



Ação Ergonômica
Revista Brasileira de Ergonomia

ação ergonômica volume 12, número 2

MULTIFUNCTIONAL FURNITURE PROJECT - ERGONOMICS APPLIED TO PRODUCT DESIGN

Luiza Fonseca de Souza (*Graduanda em Design - DEART - UFRN*)

Email: lufonsou@gmail.com

Universidade Federal do Rio Grande do Norte

Stéphanie Maia Freire de Andrade (*Graduanda em Design - DEART - UFRN*)

Email: stephanie.mfda@gmail.com

Universidade Federal do Rio Grande do Norte

Isabela Graça (*Graduanda em Design – DEART - UFRN*)

Email: isaluag@gmail.com

Universidade Federal do Rio Grande do Norte

Juliana Donato de Almeida Cantalice (*Mestre em Engenharia de Produção- UFRN*)

Email: donato.juliana@gmail.com

Universidade Federal do Rio Grande do Norte

Abstract Multifunctional furniture is a solution for environments where space is restricted. From this premise, the present article exposes the methodological development of product design of a furniture that performs the function of chair, high bench for meals and coffee table, seeking to meet the proposed requirements. The developed piece, named Triad, was computer-modeled and printed in 3D, showing ergonomically adequate in all its functions, offering versatility in a unique way, and can also be modular when used as a center table.

Keywords: Design. Product design. Ergonomics. Multifunctional furniture.

1. INTRODUCTION

With regard to living and coexistence spaces, it is observed that these have increasingly limited areas. In this way, there is a need to design furniture that adapts as much as possible to this type of environment. Multifunctional furniture is a solution to this problem, allowing users to try out different functions in the same piece of furniture, thus making the most of small spaces. The Andreu World¹ (2015) competition briefing noted design requirements that aim for functionality, suitability for different environments, as well as innovation and uniqueness. These characteristics guided the vision and development of the multifunctional furniture project in the Product Design I discipline, of the Design course at the Federal University of Rio Grande do Norte (UFRN).

Therefore, this article aims to demonstrate the design process of furniture developed through the aforementioned briefing. Ergonomic analysis lies the basis for the entire development of the form and solutions developed and in this context, various standards and adjustments of ergonomically appropriate measures were studied and observed to better adapt to the concept of multifunctional furniture.

It was observed in the methodology of Lobach (2001) 2 phases that would suit the present project, but due to its own requirements, it was adapted, inserting some methods and tools, mostly from Baxter (2000), so that the final levantamento de dados - que inclui pesquisas sobre ergonomia, público alvo, materiais a serem utilizados, assim como listar as restrições e especificações do projeto; b) análise dos dados - englobando requisitos do projeto e a análise do problema, utilizando do Método

result was achieved in a as positive as possible. The project was then guided by the following steps: a)

635, Method of analogies, Semantic panel, Comparative analysis, Flow of Operations, Task analysis and Severity, Urgency and Trend Research (G.U.T. Research, hereinafter); c) development of alternatives - through data and its analysis, the team developed ideas and possible solutions, through the creation of sketches, Rapid Prototyping, Morphological Matrix and Table of requirements and parameters; d) choosing the alternative, using the tools: Voting and Checklist; e) shape development, through MESCRAI, Controlled Convergence Process, Technical Drawing and 3D Model; and f) completion, including the development of a prototype.

As a result, a high stool was obtained for American kitchen countertops, commonly present in small spaces, which presents the possibility of being used as a chair and also as a coffee table for living spaces, being called Triad, evoking its three functions, which is ergonomically suitable.

2. THEORETICAL FRAMEWORK

In this topic, the theoretical basis for the project is presented, which comes mainly from ergonomic studies by Iida (2005) and Panero and Zeinik (2002), covering the universe of chairs and tables, detailed below. A similar study was also seen in Lima and Torres (2014), in which they started with similar problematizations to that of this article and where the solutions found match the aspects addressed here.

¹ Andreu Word is a Spanish company that since 2001 has held the International Design Competition, searching for innovative design solutions for tables or chairs, rewarding those that best meet their specifications

2.1 ERGONOMIC ASPECTS

Defined as a scientific discipline related to the understanding of interactions between humans and other elements or systems, and the application of theories, principles, data and methods to projects in order to optimize human well-being and overall system performance, in accordance with with the IEA - International Ergonomics Association (2000), it is observed that it is necessary for ergonomics to be the focus of the development of each and every project.

The different definitions of ergonomics have in common the objective of highlighting its interdisciplinary character and its object of study, which is the interaction between man and work. Focusing on one of the areas of ergonomics, which deals with the characteristics of human anatomy, anthropometry, physiology and biomechanics, which is within the scope of physical ergonomics, the objective is to improve the usability of the product, machine or system through changes in characteristics physical characteristics of the product, such as dimensions, weights, shapes, resistances, etc. Such changes aim to adapt the product to the characteristics of the user, or group of users.

