TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 64, Issue Special I, January, 2021

# FROM SKETCH TO PRODUCT THROUGH ERGONOMICS

**Diana ANDREESCU**

***Abstract:*** *The general purpose of the Design Thinking approach (which involves conception-oriented thinking) is to support the conception and design of products, services, processes, strategies, spaces, architecture and experiences ideal for optimal use. Applying the approach leads to the development of practical and innovative solutions to the problems identified in the product and/or technology design departments of companies. As described in the present article Design Thinking is a process springing from the user-centered conception-design paradigm. The objective of the article is to highlight the need to combine an ergonomic study within Design Thinking, in the case of all fields of conception-design of products. The designer himself must be familiar with the field of ergonomics knowledge, which means that in the design approach it is not necessary to collaborate with a specialist in ergonomics, soup as reflected in the specialized works.*

***Key words:*** *Design thinking, innovation, creativity, experience, empathy, thinking, consumer, health.*

## 1. INTRODUCTION

Today we have reached a high intensity of process, products and services innovation. Creativity is a MUST of all design processes and developers, designers and architects are aware of their skills and collaborative work [1; 2].

The design started modestly, from the time we lived in caves and we created tools to simplify our existence. So, “design is everything around us, everything that is created by man, whether it was made consciously or not”. Design entered the English dictionary in 1548, as a verb, meaning “to conceive and plan in the mind; to have a specific purpose; to imagine for a specific function or purpose”. But design, as a discipline, has evolved [3]. Design means planning the creation of a product or service, with the intention of improving the experience of those who have a specific problem / challenge [1; 2; 4].

Furthermore, in the modern world, design is becoming indispensable any product. And at the same time, over time, design becomes not only an applied form, but also involved in the product. This requires a more detailed study, including several aspects, such as: functionality, necessity such a product, the material used, studies sociological and prognostic, the creation of form and, finally, convenience in use. With study of productivity and convenience in place of work deals with ergonomics. And ergonomics, in turn it covers a wide range of work. Discipline is often confused with anthropometry dealing with the human dimensions. This is it happens because ergonomics, being a multidisciplinary object, it also includes the anthropometric aspect, but it is not reduced to it, but also includes psychological studies, sociological, engineering, biological, protection of work, design, etc. All these aspects are necessary to be analyzed in complex, for an effect better on comfort at work and not only [3; 4].

In this very dynamic and versatile context, the purpose of this article is to highlight the need an ergonomic study of all specialties that involve the design of a product (of any category). For decades, specialists in ergonomics have done numerous studies that put in evidence of man, as a measure of all things, analyzing its physiology and psychology, both the environment which surrounds him as well as how he becomes uses,

to give him the necessary comfort in different working or rest conditions.

## 2. WHAT IS DESIGN THINKING?

The most popular definition for Design Thinking is given by Tim Brown, CEO of IDEO. He says: “Design Thinking is a people-centered approach to innovation, inspired by the arsenal of designers to integrate people's needs, technological possibilities and what is necessary for the success of a business” [5].

Design Thinking is a practical and creative method of solving problems that has several features, which we will detail in the following lines. First, it is a human-centered approach. Problem solving with Design Thinking begins with empathy and understanding of people (customers and users) through research. It is creative and playful.

Regardless of the complexity of the problem, innovative ideas are most likely to occur in an environment that inspires creativity and openness. It is iterative. Fail early, fail often, but learn and adapt every time, which would be one of his main slogans. Design Thinking encourages early testing and feedback to improve the solutions developed. It is cooperative, but most collaborative. Participants come from different backgrounds or from the same work environment, and they create a solution that solves the problem from multiple perspectives. It is based on prototypes (Prototype Driven). The ideas explored are viewed as simple but tangible representations of potential solutions to encourage early feedback and feasibility testing [5; 6].

