

# Ergodesign and composite materials

N. Terekhova<sup>1\*</sup>, A. Kumashkova<sup>1</sup>, and M. Dyukov<sup>1</sup>

<sup>1</sup>Bauman Moscow State Technical University (BMSTU), 2nd Baumanskaya Str., bldg. 1, 105005, Moscow, Russian Federation

**Abstracts.** This article is devoted to the study of the relationship between materials and ergodesign with various attributes. Examples of experimental research demonstrating the possibilities of using materials, along with other design and ergonomics tools, are given. The article describes the history of the development of Russian design and ergonomics as stages of the creation of the theory and methodology of ergodesign. The trends of formation and new developments in this area are considered. It is concluded that the creation of new objects of the subject world and systems cannot be carried out without integrated design activities with the introduction of the achievements of ergodesign, which is an innovative technology of integrated design. The article also responds to the problem, because of which the concept of ergodesign was adopted, namely the rapid development of technology without taking into account the needs and characteristics of a person. The urgency of the research is due to the rapid development of technologies that impose new requirements on various design products. This also applies to materials that are the basis of any material form, and from the point of view of innovative design, they must have unique properties, ensuring high-quality human activity at a new higher level.

## 1 Introduction

Scientific and technological progress gave rise to a set of problems related both to the organization of labor itself and creation of comfortable conditions for life and leisure. Not only the content of the human object environment has changed, but also the nature of consumption. The results of these changes, especially at the end of the twentieth century, were shaped under the influence of the synthesis of design and ergonomics. However, for a long time the systems of views inherent in design and ergonomics existed independently, and virtually without cooperation. The task of combining the two leading design ideologies of our time within the framework of the general strategic goal - humanization of people's living conditions - is now gaining more and more urgency.

## 2 Main part

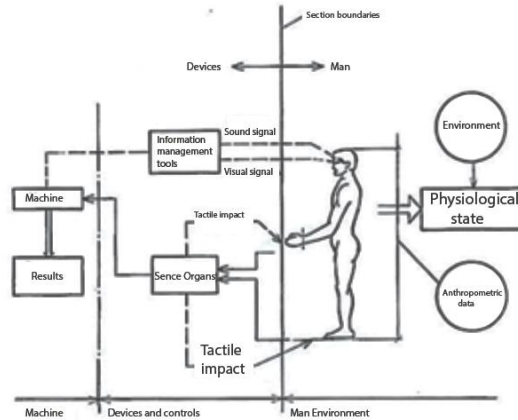
Nowadays ergonomics in traditional sense is a science about adjustment of job duties, workplaces, subjects and objects of work, as well as computer programs for the safest and

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\* Corresponding author: [terehova@bmstu.ru](mailto:terehova@bmstu.ru)

most efficient work, based on particular physical and mental properties of human organism [1,12].

There are several factors necessary for ergonomic product design that relate to the physical, cognitive, and organizational aspects of the human-machine-environment system, which is said to be traditionally dominated by ergonomics.



**Fig. 1.** "The human-machine-environment system in ergonomics".

In recent years, however, cultural and emotional issues have been the subject of study by designers, ergonomists, anthropologists, and other experts. Emotional ergonomics makes goods and services more relevant. As understanding of the users' emotional attitudes toward products and services grows, it becomes easier to develop more attractive and durable, aesthetically pleasing and enjoyable designs (Fig. 1).

From a design perspective, a product contains several elements - shape, scale, volume, color, material, texture, and others - which impartibly constitute the final object. One of the most important elements is material, which "provides the direct contact between the object being designed and the human being."

Materials have an important role in the product design process: they can determine a product's feature set, durability, cost, and its final appearance [4]. Just the same, users' experiences play an important role in this process, as they establish sensory relationships (tactile, visual, auditory, olfactory, or gustatory) when interacting with a product, which can be crucial to product design.

The choice of material is a complex task and based not only on functional requirements, production technology, and sustainability, but also on its aesthetic values, sensory properties, ergonomic aspects, and also cultural and symbolic meanings.

Understanding how people respond to the materials' tactile properties, as well as knowledge of the emotional responses to them, helps designers and engineers select materials able to provide positive tactile communication between the product and the user and, as a result, increase the perceived value of the product [3].

Thus, the material used in objects is the central theme of this research, which led to the development of the "user perception of materials" method and aims to investigate how consumers perceive the purpose of materials used in everyday objects.

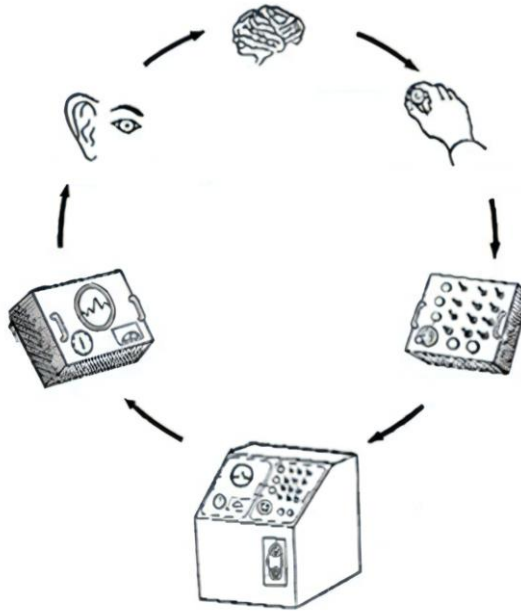
The method consists of three phases, the first of which deal with questions related to the researched product and serve for preparing data needed for the following evaluation and specification phases. It is important to do this at the initial stage of material selection and include the product being evaluated into the context of its use.

