Health and ecological aspects in shaping of furniture equipment

DSc. Ph.D. Eng. Arch.
PRZEMYSŁAW NOWAKOWSKI, ASSOC. PROFESSOR
Wrocław University of Science and Technology
Faculty of Architecture
ORCID: 0000-0002-5473-6203

The paper describes „the life cycle" of furniture items and presents a critical analysis of raw materials and intermediate products used in the furniture industry in the context of sustainable development (the impact on human health and on the condition of the natural environment). It may serve as a means to promote pro-health and pro-environmental awareness.

Introduction

Furniture equipment constitutes part of a building structure which is utilized for the shortest period of time. Frequent replacement of furniture and elements of interior furnishings is a manifestation of a consumer lifestyle. This tendency, fostered by a growing supply of increasingly cheaper furniture and household appliances available on the market, has significant economic and social consequences. It can be seen as a general improvement of the standard of living. At the same time, the investment decisions that people make are influenced by their concern for the condition of the Earth's resources and the natural environment. The choice of interior furnishings (including elements of furniture) leads to certain consequences for both the users and widely understood nature [1].

Taking into consideration such factors as „the life cycle" of furniture as well as the quality and manufacturing methods of intermediate products and complete pieces of furniture, it is clear that the impact of interior furnishings on both the users and the natural environment goes beyond the notion of consumptionism and economic prosperity.

The „life cycle" of furniture

In recent decades there has been a tendency to replace furniture every few years. It is seldom utilized for periods of time exceeding a dozen years. However, implementing the „sustainable development" concept is not limited to the financial consequences of choosing certain products. The „life cycle" of particular materials and pieces of furniture is longer than the period of time when they are actually in use. It includes such stages as acquiring natural resources or producing artificial raw materials, turning them into a particular final or intermediate product, fitting the product in a building (interior furnishings), utilization until the moment of „moral" or „technical death" (which may also involve repairs and alterations), withdrawing from utilization (disassembly), recycling of the waste, handing it over to storage or discarding (Fig. 1) [1]. At each one of the mentioned stages a certain amount of energy is used (energy consumption of materials).

The usefulness of a product is closely connected with the period of its exploitation. It is an essential aspect of the way in which a product influences its user (it has a direct impact on the user's comfort). At the same time, a large number of products which are still in a good technical condition are subject to „moral death". They are discarded and replaced with new items due to changing fashion trends or more advanced and cheaper technologies.

Acquiring and processing of materials as well as storing or discarding of waste have a serious impact on the amount of natural resources and the natural environment (this fact also directly influences the comfort of users who are sensitive to ecological issues).

The price is usually the main criterion which determines the choice of particular new furniture. However, a low price is often combined with poor technical quality (which has a direct impact on durability) and low aesthetic quality (e.g. elements produced from materials which imitate more expensive natural equivalents). Accelerated technical wear of furniture influences its usage and aesthetic quality. Quickly worn out furniture needs to be replaced (even after a few years). The period during which such furniture is in use becomes shorter in its „life cycle". Furniture waste is proportionally becoming a heavy burden on the natural environment.

Chosen materials used in furniture manufacturing in the context of sustainable development

Implementing the concept of "sustainable development" requires a broader look at the whole „life cycle" of furniture. Quality and the period of usage are not the only sufficient criteria. While selecting particular materials and end products and assessing their quality, other aspects such as health, ecology and energy consumption should be taken into account [1, 2]. A careful choice of a particular piece of furniture should be based on such criteria as: reducing the costs of production, purchase, exploitation and disposal (which lead to reduced energy input), the guarantee of a certain level of quality and technical standards to ensure the comfort of users (their safety and durability of the product), reducing harmful influence on people and the environment [3].

A properly designed „life cycle" of furniture may have an impact on the wellbeing of its users and the natural environment. The

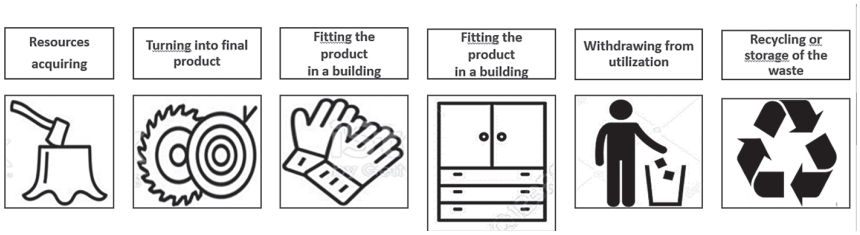

Fig. 1. Product „life cycle" diagram (author's drawing)

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choice of particular materials in furniture production should take into account such factors as: chemical influence on human health, the consumption of raw materials and the energy input, physical qualities of products and the conditions of their disposal or recycling [1]. The most common materials used in furniture manufacturing include: wood, wood-imitating materials, metals and fabrics.

