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# Ethnic Multifunctional Furniture: A Design Approach to the Use of Waste Plastic

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**ABSTRACT**

Due to the high cost of housing, many people are forced to make maximum use of the available space and space in their flats. This can be achieved by purchasing multifunctional furniture. However, such furniture is often made from traditional materials and has an unattractive design. This study presents the development of the concept and artistic image of multifunctional eco furniture in the national style, designed for use in the home, meeting modern consumer demands. The work presents the results of a questionnaire survey, on the basis of which 3D models were developed, and a new composition of a durable material for the structural elements of multifunctional furniture is proposed. Manufactured a model of a transformable multifunctional complex in the Kazakh national ethnic style using a new durable eco-friendly material consisting of the shredded plastic waste, epoxy resin and hardener. The material's durability and environmental friendliness have been tested using modern physico-chemical and mechanical investigation methods.

## 1. INTRODUCTION

Trying to make one's own house as comfortable as possible is quite a typical characteristic for every person and each of them always tries to do this. Therefore, it is important to plan the decorative element of the apartment in order to save free space because each square meter is very expensive.

After 1945, furniture developed in close connection with architecture. There was a need for serial production of furniture, composite furniture, consisting of multifunctional elements, allowing for free integration. Modification and serial production were applied to all types of furniture industry [1].

Nowadays furniture combining several functions is widely used due to modern needs [2, 3]. Today, such furniture is considered stylish, fashionable and expensive as part of the interior. In addition, in recent years, the world practice of furniture production has begun to use ethno-traditions based on the constant search for innovative solutions [4-6] for the best crafts, durability, environmental friendliness and ergonomics of products [7-9]. Our present purpose is to discuss how to keep and continue our national art and historical and cultural traditions. Unfortunately, the issues of designing multi-functional furniture and comprehensively combining both national traditions, new designs and used materials is not currently considered in Kazakhstan. Therefore, the purpose of this work is to create the design of a new type of multifunctional furniture with the elements of national style made of new materials that can meet the needs of different age groups.

During the research a new composition of material for structural elements of multifunctional furniture was developed, physical and mechanical properties of the obtained samples of the new material were studied. According to the results of strength tests and sanitary and hygienic parameters, the proposed new material is environmentally friendly and ready for use in production. A model of an item of transformable multifunctional sofa in ethnical style with the use of a new composite material is made. The variants of models of multifunctional eco, ethno furniture are offered.

## 2. HISTORICAL BACKGROUND

Tradition (lat. traditio - continuity) is a part of the socio-cultural heritage that is passed down from father to son, becomes a habit, passed on to the value system and rules of that society or social group [10-14]. Tradition includes not only the forms of heritage, but also the process of social inheritance and its methods [11].

The first type of multifunctional furniture first appeared in Germany. Later, dressers appeared in England, which served not only as home furniture but also as a suitcase for travel items. Multifunctional furniture began to gain real relevance in the late 19th century when small rental apartments became the most common type of housing. By contrast, the use of different types of multifunctional furniture in Kazakhstan is poorly developed and represented in a very small range.

Multifunctional furniture is rare in Kazakh history. This is mainly due to the development of previously unknown technologies and materials. However, if we take as an example a piece of furniture used by our ancestors, a wooden bed is a comfortable piece of furniture for lying and having a rest. It also was called among people as a "bed of wood", "bed" and

according to some artistic features - "painted", "silver bed", "bone bed", "carved bed". Although the patterns on the surface are different, they all look the same: the headboard and foot of the bed are raised by a flat beam providing a very comfortable place on which to recline; the four legs are connected by two beams beautifully decorated with bone, silver, sapphire leather, various stones of purple, yellow, green, pink and brown colours. It is made of straight planks of dry wood. The shape of a wooden bed can vary depending on the craftsmanship of the masters, the artistic taste, the materials used and the local traditions of carpentry in the regions of Kazakhstan.

**Figure 1.** Wooden bed ancestors of the Kazakhs [15]

As shown in Figure 1, the bed can be covered with a beautiful blanket as a decoration. Woodworking has given people many household items and basic necessities. The most valuable items, made by carpenters, are the many elements of the frame of the yurt, as well as wooden furniture: kebezhe and asadal for storage of products and utensils and beds presented in Figure 1. As can be seen in the photo, the wooden furniture is decorated with intricate ornaments, based on the elements of plant ornaments.

