unconscious body movement and an overall positive impact to the physical and mental state (Fig. 4.1.25).

It is good to incorporate these possibilities into spatial design and to have it in mind by choice of furnishing and equipment, by arranging an age-friendly environment.

MOVEMENT IN FORM OF EXERCISES



Another level is physical activity with intention. Besides regular walking which is the most natural sort of movement, we can speak about aerobic and anaerobic activities (power exercises) that were connected with many negative prejudices concerning with their inappropriateness for older adults.

Proper physical activity prolongs life, delays aging, reduces consumption and the need for medical care, and delays the emergence of dependence and the need for hospitalization. The stable anchoring in the social environment and the quality of contacts with the environment play an important role.

The measurement of motor skills is one of the fundamental aspects of measuring human performance. It is well known that aging is accompanied by impairments in sensorimotor as well as cognitive and perceptual functioning. Although motor performance tends to decline in old age, learning capabilities remain intact, and older adults can achieve considerable performance gains. The extent to which the learning capability varies with age, however, must be considered very carefully. While most studies revealed that performance gains in fine motor tasks are diminished in older adults, results for gross-motor-skill learning are more contradictory. Additionally, there is considerable agreement on the finding that age-related learning differences are statistically more robust in complex tasks, whereas in low-complexity tasks, the learning of younger and older adults is similar (Voelcker-Rehage, C., 2008).

This applies to fine and gross motor skills. It means that **challenging (creating challenging spatial situation and coming out of the comfort zone) like a prevention** has meaning. There are two approaches to age friendly built environment, one is the universal design, design for all, whereas space and its furnishing should accommodate people of any age or disabilities with high level of adaptability. The second approach is to search and implement solutions that are particularly considering ageing and works with respect and empathy to degenerative processes in the human body and the goal is to design or adapt the furnishings according to this.

Gross motoric skills are connected to the physical movement and exercises. Why exercise at an older age? Active people not only live to be older, but also enjoy a better overall condition. Of course, exercise often does not eliminate the problems, but it can significantly reduce their further development. Regular exercise improves mobility, the ability to walk, which is important for seniors to maintain self-sufficiency, improves or maintains muscle strength and range of motion in the joints,

thereby reducing their pain. Exercise has a positive effect on the cardiovascular system, increases metabolism (the body burns more calories), improves intestinal peristalsis (thus reducing the risk of colon cancer), improves sleep quality, learning ability or short-term memory. Incontinence problems are improving. Coordination of movements is improved, thus reducing the risk of falls.⁸

Research from kinanthropology shows many benefits of power exercise also for older adults, especially improving of gross and fine motor skills. For example, strength training for seniors caused:

- 189 % improvement in forearm extensor strength
- 87 % improvement in thigh extensor strength
- the most significant improvements in the “weakest”
- nutritional supplements did not statistically significantly affect the results
- the increased force was reflected in: spontaneous walking speed (+ 12 %), walking speed to stairs (+ 28 %), and spontaneous physical activity (+ 34 %) (Fiatarone, M. A., O'Neill, E. F. Ryan, N. D. et al., 1994, in: Hamar, 2014)

Also, long-term physical laziness can have symptoms like behavioural (non-chemical) dependence. Nowadays lower levels of physical activity – laziness, is one of the most prevalent mental disorders and shows the typical characteristics of dependence. Chronic physical hypoactivity can be a mental disorder and laziness can be primarily a behavioural dependence. First, it is important that prevention begins in early childhood through the influence of parents, schools, and the entire society. It is not optimal to take the time spent in physical activity as the criterion for its contribution to health. This would be a significant simplification. The most important indicators of the sufficiency of physical activity

are the results of clinical measurements of physiological parameters, e.g., VO₂ and pulse/heart rate (Okrúhlica, 2011).

To prevent hypo-activity and physical laziness, the space arrangement and its furnishing have to support the idea of active ageing.

⁸ This topic is more analyzed in the Module 2, Unit 3

INTRODUCING DIFFERENT BODY POSTURES AND ACTIVE SITTING AND STANDING

To fight various civilization diseases, we have to create a free choice and exchange of body postures or combine passive and active sitting positions. Standing, saddle seat and perching are examples of alternatives. More body movement, more blood flow in muscles and tissues, better cardio-vascular circulation and less degeneration can have a significant positive impact on our overall health and at the same time can help to prevent social isolation. At a young age, it is normal that people have a lot of physical activities but with the onset of older age, the importance of movement is much higher. For the interior and product design, it means integration of built-in and furnishing elements that are enabling exercises – combining various functions – e.g. training utensils combined with furniture.

How is it with **active sitting or saddle sitting by older adults**? As physical activity including power exercises, active sitting and saddle sitting and perching are more suitable in the phase of prevention, in the 3rd age, during the 4th age it can be already dangerous. Introducing different body postures during daily activities is a good prevention of degeneration and diseases caused by sedentary culture. A saddle seat and perching, plus active/dynamic sitting combined with the standard rectangular passive sitting is a suitable prevention from degenerative diseases of the musculoskeletal system. Small micro-movement like swaying, whistling, shaking and stretching) that are arising by active/dynamic sitting are good practice not only for nourishing the intervertebral disks, but they activate muscles and joints in the whole body that works like a tensegrity structure where every movement changes the whole-body posture. Small movements mean constant stimuli from tendons and joints, whereas by standard static seat, there is a deprivation of body stimuli (signals from the body). For people already suffering from some musculoskeletal disorders, it is necessary to ensure lower body stability by fit ball exercises and sitting. It is

good to use any kind of fixation of the ball by feet. Important is to know that active sitting on unstable elements is recommended only for short-term use, thus after cca 40 minutes it can create tiredness and overload of the nervous system (Kotradyová, 2015).

The question arises about the suitability of an active seat for older adults that already suffer from some degenerative body changes. If the contemporary health situation allows some kind of challenge, it is good to introduce saddle sitting or perching. These body postures allow a spine to be in the natural S-shape position, but at the same time, there is more balance and overall control over the body than by active/dynamic sitting. They activate the body through the pelvis and hip joints and also back muscles, namely lower shoulders (lower fixators) thus there is the necessity to keep the corpus in an upright position without a backrest. So, the saddle seat and perching are more suitable positions than the active sitting which is more demanding about keeping stability, at least during dining, working and other activities usually done by the table that should be height adjustable that allows also standing as short stay posture.

Standing is also suitable for older adults and it is recommended to practice **active stand** that means standing “on a broader basis”. This means standing on the width of our hips or shoulders, with toes apart, with the possibility to practice one leg and feet forward combining with a sidestep, like a “tread on the spot” and standing on tiptoe or simulating playing some piano with fingers on the feet. All these help also to improve the circulation of blood in the vascular system. It is related to the topic of barefoot functioning; thus it brings many stimuli into the body that has many already mentioned benefits.

Using different body postures than the standard right angle sitting during the day has a relation also to the state of abdominal muscles and muscles related to correct breathing (through a free belly that allows breathing through

the diaphragm – abdominal-chest breathing that is healthier). It helps to prevent or partly overcome disease stereotypes by older adults caused by passive sedentary culture.

ACTIVE AGEING AT WORK

As many 3rd age people still work, on computer or by working table, it is good to count with the working place also in the small apartments or rooms in the nursery homes. It is necessary to implement the principles of age-friendly design also in a working environment, office spaces and home offices as well, especially to consider the alternative models of sitting and also an accessible working tables (Fig. 4.1.26).

REFLECTION IN INTERIOR AND PRODUCT DESIGN

Permanent challenging by space arrangement furnishing of resignation for passive comfort? We can formulate two basic approaches to physical activity and ageing in furniture design:

- a) maximum support and somatic comfort is the most preferred and manageable way, but can support passivity and sedentary culture causing many health problems and losing goodwill to move.
- b) challenging

Being curious and further experimenting, means more risk of falling, but prevention of fragility and losing body strength. Examples of the challenging concept are the products of Norwegian designer Peter Opsvik (Fig. 4.1.27). In the BCDlab we have also developed coupled of concepts for saddle sitting, perching and active sitting (Fig. 4.1.28 and Fig. 4.1.29).



Figure 4.1.26 Tailor made working place of Austrian architect Margarete Schutte Lihotzky, a pioneer in field of social architecture, is now the museum and centre of Club of M. Sch.Lihotzky, Franzstrasse 16, Vienna, she has worked and lived there until the very high age, she lived very last years on wheelchair and the flat was adapted to this purpose, she lived very active and socially engaged life (Schutte-Lihotzky)



Figure 4.1.27 Petr Opsvik's multi-posture chairs, combining active sitting, perching and saddle seat, (Opsvik)



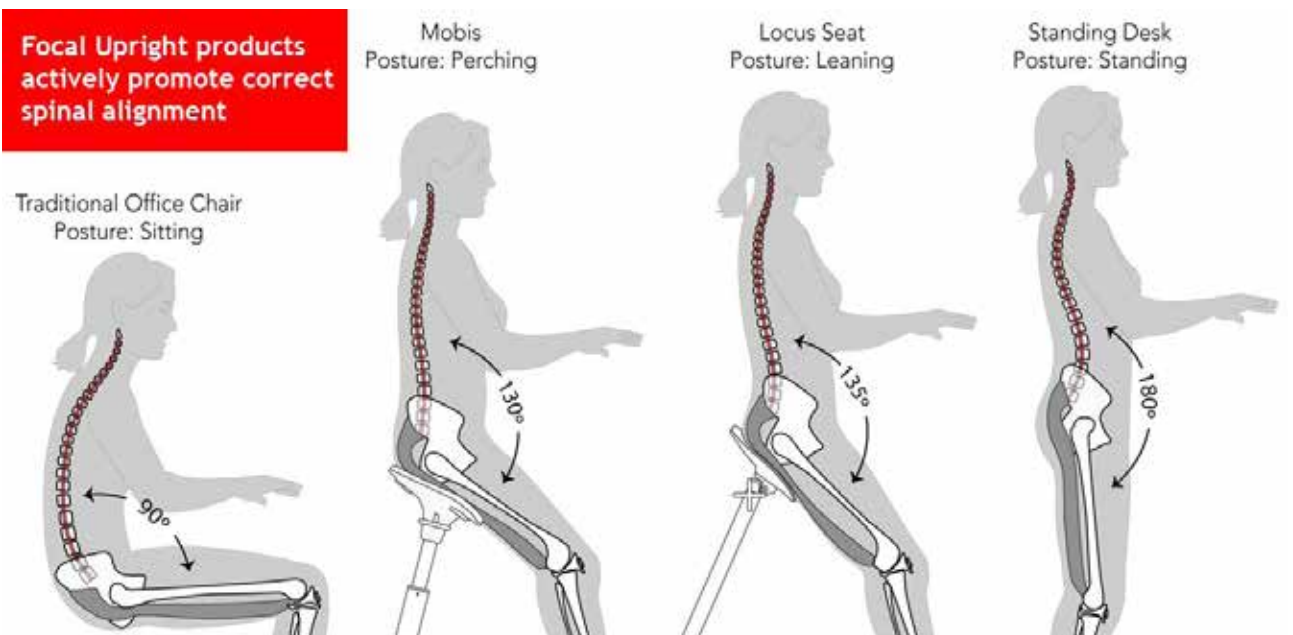
Figure 4.1.28 Muffin pouf, dynamic/active sitting allowing gentle swinging with a very civil non-health care or fitness design, design: Peter Daniel, Tatiana Lesajová, BCDlab (Knap)



Figure 4.1.29 HORSE OFFICE – multi-posture relaxing and working furniture, solid spruce, 2015 , design: V. Kotraedyová and D.Kočlík and chair Soma made of sot alder wood allows perching and saddle seat, design: V. Kotradyov, design V. Kotradyová, production: František Jánoš foto



Figure 4.1.29a Perching and saddle chair Soma, BCDlab, design: V. Kotradyová (Knap) Kotradyov, design V. Kotradyová, production: František Jánoš foto



Features and Benefits of the Locus Seat

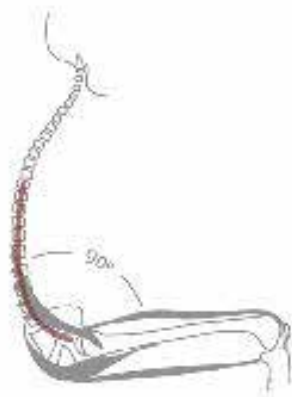


Figure 4.1.30 Introducing perching that allows open angle posture and neutral position of body by working or dining (Upright furniture, Archello)

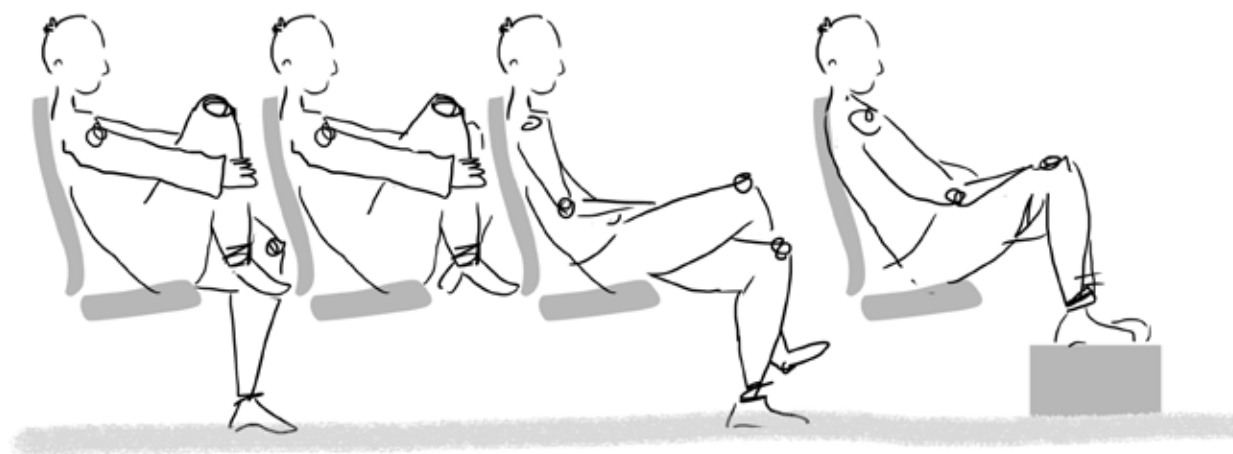


Figure 4.1.31 Allowing working with legs, with in/built solutions or with introducing more freedom in choosing body postures (Valábeková, Opsvik)

To reduce impact of sedentary culture, it is possible to provide:

- free choice and exchange body postures
- introducing of standing, saddle seat and perching as part of age friendly concept with benefits not only for good body postures and state of body strength, but also for mental health and digesting system
- combining passive and active sitting and other body postures in relation to ageing
- allowing working with legs during short and long-term sitting
- more body movement, more blood flow in muscles and tissues, cardio-vascular circulation means less degeneration of all tissues

Practicing of risk management is needed, but anyway there can arise problem with stability. There are more possibilities, how to deal with the physical activities within household. First, we must leave more free space practicing home fitness, with safe floors that are pleasant to touch by laying down.

