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CASE STUDY: ANALYSIS OF THE USE OF ERGONOMICS BY GRADUATES OF THE DESIGN COURSE AT UFCG

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Summary

Considering the applicability of ergonomics in the design activity for product development, this research conducted a diagnosis of the use of ergonomics by graduates of the Design course at the Federal University of Campina Grande — UFCG, in product creation. The research was carried out over a period of time. This study aimed to determine the ways in which ergonomic principles are adopted, the phases of ergonomics application in projects, and the correlations between design ergonomics and operational costs. The methodology used was data triangulation, which includes a case study, employing a mixed-methods approach, in addition to bibliographic research. The investigation was conducted through online questionnaires administered over a period of 15 days, resulting in a response rate of 72.4% of the minimum sample of 59 people. Analysis of the data revealed that the professional trajectory of UFCG Design course graduates does not follow a linear pattern, presenting a significant phenomenon of professional migration. It was found that only 33.3% of these participants (14 graduates) apply ergonomics systematically, using methods and techniques from cognitive ergonomics, anthropometry, and organizational ergonomics . While 71.4% use ergonomics in their projects, it was observed that 66.7% are unable to assess the impact of ergonomic use on project costs. Therefore, there is a gap in the learning of ergonomic methods among design professionals, which are essential tools for ergonomic practice in projects. This gap may be occurring because the tools taught during undergraduate studies, generally focused on physical/industrial products, are not being easily adapted by graduates. The data presented here serve as a basis for possible reformulations of the ergonomics component and future research in the areas of teaching and learning, research projects, and interdisciplinary ergonomic activities.

Keywords: ergonomics; product design; product ergonomics.

1 Introduction

During the industrial revolution in Brazil, it became necessary to expand the industrial economy through the training of professionals (Razza , 2010–2012). In this context, the Institute of Contemporary Art (IAC) emerged in 1951 (Leon, 2013), with the aim of unifying art and industry (Leon, 2006), including ergonomics in its curriculum, relating to concerns about the form and function of products (Cossio; Schiavoni, 2016).

Design-oriented ergonomics is an essential component for the development of product projects, influencing the publication of research in the field of ergonomic design as a design component, bringing with it relevant points such as: form; function (utility); economy (costs); human; industry and environment (Sitta, et al., 2015). It is a crucial discipline for creating products that provide comfort, safety, and well-being to users, because ergonomists do not design

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systems, they design the interaction between artifacts and users (Karwowski apud Soares, 2011).

Based on the monograph developed in the final course project, this study aims to understand the application of ergonomics in product development, using the work of graduates from the Design course at UFCG. The relationship between their training and professional practice is examined to understand which product ergonomics design phases are applied by graduates and their relationship to the operational costs of their use. Therefore, this article aims to present a diagnosis of the use of product ergonomics by graduates of the UFCG design course, covering the period from 2015.1 to 2019.2. An electronic questionnaire was used to delimit the ergonomic applicability in the projects and its relationship with the operational costs of development.

The relevance of this study lies in its ability to act as a quality control tool for professional training, considering the number of research participants, seeking to ensure that products introduced into society are not merely aesthetic artifacts, but safe and inclusive systems. It facilitates a deeper understanding of the use of ergonomics in product development stages, thus contributing to the effective integration of ergonomics into projects—aiming to optimize utilization and efficiency throughout the entire product designer training process.

It is essential that design courses adopt metrics that aid in the practical application of ergonomics in projects. This will help avoid gaps in the use of ergonomic methods and techniques, preventing rework and anticipating risks arising from products that use ergonomics incorrectly.

The results reinforce the existence of a gap identified in the findings that transcends technical analysis and offers a clear roadmap for improving teaching and professional practice in Design and Ergonomics, revealing that ergonomics education may be directed in isolation. The data presented in this research reveal that ergonomics should not be an isolated component, but an essential criterion for all design practices. Therefore, extension workshops, extension courses focused on ergonomics management, and interdisciplinary study groups are proposed to empower students to analyze the artifact after delivery, thereby fostering dialogue between design and ergonomics.