Over time, in the middle of the twelfth century, multifunctional devices and types of adjustable furniture developed rapidly. These include height-adjustable coffee tables, glass and metal tables with movable functional parts, and hidden wall mirrors for toiletries and other items. All these items were designed in such a way as to fit into the living space of the apartment [16].

The following research methods were used to consider the concept of furniture made of environmentally new materials that provide a cozy atmosphere, taking into account the individuality of the consumer in a multifunctional national style: historical analysis, public opinion survey, comparative analysis, preliminary analysis, physical-chemical methods and software methods.

## 3. MATERIAL AND METHOD

The research considers user-centred design, the study of user preferences by various methods, including the human-centred method, marketing [17], empirical research [18], and the method of questionnaire survey [19-21], is becoming increasingly common.

Agreeing with the arguments presented in the paper [22], visual communication, continuity and the relationship between interior and exterior spaces are the main factors influencing the physical and psychological comfort of the users. That is, everything should be in harmony, all interior elements with local traditions and the overall architectural environment, social and national motifs.

To assess the prospects and needs of the population in buying modular multifunctional furniture, the survey was conducted through an online-survey. A special public opinion forum was created on the Google platform and a conceptual decision was made to determine consumer preferences.

The main part of the survey, including the definition of the tastes of the audience, including several additional questions on the relevance and budget of the topic, as well as on the possibility of transformation, selection of material and colour count. The results of the survey are presented in Figures 2-4.

As shown in Figure 2, the survey included the participation of 70% Ages 18 to 35, 25% of people aged 35 to 55 years and 5% of older people 55 years.

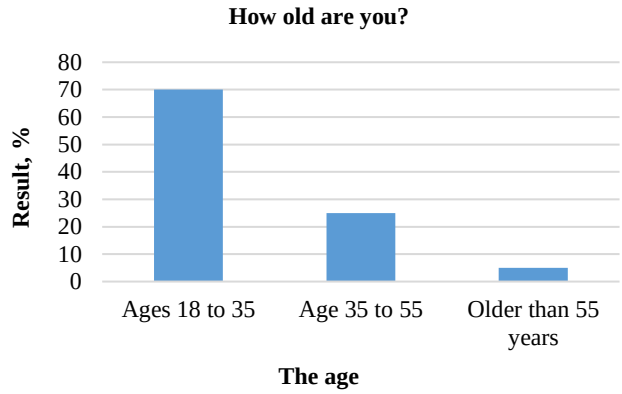


**Figure 2.** Age of interviewees

It turned out that in recent times 55% of those surveyed have heard more about multifunctional furniture, and 45% have heard about such furniture from other people.

Every buyer chooses furniture for himself from the point of view of ergonomic comfort. Many prefer only traditional (traditional form and design) furniture. However, the majority of consumers do not know about the changing types of multifunctional furniture, which for some reason rarely occurs in the market, or they are afraid to buy such furniture. Nevertheless, this is the most economical option given that modular furniture actually reduces the budget and saves space in the apartment. Hence, there is less need to change the furniture regularly, as we do with traditional furniture.

According to the results of the survey, the highest percentage of colour combinations in the room furniture - 55% prefered "light colours", 25% have chosen "pastel colours" and the rest 15% - "universal colours" (Figure 3).

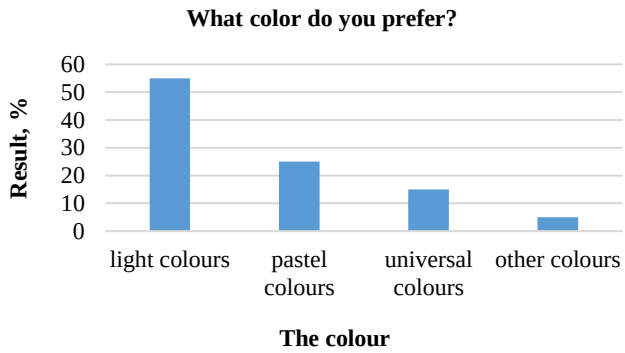


**Figure 3.** Color preferences

Psychophysiologically it is impossible to distinguish between colours and their shades, so this division is characteristic of the simple image of the world. It is also

claimed that the name of the colour is the main root in the distinction of the main, important names of flowers, that is, those that can identify national and cultural features.