Another area of ergonomics pertinent to the development of a project/furniture is cognitive ergonomics, related to mental processes, such as perception, memory, reasoning and motor response, related to interactions between people and the artifact. (IIDA, 2005). In this area, the analysis regarding mental load and decision-making was carried out in the project in relation to the interaction between man and the object, and their prior knowledge of how to use it.

To establish the requirements and parameters of furniture measurements in general, an anthropomorphic study is necessary to adapt to the use and dimensions

of the target audience. This was defined taking into account the information provided in the aforementioned briefing.

The data for developing the table for requirements and parameters below (Table 1) were mainly based on the study and deepening of Panero and Zeinik (2002).

Table 1 – Table of requirements and parameters

REQUIREMENTS	PARAMETERS
Seat width for chairs	Minimum width: 38.1 cm; Maximum width: 48.3 cm
Seat depth for chairs	Minimum: 30,5 cm; Maximum 45,7 cm
Seat height for chairs	Minimum: 35 cm; Maximum: 52,8 cm
Seat height for high stools for	Minimum height: 55.9 cm; Maximum height: 75 cm
Seat surface inclination	Minimum: 0°; Maximum: 5°
Backrest tilt	Between 100 to 110° in
Armrest height	Minimum 18 cm; Maximum: 29, 5cm
Distance between seat and footrest	Minimum: 35,6 cm; Maximum: 49 cm
Coffee table height	Between 30 to 45.7 cm.

Source: Adapted from Panero and Zeinik (2002).

The parameters in Table 1 take into account the versatility of the designed furniture, which serves as a table, chair and high stool for meals. Due to this difference, from the beginning of the project, we tried to adapt to the measurement parameters of both tables and chairs.

In addition to a study of requirements and parameters for the measurements and dimensions of the furniture, a task analysis was necessary, the same used by Lima and Torres (2014), where the different ways of using the given object are analyzed, which is used as a great importance in this project as it is multifunctional furniture.

3. METHODOLOGY

This session describes the development path of the piece Tríade, guided by the macro methodology, referenced previously, based on Lobach (2001) and adapted to include the methods described below.

Lobach's methodology (2001) recommends the following phases:

- a) Problem analysis; b) Generation of alternatives;
- c) Assessment of alternatives; and d) Realization of the solution.

3.1 PROJECT DEFINITION

The project was defined based on the use of researched methodological tools to generate ideas. Firstly, Method 6353 was used in the classroom, and the ideas generated by the authors mainly involved modular and multifunctional concepts, which guided the entire development of the project. Then, following the same line of ideas, Baxter's Analogies⁴ tool (2000) was applied, where the keyword "module" was chosen. We thought about geometric shapes, fixed fittings, personalized furniture through the arrangement of several similar pieces, versatile furniture adaptable to use and the possibility of storing objects in the furniture.

With the concepts that stood out with these two methodological tools, a Semantic Panel⁵ was created. Several references of multifunctional and modular furniture were present. Subsequently, a comparative analysis of competitors that presented the possibility of versatility in use was carried out, in order to understand the universe of the product to be developed. In sequence, Task Analysis (BAXTER, 2000) was carried out, a schematic representation of an operation, based on user observation, and the Operations Flow, a flowchart – a graphic that demonstrates the operational sequence of the development of a process – with the aim of observing usability and problems that may be presented in the artifact in question.

³ The name of the method is due to the organization of the team of 6 people, who make 3 drawings in 5 minutes. In the first round, 180 ideas are generated, and in the second, participants must evolve or modify the ideas that were proposed.

⁴ According to Baxter (2000), "Analogy is a form of reasoning, in which the properties of one object are transferred to another different object, but with certain properties in common". In this tool, you choose a term related to the project and use it to draw analogies with the most varied things, without restrictions.

As the project is multifunctional furniture, these two tools were applied twice, for tables and for chairs. The usability problems found in Task Analysis and Operations Flow were raised to prepare the G.U.T. questionnaire. The aspects that proved to be most problematic mainly concerned physical ergonomics.