It is convenient to design more attractive training utensils for practicing physical exercises by using more pleasant materials to touch and to handle with, to use materials with high contact comfort like wood or cork that invite to use them on a regular basis (Fig. 4.1.32).

Also there is an option for introducing exercises with smart pieces of furniture or just ordinary

furnishing, adapting design of the furniture for simple exercises/workouts with own body (Fig. 4.1.33).



Figure 4.1.32 Wooden one arm dumbbell Moses, made of acacia wood and brass rods has high contact comfort and civil design and more distinct functions that match to housing environment, developed in cooperation with sport medicine expert Prof. Dušan Hamar, design: V. Kotradyová,(Knap)



Figure 4.1.33 Incorporating equipment for power exercises and training with own body weight into the interior design of senior club in Bratislava, design: Eliška Pilátová, Faculty of architecture, STU, 2014 (Pilátová)

MOVEMENT OUTDOOR

By spontaneous physical activity, it is necessary to create also places for active exercises outdoors and age-friendly playgrounds that also support socialization.

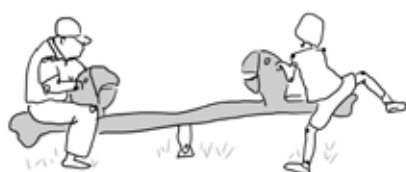
The facilities for this purpose have to be safe and challenging at the same time even when it is very demanding to find a balance between safety and challenge, but in general, all these types of equipment should support the user's own motoric effort.



age friendly playground



outdoor gym for older adults



age friendly playground



sufficient physical support and protection of falls

Figure 4.1.34 Outdoor physical activities, with pets, on playgrounds, support also socialization (Valábeková, Kotradyová)

SUPPORT OF FINE MOTOR SKILLS

During everyday day activities human bodies meet different shapes and surfaces, that have the potential to serve as stimulation for fine motor skills and to offer contact comfort.

Handles of the storage furniture should be easy to grasp and understand the function. It concerns batteries/ armatures in the bathroom and kitchen that should be intuitive for people with all kinds of disabilities.

⁹ To learn more, read Module 2, Unit 3

1.4 RECOMMENDATIONS FOR CHOICE OF FURNISHING OBJECTS

IN A NUTSHELL

It is convenient to develop solutions reflecting ageing, but universal and suitable for use of all age users and thus to belong to an adaptable, flexible age-friendly environment. This approach is related to the prevention of the negative impact of ageing -connected with marginalisation and ageism.

Age friendliness is connected with adaptable/flexible concepts of housing where universal design has its application, with no barriers and ageism, but also with a high level of individualization. It is very challenging to

connect requirements for general comfort with special needs by different kinds of health problems and impairments related to ageing. With built-in solutions it is convenient. One of the recommendations is dimensioning the storage spaces easily reachable also from a seated position. But furnishings/mobiliar can be easily movable, adaptable, exchangeable, with optimized and updated ergonomics. Products have to be easy understandable and graspable/ pleasant to touch whereas natural authentic materials play a crucial role.

1.4.1 General and ergonomic recommendations

How to introduce philosophy of age friendliness into interior and furniture design? Even when there exist new ergonomic approaches in furniture design, it is necessary to speak about the philosophy of universal, human-centred and body-conscious design, age-friendly design. First of all, it is convenient to make optimisation of existing standards that consider new findings in medicine and ergonomics to find the solution for having modern, adaptable, challenging, and cosy interior design within the age-friendly environment.

BATHROOM

In Module 3, Unit 4 there are recommendations for arranging and dimensioning the age-friendly bathroom. here we show some examples of interior design suitable for this purpose. They show the implementation of the principles of adaptable housing such as: railing with drawing/sliding curtain is the best solution for an adaptable and accessible shower, the disadvantage is more water sprinkled in the room and the visible difference in colour of floor and walls (Fig. 4.1.36).



Figure 4.1.35 Railing with drawing/sliding curtain is the best solution for an adaptable shower, the disadvantage is more water sprinkled in the room; bathrooms for the DSS Rača, (Tomová)



Figure 4.1.36 Example of age-friendly bathroom, design for nurcery home of family type in Rača, Bratislava (Slabeyová)

DO YOU WANT TO KNOW MORE ABOUT...

AGE-FRIENDLY BATHROOM

- handrails by toilet and shower
- space under washbasin thanks to inbuilt water seal of waste water
- curtain as a dividing element
- lighting with warm white colour (3000 K), lights on both sides of mirror
- foldable seat in the shower
- wall button – rescue alert
- non-slippery floor with a contrasting colour (e.g. floor is darker than walls).

KITCHEN

Standards for space arrangements of the kitchen are described in Module 3, Unit 4. At Fig. 4.1.37 is a minimal kitchen ground plan, that offers optimal space for working of 2 people simultaneously. There are initiatives to

introduce also compact kitchens or movable kitchen desks as an island that allows being flexible and variable in the space during the preparation of food and at the same provide enough support. (Fig. 4.1.40).

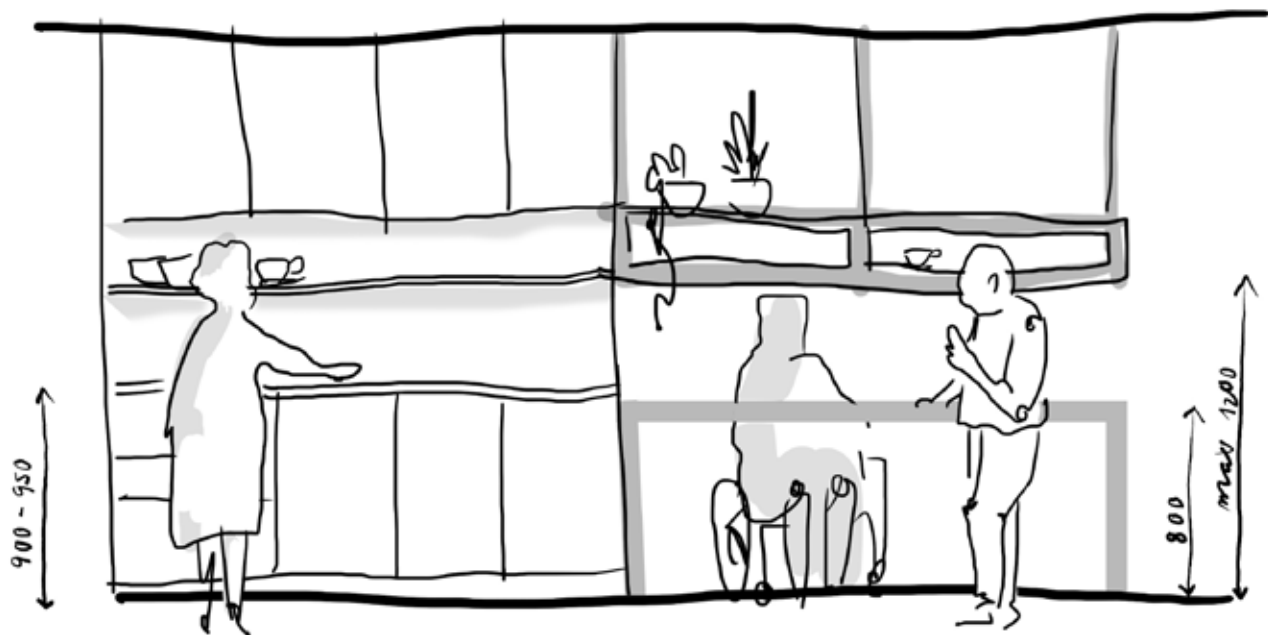
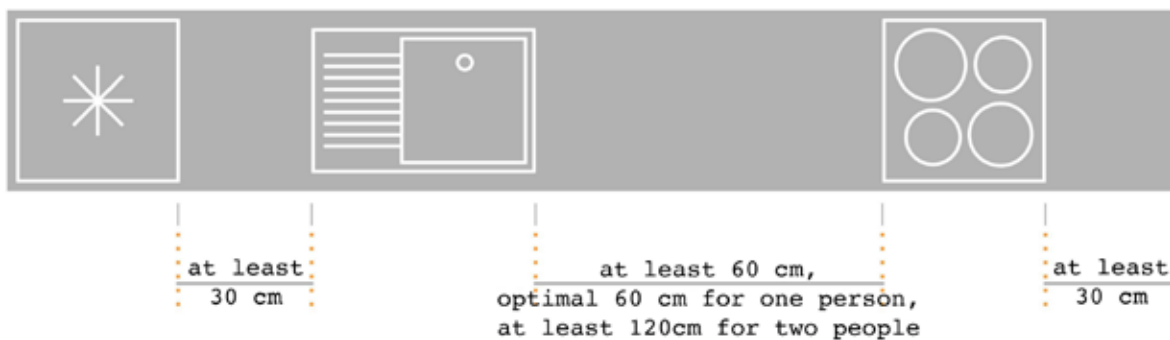


Figure 4.1.38 Introducing universal design and body conscious design simultaneously into the kitchen design, for wheelchair is optimal high 80 cm with free space under, for healthy mobile user it is more than 90cm to prevent unhealthy body posture and back pain, so it is good to have two heights or adjustable mechanisms (Valábeková, Kotradyová)



dimensions of individual workstations in the kitchen

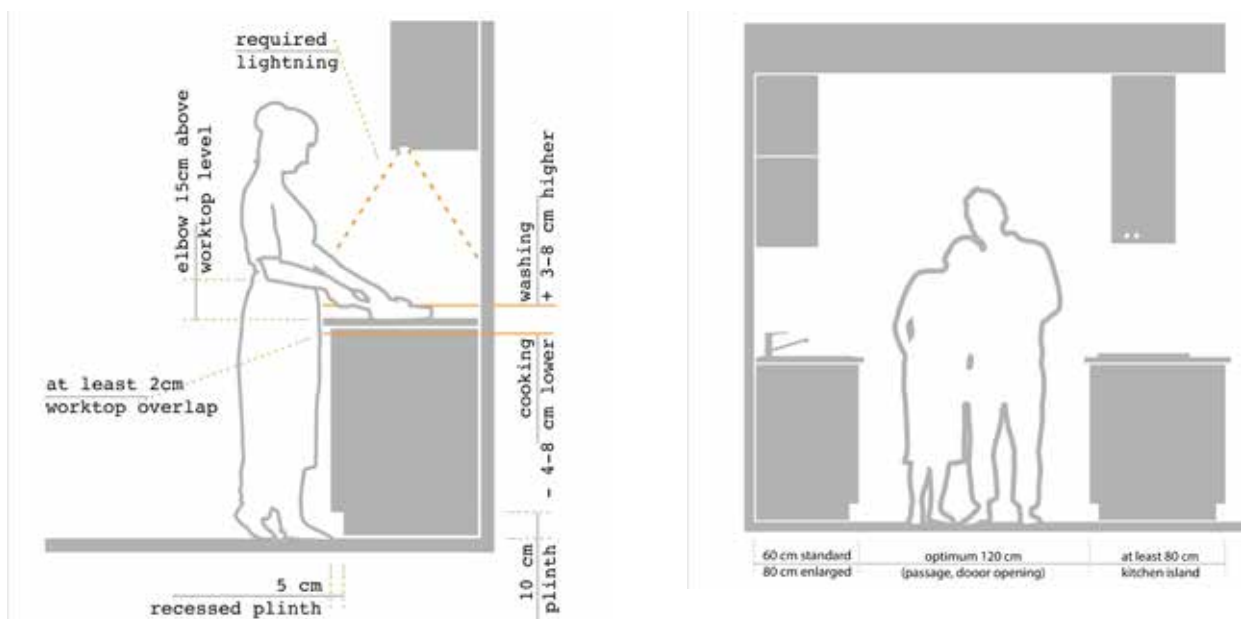


Figure 4.1.37 Minimal kitchen where is place for working of two persons at once, important is the distance between basin and oven, it should be min.60cm, optimum 90cm, for 3 people working at once 120cm (Kučerová, Kotradyová)



Figure 4.1.39 Example of an age-friendly kitchen (Ridzoňová)

DO YOU WANT TO KNOW MORE ABOUT...

AGE-FRIENDLY KITCHEN

- height adjustable working desk or desk in two heights, the lower 800 mm high, the higher is standard min 90 cm, according to the rule of 15 cm under an elbow in right angle of a standing person
- space for feet of a person in a wheelchair under the working top
- accessible free space under sink and cooktop
- lower storage space
- durable material of working desk around sink and cooktop, but pleasant to touch (e.g. solid hardwood, Corian etc.), do not be afraid of natural materials
- non-slippery floor with contrasting colours to the walls.



Figure 4.1.40 Kitchen like a triple set consisting of working desk, table suitable also for a wheelchair and a side table or container for company Drevona (Fratriková)

SITTING FURNITURE

We have on touched the topic of sedentary culture already in the 1.2 active ageing, but now we analyse the suitability of sitting furniture in general. Important is to introduce

different sitting furniture, for each occasion, easy to move and to create a “sitting landscape” according to the need to communicate or to be in quiet.