It is important not only to show individuality in multifunctional furniture, to take into account the psychological state of a person, but also to find several different colour combinations that are appropriate for a certain age. The variety of colour combinations allows the consumer to go beyond the choice of colours, choosing a furniture set in a certain harmony according to their mental and emotional properties and gender identity. It should be noted that the modular principle makes it possible to swap parts with parts of a different colour, thus changing the appearance of the furniture set and giving it individual colour options.

The book "Types and colours, complete mysteries" [23] does not specify the number of names of flowers in the Kazakh language. Furthermore, while the authors list some names of flowers, they are incomplete. Besides, such colours as greyish, red, pockmarked and brown in the Kazakh language are important for the Kazakh nation, they have ethnographic dominance and ethno-significance for the Kazakh people. The facts of Kazakh literature and paremiology testify to this, and the main thing is the study of colour. In recent times, the theme of flower names attracts the attention of many researchers. In the end, the names of the flowers are the identity of each nation. Recently, however and according to the questionnaire survey (Figure 3), there is a tendency for more people in Kazakhstan to prefer light colours.

Next, 45% of respondents answered that $200.00-$400.00 USD to buy furniture is quite affordable, 30% said that a budget of more than $400.00 is appropriate, and 25% of respondents said that $100.00-$200.00 USD is quite enough to buy furniture.

The following survey questions were conducted on the types of multifunctional furniture (Figure 4).

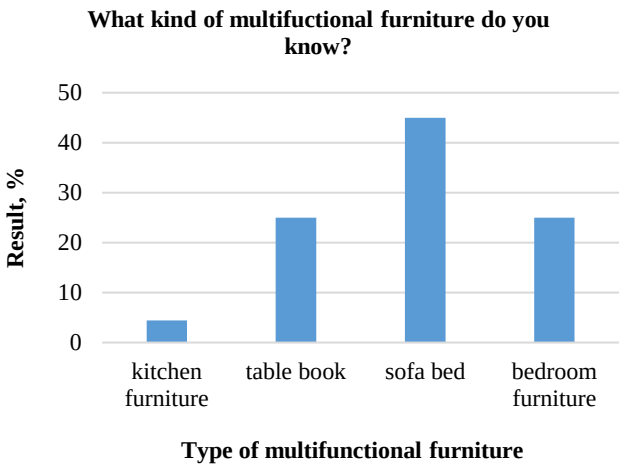


**Figure 4.** Survey for the types of multifunctional furniture

As shown in Figure 4, 4.45% of the responders know about kitchen multi-functional furniture and 25% know about table book. As for traditional types of furniture, 45% of consumers use sofa beds in everyday life, 25% use bedroom furniture, and the rest use office furniture and others.

The results of the survey confirmed the relevance of the chosen topic and identified a number of features and aspirations. In general, the purpose of this survey was to take into account the tastes of consumers and determine how much they know about multifunctional furniture. As a result, the survey considered the preferences of respondents from 18 to 35, depending on the age category of respondents.

The design of universal multifunctional furniture requires a responsible interdisciplinary approach. Every element here should not only be beautiful but also comfortable and absolutely safe. All modular details must have special elements that are well installed and connected between themselves in order to acquaint the user with the character of the form.

The next stage of the work was to choose the material for the multifunctional furniture. As the materials for the frame of upholstered furniture, tables and chairs usually choose a variety of materials such as wood, metal, fine fraction of wood, plywood, chipboard, natural stone and others. Recently, natural materials such as natural stone and wood, bamboo [24], tortoiseshell and bones [25] and various composites made of natural fibres [26] have been increasingly used for various types of transformed furniture. All these materials have certain disadvantages and advantages. The production of furniture made of completely natural wood is inefficient from both ecological, economic and technological points of view, and its design requires an interdisciplinary approach capable of integrating environmental, economic and technical aspects related to various phases of the product life cycle [27-29].