## 3. HOW DID DESIGN THINKING COME ABOUT?

Although Design Thinking was considered the secret craft of design agencies, this is far from the case. Yes, designers should be credited for popularizing this phenomenon, but Design Thinking has its roots in a multitude of fields, such as: engineering, industrial design, materials science, chemistry, human-computer interaction, psychology, anthropology, psychology cognitive, philosophy, urban architecture, management, business, economics. It is very important that, in most of these areas, Design Thinking has emerged from the analysis of the cognitive processes that underlie each [1; 2]. The first step towards Design Thinking, as we know it today, was taken in the mid-1950s by Buckminister Fuller, who introduced the term Design Science, which he says is “The effective application of scientific principles to the conscious design of to the environment, to help the earth's finite resources meet the needs of all humanity, without disrupting its ecological processes”. Around the same time, in the 1960s, the first Cooperative Design practices appeared in Scandinavia, as opposed to Fueller's practices Scandinavian Cooperative Design was based on the belief that every worker, regardless of their training or position in the organization, has the right to participate in decision-making. Also, in the 1960s, H. Rittel and Melvin M. Webber introduced “Wicked Problems”. These “Wicked Problems” are defined as “Problems that are difficult or impossible to solve because they are either incomplete, contradictory or have different needs that are difficult to recognize” and appeared, for the first time, in the field of Social Planning [6].

Later, in 1992, These Wicked Problems were related to Design Thinking by R. Buchanan in “Wicked Problems in Design Thinking”. He says that design, as a discipline, must be integrative, due to its lack of “specialization”, it has the potential to connect several disciplines [7].

In the early 1970s, H. A. Simon wrote “Sciences of the Artificial”, one of the first mentions of Design as a science. Many of the notions he presents in the book are now basic principles in Design Thinking. For example, he was talking about rapid prototyping and observation testing at the time. In 1973, R. H. McKim published “Experiences in Visual Thinking” in which he emphasized the combination of the right and left sides of the brain.

In 1982, Nigel Cross, in his book, “Designerly Ways of Knowing”, compares designers' approach to problem-solving with the way we solve problems in everyday life, problems that are not necessarily related to design.

In 1983, D. Schon, a consultant and practitioner of the social sciences, published "The Reflective Practitioner: How Professionals Think In Action", in which he analyzes specialists in five different fields: engineering, architecture, management, psychotherapy and urbanism, and thus emphasizes the importance self-reflection for a successful design process [6; 7].

In 1987, the book "Design Thinking" appeared, written by Peter Rowe. It analyzes the way Architects and Urban Planners approach problems. In 1991 IDEO was formed which is now a global design agency and they are probably the ones who helped the most to popularize the phenomenon of Design Thinking. They brought to the world the processes used at Stanford Design School and brought together experts from various fields such as Anthropology, Business, Education and Health to work closely with design teams. They are considered pioneers in what we know today as "Human-centered Design".

What is important to remember is that it must always be based on people's needs, be solution-oriented and focus on collaboration. Design Thinking is based on three pillars as described in Figure 1 and Figure 2.

## 4. WHAT CAN YOU USE DESIGN THINKING FOR?

It helps you discover people's needs, unmet so far, based on which you can innovate. Reduces the risk associated with launching new products (Most startups fail because there is no real need for their products or services.) Generates solutions with disruptive potential, not just incremental. Helps organizations learn faster.

Design Thinking is somewhat understood as a tool for acquiring design optimization, but it is still far from being considered a tool for a competitive advantage. The main idea of this approach is based on the concept that the kind of thinking that designers use when solving problems for business or optimizing the work system can be applied. Instead of the usual decision-making methods, designers' resort to iterative processes. This translates into nonlinear reasoning and creative thinking. Thus, according to Design Thinking theory, we can apply innovative schemes and creative actions during any type of project, or even business locations.