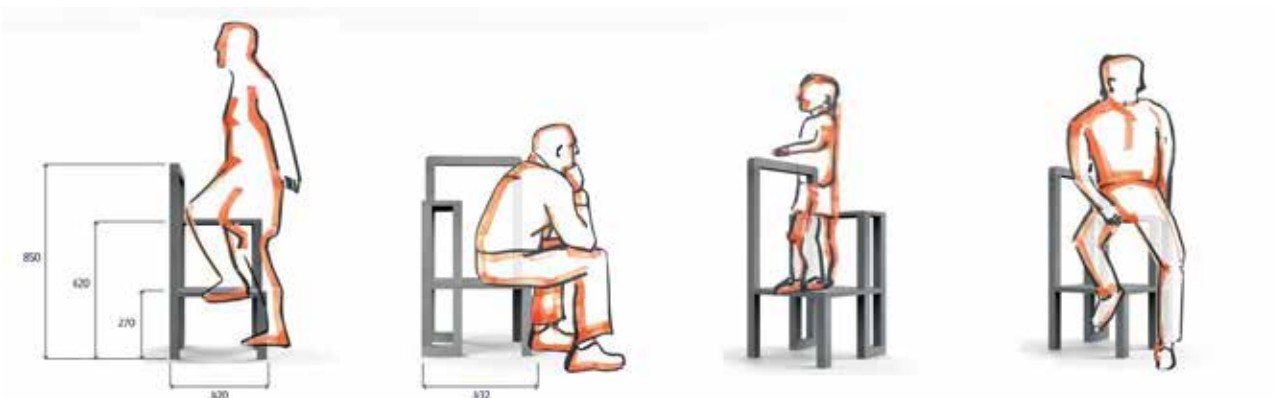


Figure 4.1.41 Skalio – age friendly element useful for sitting, perching and elevation, design: L. Sasvary, STU BA, mentor: V.Kotradyová

Even when there exist new ergonomic approaches in furniture design, it is necessary to speak about the optimisation of existing standards that consider new findings in medicine and ergonomics.

It is important to have the standard high (72–76 cm) of the dining table, thus dining by to low coffee table by sitting on the easy chair, armchair or sofa creates press on the digesting system and in the same time deforms spine into C-shape and avoids communication with other people, especially when happening in living room in front of TV.

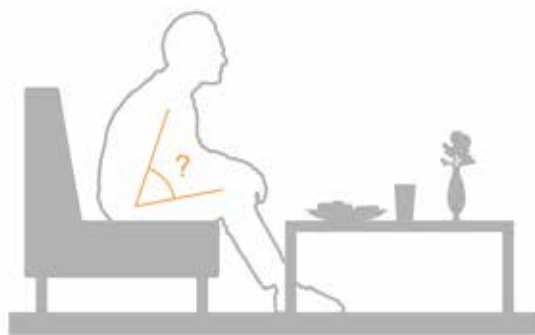


Figure 4.1.42 Dining by to low table cause not only deformation of spine, digesting problems due to a pressure on inner organs, but also it is minimizing interaction with other people face to face, especially, when it is happening by watching TV (Kučerová, Kotradyová)

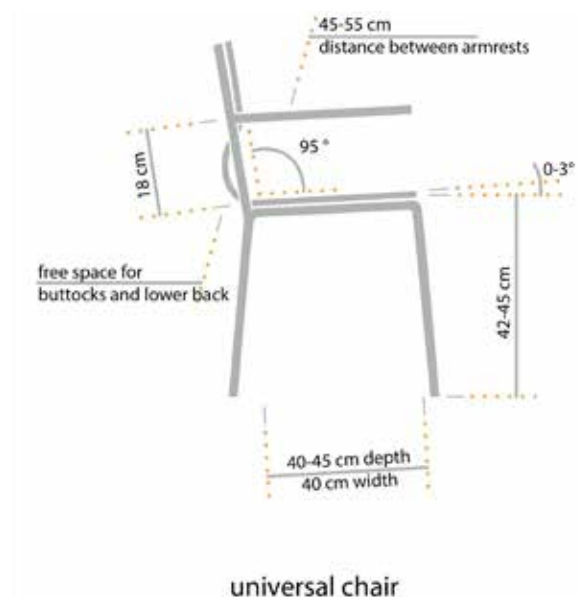


Figure 4.1.43 Recommendation for universal chair, important here is to have a free space for low back, otherwise there is happening a deformation of spine into C-shape (Kotradyová, Kučerová, 2019)

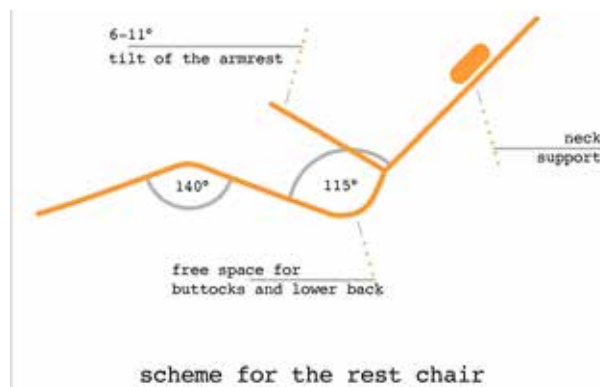


Figure 4.1.44 Recommendation for reclining chair, important is to have the support of the neck and the possibility to put the legs up, plus the same, it is good to have free space for the low back, otherwise, there will be defamations of the spine and lower comfort by reclining (Kotradyová, Kučerová, 2019)

TABLES

By the dining table' optimal height is 80 cm, with no massive legs and storage space, to have access with a wheelchair, Coffee and side tables have no special adjustments in age friendly environment, there is an advantage, if they are easy movable and can create new environmental settings, e.g., helping to make a sociopetal arrangement.

Age friendliness is connected also to the working environment. Working tables – high adjustable concepts and heights of the tables suitable for introducing perching.

possibility to have access under the working desk also with a wheelchair, but at the same time, for healthy people able to sit on a regular chair it is a big relief if users can put the legs up or into any elevated position during sitting by the table, so the different table stilts are helpful (Fig. 4.1.45) Working environment can be furnished also with a stand-up tables or desks where it is possible to practice active stand.

In general, for optimum high of the working desk, there is a rule that the angle of the elbow should be in the right angle in any kind of table high.

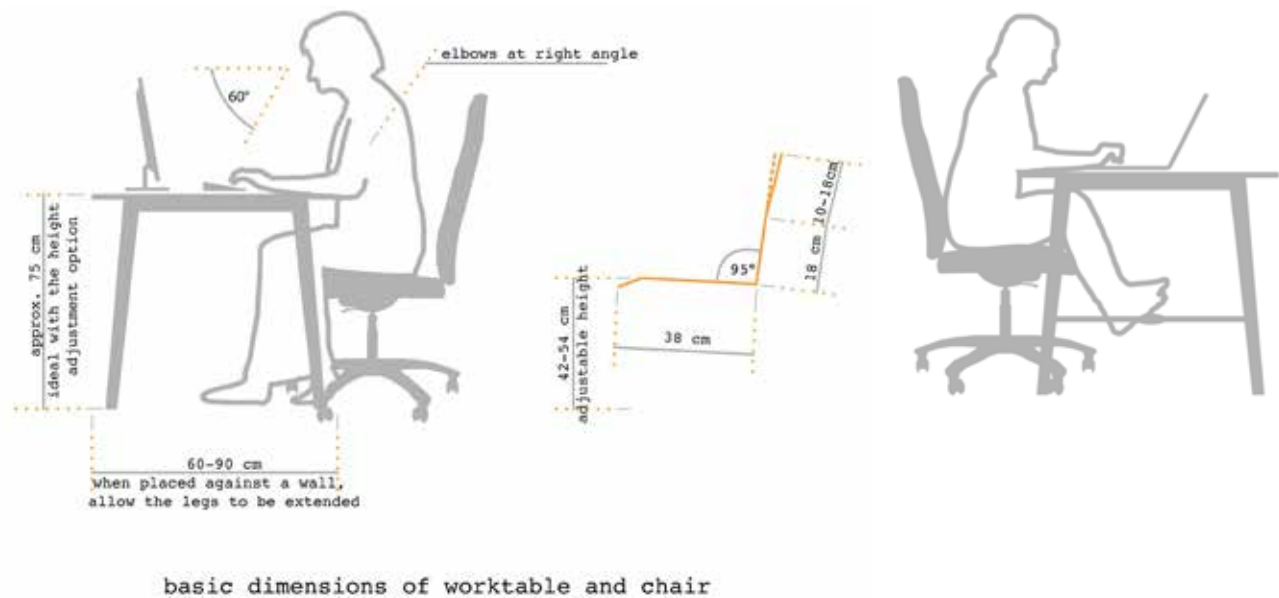


Figure 4.1.45 Recommendation for working table, for wheelchair is good to have no obstacle under the working desk, but a support for legs that works also like a still strengthening whole construction, can be advantage for mobile users (Kotradyová, Kučerová, 2019)

BEDROOM, BEDS, AND MATTRESSES

The space arrangement of the bedroom should provide protection of back and view to the entrance and window that strengthen the feeling of safety. It is convenient to search for the optimum combination of prospect and refuge in the bedroom. So the placement of the bed in relation to a window and entrance is crucial, for all ages (Fig. 4.1.47).

By choice of the concept of bed, there is good to think about easy exchangeability of all elements and cleanability, thus layering of single layers is very suitable for age-friendliness. The concept of fixed upholstery that was usual in the late 20th century, or day beds with fixed upholsteries with no possibility to take out the mattress, are not suitable thus they are not dimensioned and constructed for everyday usage

In case of small spaces storage space under, also box spring beds can have it (Fig. 4.1.48)

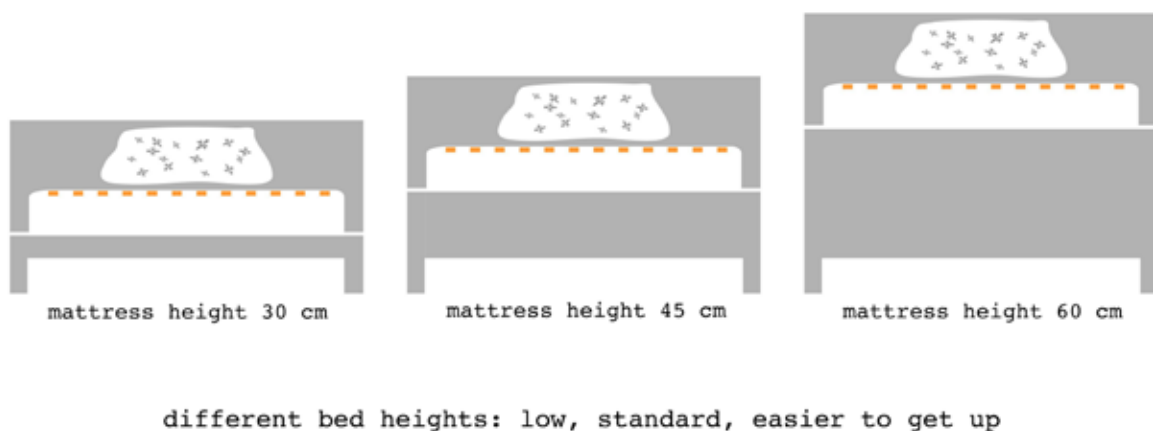
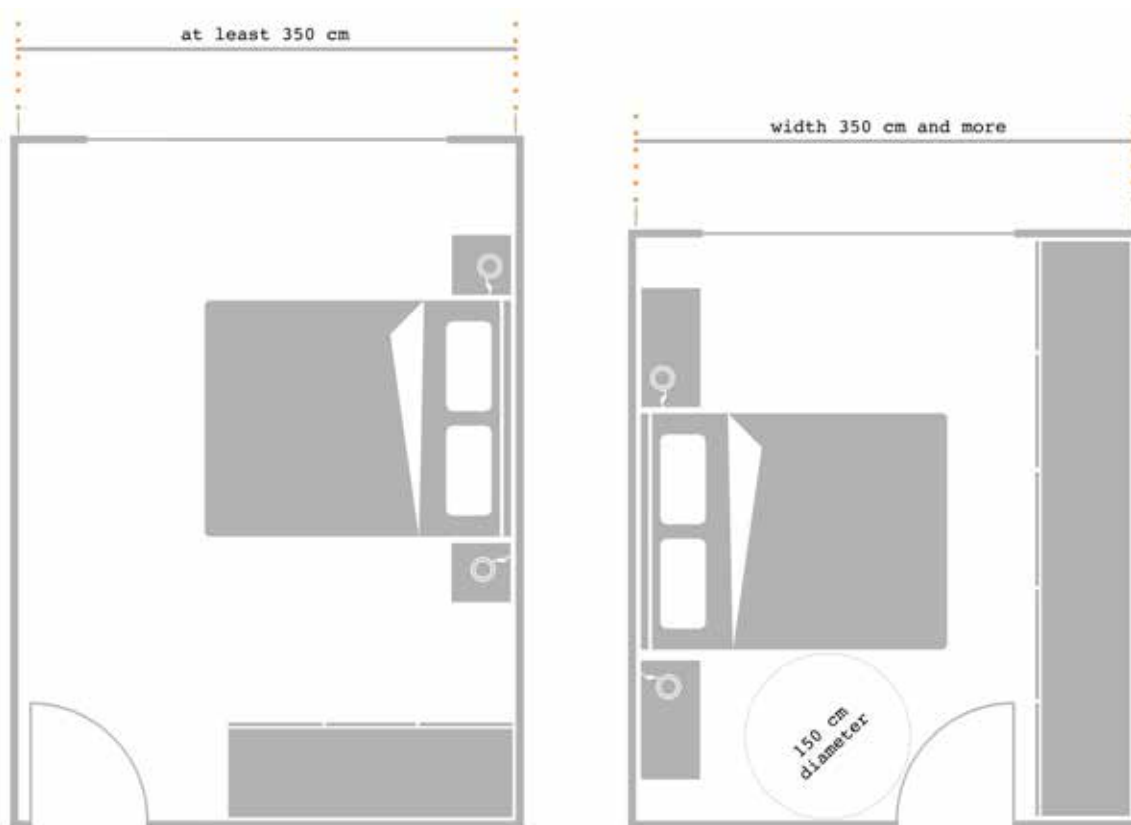


Figure 4.1.47 Variation of bed highs of beds, the high 60 cm is the optimal for older adult (Kotradyová, Kučerová, 2019)



bedroom layout options

Figure 4.1.46 Variation for arrangement of double bed and wardrobe, with a protection from back and view to the entrance and window, that offer optimal combination of prospect and refuge, the left variation is suitable also for wheelchair user (Kotradyová, Kučerová, Hencová, 2019)



Figure 4.1.48 Box spring bed with an elevated height of mattress – concept can have a different setup, also including storage space, Bed Greta (Nesia)

Higher box spring beds consisting of more separate units are nowadays introduced also in Europe. They provide a higher plane for sleeping with easier standing up or laying down. The high between 50–70 cm at the same time offer capacity to have a storage space under the bed. To have a standard-looking bed that

is higher is not so easy to find in the shops and then it is necessary to find a tailor-made solution. On the other side, sleeping on a podesta bed or on a futon bed at a lower height level can be uncomfortable for laying down or standing but is challenging for spontaneous movement at the same time (fig. 4.1.50).

In bedrooms for the 4th age which are often furnished with hospital beds for homecare, it is good to choose ones that have designs not related to hospitals, just like standard bedroom furniture. The height and inclination adjustments are often necessary, but it is possible to use solutions that match more into the housing environment (Fig. 4.1.49).