The purpose of further work was to find a material that would meet the requirements of safety, durability, and to be economically and technologically advantageous. Nowadays, people have become aware of the importance and necessity of recycling used materials, for example, the idea of recycling discarded wooden furniture with the creation of added value [30]. There are examples of the use of hybrid composites as materials for indoor furniture [31]. This paper proposes the use of such waste recycled material as plastic mixed with epoxy resin. The spread of plastic pollution is due to the low price and durability of plastic. The average decomposition time of plastic products made with different technologies varies from 400 to 700 years. The plastic bags that people use daily decompose in nature for 100 to 200 years. The durability of these plastic products is the downside of the environment [32]. As a solution to this problem, it is proposed to recycle plastic waste by shredding it, in the process turning it into pellets or fibres.

The following instruments and equipment were used to conduct experimental studies: a complex of hydrometers for determining the density of polymer material, high-precision electronic scales and a hydraulic press for testing a polymer sample for strength.

Three compositions were developed: from shredded plastic, two-component epoxy resin and hardener; the second - from shredded plastic and glue; the third - from shredded plastic and a small amount of tin and resin.

The most optimal is the composition of shredded plastic, two-component epoxy resin and hardener in the proportions below. The components of the mixtures were selected with the optimal mass ratio, % according to the above compositions:

- crushed plastic - 60,
- epoxy resin - 20,
- hardener - 20.

The polymerization process and its duration at room temperature, from about 17º-25℃, was 24 hours. The process of grinding and mixing all the binder components was carried out in laboratory conditions in specially prepared containers (Figure 5).

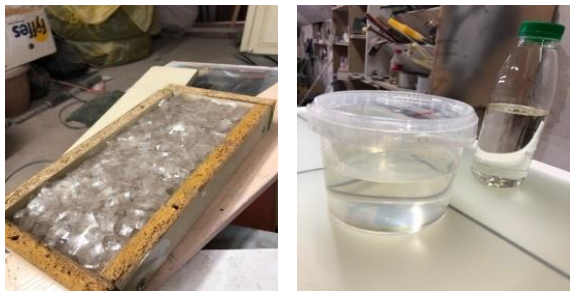

**Figure 5.** Photos of the materials used

The material was experimentally obtained, poured from the matrix of 240x50x15 mm giving a finished polymer material in the form of a plate of dark gray colour and then after completion, the curing was tested for strength (Figure 6).

Next, after a 2-day exposure, the samples were tested for compressive strength with a hydraulic press (Figure 7).

As a comparative material for furniture, plastics used in the woodworking and furniture industry and wood chipboard furniture were taken. Their strength values were 70 MPa and 25 MPa, respectively. Consequently, the results of experimental studies on the strength of the experimental material revealed that the new material (pilot composition number 1) is stronger than the above-mentioned materials used in furniture production (Table 1).

The proposed new polymeric composition was also investigated for sanitary and epidemiological and hygienic indicators. Determination of the specific effective activity of natural radionuclides tests was carried out under the following conditions: humidity 35.0%; temperature 25°C. Thus, the equivalent dose rate of gamma radiation is 0.11-0.12 μSv/hour, with a tolerance of no more than 0.33 μSv/hour.

Measurements were taken with the following instruments: radiometer-dosimeter DCS-AT-1123 and spectrometric unit MKS-01A "Multrad". The results of the specific activity indicator are given in Table 2.

**Figure 6.** Photos of the obtained polymeric material and the device for measuring the strength of materials

**Figure 7.** Testing the composite specimen on the hydraulic press

The results of the strength test are given in Table 1.

According to the results of the hygienic studies, a sample of polymeric material obtained by experiment in the form of a plate 240x50x15 mm in dark gray colour has no odor (0 points out of 2 points allowed). At the same time, this polymer material is resistant to solar and thermal radiation and can be used in both outdoor and indoor products that. In the manufacturing of various types of furniture structures, it should be considered that this type of material can be made by casting, as well as subjected to laser milling. It is important to note that from the experienced composite material we offer to make not the entire frame of furniture, but only wear and tear and those critical parts of furniture, which are responsible for its multi-functionality.

Then we worked on the design of multifunctional furniture in the ethnostyle using a new material as materials for some details.