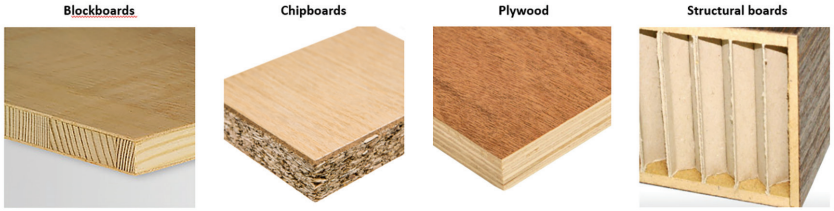

Fig. 2. Examples of wood-based materials (author's drawing)

Wood

Wood is the most willingly used material in furniture production. It belongs to a limited group of so-called renewable natural resources. It does not require complicated processing and has very good durability parameters. The most important advantages of wood include: the ease of obtaining raw material, the ease of processing with low energy consumption, bactericidal and rot-resistant properties of certain types of wood, moisture exchange between wood and air through wood pores (which helps to sustain a stable moisture microclimate in rooms), low capability to accumulate electrostatic charges, easy recycling process and biodegradability [1, 3]. Some of the above mentioned properties may be significantly reduced due to the use of chemical impregnation substances such as: paints and varnishes (these substances may also become the source of chemical contamination of the air in the room).

The main disadvantages of wood contain: low resistance to biological corrosion (the effects of fungi and parasites), susceptibility to changes in volume and shape (shrinking and twisting of overdried wood), poor resistance of surfaces to scratches. Wood does not have any harmful influence on the microclimate inside rooms or people's health (however, pine wood may at times cause allergic reactions in people). It is the varnishing with harmful substances that that may lead to diseases and allergies.

Furniture production uses solid wood obtained from coniferous trees (e.g. pine, spruce) or deciduous trees (walnut trees, linden, oak). Until almost the end of the 20th century precious exotic types of wood were willingly used (e.g. mahogany, teak). Nowadays, as a result of the necessity to protect tropical forests from over-exploitation, such wood is not as commonly used.

Furniture produced from solid wood or glued laminated timber is normally very durable (some „antiques" preserved to the present day are often over 100 years old). Its durability is extended by impregnating the wood and using traditional carpentry joints (gradually being replaced with metal joints as the latter ones are more cost efficient).

Wood-based materials

Wood-based materials include wood boards (plywood and blockboards, chipboards, fibreboards, and cellular boards) [1, 3]. Plywood is made from layers of veneer (thin slices of wood obtained by circumferential cutting from a log). The structure of blockboards resembles plywood, however, pieces of wood used to produce it are thicker. Chipboards and fibreboards

(MDF and HDF) and cellular boards are produced from wood waste (mainly sawdust or wood fibers of different thickness) ground in a certain way and then joined with adhesives, usually synthetic ones. The above mentioned materials are commonly used in the furniture industry nowadays, which results in reduced consumption of solid wood (Fig. 2).

Adhesives and varnishes which were used in the past often released extremely harmful substances such as formaldehyde, isocyanate, etc. to human health. In higher concentrations they were cancerogenic. The materials used nowadays have safety certificates which ensure that the level of the most harmful substances is low [3]. Therefore before choosing particular wood-based materials it is a good idea to have a closer look at adhesives, wood preservatives, solvents and varnishes which in time may lead to poorer chemical quality of the air in rooms affecting the users' health.

Furniture manufactured in 1950s and 1960s was mainly produced from furniture boards. Bonded with adhesives and covered with a thick veneer layer such boards were very durable. Therefore, in many cases, the furniture produced in that period is still in a good technical condition. For many years though, such furniture was considered unfashionable and was replaced with newer products, very often of poorer quality where furniture boards were substituted with chipboards and fibreboards. Their surfaces are veneered mainly with melamine foils of different colours and structures (including wood imitations). Easily cut to size boards are connected with metal or plastic joints. However, furniture manufactured in this way cannot be disassembled and reassembled several times as chipboards are susceptible to damage at the joints.

Structural boards, three-layered, have gained popularity in the recent years. The outside layers are made of laminated thin fibreboards (HDF) and the inside is filled in with a cardboard structure which resembles a hexagonal honeycomb. The inside layer keeps relatively thick boards stiff. Materials used in the production of such boards are recycled. Being empty inside, the boards are less resistant to loads as compared to heavier and more expensive chipboards [5].