It can be also made of wood or have at least wooden panelling even by using a metal skeleton but also can be made just from wood, with complements that help also the caregivers to have easier handling (4.1.49a).



Figure 4.1.49 Easy adjustable system with civil non-institutional design belongs to age-friendly environment, in the 4th age, Regia EasySwitch (Pflegebett)



Figure 4.1.49a Adjustable bet made of the beech solid wood match more with the design of a standard bedroom (Velcon)





Figure 4.1.50 Podesta bed is challenging and motivating to move/stretch the spine, but it can be problematic for some users with certain diagnoses, e.g. degeneration changes of the joints (Kučerová, Kotradyová)

When there is an inclination of the part under head by reclining, it could be in the level of shoulders, also heart and heels should be at the same level

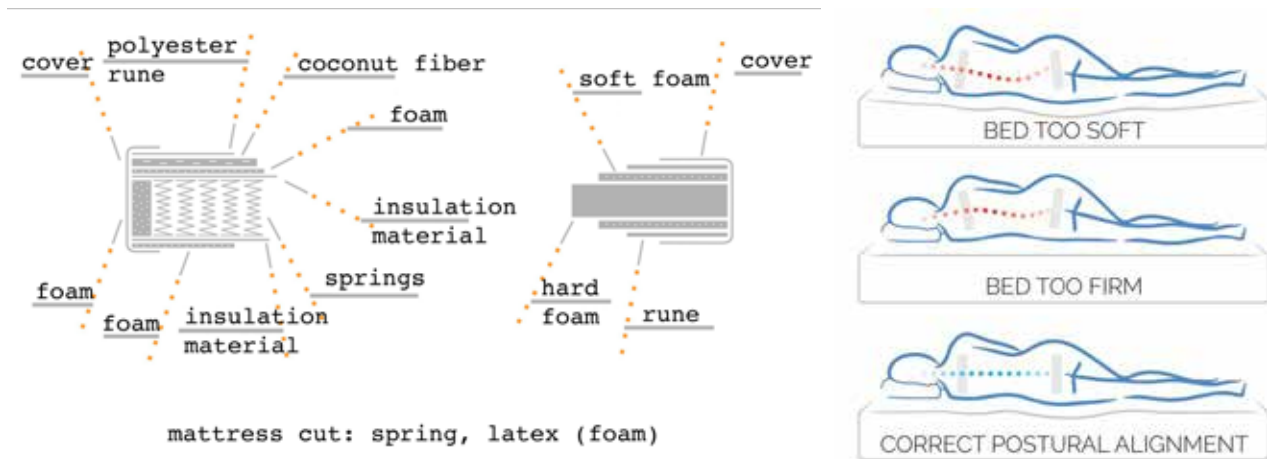


Figure 4.1.51 Usual structure of mattresses, too soft or too firm mattress are not suitable for older adults, the zoning of softness/hardness is also recommended, the zoning (usually 7 hardness zones) reflects the pressure of the body into the mattress differently (Kučerová, Kotradyová, Hencová, Mybed)

STORAGE FURNITURE

As it is mentioned in Module 3, Unit 4, by inbuilt storage space it is necessary to provide sufficient access space to enable manoeuvring space, it is important to place any other furnishing object in a way that there stays free space of a circle with the diameter min. 1,500 mm, opt. 1,800 mm.¹⁰ For easier moving around with a wheelchair or other walking support utensils, the inbuilt solutions can well serve, but also movable storage units like shelves, chests of drawers. It helps to increase the flexibility and adaptability of space. The accessible height from the wheelchair is opt. 120 cm. Fig. 4.1.52 and 4.1.53 are examples of using lower storage furniture. Easy adaptable, lower, and accessible removable free-standing hangers, combined with an inbuilt solution provide enough capacity for the storage of clothes and all different personal belonging, very often in minimal housing space. So the perfect organisation of the storage space is needed.

By the contemporary trend of push systems by doors of cabinets that allow the opening of the standard turning or sliding door with no visible signal on the front, with some age-related cognitive handicaps is better to have a visible touch point, even by push systems, ideally, the visible handle made of some pleasant material, or the places to open are marked, intuitively inviting to grasp.¹¹ It is also helpful if there is some inbuilt lighting to better orientate inside the storage space (Fig. 4.1.54).

¹⁰ This topic is analyzed in the Module 3, Unit 4

¹¹ This topic is further analyzed in Module 5, Unit 3

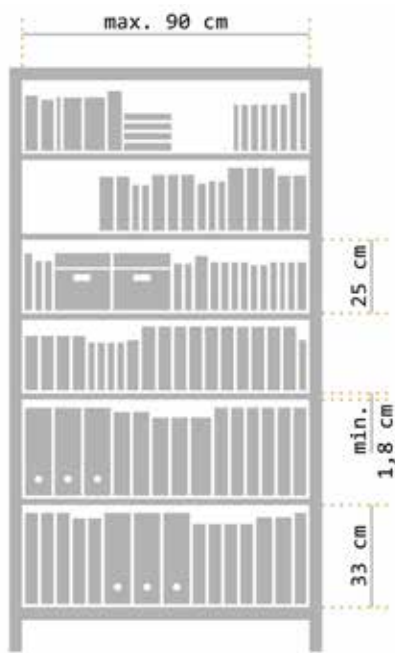


Figure 4.1.52 Recommended is to have different distances between the shelves to accommodate all the personal belongings that are suitable to display and in the same time also closed storage space with doors that can hide everything that could bring discomfort to be shown.; the storage space is good to be lower, to be reachable also from the wheelchair, right is an example of a room with lower storage units, for a nursery home of family type in Rača, Bratislava, design (Ridzoňová)



Figure 4.1.53 Storage furniture for entrance door, has good access and availability also for person sitting on a wheelchair, for company Drevona, 2022, design: Frederika Krištofová, STU Bratislava, mentor: V. Kotradyová. Krištofová, (Drevona)



Figure 4.1.54 Chest of drawers with intuitive openings used for handling the drawers and inbuilt light that makes the orientation easier, design: Ondrej Ferianec, STU, 2022, for company Drevona, mentor: V. Kotradyová (Drevona)

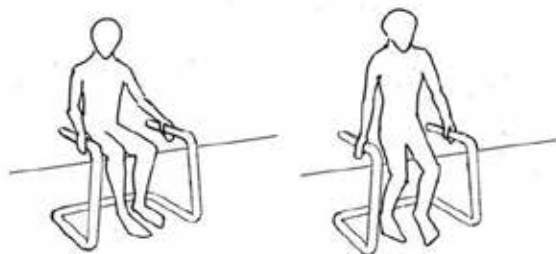


Figure 4.1.55 Compensation instrument useful also like a side table is a good example of universal design, preventing ageism, MENDEL university in Brno, 2015, design: Zdena Havlásková, the output of the course Humanisation of microenvironment, mentor: V. Kotradyov (Havlásková)

1.4.2 Choice of materials, surfaces, and colours

In human-centred design, natural materials clearly prove to be the most suitable for the creation of living spaces as well as public interiors and public spaces. It may sound trivial, but the use of authentic natural materials has a direct positive effect on humans.

It is the practice of biophilia, the natural inclination of human beings towards nature, natural materials and solutions inspired by nature, which applies to the search for shapes up to biomimicry.

When creating an environment, the choice is about the use of greenery and natural materials. These have several positive properties, in addition to the fact that they have high visual and tactile contact comfort, thanks to their colours, textures and structures, soften the light atmosphere even in cold light, can improve air quality, contribute to acoustic comfort, and have antimicrobial effects if they are left untreated on their surface. Their weakness is more demanding maintenance and price.

However, due to efficient maintenance, hygiene and demands for high durability, imitations are used, from laminates, vinyl to ceramic tiles with wood decor and other attractive natural materials. On the one hand, while the surface is created from a distance like the authentic one, on the other hand, it is the “deception of the senses” and the ignoring of material truthfulness, which is one of the foundations of the quality of the indoor environment in the wider context.

The cleanability and disinfectability of surfaces became even more important during the coronavirus pandemic and gained high priority in interior design. But nothing has changed about the fact that each material has its own character and expression. Therefore, if we go to use artificial materials because of their price, availability or hygiene and sustainability, we will find them an expression that does not hide the fact that they are artificial, and even in this original form they may look attractive.

Natural materials such as wood in their authentic form are therefore irreplaceable in creating a healthy indoor environment.

DO YOU WANT TO KNOW MORE ABOUT...

In an age-friendly environment is the maintainability put like a priority, thus there are happening many “accidences”, especially in the 4th age. But the authenticity of surfaces connected with natural ageing and getting a patina is so important for the well-being and complex comfort that it is worthy

to use then at least on the less exposed zones or even in the exposed ones like table tops or kitchen working desks and floors and to be equipped with useful instruction and tools for caregivers, how to maintain and to renew the natural surfaces.



Figure 4.1.56 Different finishing of the oak wood surface, whereas with no finishing (top left picture) there are stains left after putting wet glass with red wine, coffee, coke, and olive oil, with flax oil finishing there are just light stains (right top picture) and with using modern synthetic coating there are no stains left, company Adler presents this way the behaviour of the surface for the customers to be informed (Adler)

COLOUR CHOICE FOR INTERIORS

The interior design of the apartment unit should be based on a contrasting solution to the space of the apartment or furniture elements. The colour solution of individual zones in the apartment can be beneficial in orientation in the space. Furniture elements or doors, for example, should have a contrasting colour to the wall on which they are installed. Contrasting or assorted colours should also be elements or objects that may threaten the safety of users. Warm-tone colours and pleasant to the touch materials is preferred for the equipment.

The interior should create a pleasant and welcoming atmosphere. Users should be able to equip the interior with their own furniture, they should have the ability to pick colours of the walls so that their space acquires a personal character.

Colour contrasts in interiors do not have to be limited only to walls and floors, the contrast between the stairwell and the wall, colour highlighting of important points and zones is also suitable. These places can also be coloured by graphic elements, while the entrances to the rooms should also be coloured, ideally at eye level.



Figure 4.1.57 Difference in colour, tone and patterns between floor and walls (left) helps to get better orientation, pastel colours make a pleasant soft atmosphere even with hard ceramics, Oude Dijk apartments, in comparison to the unicolour setup (Shift-au)

1.4.3 Recommendations for floors

IN A NUTSHELL

Floors should be safe and inviting to walk and freely move that is why the choice of floor material is crucial for age-friendliness. Important is to have a clearly visible contrast between a floor and wall (surface colour), for

better orientation. It can be also tone in tone, but the brightness difference must be clear. Floors with fool carpeting are safer by falling and motivate, encourage to walk, move and welcoming for visitors as well.

It is a promising idea to complete the floor with relief elements, for example, artificial guidelines of various textures and colours. Alternating the colours of the floor covering, marking the purpose of the rooms with a relief sign, or other guiding signs is also beneficial in helping seniors to orient themselves. There

must not be any obstacles on the ground in communication spaces that would limit the movement and safety of seniors. Safe floors must be solid, uniform and protected against abrasion and slipping. It is suitable to choose full-surface floor coverings or tiles that do not shine, so as not to worsen the orientation in

the space. If a carpet is used, it should have a low pile and be passable by wheels (strollers, strollers, beds, suitcases etc.). Floor coverings must be easy to maintain for hygienic reasons. In the colour solution of the floor, walls, and ceilings, it is appropriate to use lighter shades without colours without patterns, which do not unnecessarily exhaust the user with their stimuli. Seniors prefer more “earthy”, warm, less pigmented shades of colours.

The darker surface of the floor is good not only for a feeling of being grounded but also for better orientation in space. The difference in colour, tone and patterns between the floor and walls (left) helps to get better orientation, pastel colours make a pleasant soft atmosphere even with hard ceramics, in comparison to the unicolour setup (Fig. 4.1.57).

If a carpet is used, it should have a low pile and be passable by wheels (strollers, strollers, beds, suitcases...). Floor coverings must be easy to maintain for hygienic reasons. Carpet floorings has some major advantages. Carpeting transfers less pathogens to hands than vinyl or rubber flooring, and certain serious pathogens survive for a shorter period of time. Noise and glare is reduced, walking is easier, falls and resultant injuries are less likely, visits by family and friends are longer (increased social support), and carpets encourage a feeling of safety and improved personal psychological and thermal comfort, and produce a more homelike, non-institutional, ambience.

The few disadvantages of using carpets are, that they are more difficult to keep clean than hard flooring and bacteria returns fairly quickly. It may be difficult for staff to push carts and wheelchairs, so it is not suggested to use it in the hallways (Salonen at all, 2015).¹²

Several studies have also proven the perceived indoor air quality as well as worsening of symptoms in individuals with asthma and allergies. Modern rugs are less or completely unproblematic, causing no problem for indoor air quality and health, and no longer represent a problem for indoor air quality. Rather, they now claim to be a good option, even for people with asthma and allergies (Rune at all, 2018).¹³

Carpet manufacturer United Carpets and Beds recently revealed that using carpets has major improvement of people shoe habits in the UK. Typical shoe is carrying an average of 421,000 units of bacteria. Carpeted floor as opposed to hard wood floor would provoke more people to remove their shoes before walk on.¹⁴

If a carpet is used, it should have a low pile and be passable by wheels (strollers, strollers, beds, suitcases, etc). Floor coverings must be easy to maintain for hygienic reasons. In the colour solution of the floor, walls, and ceilings, it is appropriate to use lighter shades without colours without patterns, which do not unnecessarily exhaust the user with their stimuli. Seniors prefer more earthy, warm, less pigmented shades of colours. Darker surface of floor is good not only for the grounding, but also for better orientation in space, especially when the walls have much lighter colour.

Carpet floorings has some major advantages. Carpeting transfers less pathogens to hands than vinyl or rubber flooring, and certain serious pathogens survive for a shorter period. Noise and glare are reduced, walking is easier, falls and resultant injuries are less likely, visits by family and friends are longer (increased social support), and carpets encourage a feeling of safety and improved personal psychological and thermal comfort, and produce a more homelike, non-institutional, ambience.