Currently, there are many computer programs for 3D modeling, animation and visualization, such as SketchUp is one of the most popular options for 3D furniture modelling, SolidWorks, CAD Pro Furniture Design, SketchList 3D, Woodwork for Inventor, PRO100, eCabinet Systems, Rhinoceros, Autodesk 3ds max. Efficient algorithms are proposed that allow even unskilled users to design transformable furniture items [33], as well as the use of 3D printing in manufacturing technology when assembling wooden furniture components [34].

Adhering to the national style, with the help of a computer program, we began to develop the design of multifunctional furniture for the medium price category using light colours (according to the preferences of users) and for some parts used a new, experimentally obtained material.

**Table 1.** Strength test results (averages of 5 samples)

| No. Experimental compositions | Sample weight, gr | Thickness, mm | Sample length, mm | Resistance in compression, MPa |
|---|---|---|---|---|
| 1 | 225 | 15.35 | 250 | 90 |
| 2 | 243 | 15.40 | 250 | 50 |
| 3 | 213 | 15.32 | 250 | 73.7 |

**Table 2.** Results of specific activity indicator

| Name of parameter | Characteristic of the parameter | Analysis result | Normative document for test methods |
|---|---|---|---|
| Specific activity $A_{eff}$, Bq/kg | Upto 370 | 21.7 ± 49.5 | Standard 30108-94 |

## 4. RESULTS AND DISCUSSION

As a result of a survey of public opinion and tastes, the first models were built with the help of 3D programs. The original prototype for the form of multifunctional furniture was based on the Kazakh ornament "koshkarmuiz" (Figure 8).

**Figure 8.** Stylization of the "koshkarmuiz" ornament

The Scythians used a realistic image of a koshkarmuiz in the "animal style". This element is found in tekemet, syrmak, baskur, alasha, carpets, leather, bone, wood, all kinds of jewelry. This element is found in national products such as tekemet, syrmak, baskur, alasha, carpets, leather, bone, wood and all kinds of jewellry. In felt products, this ornament is carved from coloured fabrics and sewn by reeds and stitches. The “koshkarmuiz” element is a symbol of happiness, wealth and the increase of livestock. During the design of the work process, attention was paid not only to the appearance of the product shown in Figure 9 but also to its versatility.

As for the multifunctional sofa-transformer, its design also features the silhouette of an ornament. That is, the Kazakh ornament of a ram's horn was also taken as the basis. This ornament is located on both sides of the sofa and is also a table support.

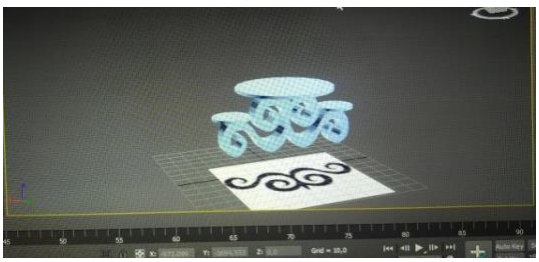

**Figure 9.** The model of multifunctional furniture in a national style (kitchen table)

Below we present the models created in the three-dimensional modelling program-3D Max. Figure 10 shows the complex transformable furniture in the folded state.

**Figure 10.** The multifunctional transformable furniture complex in the folded state

The design of multifunctional furniture (sofa + bed + table), developed in the Autodesk 3ds Max program, with the use of a new polymer material as the material for the legs of the table, is shown in Figure 11.