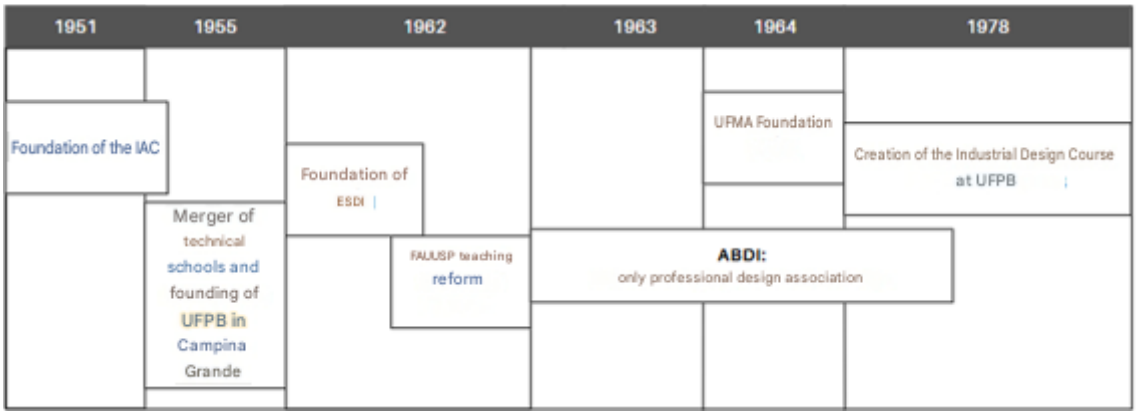
2 The industrial design course at UFPB/UFCG

The emergence of pedagogical practices in industrial design began with the first industrial design school founded in Brazil, the Institute of Contemporary Art (IAC), through the initiative of architect Lina Bo Bardi (1914–1992), Assis Chateaubriand (1892–1968), and Pietro Maria Bardi (1900–1999) (Leon, 2013). Soon after the closure of the IAC, the pioneering design school in Brazil, ESDI, was founded in the state of Guanabara in 1962, with references to the Ulm School (Basso, 2010).

In 17th-century England, the term "Design" emerged as a translation of the Italian "*desegno*." According to Cara (2010), Cardoso posits the origin of design as derived from English, where it possesses ambiguity between the abstract and the concrete element. In 1964, UFMG was authorized and recognized as a higher education institution, along with institutions such as ESDI, FAUUSP, and ABDI, shown in Figure 1. These organizations marked the institutional advent of the professional field of design in Brazil (Braga, 2016).

Industrial design, from a pedagogical perspective, involves the development of critical awareness regarding the acquired meaning of products within a social context. In this context, "the social practice of the industrial designer can accentuate or conceal the use value of artifacts" (Batista, 2012).

Figure 1– Implementation of teaching and establishment of industrial design institutions



Source: Author's own work.

In 1978, prior to the splitting of UFCG into the current UFCG, Rector Lynaldo Cavalcanti de Albuquerque (1932–2011) founded the Industrial Design Course (CDI), with the aim of decentralizing the university and expanding its areas of knowledge, bringing design to the Northeast region (Medeiros, 2017), being one of the five design courses implemented in Brazil by the National Council for Scientific and Technological Development (CNPq) (UAD/UFCG). Initially introduced in the Mechanical Engineering department, with an emphasis on industrial product design, its faculty consisted of: Áurea André Baltazar; Helena Maria Lopes Guedes; Ana Albertina C. Branco; Gustavo Amarante Bomfim; Ivan Assunção de Macedo ; Tamico Yamada; Wagner Braga Batista; Lia Monica Rossi; Eduardo Carvalho Araújo; Alexandre Eduardo Weiss; Norma Eleonora M. Wess and Luis Eduardo Cid Guimarães (Witter, 1985).