¹² <https://eprints.qut.edu.au/96356/>

¹³ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5858259/>

¹⁴ <https://www.floortrendsmag.com/articles/105617-consumers-fail-to-consider-health-when-walking-germs-into-homes>

Using of soft floors motivates also to use the floor for sitting on the floor in the lotus seat or squatting, sitting on hills, or stretching the spine by lying on the floor.¹⁵



Figure 4.1.59 Full carpet in spaces like bedrooms or living room are the best solution, it is better to prevent rugs that can be an obstacle and reason to fall (The Spruce)

¹⁵ These postures require more physical flexibility that must be fostered in the earlier age and thus prevents the sturdiness of the joints or less movability of the whole body later. We have explored this topic in the chapter 1.3 Solutions for active ageing, prevention of sedentary culture and support of motor skills

1.5 CO-LIVING WITH PETS

IN A NUTSHELL

Co-living with pets has many social and health benefits and belongs to an age-friendly environment, it supports spontaneous movement and socialisation, even when it brings more demanding maintenance.

Combining prospect and refuge works in the same way, like by human beings, particularly by dogs and cats, but also by other small animals suitable for keeping at home like pets. Prospect in form of any higher platform can be a shelf, available parapet, or table with some cushion or padding) that allows a view outside.



1.5.1 Health and social advantages

Keeping pets and breeding domestic animals have several health and social advantages when the physiological and social needs of animals are maintained.

In general, keeping pets brings more spontaneous movement, more socialisation outdoor, a feeling of belonging, motivation to live and have plans for a future, more well-being, caring about the welfare of animals practising animotherapy at home.¹⁶

Another level is the breeding of domestic animals that generates a lot of spontaneous movement and social interactions between humans and animals, connecting with some basic gardening and planting own vegetables and flowers, but in case of living in multi-generation housing or in a community, where the care about animals can be shared among family or community members has multiple positive effects. This means that **pets are deeply involved in the age-friendly environment** and the space, and its furnishing elements should be adaptable for this occasion.

¹⁶ The topic of co-living with pets is further developed in works of Elena Farkašová and her students, from Technical university in Zvolen, e.g: Farkašová, E. (2022). Humanita v dizajne/Humanity in Design. Designum 4



Figure 4.1.60 Pets like dogs and cats need at a home combination of shelter and view—visual contact with the outdoors (Valábeková, Kotradyová)

1.5.2 Principles of space organization and choice and recommendation for furnishings

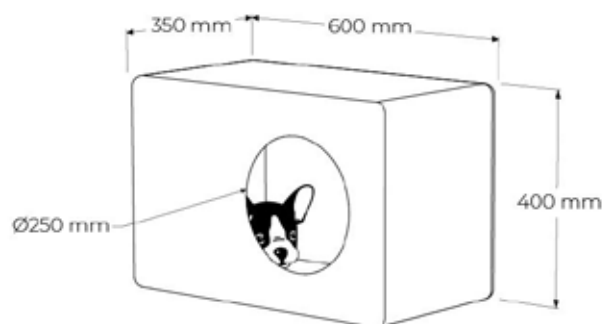
Combining prospect and refuge works in the same way, like by human beings, particularly by dogs and cats, but also by other small animals suitable for keeping at home like pets. Prospect in form of any higher platform can be a shelf, available parapet, or table with some cushion or padding) that allows a view outside (Fig.4.1.60 and 4.1.61). Refuge in form of shelters, this environmental setting brings well-being especially when the pets stay alone at home.

Avoiding steep staircases in the housing area is suitable not only for older adults but also for dogs. Also, a big benefit can bring a higher platform or desk in the bathroom for cleaning, drying, and styling the animal as we can see in pet grooming saloons for dogs or by an investigation by veterinary doctors. The higher platform in the bathroom, potentially with some light movable steps for the pet or some height adjustable system can make the maintenance of the animals easier (Fig. 4.1.62).



Figure 4.1.61 Prospect and refuge is an optimal environmental setting also for pets (Cón)

There are already many inventions, how to incorporate the place for pets into the furnishing objects, and to save place in smaller apartments. It can have a form of a small storage unites like side tables or shelves, where the pets have an easy entrance in the appropriate high and their refuge shelter and at the same time also a prospect. At the Fig 4.1.63 a solid wooden furniture element Pethouse BUDDY from Slovak furniture producer Javorina that create the impression of furniture and thus fit into the interior, the uniformity of which will remain intact.



At the Fig. 4.1.64 is inbuilt box for free inlaid matt for dog into the wooden podesta of a sofa, with free cushioning as a tailor-made solution in the living room. This kind of elements are making co-living with pets easier and do not disturb a look of interior.



Figure 4.1.63 Furniture element Pethouse BUDDY from Slovak furniture producer Javorina, for dogs it can be laid on the ground, cats will certainly enjoy the little elevation, design: Dušan Kočlík (Javorina)



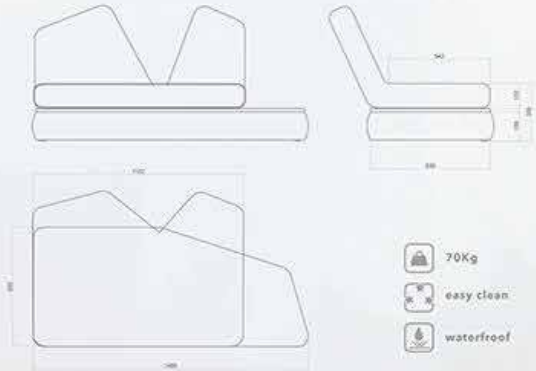
Figure 4.1.62 Grooming salons are equipped with higher or height adjustable desk, with pneumatic or electric elevation (Easyweek)
Resource: <https://easyweek.io/best-pet-grooming-software.html>



Figure 4.1.64 Inbuilt box for free inlaid matt for dog into the wooden podesta of a sofa, with free cushioning as a tailor-made solution in the living room, design: V. Kotradyová (Matúš)

how couch

bakalárska práca
zvíra v interieri



Bakalárska práca z oblasti dizajnu nábytku sa zaoberá problematikou spoluzitia človeka so spoločenským zvierateľom - psom. K tejto interakcii často krát dochádza v interiéri a tak aj samotný nábytok ju môže do určitej miery ovplyvniť. Predmetom štúdia sa stala otázka, či a ako môže nábytkový prvok vzájomnú komunikáciu posilniť, alebo naopak oslabiť. Čo sa môže stať, keď sa na jednom mieste stretne človek a pes? **Častokrát sa nám naskytuje pohľad skoby priamo na javisko divadelnej hry.** Ide o akési javisko alebo stáje na ktorom sa odohráva scéna zobrazujúca vzťah medzi užívateľmi. Konštrukcia v sebe ukrýva mechanizmy umožňujúce naklápanie a nastavenie sklonu jednotlivých častí kresla, podľa potreby.

Symbolika otvorených a zatvorených dlaní ukryvajúc sa v tvarosloví kresla má zobrazovať postoj človeka, ktorý môže aj takýmto spôsobom dať najavo svoju otvorenosť pre človeka a trávenie času so svojím psom alebo mačkou. či sa momentálne chce uzavrieť a dopriať si viac súkromia a komfortu.



Figure 4.1.65 Howcouch, sofa for practicing animotherapy, design: Matej Vražel, mentor: Elena Farkašová, TU Zvolen (Farkašová)

CONSEQUENCES FOR HYGIENE AND MAINTENANCE

Naturally, it is more demanding to keep the household clean when living with pets. To minimise the demanding cleaning, it is possible to have certain measures

- using of exchangeable, washable, and renewable elements that are worn out first (covers of upholstery furniture, hangers, floors, rugs, etc.)
- the textiles and fabrics dismountable from the upholstery furniture washable in the wash machine is a big benefit,
- in case of fixed upholstery covers, to have a possibility to shampoo the dirt/ stains,
- short hairs upholstery fabrics and carpets
- by hard surfaces is easier to clean the smooth surface than the one with a certain “topography”
- by soft fabric surfaces can be gained higher durability and cleanability with a special coating (Teflon, PVC etc.) that often reduce the authenticity, porosity/ breathability of the fabric surface that is a disadvantage of such a surface upgrading.



Figure 4.1.66 Robotic vacuum cleaner suitable for households with pets, DEEBOT U2 PRO – Black, vacuum cleaner Cynotopia (Depot, Cynotopia)

For cleaning the floors, robotic vacuum cleaners are an immense help. It is good to count on them in an age-friendly environment in general.

There are also specific vacuum cleaner robots for households with pets, that count already with specifics of cleaning the pet hairs, e. g. DEEBOT U2 PRO – Black, has even specially designed air outlet, designed upward to avoid flicking hairs up in the air, or it has “magnetic boundary stripe that block areas at home that the machines do not have to disturb or to protect by having pets at home (Fig. 4.1.65).



RECOMMENDATIONS FOR EXPERIENTIAL LEARNING WITH A GROUP OF TRAINEES

- Work in groups of 3 people and try to set in a room with available elements (e. g. chairs, tables, bags etc.) environmental a space situation / environmental setting that evokes intimacy, socialisation, fear, safety, wellbeing etc.
- Bodystorming: take different chairs from the rooms and let the people sit on them and explain what is good on the chair and what they would improve on it to create a comfortable seat.

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MODULE 4

AGE-FRIENDLY BUILT ENVIRONMENT
- INTERIOR

UNIT

2

INDOOR QUALITY

Dean Lipovac



DESIRE

DESIGN FOR ALL METHODS TO
CREATE AGE-FRIENDLY HOUSING

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UNIT 2 – INDOOR QUALITY

2.1 PRINCIPLES OF HEALTHY LIGHTING

IN A NUTSHELL

Proper lighting is essential for even the most basic activities occurring in the built environment, and light plays an important role in human health and wellbeing. Natural light should be abundant in indoor spaces, because it has qualities that are difficult to replicate with artificial light. This can be achieved in a number of ways, such as placing windows on walls facing the sunniest cardinal direction and installing large windows or glass walls and roofs. Despite the importance of natural light, artificial light is necessary to keep buildings fully functional without sunlight. Sources of artificial light should

be carefully planned and integrated with room layouts and materials so that the light is evenly distributed throughout the space without causing unpleasant reflections. Lighting should be matched to the intended function of the space. For example, breakfast rooms need light in the morning and should face east, while rooms that need light primarily in the late afternoon and evening should face west. Lighting should also be adaptable, because the same room can be used in different ways, depending on the user, occasion, and time of day.

2.1.1 The importance of natural lighting and its role in buildings

The built environment can hardly serve its purpose without proper lighting. Good lighting is essential for even the most basic activities: for people to move through the building safely, communicate effectively, and perform work, household, and leisure tasks constructively. But the importance of light goes beyond its role in supporting functioning in the built environment. Light has a major role in human health and wellbeing; it is linked to circadian rhythms, sleep, mood, stress, alertness, and vitamin D synthesis. The importance of light is clearly seen in cases of seasonal affective disorder – a type of depressive disorder that typically occurs in winter, when light levels are low, and for which the treatment includes increased exposure to sunlight or an artificial source of bright light (Edwards & Torcellini, 2002; Nousiainen et al., 2016).

The overall guideline is that spaces should provide appropriate lighting to support people's day-to-day activities by using sources of light that are not conspicuous or disturbing. Natural light should be abundant in indoor spaces and serve as the primary source of light during the day. Natural light not only connects building users to the outside world, but also saves electrical energy and has features that are difficult to match with artificial lighting. One of the first steps in trying to optimize natural light in indoor spaces is to consider the orientation of the building and windows relative to the movement of the sun. In the Northern Hemisphere, the sun is always on the south side throughout the day, and orienting buildings along an east-west axis can increase exposure to the sun. The amount of natural

light can be maximized by installing glass walls, tall windows, or windows that are placed higher on the wall. In the northern hemisphere, spaces with south-facing windows will receive the most light, so these should be spaces that are used frequently and require a lot of light, such as kitchens, rather than spaces that are used less frequently or need less light, such as storage rooms or bedrooms (Mahoney, n.d.).

North-facing windows receive the least amount of light compared to any other orientation, and larger windows are needed to let in a comparable amount of light compared to other orientations. The advantage is that the light from the north is indirect and does not cause

glare, which can be useful for some spaces, for example, rooms with computers and televisions. Windows facing the east receive direct light in the morning, making them ideal choices for places where people sleep and spend time early in the day, such as breakfast rooms. The opposite is true for windows that face west, which will receive the most direct light in the late afternoon and evening, making them ideal for rooms that are used primarily in later hours of the day, such as living rooms. Both eastern and western light can often cause glare due to the lower angle of the sun after sunrise and before sunset. This can be managed with vertical (rather than horizontal) sun shades (Mahoney, n.d.).



Figure 4.2.1 Transparent walls and roofs allow large amounts of natural light to enter indoor spaces. (Pexels)

2.1.2 Artificial lighting and the importance of adapted and adaptable lighting

Even though natural lighting is essential, buildings should be fully operational even without sunlight. It is especially important to sufficiently illuminate building elements that play an important role in the mobility of the occupants, such as stairs, as otherwise injuries can occur. In the lighting industry, Kelvin (K) refers to the warmth or coolness of the light. Light sources in the lower range tend to appear yellow (orange at the extremes) and those in the upper range tend to appear white (blue at the extremes). Commonly used light sources span from 2000K to 8000K, with 5000K being the most common colour temperature. Cooler colours at the upper end of the spectrum are typically used in spaces that require bright light for people to perform their tasks, including manufacturing facilities, warehouses, and healthcare facilities. Warmer colours at the lower end of the spectrum are typically used in spaces where bright light is not a priority, and the goal is to create spaces that feel more inviting and cosier (Larson Electronics, 2019).

Ideally, lighting should be adaptable in all spaces, because the same space can be used in different ways, depending on the user, occasion, and time of day. For example, playing a board game in the living room may require more light than having a conversation, and older adults may need brighter light for reading than younger people.

In places where frequent conversations are expected to happen, such as reception areas, lighting should illuminate people's faces. This is especially important for people who read lips. Adaptable lighting can be achieved with smart light bulbs as well as with blinds and curtains that can control sunlight (Edwards & Torcellini, 2002; Nousiainen et al., 2016).

Light should be evenly distributed and diffused in a space. This can be achieved by having more (less intense) sources of light rather than few (intense) sources. For example, several smaller windows distribute light more evenly compared to few large windows. Light coming from few intense sources can also create strong shadows, which can interfere with people's perception of step edges. The distribution of light is also affected by the layout of spaces and selection of interior materials. Larger spaces can distribute light more effectively than several smaller or subdivided spaces. Subdivided spaces can diffuse more light when the separating elements are transparent (e.g., glass walls). In general, transparent and bright materials allow light to spread through the space more effectively. Some materials, especially artificial and heavily treated ones, can cause unpleasant reflections, making natural materials with matte finishes a preferred option (Edwards & Torcellini, 2002; Nousiainen et al., 2016).