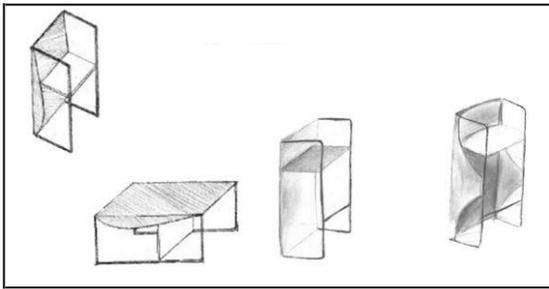
After the first stage of research and definition of ideas, the desirable aspects for the piece to be produced were established: a) Modular – Possibility of forming personalized furniture by joining more than one example of the designed piece; b) Simple – Harmonization with the briefing and relevant to the practical issues of project development; c) Versatile and multifunctional

– Proposal to include chair and table in a single object; d) Adaptable to small spaces

3.2 3.2 DEVELOPMENT AND CHOICE OF ALTERNATIVES

The process of generating alternatives began with the development of sketches⁶ by the authors, first individually, then with the exchange of these between team members, where there was freedom of redesign and suggestions for new versions and improvements, in a simplification of the Morphological Matrix tool (BAXTER, 2000), detailed in the next topic. In the classroom, the team used the Rapid Prototyping tool (BROWN, 2005), where simple models are constructed using different materials (modeling clay, paper, wooden sticks, etc.) to better visualize the ideas generated so far. At this stage, the alternative was chosen through the check list⁷ (where modular was the only aspect not to be achieved) and voting⁸. As seen in Figure 1 below, this alternative proposes the idea of multifunctional furniture that serves as a chair and coffee table.

Figure 1 - Alternative chosen from the first sketches.



Source: Prepared by the authors (2015).

3.3 DEVELOPMENT OF SHAPES

To generate ideas for variations and improvements to the chosen alternative, the Morphological Matrix tool and MESCRAI (BAXTER, 2000) were used. The Morphological Matrix is used to study all possible combinations between product components, where the variables are identified and the options for each one are organized in a table (Variables x classes), to generate combinations between classes and look for solutions for the proposed problem. MESCRAI is an acronym for Modify, Eliminate, Replace, Combine, Rearrange, Adapt and Invert, concepts that function as a checklist for possible modifications to the product's shape.

The sketches were submitted for appreciation in the classroom (critical session⁹). Among the best evaluated sketches, the team selected what was judged to be the best concept (Figure 2), whose main change is the expansion of multifunctionality, making three distinct uses possible of the same furniture.

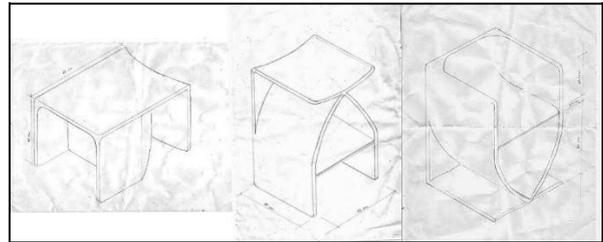
⁵ The semantic panel is a collection of visual references. Images help visualize the essence of the project concept.

⁶ *Sketch, in English, sketch, draft. Free drawing that aims to illustrate an idea.*

⁷ The desirable aspects are listed in a table, and it is verified which are present in the evaluated idea.

⁸ Inspired by Baxter (2000), voting is done in two stages, where participants first vote on the given ideas, selecting the best ones, and then order and choose one or two of them to be developed.

Figure 2 - Isometric view of the chosen furniture idea, in its function as a coffee table and high stool, respectively.

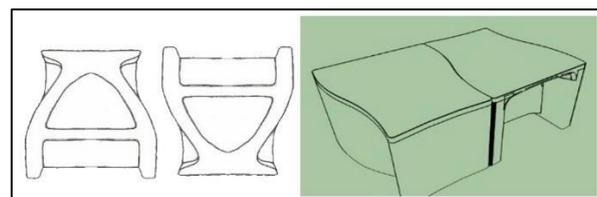


Source: Prepared by the authors (2015).

Concept selection tools such as Pugh's (1991) Controlled Convergence Process and Baxter's (2000) Opportunity Selection Matrix were used for final concept selection. With these techniques, the main change made was to the table top, detailed below.

Taking into account all the other aspects defined as desirable, we came up with the concept of a multifunctional piece of furniture (Figure 3), which, just by changing its arrangement, can be used as a chair, coffee table or high stool for an American kitchen, proving to be ideal for reduced environments. Due to the possibility of being used as a high stool for an American kitchen, the consumer will be able to use more than one Triad unit together. The modular feature is present in this case, as in situations where the function of a coffee table is preferred, there is the option of joining two or more pieces, fitting them laterally along the edges in an "S" shape, generating a coffee table longer.

Figure 3 – Sketch of the front view of the Triad in the bench and chair function and modular possibility, when used as a coffee table, respectively.



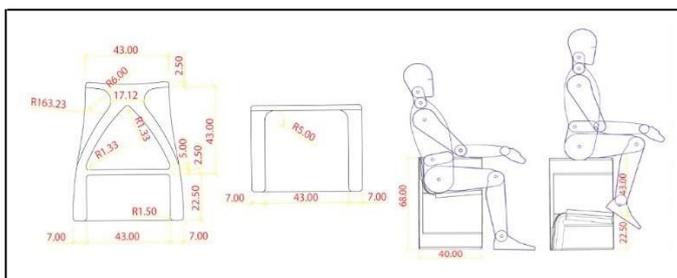
Source: Prepared by the authors (2015).