> The Industrial Design Course was an important instrument for the recognition of the area in the state and had repercussions on the national scene through the promotion and dissemination of events and actions such as the First Postgraduate Workshop in Design in Brazil and the Industrial Design Update Course, taught by professors Gui Bonsiepe , Petra Kellner and Holger Poessnecker, recorded in a publication sponsored by CNPq under the title Experimental Method: Industrial Design (Leon, 2014, p. 67 – 73 *apud* Silva, 2021).

On July 6, 1982, the Industrial Design course at UFPB was approved by the MEC (Ministry of Education) through Ordinance No. 248, with the objective of training professionals in a single area of specialization: Product Design (Medeiros, 2017). According to Resolution 04/2011 of the Higher Education Chamber of UFCG, in compliance with the guidelines of the Ministry of Education, the Industrial Design Course at UFCG was renamed the Design Course in 2011, maintaining, however, the focus on Product Design (Silva, 2021).

3 Teaching and learning ergonomics in design courses and its approach in the curriculum of the UFCG design course.

Ergonomics is a field of study that encompasses an integrated and interdisciplinary perspective, analyzing how people interact with various systems, considering physical, social, organizational, and environmental components, aiming to improve human well-being (Sousa, 2024). As Barbosa (2009) points out, "Ergonomics and the design process go hand in hand and should work in parallel from the beginning of the design process. In this way, usability is increased, user comfort and safety are enhanced, quality is guaranteed, and, as a result, greater

competitiveness is achieved." Teaching methodologies differ in the context of ergonomic learning, according to the pedagogical practices of Design courses, and aim at understanding and ensuring the effectiveness of human-task-machine relationships, which underpin the principles of the ergonomic system, instructing the deepening of ergonomic design systems (Santiago, 2018). The curriculum, or any other educational element, undergoes updates; in this case, it presents ethical, political, aesthetic, and cultural training, but these are not always highlighted. Therefore, the curriculum is developed to demonstrate results in educational institutions (Marcedo, 2012).

Gonçalves (2018), when discussing the subject of ergonomics applied to fashion offered at Anhembi Morumbi University in 2007, emphasizes that the professors aim to:

> To study the suitability of cultural objects to humans, considering ergonomic studies of physiology, perception, cognition and memory, dynamic and static anthropometry, handling, controls and displays. It analyzes interaction and perception cycles, usage scenarios, routines and interpretations. It addresses evaluation and measurement methods, centered on the user of design projects (Gonçalves, 2018).

According to Farias (2015) *apud* Gonçalves (2018), the use of active methodologies in higher education aims to "train independent, critical professionals who are opinion leaders." High-quality product design is extremely relevant for characterizing consumer needs, considering their physical, perceptual, and cognitive capabilities, as well as meeting the demands related to work tasks (Pequini , 2005). Cruz and Reis (2022) state that the Ministry of Education does not directly mention ergonomics. However, it is possible to observe the application of the three areas of ergonomics (physical, cognitive, and behavioral) in some content present in design course curricula, such as the relationships between user, object, and environment, studies involving physical and virtual projects, and the integration between theory and professional practice. UFCG is ranked 11th in terms of including ergonomics in the Design course curriculum, addressing only the introduction of cognitive ergonomics and the use of only two factors of physical ergonomics, completely excluding studies of organizational ergonomics, according to the research developed by Cruz and Reis (2022), represented in Table 1.

Table 1– Organization of course content according to the responsibilities of each area of Ergonomics and its application at UFCG.