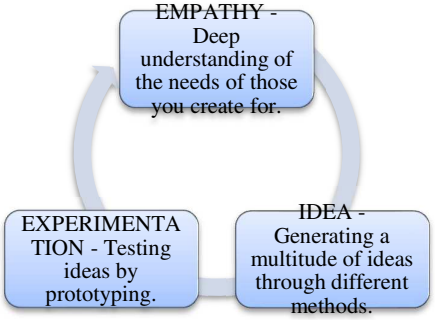


**Fig. 1.** Design Thinking pillars (the cycle of thinking)

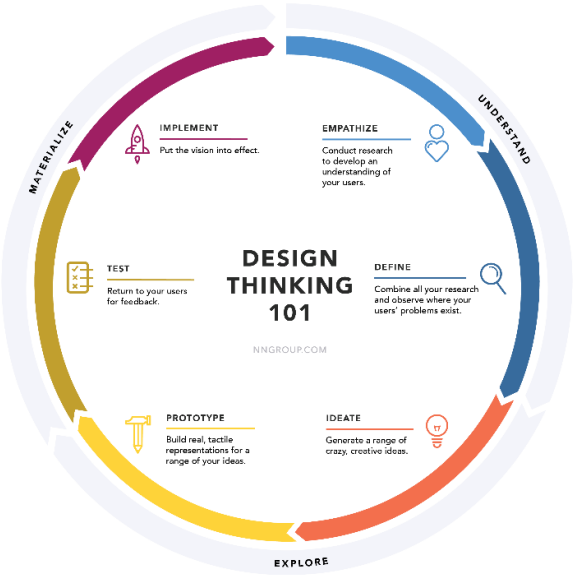


**Fig. 2.** The design-thinking framework (https://www.nngroup.com/articles/design-thinking/)

A long-term and strategic approach, which means much more than the simplistic epithet "out of thought", often attached, can change the paradigm to constantly promote workplace innovation.

Design Thinking involves a creative, agile mindset that incorporates the ability to ask questions from a variety of points of view. These attributes are applicable not only for the design of the workplace, but for the evolution of a culture that quickly generates, shares and evaluates the economic viability of an idea. Design Thinking can also help differentiate a

brand, while also providing a competitive advantage (Figure 3).

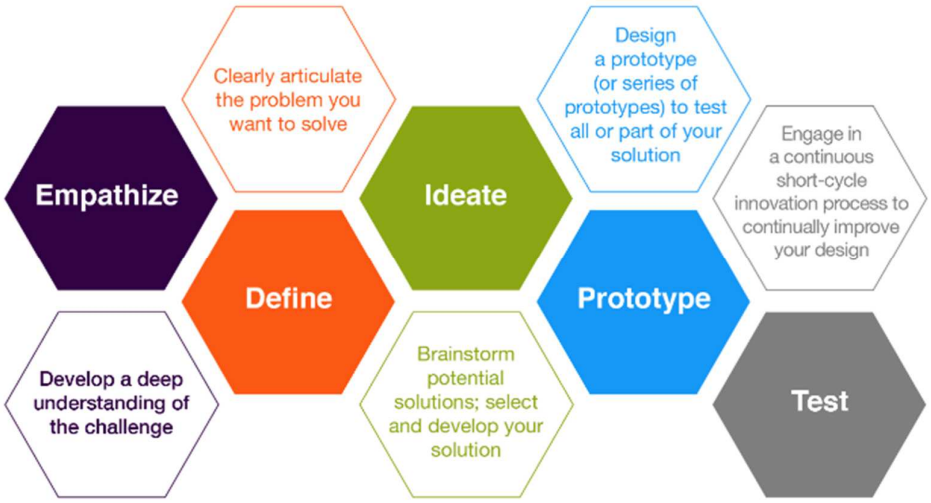


**Fig. 3.** Design Thinking practical approach (https://www.acceleratedfw.org/web/event/design-thinking-practical-workshop)