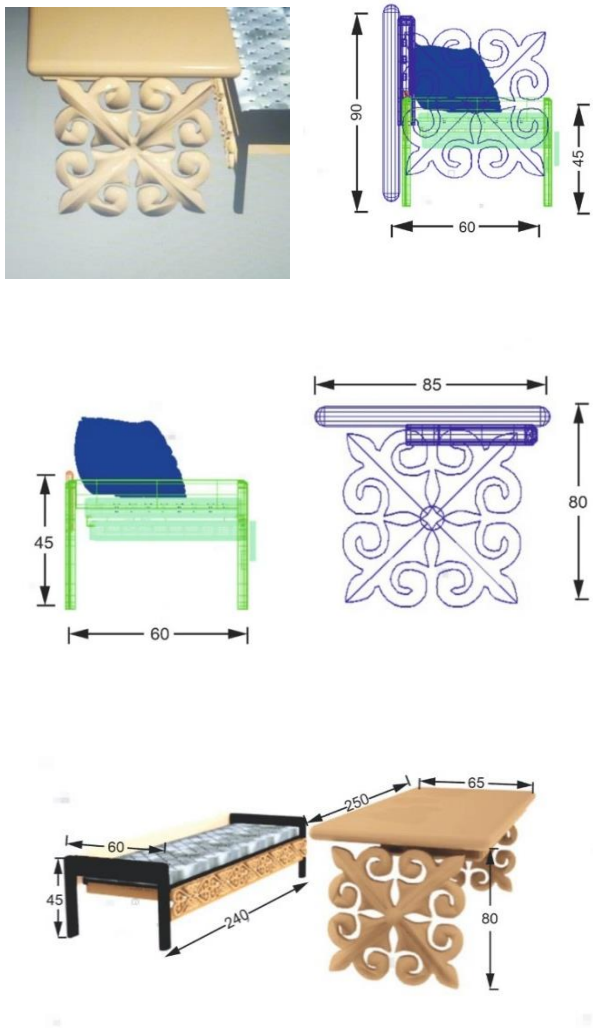


**Figure 11.** Design developed in the program 3D MAX

Figure 12 shows the multifunctional furniture in the unfolded state. The backrest rotates 90 degrees and turns into a table.

**Figure 12.** Multifunctional transformable furniture complex in the unfolded state (interior view)

One piece of furniture performs several functions at once, so it is very convenient. It is enough to make a few movements to turn the sofa into a sleeping place for two people or a place for eating, the next state of change of the sofa is a double bed, the model of which is shown in Figure 13.

**Figure 13.** Sofa-bed complex

A mock-up of a multifunctional furniture set was produced using a new material for the furniture elements such as table legs, bed legs and a sofa. This furniture set performs several functions, is ergonomic, comfortable and most importantly durable and reliable.

Figures 14-15 shows photos of the model of the multifunctional furniture from different angles.

a

b

**Figure 14.** Photo of the model: a) front b) side view

**Figure 15.** Photo of the model: rear and side views

We offer another type of transformable furniture using national Kazakh ornaments - a sliding low table. Kazakhs often use such round-shaped tables with low legs. However, there are no sliding tables of this shape yet. We offer a view of the table with sliding elements in the center, to increase or decrease the size of the surface if necessary.

Normally, when these tables are folded, they consist of two sections. When a wide table is to be obtained, the partitions simply have to be moved, resulting in a gap between them, which is then joined together (Figure 16). Here additional fragments are installed, in some cases they are stored inside the table or separately from it. Figure 16 shows a 3-dimensional model of a compact table.

**Figure 16.** Models of a sliding Kazakh table

The compact extension mechanism is star-shaped, which allows the creation of tables with a large diameter. Another feature of the sliding round table is the preservation of the structure and pattern of the table in the closed and extended state, and the Kazakh ornament gives special expressiveness.

## 5. CONCLUSIONS

Currently, in world practice different types of transformable multifunctional furniture are widely used. However, there are no works with a comprehensive interdisciplinary approach that would combine design (ethnodesign), design (multifunctionality), materials science and technology (using new economically and environmentally efficient materials).

In order to preserve and transmit to the descendants of the national identity in the interior objects often used in everyday life (furniture), as well as to some extent solving the issues of disposal of used plastic, this work proposes the concept of multifunctional furniture in the national style using a new material.

The results of physical-mechanical, sanitary-hygienic and radiological tests of experimental samples of the new material indicate the possibility of its use in furniture production. The technology of production is simple, does not require high temperatures and the use of water. The proposed designs of multifunctional ethno furniture, in our opinion, have a modern design, look aesthetically attractive, and are very effective from ergonomic, environmental and economic points of view. At the same time, in our opinion, the developed concept of the line of basic furniture items with the use of national ornaments shows a creative approach to the interior design of small-sized apartments.

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## REFERENCES

[1] Rungle, W.F. (2006). History of design, science and technology. Moscow: Architecture-S, 370. https://vk.com/wall-71630588_16557?lang=en, accessed on Jan. 17, 2023.