Figure 4.2.2 Warmer lights appear yellow or orange, while cooler lights appear white or blue (Larson Electronics)

2.2 INDOOR AIR QUALITY

IN A NUTSHELL

Poor air quality is responsible for a variety of illnesses, including respiratory diseases, diabetes, and dementia. In the Western world, some of the most important indoor air pollutants are volatile organic compounds emitted by various materials and products, such as paints, furniture, carpets, and cleaning agents. These pollutants contribute to the sick-building syndrome, which is characterised by increased respiratory illnesses, allergies, and decreased immunity. The first step in improving indoor air quality is to reduce emissions of pollutants. It is especially important to avoid materials that contain chemicals on the Living Building Challenge red list¹, such as asbestos or lead. Natural materials, such as wood, are generally preferred, although these materials can also

be problematic. A complementary method to using less harmful materials and substances indoors is to remove pollutants from the air. This can be accomplished in part by increasing the amount of indoor vegetation, which can remove toxins, dust, and germs from the air. Harmful substances can also be removed from the air by passive (gravitational) and/or mechanical ventilation. Passive ventilation uses temperature and pressure differences between indoor and outdoor air to bring in fresh air from the outside and remove stale air from the inside by strategically positioning building openings. Mechanical ventilation uses electrical devices that move air from the inside to the outside and, in some cases, also from the outside to the inside.

2.2.1 Poor air quality and health

Poor air quality has been implicated in various diseases and health issues, including cardiovascular disease, respiratory disease, adverse birth outcomes, diabetes, neurodevelopmental deficits, and dementia. Conversely, reducing air pollutants leads to observable health benefits, both within a short time period and over the longer term (Kelly & Fussell, 2019). Because people spend most of their time indoors, indoor air quality is of critical importance. The level of indoor air pollution varies widely in different parts of the

world. In rural areas of the developing world, burning solid fuels for cooking and heating without proper ventilation significantly harms health and increases the risk of death. In dense Asian megacities, indoor air is polluted primarily by outdoor pollutants, including industry and vehicle exhaust. In the Western world, indoor air quality is negatively affected by chemicals from cleaning and consumer products, furniture and building materials, and inadequate maintenance of ventilation and air conditioning systems (Kelly & Fussell, 2019).

¹ <https://living-future.org/red-list/>



Figure 4.2.3 Industrial pollutants are significant contributors to poor air quality (Pexels)

In recent decades, the use of mechanical air recirculation ventilation systems and the constant upgrading of interior furniture have led to an increase in indoor air pollution. The main pollutants are volatile organic compounds such as benzenes, phthalates and formaldehyde, which are emitted from materials and products such as paint, furniture, carpets, cleaning agents, cosmetics, and disinfectants. Most of the emissions come from human-made substances. Perhaps the most harmful

substance, however, is naturally occurring radon, which can enter indoor spaces through soil, stony building materials, and household water. The unhealthy conditions created by emissions of various harmful substances contribute to the sick-building syndrome, which is characterised by an increased number of respiratory diseases, allergies, and decreased immunity, with symptoms including headache, fatigue, dizziness, nausea, and eye, nose, and throat irritation (Joshi, 2008).

2.2.2 Improving indoor air quality

The first step in improving indoor air quality is reducing the emissions of harmful substances. It is not possible to create modern indoor spaces without having objects that emit at least some pollutants for at least some of the time, but air quality can be greatly improved if certain materials are chosen over others. It is especially important to avoid materials containing chemicals from the Living Building Challenge red list², such as asbestos or lead (The Living Building Challenge, n.d.). Soft materials like carpets and drapes can retain dangerous air pollutants and serve as their reservoir long after the original sources of pollutants have been removed, especially if they are not cleaned regularly. Although natural materials, such as wood, should generally be a preferred choice, it should be noted that even materials like wood can be problematic – the number of emissions is high when wood is fresh or heavily treated with adhesives and coatings. Older materials (and older buildings) generally emit fewer substances which increase when renovation or maintenance work is done, such as when new furniture is added or when walls are painted.

A complementary method to using less harmful materials and substances in indoor spaces is to remove pollutants from the air. One way to accomplish this is to increase the amount of indoor vegetation with large leaves, which can remove toxins, dust, and germs from the air, including air pollutants present in building materials and furniture, such as acetone, ammonia, benzene, and formaldehyde. However, plants can reduce air pollutants only to a certain extent, and proper ventilation is required for good air quality. Ventilation can be divided into passive (gravitational) or mechanical. Passive ventilation relies on temperature and pressure differences between indoor and outdoor air to supply fresh air from the outside and remove stale

air from the inside by strategically positioning building openings. Passive ventilation works best in the winter, when the outdoor and indoor air differ considerably. It is much less effective in the summer, when the differences between outdoor and indoor air are much less pronounced. The design of buildings for effective passive ventilation can be complex and needs to consider a variety of factors, such as the location and dimensions of the building, layout of spaces, and the location and type of openings, such as doors and windows (Nousiainen et al., 2016; Spengler & Chen, 2000).

When passive ventilation is inadequate, it can be supported or replaced by mechanical ventilation. Mechanical ventilation uses electrical devices that move the air from the inside to the outside (exhaust ventilation) and, in some cases, also from the outside to the inside (supply ventilation). Supply ventilation allows for the incoming air to be filtered before it enters indoor spaces. The downside of mechanical ventilation is that it requires energy, can be a source of disturbing noise, and contains filtration systems that must be cleaned on a regular basis, otherwise they can become sources of air pollutants themselves (Nousiainen et al., 2016; Spengler & Chen, 2000).

In addition to air pollutants, room temperature and relative humidity are other important aspects of indoor air quality. People tend to feel most comfortable and function at their best when the temperature is around 21–22 °C. However, this can depend on various factors, such as physical activity level of people, and it should be possible for building users to regulate the temperature. When the temperature is significantly higher or lower than the preferred temperature, people can become tired and inattentive. Relative humidity should be around

² <https://living-future.org/red-list/>

the range of 40–50 %. Dry air can irritate the skin and respiratory system, while mould and microbes are more common in the humid air. Suitable temperature and relative humidity can be maintained through specific building

design approaches, heating, ventilation, and air conditioning systems, and use of certain materials – wood, for example, can regulate both temperature and humidity (Nousiainen et al., 2016).

2.3 ACOUSTIC PROPERTIES FOR WELLBEING

IN A NUTSHELL

Frequent exposure to noise can lead to cardiovascular disease and other stress-related consequences. Conversations of others are sources of unwanted sound that can be particularly distracting for people, especially if the speech is clear enough to be understood. This can be remedied by installing a background noise source that masks intelligible speech. Ideally, these should be sounds from nature, as they not only mask intelligible speech, but can also directly make people more relaxed and focused. In general, the acoustic design of a space should satisfy two conditions: people should be able to hear what they want to hear – most often each other during conversations, and they should be disturbed as little as possible by

unwanted sounds. Spaces with acoustic conditions that support conversation should generally have a short reverberation time. Reverberation time is short in small rooms and can be further shortened by using more absorptive materials, such as carpets, and fewer reflective materials, such as brick. One way to protect people from noise is simply to lower the noise level or move people away from the source of noise. Another way is to install products for controlling noise, such as acoustic ceilings. More generally, comfortable acoustics can be achieved through specific construction approaches that consider materials and furnishings, as well as the size, shape, and layout of rooms.

2.3.1 Noise and wellbeing

The ability to listen has been fundamental to the evolution of the human species. Speech is one of the most important means of communication for people, and listening is one of the key abilities they use to examine and understand the environment around them. The importance of sound is already evident in infants, who are able to turn their heads toward a sound source (Altomonte et al., 2017). Soundscape – an environment of sound with emphasis on how it is perceived – therefore plays an important role in the way we experience our environment. Negative

soundscapes – those that can be damaging to wellbeing and health of people – are especially important.

Noise – unwanted sound that is perceived as disruptive – can affect both physical and mental health and wellbeing. One obvious way in which noise can negatively affect people is by leading to hearing loss, which can be caused by sudden exposure to exceptionally intense sounds or, more commonly, it occurs gradually with prolonged exposure to loud sounds. However, most built environments

rarely reach the sound levels that can trigger hearing loss, so noise-induced hearing loss is a risk only in noisier places, such as airports (Cowan, 2016). A more common concern is the association between noise exposure and increased risk of cardiovascular disease, where noise leads to stress, and stress puts a strain on the cardiovascular system (van Kempen et al., 2002; Westman & Walters, 1981). Noise-induced stress also leads to a variety of other negative consequences, including worsened cognitive performance, lower mood, sleep disturbance, and reduced learning ability.

Conversations of others are sources of unwanted sound that can be particularly distracting for people, especially when the speech is clear enough to be understandable (Schlittmeier & Liebl, 2015). In some spaces, this issue is addressed by installing a source of background sound that masks intelligible speech. These masking sounds can be simple – for example, sounds resembling ventilation noise – but people prefer sounds emanating from nature, such as sounds of pouring water (Haapakangas et al., 2011). Natural

soundscapes are especially promising because their effect can go beyond mere masking of unwanted sound and more directly lead to positive outcomes by making people more relaxed and focused (Ratcliffe, 2021). The soundscapes should ideally be relatively simple, not too loud, and their sources should be easily discernible, otherwise they may confuse or frighten certain people, particularly individuals with dementia.

It should be noted that the degree of annoyance with noise only partly depends on physical acoustic conditions, as several other factors play an important role, including the perceived control over the source of the sound, context and attitudes toward sound sources, and people's personality traits and mood. This opens up an opportunity to decrease the annoyance people feel in response to noise without changing the characteristics of the noise. One way to achieve that is to visually expose people to elements of nature, such as views of landscapes or indoor greenery, which can make them less disturbed by noise (Li et al., 2010).



Figure 4.2.4 Traffic is a problematic source of noise, especially in densely populated cities (Pexels)

2.3.2 Acoustic design for wellbeing

Acoustic design should fit the intended function of the space. Overall, there are two broad groups of potential issues that need to be considered when it comes to acoustic comfort: people need to be able to hear what they want to hear – most often each other during conversations, and they should be disturbed as little as possible by unwanted sound – noise. People should be able to easily understand speech without being bothered by background noise or reverberation – spaces with acoustic conditions supporting conversations should generally have a short reverberation time. Reverberation time is short in small rooms, and it can be further shortened by using more absorptive (softer) materials, such as carpets, curtains, and upholstery, and fewer reflective (harder) materials, such as brick, plaster, and concrete. Another option is to install specific commercially available products for controlling noise, such as acoustic ceilings and vertical screens and barriers. These are usually made of wood-based composite materials (e.g., chipboard), gypsum, polycarbonate, or glass, and they can be treated with paint or a layer of acoustic fabric. However, some reverberation is usually desirable – for example, it can help people hear better in larger spaces when they are located far from the sound source (Altomonte et al., 2017).

The design process for acoustic comfort needs to consider several important factors, including **1)** how sounds generated in a space propagate across the interior surfaces of that space, **2)** how sounds of one space can be heard in another, **3)** noise of mechanical devices, and **4)** how certain activities may require privacy (Grigoriou, 2019). Sources of noise can either be transmitted through the air, such as conversations or music, or they can be generated by impact, such as walking on the floor in high-heeled shoes. One way to protect people from noise is simply to change the noisy activities in a space, place the noise source far away from people, or separate noisy areas from people with buffers, such as lobbies. Another way to create comfortable acoustics is through specific construction approaches – materials and furnishings as well as the size, shape, and layout of the rooms should all be considered. It should be noted that the goals of good acoustic design may clash with other design goals; for example, design intended to improve lighting. Large spaces, for instance, can maximise the amount of natural light entering the interior, but they can also lead to higher transfer of unwanted sound and longer reverberation times. In such cases, it is important to carefully analyse the situation and find a solution that strikes a suitable balance between conflicting design goals.

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MODULE 4

AGE-FRIENDLY BUILT ENVIRONMENT
- INTERIOR

UNIT

3

ECOLOGICAL APPROACHES
TO THE BUILT ENVIRONMENT

Veronika Kotradyová



DESIRE

DESIGN FOR ALL METHODS TO
CREATE AGE-FRIENDLY HOUSING

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UNIT 3 – ECOLOGICAL APPROACHES TO THE BUILT ENVIRONMENT

IN A NUTSHELL

¾ of the product life service is decided already by its design. Universal design and design for all, and human-centred design is the way how to prevent many ecological problems. All used materials used in the interior should

be demonstrated by the producer, to have something like a passport that declares the structure/content of used materials, their additives, and their origin.

Considering sustainability is a key issue also in the age-friendly environment, especially nowadays when the global civilisation faces an environmental crisis that is caused also by human behaviour, housing connected with building activities and consumption. That is why it is necessary to raise awareness of environmental issues in design and architecture, especially the environmental impact in the whole life cycle of each product or service.

So, the unit will provide an overview of principles and recommendations in the application of ecological approaches in architecture, interior and product design with the aim to prevent

ecological problems and to give awareness the sustainability issues, in relation to an age-friendly environment.

Sustainability with many ecological innovations has also social impact- social added value in the age-friendly environment, where some projects can be designed and constructed together through participatory design that gives the possibility to express self through common issues, to be part of the creative process and to experience engagement, being involved, care, attachment to places and things. This helps to build community and get social networks from different social groups.

3.1 ENVIRONMENTAL PROBLEMS CONNECTED WITH BUILT ENVIRONMENT AND HOUSING

We can conclude then with these bullets:

- exhausting of resources that are not renewable and bad management of renewable resources, using of solutions with high carbon (CO₂) footprint¹ and using solutions for materials and products with no ecological awareness
- energy waste, especially by heating
- producing waste by new buildings and reconstructions of the old ones that are hard to recycle or diminished without releasing pollutants and toxins into the environment
- low quality of the outputs in general that cause rapid moral and physical obsolescence.

¹ A carbon footprint is the total amount of greenhouse gases (including carbon dioxide and methane) that are generated by our actions.

WASTE

Due to demanding reconstructions to create accessible and adaptable housing, there is created a big volume of waste of ceramic, plastic and metal origin often fixed together in a way that it is hard to provide upgrading of the waste into the new construction materials and prefabricates, but only the downgrading (e. g using of rubble in the foundations of buildings). The opposite is the waste created from a wood structure with a smart disassembly, where many elements can be returned into the life cycle in some new construction materials.

Especially upholstery furniture is often first exchanged in households due to early obsolescence, which creates a problem by the end of its use and removal, thus many different materials are fixed to each other with no solution to disassemble and further recycle



Figure 4.3.1 Upholstery furniture creates a big ecological problem with its standard construction principle which is joining together materials in a fixed way which causes the problem to dismount the product by recycling/reusing.