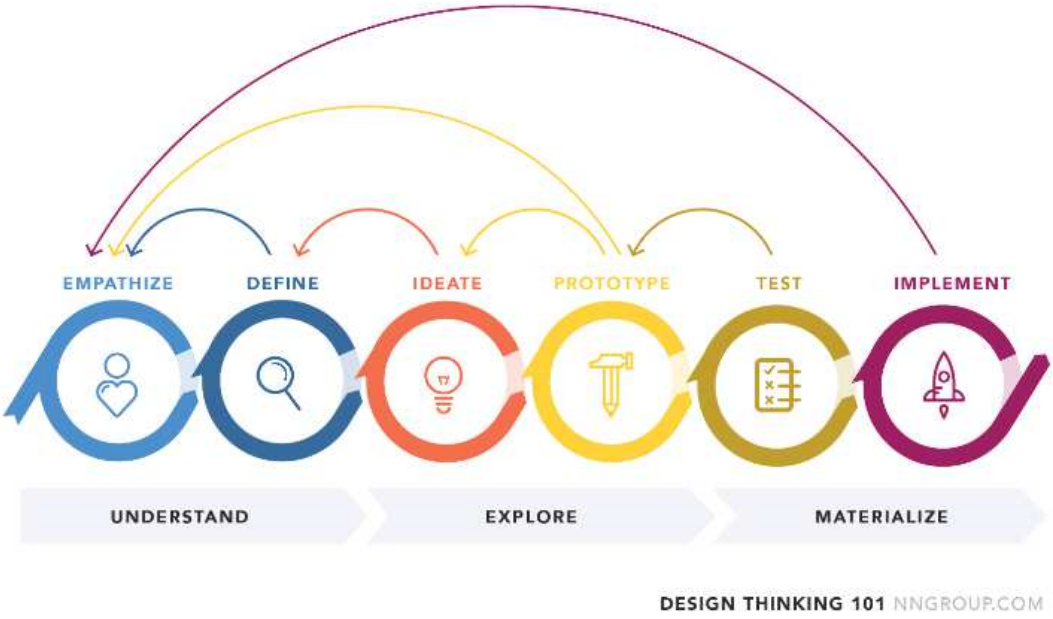


**Fig. 4.** Design Thinking lifecycle (https://www.nngroup.com/articles/design-thinking/)

Design Thinking: not just for the designer David Kelley, the founder of international design firm IDEO, is widely regarded as one of the pioneers of Design Thinking. They describe a “human-centered designer toolkit” that contains five elements to facilitate a design thinking process. They include (Figure 4):

- **Empathize.** It is never enough to offer basic services to contrasting points of view. The design mentality examines these points of view, the reasoning behind them, and considers their validity for defining the problem to be overcome.
- **Define.** This is not a place for vague ideas. The innovation model must be clearly defined, together with its purpose and the measurement of its efficiency.
- **Ideational.** This word "to imagine, conceive or form an idea or image" has been associated

with Plato's philosophies, but he has found a place in modern design thinking through discussions that favor the generation of creative ideas.

- **Prototype.** This tool goes beyond theory. It is a version of the product or approach that needs to be reviewed by a team then modified or modified to obtain the desired solutions.
- **Test.** The element, product, approach etc., are tested through an "iterative process" to assess and measure whether it effectively meets the objectives set out in the previous stages. The Interactive Design Foundation states that among the purposes of the testing stage are "redefining one or more problems and informing users' understanding ...".

One element that is not in the toolbox, but worthy of inclusion is agility. When it comes to the workplace, an agile environment is one where work is not concentrated in a single office, but rather where workers have a variety of different spaces where they can perform their duties.

Agility refers to human behavior and the ability of people to respond to the changing nature of work. An agile workplace is one that supports a wide variety of working modes: concentration, collaboration, learning, socialization, respite, rejuvenation, and nutrition. The agile workplace improves employee involvement and allows users to decide and create a work experience away from the traditional office. Such surroundings encourage feedback loops for exchanging thoughts and suggestions for improvement that may have innovative results [1; 2; 3].

Here is a summary of how each one manifests itself in the work environment:

- **Volatility -** The term represents a rapidly changing and unpredictable market due to foreign factors, from terrorism and politics, to disruptive technologies and socially accepted habits, customs and models.
- **Uncertainty -** Doubts about the state of the market or economy can impact decisions such as investments or expansion plans.
- **Complexity -** Unlike a complicated system, which is largely linear and easy to understand, the complex system is nonlinear with interactions and interdependencies, some of which can be easily obvious. Corporations are struggling with complexity due to a wide range of seemingly unrelated sources, such as international competition and attracting the best talent that can affect current and future planning.
- **Ambiguity -** Like uncertainty, an ambiguous environment produces multiple interpretations. Fear of ambiguity is likely to prevent decision making.