[2] Husein, H.A. (2020). Multifunctional furniture as a smart solution for small spaces for the case of Zaniary towers apartments in Erbil City, Iraq. Int. Trans. J. Eng. Manag. Appl. Sci. Technol, 12(1): 1-11. https://doi.org/10.14456/itjemast.2021.8

[3] Cheng, H.Y., Ng, P.K., Nathan, R.J., Saptari, A., Ng, Y.J., Yeow, J.A., Ng, K.Y. (2021). The conceptualisation and development of a space-saving multipurpose table for enhanced ergonomic performance. Inventions, 6(4): 67. https://doi.org/10.3390/inventions6040067

[4] Wu, S.H., Fan, K.K., Sun, C.J. (2021). A study on the application of code theory in the decorative design of Taiwan bamboo tube furniture. Sustainability, 13(7): 3722. https://doi.org/10.3390/su13073722

[5] Chen, W. (2022). Research on furniture design integrating ming-style furniture modeling elements and image sensor data: taking suitable old furniture as an example. Journal of Sensors, 2022. https://doi.org/10.1155/2022/5306491.

[6] Wu, S. (2022). Application of Chinese traditional elements in furniture design based on wireless communication and artificial intelligence decision. Wireless Communications and Mobile Computing, 2022. https://doi.org/10.1155/2022/7113621.

[7] Marrocano, J.H. (2021). Portuguese natio-nal style furniture: the bufete forms, origin and identity. Res Mobilis-International Research Journal of Furniture and Decorative Objects, 10(12): 44-74.

[8] Lungu, A., Androne, A., Cosereanu, C. (2021). Textile heritage motifs to decorative furniture surfaces. Transpose process and analysis. Journal of Cultural Heritage, 52: 192-201, https://doi.org/10.1016/j.culher.2021.10.006

[9] Huang, J. (2020). An evaluation model for green manufacturing quality of children's furniture based on artificial intelligence. International Journal of Design & Nature and Ecodynamics, 15(6): 921-930. https://doi.org/10.18280/ijdne.150618

[10] Hasoglu, R., Artut, S. (2018). Passing down cultural design heritage through craft objects of memoir. Sanat Tarihi Dergisi, 27(2): 409-423. https://doi.org/10.29135/std.450637

[11] Wojcik, A. (2019). Interior and furniture designs presented at the exhibition "architecture and interiors in garden settings" in Krakow in 1912. Roczniki Humanistyczne, 67(4): 109-140. https://doi.org/10.18290/rh.2019.67.4-4

[12] Qian, Y. (2017). Research on the relationship between regional culture and street furniture design. In 3rd Annual International Conference on Social Science and Contemporary Humanity Development (SSCHD 2017) (pp. 62-66). Atlantis Press. https://doi.org/10.2991/sschd-17.2017.12

[13] Thai, H.M.H. (2021). Unbounded: on the interior and interiority. Journal of Housing and the Built Environment, 36(3): 1343-1345. https://doi.org/10.1007/s10901-021-09865-6

[14] Celikoglu, O.M., Alpay, E.R. (2012). The story of convertible Sofa-Bed: reading the social change in Turkey through the design of an industrial product. Blucher Design Proceedings, 1(1): 502-506. https://doi.org/10.5151/design-icdhs-111

[15] https://el.kz/news/archive/a-ash_b-yymdar/, accessed on Nov. 12, 2022.

[16] Turganbaeva, L. R. (2002). Essays on the history of material culture and design. Almaty: FGC, 448.

[17] Szokeova, S., Fictum, L. (2021). First and second phase of human centered design method in design of exterior seating furniture. DRVNA Industrija, 72(3): 291-298. https://doi.org/10.5552/drvind.2021.2101

[18] Prabhakaran, A., Mahamadu, A.M., Aigbavboa, C.O. (2021). The effectiveness of interactive virtual reality for furniture, fixture and equipment design communication: an empirical study. Engineering Construction and Architectural Management, 28(5): 1440-1467. https://doi.org/10.1108/ecam-04-2020-0235

[19] Nomana, A., Roland, A., Paul, J. (2015). The visual questionnaire an innovation in design research. The Design Journal, 1(2): 37-49. https://doi.org/10.2752/146069298790718724