3.4 ERGONOMIC ASPECTS

In the project, due to its multifunctional nature, the ergonomic study was essential because it is a piece of furniture with three possibilities of use, the study of requirements and parameters became the basis, thus using the so-called design ergonomics (IIDA , 2005), where the ergonomic contribution is present during product design.

For example, as seen in Figure 4 below, the same dimension of the total depth of the Triad seat (40 cm) should match the appropriate height of a coffee table, just as the height of the chair seat to the floor has the same measurement (43 cm) than the distance between the seat cushion and the footrest. The seat, for better ergonomic adaptation, as well as the backrest was designed with a small curvature to better adapt to the user's body, (the seat) also has an inclination of 5° in relation to the floor, and its angle in relation to the backrest is 100° , as shown previously in Table 1.

Figure 4 - Technical drawing in front, top and left side view, and side sectional view of the Triad in use as a chair and high stool, respectively (units in centimeters).



Source: Prepared by the authors (2015).

The project was guided by averages and anthropomorphic parameters to make such possible uses possible, thus focusing on physical ergonomics. In relation to cognitive ergonomics, the project has a certain distance from the experiences and stereotypes in the repertoire of some users. However, at the same time it provokes a new interaction and relationship between user and object, as it presents the modular possibility where by purchasing more than one piece there is the possibility of a longer coffee table, also as a use in the form of a chair, or as a bench for high kitchen countertops.

4. CONCLUSION

Through its shape and ergonomically appropriate measurements, the result achieved in the Tríade met all the desired objectives, offering in a simple and unique way the multifunctionality of three different types of furniture, which can be a chair in its natural placement, a bench for high benches when arranged upside down or on a coffee table, placed horizontally with the back of the chair placed upwards, presenting the modular feature in case there is a need for a longer table - where the curves of the furniture fit perfectly -, the which makes it suitable for environments where space is limited, in addition to offering an interesting aesthetic proposal, harmonizing the weight of the wood with sinuous and organic shapes and proving ergonomically suitable for all indicated uses. The Tríade project concerns product design and engineering solutions for small spaces and multifunctional furniture, making it clear that they can be designed and developed without leaving aside the ergonomic aspect. From the modeling of the Triad in 3D software, where it was set for consideration, as well as in its 3D printing, it can be seen that all its aesthetic, ergonomic and functional aspects were in accordance with the ergonomic aspects and the requirements referred to in

this article. Figure 5 below shows the three possible uses of the designed furniture, and the final 3D printed model, in scales of 1:7 and 1:5.

In addition to showing in its development and conclusion the importance of designing furniture based on ergonomic adjustments, the Tríade project brings in its soul its own ergonomic research, as it depends entirely on it to make it possible. Thus, through the surveys and analyzes carried out in

this work, a contribution, albeit initial, to research in the area of developing ergonomically appropriate and multifunctional furniture is expected.

Figure 5 – The three functions that the Triad offers in computational modeling, printed models and ambience, respectively.



Source: Prepared by the authors (2015).

5. BIBLIOGRAPHIC REFERENCES

BAXTER, Mike. **Projeto de produto: Guia prático para o design de novos produtos**. 2. ed. São Paulo: Blucher, 2000. 260 p.

BROWN, Tim. **Design Thinking**, 2008. Disponível em: < <http://designthinking.ideo.com/>>. Acesso em: 20 de novembro de 2015.

ESPANHA. ANDREU WORLD. **Andreu World**. Disponível em: <<http://www.andreuworld.com/>>. Acesso em: 11 ago. 2015.

IIDA, Itiro. **Ergonomia - Projeto e Produção**. 2ª ed. revisada e ampliada. São Paulo: Edgard Blücher, 2005.

LIMA, Marco Antonio Magalhães, **Introdução aos Materiais e Processos para Designers**. Rio de Janeiro: Editora Ciência Moderna Ltda., 2006.

LOBACH, Bernd. **Design industrial: Bases para a configuração dos produtos industriais**. 1. ed. São Paulo: Edgard Blücher, 2001. 206 p.

PANERO, Julius; ZELNIK, Martin. **Dimensionamento humano para espaços interiores**. Barcelona: Gustavo Gili, 2008.

PAZMINO, Ana Veronica. **Como se Cria: 40 Métodos para Design de Produtos**. São Paulo: Blucher, 2015. 278 p.

PUGH, S., **Total Design: Integrated Methods for Successful Product Engineering**. Workingham, UK: Addison-Wesley Publishing Co., 1991.

LIMA, Andressa; TORRES, Pablo. **Mobiliário Multifuncional de Descanso para Habitações com Dimensões Reduzidas**. Universidade Federal de Campina Grande – UFCG, 2014.