3.2 BASIC PRINCIPLES SUPPORT THE PROTECTION OF THE ENVIRONMENT AND REDUCING THE IMPACT OF CLIMATIC CHANGE, APPLICATION OF LIFE CYCLE MANAGEMENT

In a civilised society, there are used materials, products and spatial solutions that were developed with low or no ecological awareness. To be consequential, it is necessary to consider and evaluation of products during their whole life cycle or life span and it is:

Pre-production/production of materials and prefabricates by processing raw materials, the renewability of the resources and the fewer pollutants together with saving energy are here crucial

Production/manufacturing/production of the final products, including transport to the final user where saving of energy, fewer emissions (e.g., VOCs), production waste separation at the working place and smart planning that is directly influenced by design (shape and construction principles, e.g., flat pack concepts have many ecological and economic benefits)

Using/life period when the product is by the final user, here is the strong connection to the health and wellbeing of users by using materials that need fewer additives which means fewer emissions during use. The physical and moral life span during use is also directly influenced by design.

Recycling/removing/at the end of the life span, it is decided if the product will be recycled or removed and it is already by the designing of the product or service if the product can be dismantled and its single parts

Considering the whole life cycle by developing new products and services it is convenient to support a circular economy that can spur growth, reduce costs, and build resilience. Green/ecological concepts can be accessed by different approaches that can be combined. There are complex evaluation systems at the building market, that are issuing certificates

like BREEAM, LEED, DGNB, BREEAM, LEED, WELL, ESG, EPD or system Living Building Challenge (Figure 4.3.2) serve for orientation if the buildings were designed and are used

according to the sustainability philosophy. Also, carbon neutrality is a parameter that can be calculated and serve for ecological feedback.

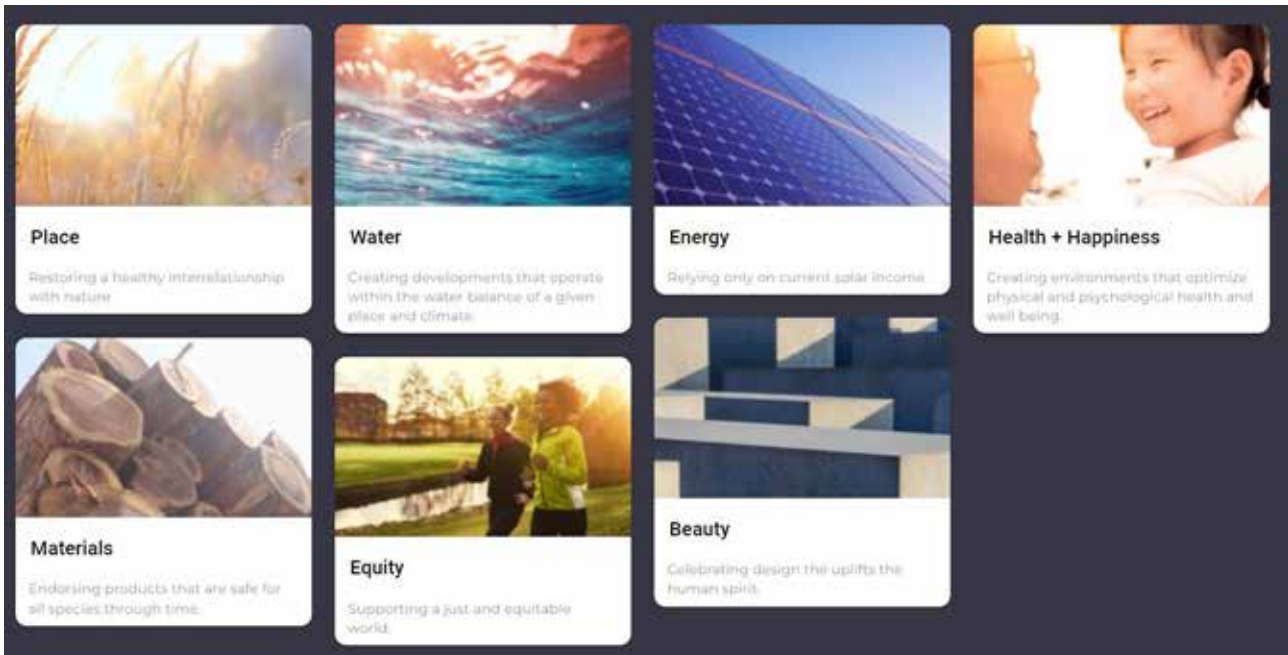


Figure 4.3.2 Living Building Challenge is organised into seven performance areas (International Living Future Institute)

For some orientation in the ecological profile of product serves different certificates and ISO norms such as ISO 9001 (if you want to know more, read Module 6) LCA: life cycle assessment of products.

Important is to consider the ecological aspects early before the building and manufacturing process, thus $\frac{3}{4}$ of the product life service is decided already by its design.

In an age-friendly environment is important to work with universal principles, to avoid demanding reconstructions (with a negative impact on the environment and the finances as well) and update the furnishings, it is convenient to work with universal principles, adaptable housing concepts by the spatial organisation, with human centred design by choice of furnishings objects that should have a timeless design and trend neutrality.



Figure 4.3.3 Öko control is a certificate that is issued by the European Association of ecological furniture showrooms (one of the members is furniture seller Eckhard Bald, Munster, Germany), their criteria are related mostly to the choice of materials that must be as solid as possible, with little additives, e.g., Austrian company specialised in solid wood furniture – Team 7 own this certificate, bed Paso (ÖkoControl)

3.3 ECOLOGICAL APPROACHES TO THE CONSTRUCTION OF PRODUCTS

In addition to the known and traditionally used design principles, it is necessary to additionally consider ecological aspects, i.e., oriented to environmental protection and recycling.

Known aspects to consider are:

- technical requirements, functionality, safety requirements, optimal production processes or good user properties, (if you want to know more, read Module 5)
- economic requirements, such as low production costs, and low user costs.

Here comes the principal moment of decision between differentiation and integration design principles (Brinkmann, 1995, in: Kotradyová, 2004).

INTEGRATED CONSTRUCTION PRINCIPLE

The term integrative construction principle means the merging (summarization) of several individual parts made of the same material without using some joints.

Advantages

- acceptable construction for later recycling (product made of one material), condition: the material must be recyclable! (e.g., plastic furniture without joints – welds; or fibrous moulded parts, chip moulded parts)
- the cost of disassembling the overall product during removal is negligible, or at least significantly less than with a differential design principle,
- economic benefits for many pieces.

Disadvantages

- high costs for forming moulds and for changes (a high number of pieces is a prerequisite for cost-effective production, otherwise it is wasteful production),
- based on differentiated demands on the product (different stress on the product), the optimal use of materials is not possible in every case! (e.g., the connection of the back wall and the structural bottom),

- from the point of view of orientation towards the appropriate use of material, it can cause a more expensive construction (result: increase in the weight of the entire product, increase in the burden on the environment when using the product).



Figure 4.3.4 Hemp chair, design: Werner Eislinger, a chair made of hemp fibre composite, an example of the integration construction principle (Designboom)

DIFFERENTIAL CONSTRUCTION PRINCIPLE

It is the breakdown of one part into more technically advantageously produced workpieces, which require a suitable method of joining.

Advantages

- use of material appropriate to the load and requirements,
- the possibility of multiple uses of a part for another construction (principle of a children's kit),
- use of a light type of construction, thus energy-friendly production.

Disadvantages

- high production and assembly costs based on several individual parts (in part),
- higher costs for disassembly when disassembling into individual construction parts, or materials (e.g., composite materials)

such as coated particle boards should be separated from solid wood or block boards etc.).

A prerequisite for ecological construction is that the differentiated parts in the summation (as a whole) are assembled in such a way that they are acceptable for the environment and further usable (Brinkmann, Ehrenstein, Steinhilper 1995, in: Kotradyová, 2004).

Chair Picto, German company Wikhahn, 1992 (Fig. 4.3.5) was the first ecological office chair, it is a good example of the differentiation

construction principle, where all the parts made of metals (aluminium) and plastics are made by different specialised producers with eco audits and after finishing of the life span it is possible to disassemble and recycle them. Company Wikhahn has set its whole philosophy, technology, and corporate identity on sustainability, including its production facilities which are experimental wood structures. As a manufacturer, they consider it as a duty to minimize any negative and maximize any positive impact on the environment and society.



Figure 4.3.5 Chair Picto, German company Wikhahn, 1992 was the first ecological office chair, company catalogue, 1998, it is a good example of the differentiation construction principle (Wikhahn)



Figure 4.3.6 Exchangeability of the covers or whole upholstery prefabricates can prolong the moral and physical life span and to prevent obsolesce, left exchangeable and washable upholstery cover (Kotradyová); right upholstered shell removable from the sitting shell made of plywood enable exchange whole upholstery element in case it is already worn out, a solution developed by Becker Brackel, a German producer of moulded elements, (Becker Brackel, Formholzbriefe, 1998)



Figure 4.3.7 Flat pack system that is applied on the bed Siebenschläffer, from company Moorman möbel, made of plywood with openings made by CNC machines enabling disassembly, instead of traditional metal joints (Moorman Möbel)

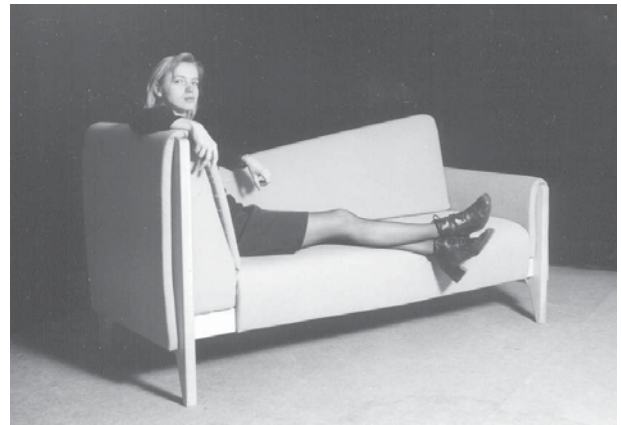
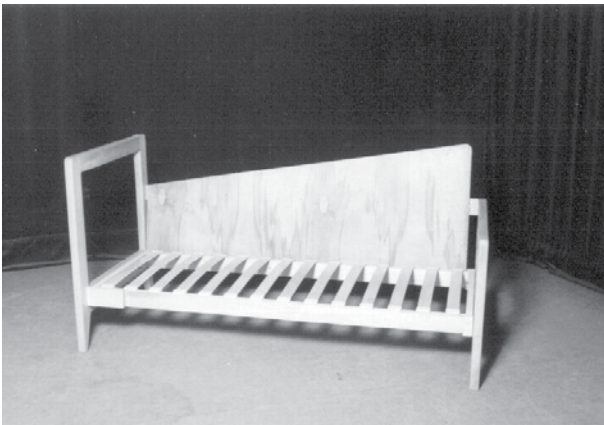


Figure 4.3.8 Sofa Teo is an example of ecological construction of upholstery furniture, it is completely dismountable, design: Veronika Kotradyová (archive of author)



Figure 4.3.9 Stand Aladar is completely foldable, its skeleton is made of durable and flexible ash and oak wood and the textile or leather (of local origin) connectors are fixed to it through dismountable joints, project Kusok dreva, design: V. Kotradyová, (Knap)

Fig. 4.3.6 – 4.3.9 are examples of the products that have applied the differentiation principle and are easy to fold or disassemble that have an advantage by manufacturing (easy to sort the waste and to organize production process – to delegate the manufacturing to specialised

producers) optimize the logistics – transport within production cycle and to end consumers/ customers thus they need less volume by transport; and in the phase of using they offer high variability, adaptability and performance comfort.

3.4 ENVIRONMENTAL AWARENESS IN THE CHOICE OF MATERIALS

Choosing local renewable materials by building, reconstructing, and furnishing, using wood, clay, straw, wool, flax etc. using local human resources that support also the local economy. The first choice is **using natural/renewable raw materials** that have not only an incredibly low CO₂ footprint but especially in their authentic form have also a direct positive impact on the microclimate of an indoor environment, with health benefits and a direct impact on the wellbeing of users.

To be consequent by using renewable raw materials, they should originate from plants coming from sustainable agriculture and forestry. For a rough orientation can serve certificates like PEFC (Programme for the Endorsement of Forest Certification) and FSC certificate (Forest Stewardship Council) that are issued to the producers of biomaterials, especially wood products and services providers.

PEFC cooperates with local organisations and provides forest owners, from the large to the small, with a tool to demonstrate their responsible practices, while empowering consumers and companies to buy sustainably.

Using wood in the building and furniture industry reduces the carbon footprint of buildings in two key ways—through carbon storage and avoiding greenhouse gas emissions. As trees grow, they absorb carbon dioxide (CO₂) from the atmosphere, release oxygen (O₂), and incorporate the carbon into their wood, leaves or needles, roots, and surrounding soil. **Wood** products typically require less energy to manufacture than other building materials, substituting wood for fossil fuel-intensive materials is a way of avoiding greenhouse gas emissions². The condition is that it must originate from sustainable forestry management.

² <http://www.woodworks.org/why-wood/carbon-footprint/>

Here also the purity of the sort in one material or prefabricate is a high value, this means no mixture of varied materials that is not possible to recycle once more, into one composite. This means that e.g., furniture, floors and the whole structures should originate from forest management or agriculture that respect environmental issues.

Big advantage of using local renewable materials is a quick construction works and less energy and emissions by raw material to prefabricate, it's finishing and using.

Nowadays very actual is choosing for new built structures or by reconstruction passive or active houses solution, from ecological and economic reasons. Passive houses made of natural renewable materials (wood, straw, clay, flax oil), save energy for heating and production, thus have a low carbon footprint, have quick assembly/construction works and offer a healthy indoor microclimate, including a high level of well-being for users, are suitable as a concept for day care centres for elderly or for all kind of housing (Fig. 4.3.10).

UPHOLSTERY AND HOME TEXTILES

By the upholstery fabrics, carpets, and household textiles it is hard to use only renewable materials only (e.g., domestic wool, flax, hemp or imported bamboo, organic cotton etc.) thus they are less durable³, have more demanding cleaning and maintainability, so they are mostly mixed with synthetic fibres. Filling materials are also the domain of synthetic foams (PUR- foam), but there are also alternatives that are less available such as gummy-coconut fibres, sheep's fleece, cotton fleece, straw, horse hairs, kapok, African grass etc.) But textiles made of natural and local yarns have not only a low carbon footprint, but also give special warmth and cosiness that are so important for the age-friendly environment (Fig. 4.3.11, 4.3.12).