[20] Fabisiak, B., Jankowska, A., Priedulena, E. (2021). Comparative study on design and functionality requirements for senior-friendly furniture for sitting. Bioresources, 16(3): 6244-6266. https://doi.org/10.15376/biores.16.3.6244-6266

[21] Abdulqader, O., Ahmed, J. (2020). Relationships between interior and exterior spaces as a factor of efficient university buildings. International Journal of Design & Nature and Ecodynamics, 15(5): 757-762. https://doi.org/10.18280/ijdne.150518

[22] Tarrad, M., Sqour, S. (2020). Applications of green architecture in vernacular dwelling architecture-a case study from Jordan. International Journal of Design & Nature and Ecodynamics, 15(4): 515-522. https://doi.org/10.18280/ijdne.150408

[23] Balabekov A.K. (2022). The name of colour terms in the Turkic languages. Culturology, art history and philology: modern views and scientific research: a collection of articles based on the materials of the LXVI International scientific-practical conference "Culturology, art history and philology: modern views and scientific research". 11(59). https://doi.org/10.32743/25419870.2022.11.60.346715

[24] Lou, Z.C., Wang, Q.Y., Li, Y.J. (2021). Bamboo flattening technique: a literature and patent review. European Journal of Wood and Wood Products, 79(5): 1035-1048. https://doi.org/10.1007/s00107-021-01722-1

[25] Cayeros, P.D. (2021). New Spanish furniture with geometrical designs: woods, tortoiseshell and bone. Res Mobilis-International Research Journal of Furniture and Decorative Objects, 10(13): 31-53.

[26] Suriani, M.J., Zainudin, H.A., Mustapha, R. (2021). Kenaf fiber/pet yarn reinforced epoxy hybrid polymer composites: morphological, tensile, and flammability

properties. Polymers, 13(9). https://doi.org/10.3390/polym13091532
[27] Bianco, I., Thiebat, F. (2021). Life Cycle Assessment (LCA)-based tools for the eco-design of wooden furniture. Journal of Cleaner Production, Vol. 324. https://doi.org/10.1016/j.jclepro.2021.129249
[28] Wang, Y.Z., Wang, H.M., Tan, Y.D., Liu, J.L. Wang, K.L. (2021). Measurement of the key parameters of VOC emissions from wooden furniture, and the impact of temperature. Atmospheric Environment, Vol. 259. https://doi.org/10.1016/j.atmosenv.2021.118510
[29] Gonzalez-Garcia, S., Lozano, R.G., Murphy, R.J. (2012). Eco-innovation of a wooden childhood furniture set: An example of environmental solutions in the wood sector. Science of the Total Environment, 426: 318-326. https://doi.org/10.1016/j.scitotenv.2012.03.077
[30] Yang, D.R., Zhu, J.G. (2021). Recycling and value-added design of discarded wooden furniture. Bioresources, 16(4): 6953-6963. https://doi.org/10.15376/biores.16.4.6954-6964
[31] Arif, S., Nawab, Y., Shaker, K., Umair, M. (2022). Mechanical performance of flame retardant and antibacterial glass-carbon/epoxy hybrid composites for furniture applications. Journal of Industrial Textiles, 51(4_suppl): 5822S-5846S. https://doi.org/10.1177/15280837221080185
[32] Chamas, A., Moon, H., Zheng, J., Qiu, Y., Tabassum, T., Jang, J.H., Suh, S. (2020). Degradation rates of plastics in the environment. ACS Sustainable Chemistry & Engineering, 8(9): 3494-3511. https://doi.org/10.1021/acssuschemeng.9b06635
[33] Zhou, J., Chen, X. (2018). Convertible furniture design. Computers & Graphics, 70: 165-175. https://doi.org/10.1016/j.cag.2017.07.033
[34] Nicolau, A., Pop, M.A., Coșereanu, C. (2022). 3D printing application in wood furniture components assembling. Materials, 15(8): 2907. https://doi.org/10.3390/ma15082907

## NOMENCLATURE

| | |
|---|---|
| W | the sample weight, gr |
| $\delta$ | the thickness, mm |
| L | the sample length, mm |
| R | the resistance in compression, MPa |
| $A_{eff}$ | the specific activity, Bq/kg |