## 5. WHAT IS ERGONOMIC DESIGN?

We call **ergonomic design**, learning the ergonomic principles in systems design and that can be a working device, equipment or a whole working environment. Therefore, it is directly related to innovation and project management. Usually, designers do not report ergonomics to the degree of adequacy of the activity. In fact, from furniture to cars, from appliances to their packages, ergonomics can be incorporated into everything that people see around them. Unfortunately, of all types of ergonomic actions, ergonomic design is the least used by organizations in general. It is a cultural habit - bad and it is since most of the key people in companies do not believe that ergonomics should be incorporated in the early phases of the product development process. "We used to say that Ergonomics is a design terminator" (Shipyard Manager, personal communication). This report represents a fairly accurate perspective on how many people consider Ergonomics precisely because - as opposed to common sense - they are presented in the final stages of product development. Even if we rarely think about ergonomic contributions outside of product development processes, it can be applied to service implementations and even work systems. This involves a more detailed study, including several aspects, such as: functionality, the need for such a product, the material used, sociological and prognostic studies, the creation of form and, finally, the convenience in use. Ergonomics deals with the study of productivity and convenience at the workplace. And ergonomics, in its turn, encompasses a broad spectrum of work study. Often the discipline is confused with

anthropometry that deals with human dimensions. This is because ergonomics, being a multidisciplinary object, also includes the anthropometric aspect, but it is not reduced to it, but also includes psychological, sociological, engineering, biological, labor protection, design and so on. Respectively, if a company wants to increase its productivity and give high quality to the products offered by it, this company must raise the level of working conditions for its employees. The design and ergonomics of the objects are some of the means available to companies to personalize their own offer.

From the point of view of the object of the concerns, ergonomics can take two forms in this case: the ergonomics applied to the design of the products (work means and consumer goods), known as the ergonomics of the product and the ergonomics applied to the design of the production processes, known under the name of production ergonomics.

At each workplace, certain work operations are carried out, in which the labor force, the means of work and the objects of work participate. In the workplace, the man acts on the objects of work through the means of work, and the activity is carried out in a certain physical and psychological environment.

Ergonomics comes with several measures to reduce it visual stress: two-dimensional flat displays, contrast limitation - a room without big differences brightness, black characters on white background which ensures maximum visual comfort, recommended height for characters being between 2.5 mm and 3.00 mm, ergonomically designed keyboards, special glasses for the computer, the distance from which it is viewed the monitor screen (47-70 cm), the computer must to be placed on a mobile support that allows position adjustment etc. [6].

Ergonomics is very important at the site for work. An ergonomic chair that respects the physiological curves of the spine, which to be adjustable, stable, easy to handle and a place of work properly arranged, considering functionality and comfort are important for health employee.

A healthy posture and correct habits will have beneficial effects over time. The main advantage of Ergonomic Design Thinking is its methodological flexibility and broad outreach for the various contexts one may face in a work environment. In fact, it should be used “outside the box” since ergonomics and human factors is not a property of one single organizational domain. People that have been consulting in human factors and ergonomic for so many years have seen good ideas fade way during an imposed “perfect” methodology for their actions. However, sometimes people get so tied up to the rigidity of a methodology that the ends become a mere detail of a mean. In other words, a methodology is a roadmap in which people rely on to reach from point A to point B without losing track [6; 7; 8].

Ergonomic design for special populations. Many populations fall outside the range of the “regular adult” population, due to pregnancy, age (both young and old), body mass, disability (permanent or temporary). Such “special” populations constitute at least one third of the total population and need special ergonomic attention, but a great deal of information is missing or incomplete. In some cases, adjustability or accommodations are needed to ensure safety and efficiency in performance of work and daily living. Such interventions include appropriately designed facilities, installations, and devices according to human factors principles and practices accompanied by proper training. Medical devices require specific ergonomic attention to reduce the risk of use errors and improve safety and efficacy for both users and patients.

## 6. WHY USING ERGONOMIC DESIGN?

The importance of ergonomics. Ergonomics is about ensuring a good fit between people and the things they interact with.

This could include the objects they use or the environments they live in. You should consider ergonomics in the design of every product, system, or environment.

You should focus on ergonomics early in the design process. Ignoring ergonomics can lead to designs that are likely to fail commercially - as they do not fit the needs of the user. Ergonomics is an important part of research in the product development process. Its purpose is to increase the safety, comfort and performance of a product or an environment, such as an office [8; 9].

Ergonomics uses anthropometrical data to determine the optimum size, shape, and form of a product, and make it easier for people to use. Ergonomists can help you to identify which user characteristics you should consider during your design process. This is important when you consider how much individuals vary in terms of: body size, body shape, strength, mobility, sensory sensitivity, mental ability, experience, training, culture, emotions. Its purpose is to increase the safety, comfort and performance of a product or an environment, such as an office [6; 8].