A weakness of the wood-based boards is the thin melamine veneer. They are not very resistant to mechanical damage (point loads and scratches) [1, 3].

Metals

Stainless steel, corrosion-resistant, is the most commonly used metal in the furniture industry. Numerous non-ferrous metals in a homogeneous form (e.g. aluminium and copper) and alloys (e.g. brass and bronze) are also widely used. Metal extraction is an energy consuming process, and it requires large quantities of raw materials (the ore) [1]. The metalwork is quite easy (these metals are susceptible to moulding, rolling, forging, grinding, leatherwork, etc.) therefore they are used to produce various (even very small) objects. The influence of metals on people is usually neutral. However, there are some exceptions, one of which is nickel. It may cause various health problems, including allergies [1, 3]. Steel, contrary to non-ferrous metals, is biodegradable. All metals, however, can be easily recycled (in the form of scrap metal). Metals are „cold" to the touch therefore they are used in furniture manufacturing only in small quantities. They are recommended as slats and profiles securing such elements as edges, corners and slots in furniture boards. Moreover, various metal fittings (e.g. hinges, drawer guides, handles, hangers) and mechanisms (e.g. actuators), increase the comfort of utilizing various products.

Fabrics

Fabrics protect the organism from adverse external conditions such as cold, heat rain and wind. They also play an important role in internal decoration and furniture manufacturing. They serve several purposes: they increase the quality of microclimatic conditions (thermal and acoustic), give a pleasant feeling while touching particular elements, increase the aesthetic values of rooms and furnishings.

Fabrics can be created from natural and artificial fibres. Loose natural and artificial fibres (often pressed) are used to manufacture such products as mattress and upholstery fillings. Fabrics, on the other hand, are turned in-

to curtains, upholstery materials, carpets, bedclothes, clothes and floor coverings.

Natural fibre is obtained from so called renewable sources (plants, animals). It is considered environmentally friendly and human-friendly. However, manufacturing and processing of natural fibres often requires the use of toxic chemical substances. In order to equip natural fibre with certain features, such as softness, elasticity, durability, non-combustibility, to make it unshrinkable and crease-resistant and dye it (which includes bleaching) arduous chemical treatment is necessary. Protecting fabric from moths, insects, fungi, etc. requires applying chemical preservatives (e.g. pesticides, vinyl acetate, permethrin). These substances may, with time, cause allergic reactions, cancer, skin diseases, problems with the nervous system and the respiratory system, etc. [1, 3, 4].

Natural fibres and natural fabrics are obtained from such plants as: flax, cotton, cap wood (kapok), jute, hemp, Brazilian agave (sisal), coconut. Animals (usually farmed) provide skin (calfskin, pig skin, horse skin), feathers and down (especially from ducks and geese), sheep wool, camel hair, goat hair or llama hair. Artificial fibres and fabrics include nylon, stylon, polyester, polyamide, enala, lycra, etc. For example, easily crumpling and felting woolen fabrics are often combined with polyester fibre in order to increase their durability [3]. Synthetic fibre is also produced from natural raw materials (e.g. cellulose) or petroleum raw materials obtained in the process of polymerization. The production process of such fibres is harmful for the environment. They are not biodegradable (contrary to natural fabrics) and the disposal process is complicated.

Such properties as elasticity (softness), thermal insulation („being warm" to the touch) influence the increase of demand for upholstered furniture. Apart from utility values, such furniture has an impact on people's psyche through creating an impression of a cozy, and warm atmosphere. Leather upholstery, natural or, so-called, ecological leather give prestigious character to various types of furniture used for sitting or lying down.

Summary

Furniture equipment has a significant impact on the users' sense of comfort. It also influences the microclimate in rooms and people's health (influence on microscale). Increased production of new furniture and frequent replacement of furniture equipment in a modern-day interior affect the economy, the society and the natural environment (influence on macroscale). Contemporary trends include searching for methods of preventing harmful influences of furniture equipment and its particular components on people's health and on the condition of the natural environment. These methods include such activities connected with the „life cycle" of particular materials as: reducing the usage of raw materials and energy during production, increasing the amount of acquired and used recyclable materials (recycling), extending the period during which particular furniture is in use, undertaking efforts to increase biodegradation (limiting energy consumption connected with the waste disposal process and cumbersome waste storage).

The above mentioned activities remain in accordance with the trend of „sustainable development". At the same time it is important to limit the use of plastics, and materials which contain substances harmful to human health and the microclimate in rooms and, on the macroscale, to the natural environment.