The first step is defining the elements of the product. It allows you to understand the product in detail, listing the elements that make it up, the most important features, and the

main functions, both aesthetic and ergonomic. It works as a kind of dividing the product being developed into elements that are perceived by the user [7].

The second step, the interaction cycle, focuses on understanding and analyzing the process of the relationship between the product and the user throughout the usage cycle. It is assumed that each product has its own life cycle, but the interaction cycle with its users is also established. The latter begins with the first contact with the product, even before its purchase, followed by experimentation, transportation, unpacking, usage, and disposal [9]. The most important thing in this stage is the interaction cycle influence on the users' emotional evaluation, because emotions change during usage.

In the third step, haptic process analysis seeks to verify the sensations which occur during each step of the product-user interaction cycle, focusing on all the consequences of these interactions with respect to the materials contained in the product. This step deals with five commonly used sensations: visual, tactile, auditory, olfactory and gustatory, as well as thermal and functional perceptions.



**Fig. 2.** Structural diagram of the human-machine-environment system.

The material aesthetic properties are directly related to the aesthetic impression of an object obtained through our senses; they are also equivalent to the intuitive level of design.

A number of professionals from different fields, including engineers, designers, and ergonomists, are involved in product development. Each area is responsible for certain parts, but design and ergonomics are the closest to users. Ergodesign is an area in which both aspects are combined exactly to increase the effectiveness of interaction between the two disciplines.

Color can create an overall mood and evoke an emotional response in the user. Besides integrating certain colors, the human brain also associates colors and color combinations with certain emotional states, feelings, and values.

The use of color in human-machine-environment systems helps to raise formal differentiation; highlight the structural organization of its elements; distinguish areas from each other, especially if you want to draw attention from some part; code elements with different colors; conceal or disguise areas by reducing contrast [10].

Color also acts physiologically because it can reflect and absorb colored surfaces, for example, white to reflect heat in roofing, black to absorb solar energy. Warm colors increase and cool colors decrease body temperature, a factor that can interfere with the perception of materials, especially when in contact with the body (Fig.2).

Brightness matters for the visual perception of objects and finishings.

On the other hand, the field of materials acts in a similar way. It combines knowledge from chemistry, materials science, biology, physics, engineering, and design [6,14]. Thus, multidisciplinary is necessary when selecting materials to fulfill the needs of all interested parties: the buyer, the manufacturer, the supplier, the developer, and the final product user.

Object shapes bring out different reactions from the user. Shapes are potential factors influencing users' emotional attitudes toward products.

Anthropomorphism is the tendency to cogitate "attractive shapes that exhibit human characteristics." Rounded body shapes and proportions more easily connect emotionally, being viewed as more attractive, natural, and vivacious.

Natural materials of animal and plant origin have an odor inherent in each material, such as the smell of wood, bamboo, fibers, leather and rubber. Metals have no odor because they are non-volatile. Other materials of mineral origin, such as stones, marble, ceramics, and glass, are also odorless.

It is possible to say that many physical properties of materials are visible, they are manifested and transmitted in the very structure of things and objects. Thus, we can observe the rigidity and brittleness of glass when it breaks with a crystal-clear sound. We also see the pliancy of burning hot steel, the hardness of a planer's blade, and the springiness of swarf.

The object shape has a certain relationship to the nature of the properties of the materials at work, and we can perceive it with all our senses. Some particular situations allow to observe "the shape of the fold on a linen or cotton fabric allows us to see the flexibility or dryness of the fiber, the coolness or warmth of the fabric."

The material and shape combination is used to obtain attributes of a particular product (lightness, heat resistance, elasticity, transparency, and surface quality) and specific characteristics. For example, a short piece of bamboo is perceived as stiff and hard, whereas a long piece seems flexible.

Our perception of the way things are produced has also changed with the advent of plastic. Most people have an idea or some knowledge of how to process or carve wood or how to mold clay, but it is difficult to imagine how to process artificial materials such as plastic or rubber.

The use of objects with handles and fittings is an example of how materials can affect the usage of a product. The efficacy of hand controls such as levers, buttons, keys, steering wheels, and other non-manual devices such as pedals directly depends on materials and their surfaces [3,13].

Visual and haptic texture applied to polymeric materials (plastics and elastomers) can produce the following practical effects: the first is a texture, known as "smooth in appearance," which gives the material a soft and velvety look and is pleasant to touch. The second is used for objects that require a tightening motion (key, handle, toothbrush, tool handle and controls) where the tactile texture is smooth and nonslippery.

User problems are problems that reflect the consumer's difficulty in using the object properly. Consequently, utility is closely related to the emergence of positive emotions.

Designers should pay special attention to products designed for extreme user groups, such as athletes, children, the elderly, people with disabilities, because of the special ergonomic requirements and specific biometric and biomechanical characteristics of each group. In these cases, materials are important: heavy objects, often difficult to lift or move, can be lightened by using metal alloys, polymers and composite structures with foam inside. Elastomers can provide elasticity.

If necessary, polymeric gels and foams can make surfaces soft to touch, and fabrics or nonwovens conform to the shape of the body [5]. Molded products fit comfortably in the hand, and their smooth rounded corners do not cling to clothing and reduce the risk of accidents.

Size differences can be compensated for by using adjustable materials, such as Velcro, removable adhesives, and elastomers.

The usage context relates to the interaction of the product/material with respect to environment, space, and frequency of use.

Products can be designed both for household or professional use; may or may not be owned by the user (private or public); can be used by one person but also can be shared with others; can be suitable for either indoor or outdoor environment [11].

The product can be used daily, from time to time, or rarely. This problem is related to the chosen materials as it affects their longevity, aging, and disposal.

The discussions presented in this article demonstrate that the materials used to create products are directly relevant to the discipline of ergodesign.

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