³ really durable cover fabric has more than 25 000 Martindale



Figure 4.3.10 Self-bearing Straw bale dome made in passive standard, in Hrubý Šúr, Slovakia, is the headquarter of the architecture studio Createrra, made of natural renewable materials: straw bales as the main construction material, wood structure, with using of green roof on the top, clay floor finished with flax oil varnish, walls covered by clay plaster (Createrra)

Using wool or flax with their natural surfaces are contributing massively to the wellbeing and warm, cosy atmosphere in age friendly environment, whereas the tactility and contact comfort of wool or flax is depending on the length and thickness of their fibres. Another added value is the local origin; traditional craft with a positive impact to the social sustainability in the economically less developed regions.

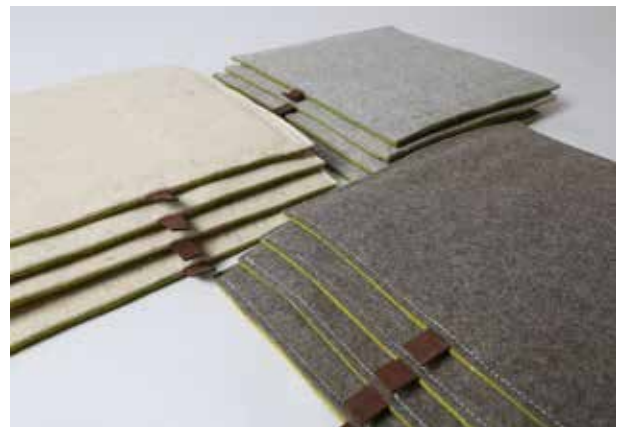


Figure 4.3.11 Wool felt seat padding, softened with a layer of cotton fleece, Samsara, design: V. Kotradýová (N. Knap)



Figure 4.3.12 Traditional wool rug/“guba”/made of local sheep fleece is hand-made with traditional weaving on looms by one of the last craftsman “gubár” Jan Fotta, region Malohont, Slovakia(Knap)

RECYCLATES AND COMPOSITES

From the sustainability point of view, on another level are new plastics – recyclates and bioplastics or biocomposites instead of fossil and mineral raw materials, where the purity of sort is very questionable, thus these are often already composites that later after finishing this life cycle has to be removed by burning/waste incineration. There are cases of recyclates –

composite that are made by technology that does not need strong chemicals as joining medium to create the new material and thus it is possible to return them into the life cycle as it is by textile recyclates from company SK-tex (Fig. 4.3.13), or by company Kuruc that produce panels made of recycled Tetra packs useful as an acoustic isolation or construction board as a substitution of plasterboards (Fig.4.3.14)⁴.

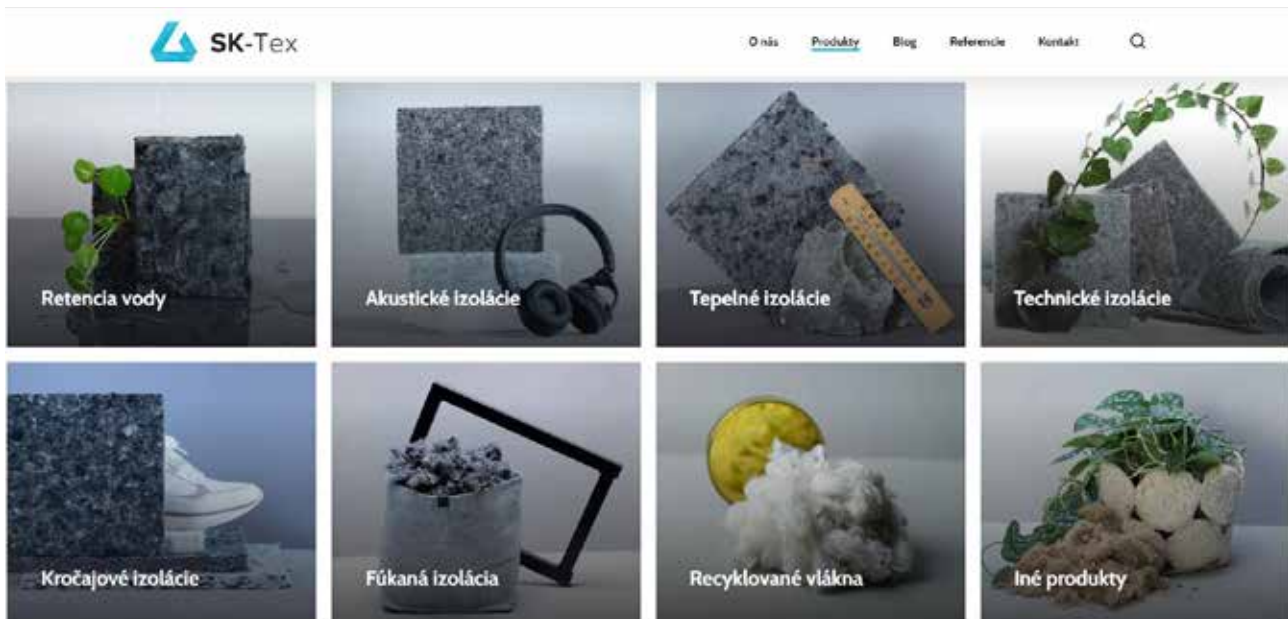


Figure 4.3.13 Recycled textiles from Slovak company SK-Tex processed into isolation and upholstery materials are using old textiles, they can be returned into the life cycle back (SK-TEX)

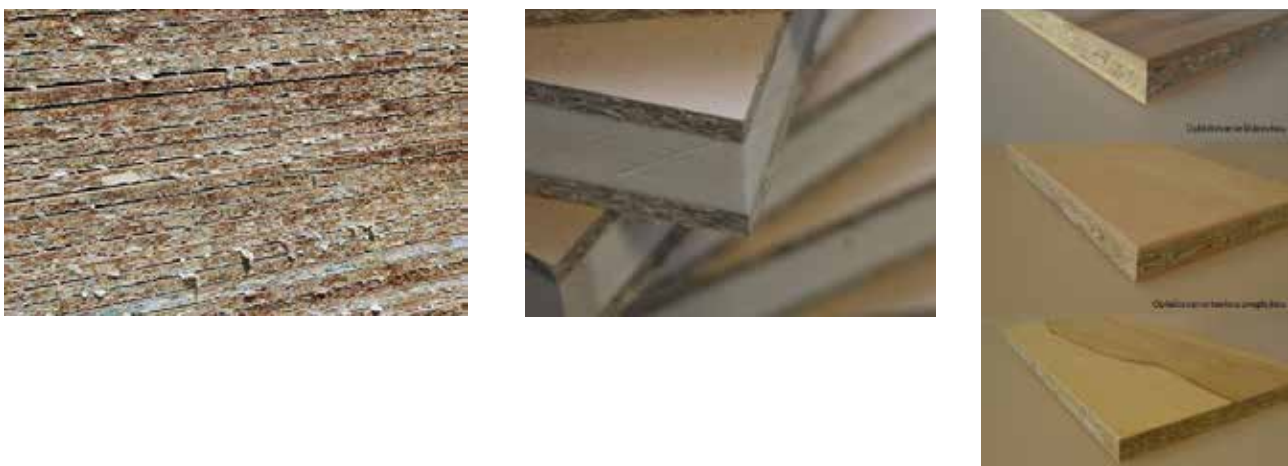


Figure 4.3.14 Tetra K, a material made of tetra pack recyclates, technology using no additives, then enabling returning into the life cycle again (Kuruc), right is the construction sandwich panel TETRA WOOD, applicable for building furniture, project: Interaction of man and wood (BCDlab)

⁴ In the project Interaction of man and wood we did an experiment with this material and used it into the sandwich panel as a construction (tetra wood), and test it, if it is possible to join it with regular furniture joints and also if it is suitable outdoor.

METALS, GLASS, AND PLASTIC

Concerning industrial materials like glass and metals (steel, aluminium, cuprum), standard plastics (like PVC, ABS, polystyrene, polypropylene, polyurethane that are nowadays used in buildings and by the manufacturing of furnishings (furniture, lights, accessories), their prefabrication is extremely

energy consuming and is responsible for a lot of emissions, but they are durable and can be recycled perfectly. Important here is the application of the differentiation construction principle by the final products in a way that the single elements can be then separated and recycled.

SUMMARY

- using of local renewable materials, recycles,
- by using of industrial materials like metals, glass, and plastics, using the products, prefabricates and services from producers with ecological certificates,
- energy and pollution-saving concepts in all life cycle phases: prefabrication, manufacturing, using, and removing/ recycling,
- using of assembly-friendly construction principles (differentiation construction principle) or integration into the solid monolithic or moulded elements with a purity of sort, fewer additives, where are combined raw materials that compatible with each other,
- by an ecological concept also thinking of social innovations and sustainability-participatory design, supporting of craft and hand works, inclusiveness of marginalized social groups,
- $\frac{3}{4}$ of the product life service is decided already by its design.
- Universal design and adaptable housing can prevent ecological and economic problems.

EXERCISE:

1. Work in groups and find in your classroom any products, make an investigation or estimation of what are they from and how they are made (material that are they made of) and try to guess what their carbon is footprint.
2. Motivate students to discuss, what they do at home to contribute the sustainability. What can they do more in this field?

DESIGN

- TREND NEUTRALITY – TIMELESS DESIGN
- VARIABILITY
- POSITIVE IMPACT TO COMPLEX COMFORT/WELLBEING USERS
- TECHNICAL ADVANCE AND EXCELLENT FUNCTION
- USING OF SHAPES CONSIDERING MATERIAL AND TECHNOLOGY

CONSTRUCTION

CHOICE OF MATERIALS

- USING MATERIALS FROM GROWTH OR RECYCLATES
- CHOICE OF MATERIALS FROM PRODUCERS WITH ECOLOGICAL CONCEPTION
- MINIMAL DIVERSITY OF MATERIALS
- USING MATERIALS THAT ARE ACCEPTABLE TO EACH OTHER BY RECYCLING (PURITY OF SORT)
- USING OF MATERIALS WITHOUT HARMFUL ADDITIVES

DIMENSIONING

- MAINTAINING TECHNICAL PARAMETERS
- STRENGTH OF CONSTRUCTION
- UNIFICATION OF DIMENSIONS
- MINIMAL CONSUMPTION OF MATERIAL (LESS MASS)

JOINING TOGETHER

- EXCELLENT CONSTRUCTION SOLUTION
- SOLUTION FRIENDLY FOR DISMOUNTING (IMPACT ON RECYCLING, REPAIRS, OPTIMISATION OF TRANSPORT)

TECHNOLOGY

- CONSEQUENT PRODUCTION PREPARATION
- CHOICE OF TECHNOLOGY FRIENDLY TO THE SOIL, WATER, AND AIR BY PRODUCTION
- CHOICE OF TECHNOLOGY THAT IS ENERGY SAVING
- CHOICE OF TECHNOLOGY THAT CREATES A FRIENDLY WORKING ENVIRONMENT
- CHOICE OF TECHNOLOGY THAT WITH BETTER MATERIAL CONSUMPTION

Figure 4.3.15 Recommendations for rough orientation by designing sustainable products are divided into 3 categories: design, construction, and technology (Kotradyová)

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Figure 4.3.2 Living Building Challenge is organised into seven performance areas, Resource: <https://living-future.org/lbc/> visited, November 29, 2022.

Figure 4.3.3 Öko control is a certificate that is issued by the European Association of ecological furniture showrooms (one of the members is furniture seller Eckhard Bald, Munster, Germany), their criteria are related mostly to the choice of materials that must be as solid as possible, with little additives, e.g., Austrian company specialised in solid wood furniture – Team 7 own this certificate, bed Paso, Resource: <https://www.e-bald.de/produkt/schlafzimmer-paso/>, <https://oekocontrol.com/> visited, December 10, 2022

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Figure 4.3.5 Wilkhahn (1999). Company catalogue, Chair Picto, developed by German company Wilkhahn in 1992 was the first ecological office chair, it is a good example of the differentiation construction principle, Resource: <https://www.wilkhahn.com/en-au/about/corporate-responsibility>, visited, December 9, 2022.

Figure 4.3.6 Kotradyová, V. (2008). Exchangeability of the covers or whole upholstery prefabricates can prolong the moral and physical life span and prevent obsolesce. BECKER Brackel, Formholzbrieffe (1998). Upholstered shell removable from the sitting shell made of plywood enable an exchange of the whole upholstery element in case it is already worn out, a solution developed by Becker Brackel, a German producer of moulded elements

Figure 4.3.7 Flat pack system that is applied on the bed Siebenschläffer, from company Moorman möbel, made of plywood with openings made by CNC machines enabling disassembly, instead of traditional metal joints, Resource: Moorman Moebel (2018) <https://www.moormann.de/de/siebenschlafer.html>, visited, December 9, 2022.

Figure 4.3.8 Kotradyová, V. (2000). Sofa Teo is an example of ecological construction. Design: V.Kotradyová,, archive of author.

Figure 4.3.9 Knap, N.(2020). Stand Aladar is completely foldable, its skeleton is made of durable and flexible ash and oak wood and the textile or leather (of local origin) connectors are fixed to it through dismountable joints, project Kusok dreva, www.kusokdreva.sk, design: V. Kotradyová

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Figure 4.3.11 Knap, N. (2018) Wool felt seat padding Samsara, softened with a layer of cotton fleece, design: V. Kotradyová

Figure 4.3.12 Knap, N. (2020) Traditional wool rug/“guba” /made of local sheep fleece is hand-made with traditional weaving on looms by one of the last craftsman “gubár” Jan Fotta, region Malohont, Slovakia, design: V. Kotradyová

Figure 4.3.13 Recycled textiles from Slovak company SK-TEX processed into isolation and upholstery materials are using old textiles, they can be returned into the life cycle back, Resource: <https://sk-tex.com/#produkty> , visited, December 10, 2022.

Figure 4.3.14 Tetra K, a material made of tetra pack recyclates, technology using no additives, then enabling returning into the life cycle again, Resource: https://www.kuruc.sk/?page_id=44, visited December 15, 2022; BCDlab,(2016) Construction sandwich panel TETRA WOOD, applicable for building furniture, project: Interaction of man and wood.

Figure 3.4.15 Kotradyová, V. (2004). Recommendations for rough orientation by designing sustainable products are divided into 3 categories: design, construction, and technology.