Institution			
Física	the	The content of the course syllabus relates to: Human anatomy, anthropometry, physiology, and biomechanics.	+1
	b	The content of the course syllabus relates to: Work postures, materials handling, repetitive movements, work-related musculoskeletal disorders, and workplace layout.	+1
	w	Course content related to: Job design and environmental specifications in the physical human-machine relationship.	+1
Cognitiva	the	The content of the course syllabus relates to: Perception, memory, reasoning, and motor response.	+1
	b	The content of the course syllabus relates to: Mental workload, decision-making, skilled performance, human-computer interaction, human reliability, workplace stress, and training.	+1

	w	Course content related to: Interface and information systems design in human-machine communication.	+1
Organizacional	the	Course content related to: Organizational structures, processes, and policies	+1
	b	The syllabus for the subjects relates to: Communication, team resource management, work design, work schedule allocation, teamwork, participatory design, participatory ergonomics, cooperative work, new work paradigms, virtual organizations, telework, and quality management.	+1
	w	The content of the course syllabus relates to: Project design, process modeling, requirements analysis, and the development of organizational change plans or new organizations within the human-machine-environment system.	+1

Area	**Physical**			**Cognitive**			**Organizational**		
UFCG	the	b	w	the	b	w	the	b	w
	+1	+1		+1					

Source: Adapted from Cruz and Reis, 2022.

The trajectory of Ergonomics teaching at the Federal University of Campina Grande (UFCG) reveals a pedagogical maturation that accompanies the global transformations of the discipline. This evolution can be segmented into three fundamental milestones: (1) In the inaugural pedagogical project (1978 – 2000), Ergonomics was introduced late (5th semester), consolidating itself as a fundamental axis for professional training, focusing on industrial practice; (2) methodological integration (2001 – 2013), the 2001 PPC reform represented a critical advance by bringing the discipline forward to the 4th semester and, fundamentally, by hybridizing ergonomics with design practice. The discipline ceased to be an isolated content to become a methodological tool of design. This change signaled the recognition that the human factor must be considered at the conception stage (design ergonomics), and not only as a later correction; (3) in effect from 2014 to the present, which consolidates Ergonomics as an interdisciplinary axis, maintaining its approach in the 4th period of the course. Contemporary analysis transcends the "form-function" binary to address the human-machine-environment triad under four new layers of complexity:

1 - **Cognition and Criticism:** The teaching encourages analytical thinking about the role of ergonomics in the design and development of products.

2 - **Universal Inclusion:** The diagnostic practice provides ergonomic recommendations for the environments where these products can be used, integrating accessibility parameters for users with and without disabilities, aligning with Inclusive Design.

3 - **Extended Interdisciplinarity:** Product design begins to incorporate social, cultural, and emotional determinants, recognizing the user as a psychosocial being.

4 - **Holistic Approach:** The terminological transition to "component" reflects a more fluid integration between theory and practice, where ergonomics acts as a mediator between technical requirements and the subjective expectations of the user (UFCG, 2023).

The transition observed in the UFCG's PPCs (Pedagogical Project Courses) indicates a shift in Ergonomics from a strictly biometric and industrial scope to a synthesis discipline, capable of integrating the social and emotional dimensions of design with the technical rigor of usability. For more information on the PPCs of the UFCG design course, access the library

repository, specifically the final project entitled "Case study: analysis of the use of ergonomics by graduates of the UFCG design course".

3.1 The crucial role of knowledge in product ergonomics in the design curriculum.

Ergonomics can provide a valuable contribution to design research and subsequent stages of the design process (Moraes, 2003 *apud* Barbosa, 2009). Jordan (1998), together with Iida and Guimarães (2016), emphasize the importance of incorporating principles of ergonomics and usability in the creation of design projects. The contribution of ergonomics to the organizational process characterizes it as a structured discipline that involves human tasks, particularly in the productive environment (Freitas ; Minette , 2014). In this vein, the multidisciplinary nature of ergonomics needs to be developed during the academic training of professionals.