References

[1] Scholz W., Hiese W., Möhring R., Baustoffkentniss, Bundesanzeiger Verlag, Koeln 2016 (p. 890, 888, 886, 824, 845, 848, 437, 545-546).
[2] Waltjen T., Details for Passive Houses. A catalogue of ecologically rated constructions, Springer Verlag, Vienna 2008 (p. 10-11, 270-278).
[3] Fritsch M., Gesundes Bauen und Wohnen, Deutscher Taschenbuch Verlag, Munich 1996 (pp. 9, 141-147, 299-304, 356-357).
[4] Zwiener G., 1996, Materialauswahl unter ökologischen Aspekten (in) Öko-Test-Magazin no. 20, Öko-Test Verlag, Frankfurt (p. 34-36).
[5] https://twojepierwszemieszkanie.pl/z-czego-sa-zrobione-meble-ikea/ (November 2020).

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Abstract: The choice of furniture does not only affect the comfort of one's life or work space. Materials utilized in furniture production may contribute to the quality of chemical microclimate in rooms and have an influence on the users' health. Plenty of substances used in the furniture industry have negative effects on human health. These effects are usually of low intensity. However, they occur over a long period of time and as a result they may even lead directly to permanent health problems.

Consumer lifestyle boosts frequent changes in interior decoration. The changes include mainly replacing furniture and household appliances. The furniture industry offers a wide range of products to satisfy the growing needs of buyers. Mass production results in a significant increase in the exploitation of natural resources and (often) leads to degradation of the natural environment. The downsides of mass furniture production are usually considered only in terms of utilizing various resources. Producers, however, implement measures to reduce the consumption of materials and energy. Their aim is to cut the production costs and lower the final price of manufactured goods. Worn out furniture, produced from highly processed materials is not biodegradable. Such waste is a heavy burden on the natural environment.

The paper describes „the life cycle" of furniture items and presents a critical analysis of raw materials and intermediate products used in the furniture industry in the context of sustainable development (the impact on human health and on the condition of the natural environment). It may serve as a means to promote pro-health and pro-environmental awareness. A thorough assessment of the furniture available on the market may facilitate in making conscious decisions which will also take into consideration additional technical criteria. The choice of furniture neutral for people as well as for the environment is not an easy task and often involves higher spending.

Keywords: furniture design for human health and ecology, furniture „life cycle", furniture materials for sustainable development

Streszczenie: ASPEKTY ZDROWOTNE I EKOLOGICZNE W KSZTAŁTOWANIU WYPOSAŻENIA MEBLARSKIEGO. Zakup wyposażenia meblarskiego wpływa nie tylko na komfort zamieszkiwania lub pracy. Materiały wykorzystywane w produkcji mebli mogą mieć wpływ na jakość mikroklimatu chemicznego w pomieszczeniach i zdrowie użytkowników. Wiele stosowanych substancji jest szkodliwych dla zdrowia ludzi. Negatywne oddziaływania mają zwykle niskie natężenie, jednak trwają bardzo długo. Mogą mieć one zatem pośredni wpływ nawet na trwałe pogorszenie stanu zdrowia.

Konsumpcyjny styl życia sprzyja częstej wymianie wyposażenia wnętrz. Masowa produkcja istotnie wpływa na wzrost eksploatacji zasobów naturalnych oraz (często) na pogorszenie stanu środowiska naturalnego. Negatywne zjawiska są najczęściej rozpatrywane jedynie w kontekście użytkowania różnych produktów. Producenci prowadzą jednak działania mające na celu zmniejszenie materiało- i energochłonności. Ich rezultatem ma być obniżenie kosztów produkcji i finalnej ceny oferowanych wyrobów. Zużyte meble wykonane z mocno przetworzonych materiałów nie ulegają biodegradacji. Ich odpady stanowią duże obciążenie dla środowiska naturalnego.

W artykule zostanie opisany „cykl życiowy" mebli oraz przedstawiona krytyczna analiza surowców i półproduktów do wyrobu mebli w kontekście zrównoważonego rozwoju (wpływ na zdrowie człowieka, stan środowiska naturalnego). Opracowanie może służyć upowszechnieniu wiedzy prozdrowotnej, a także proekologicznej. Rzetelna ocena dostępnych na rynku mebli może umożliwić podejmowanie bardziej świadomych decyzji uwzględniających dodatkowe, techniczne kryteria. Wybór neutralnych dla człowieka i środowiska produktów meblowych nie jest bowiem łatwy. Wiąże się zwykle z większymi nakładami finansowymi.

Słowa kluczowe: projektowanie mebli a zdrowie ludzi i ekologia, „cykl życiowy" mebli, materiały meblowe a zrównoważony rozwój