Ergonomics can have a strong impact on any organization and there are several benefits while applying it:

1. Reduced cost by decreasing injuries occurrence of the workers;
2. Improved productivity is the result of the better designed workplace which ensures good posture, less exertion and fewer motions of the workers;
3. Better quality because poor ergonomic leads to frustrated and fatigued workers that do not do their best at work;
4. If an employee does not experience fatigue and discomfort during their workday, this can result in decrease of absenteeism, improved moral and increased employee involvement;
5. Better human performance because of safe and health culture created in the organization.

## 7. CONCLUSION

I would like to mention, once again, the need for ergonomic study in all spheres of design, because ergonomics involves solutions to questions that arise during the design and, respectively, an improvement in the job leading to a higher productivity and progress in all areas of human activity.

Ergonomic design requires an understanding of this variability in human bodies as well as human preferences, and its incorporation into the design process [6; 8; 9].

## 8. REFERENCES

[1] Riel, A., Draghici, A., Draghici, G., Grajewski, D., & Messnarz, R., *Process and product innovation needs integrated engineering collaboration skills.* Journal of Software: Evolution and Process, 24(5), 551-560 (2012).

[2] Dragoi, G., Draghici, A., Rosu, S. M., & Cotet, C. E., *Virtual product development in university-enterprise partnership*. Information Resources Management Journal (IRMJ), 23(3), 43-59 (2010).

[1] Manzini, E., *Designul, când toți suntem designer*, Ed. Vellant, 2017

[2] Evans, D., Burnett, B., *Designing your life*, Editura Publica, 2017

[3] Kotler, Ph., *Managementul Marketingului: Analiză, Planificare, Implementare, Control*, Bucureşti, Teora, 1999.

[4] Euramis, https://euramis.ro/componenete-it-pentru-ergonomia-muncii-la-birouri/

[5] Santos, M., Soares, M., *Ergonomic Design Thinking,* Advances in Ergonomics in Design, Rebelo, F., Soares, M., (Eds.), pp. 560-571, AHFE Conference, 2014

[6] Pheasant, S., Haslegrave, C. M. *Body Space: Anthropometry, Ergonomics and the Design of Work*, 2006.

[7] Gáspárik, A. I., Ábrám, Z., Ceana, D., Sebesi, S., Farcas, D., & Gáspárik, A. C., *Shortages of doctor-patient communication. Teaching patients to communicate effectively*. Procedia-Social and Behavioral Sciences, 142, 376-379, 2014.

[8] Cirjaliu, B., & Draghici, A. *Ergonomic issues in lean manufacturing*. Procedia-Social and Behavioral Sciences, 221, 105-110, 2016.

[9] Neag, P. N., et al. *Ergonomic intervention combined with an occupational and organizational psychology and sociology perspectives in production systems*. MATEC Web of Conferences. Vol. 305. EDP Sciences, 2020.

# DE LA SCHIȚĂ LA PRODUS PRIN ERGONOMIE

**Rezumat:** Scopul general al demersului de *Design Thinking* (concept preluat în limba română fără traducerea sa și care presupune gândire orientată spre concepție) este de a sprijini concepția și proiectarea de produse, servicii, procese, strategii, spații, arhitectură și experiențe ideale pentru utilizare optimă. Aplicarea demersul conduce la dezvoltarea de soluții practice și inovatoare pentru problemele identificate în departamentele de proiectare produs și/sau tehnologie din companii. După cum este descris în cadrul articolului Design Thinking este un proces izvorât din paradigma de concepție-proiectare centrată pe utilizator. Obiectivul articolului este de a evidenția nevoia conjugării unui studiului ergonomic in cadrul Design Thinking, în cazul tuturor domeniilor de concepție-proiectarea a produselor. Conceptorul însuși trebuie să fie familiarizat cu domeniul de cunoaștere al ergonomiei, ceea ce face ca în demersul de concepție și proiectare să nu fie necesară colaborarea cu un specialist în ergonomie, supă cum este reflectat și în lucrările de specialitate.

**Diana ANDREESCU,** Assoc. Prof., PhD., West University of Timisoara, Faculty of Arts and Design, diana.andreescu@e-uvt.ro, +40-(0)256-592906, 4 Oituz str., 300086 Timisoara, Romania