With the aim of guiding universities, companies and professionals, the International Ergonomics Association (IEA, 2000) developed the document *Core Competencies in Human Factors and Ergonomics* , made available in 2021 to all academic units, outlines the ability to describe the ergonomic competencies that HFE professionals should possess (Neto *et al* ., 2023). Ergonomics/Human Factors (HFE) is a scientific field focused on understanding the interactions between humans and systems, aiming to harmonize these interactions and consider the needs, abilities, and limitations of people (Graf, 2021). Therefore, ergonomic applications in courses or guidance, particularly regarding Instructional Design (the process of developing and presenting instructional content to students in a way that is understandable), are based on Design Thinking tools . Aspects of Design Thinking can be considered an ergonomic approach to instructional problems (Gruber *et al* ., 2017). The aim of ergonomic action is to transform work, and Design Thinking is the realization of ideas that have an impact on users. The union of both actions focuses on human-system interaction, consumers and services, addressing system development methods using user-centered design, and incorporating ergonomics and usability techniques. This approach improves efficiency and effectiveness, human well-being, user satisfaction, accessibility, and sustainability, as well as reducing potential negative effects on human health, safety, and performance (ISO , 2010; Guérin *et al* ., 2001; Brown, 2010 *apud* Gruber *et al* ., 2017).

It is evident that design, along with ergonomics research, plays a crucial role in identifying problems, thus providing improvements or designing products that are suitable for users (Paschoarelli, 2009). Ergonomics, being a discipline focused on product design, has as its essential characteristic the ability to allow an interdisciplinary and multidisciplinary understanding of human-technology interaction systems in product creation, contributing to the design process through two approaches: (1) understanding the relationship between the product and the user; (2) meeting user demands, minimizing problems as much as possible (Vergara, 2008). The cost-benefit ratio of ergonomics should be considered in all projects, as its late incorporation into the design process prevents its adequate implementation as design ergonomics, which generally results in the need for adjustments to adapt the design to the user inadequately (Barbosa, 2009).

Ergonomics, as a structured discipline encompassing human activities in the productive environment, has contributed significantly to organizational processes (Freitas; Minette , 2014). Given this relevance, mastering its competencies becomes essential for any professional, regardless of their field of work. Thus, it is fundamental that this multidisciplinary vision begins to be developed during academic training.

4 Methodology

This research is a case study, conducted in July 2025, whose research methodology is based on multiple sources, such as bibliographic research, to support the analyses (Yin, 2001; Santos, 2018). The main unit of analysis is the Design course at the Federal University of Campina Grande (UFCG), focusing on the ergonomic practices used by graduates over a period of time, whose perceptions allow for a deeper understanding of the phenomenon. The choice of a case study is justified by the need to examine a current phenomenon in its real context, where the boundaries between the phenomenon (training and professional insertion) and the context (the educational institution) are not clearly defined. The study employs a mixed-methods approach, characterized by the combination of systematic processes of quantitative and qualitative data collection and analysis in a single study (Creswell, 2021), providing a more comprehensive understanding of the phenomenon than the isolated use of only one approach. For data interpretation, the main strategy used is data triangulation, as it allows for the interaction of results from bibliographic research, document analysis, and the perception of graduates, reducing the individual biases of each method and strengthening the validity and reliability of the conclusions drawn about the analyzed reality (Minayo; Assis; Souza *et al*., 2006).

Communication and questionnaire administration were conducted via email, using addresses previously provided by the course coordinator. The questionnaire was developed using the *Google Forms platform* , structured to contain 15 objective and specific questions, and made available from July 8th to July 22nd, 2025, totaling 15 consecutive days, with the aim of obtaining clear information aligned with the objectives of this study.

4.1 Sample Universe

Through the list provided by the Design course at UFCG, the graduates who completed the academic period from 2015.1 to 2019.2 were identified, totaling 167 students.

The sampling in this research is classified as non-probabilistic by convenience, since the selection of participants depended on the voluntary participation of graduates in answering the questionnaire made available via email. Despite the inherent limitations of this technique regarding rigorous statistical generalization, an attempt was made to confer greater robustness to the study through the use of the sampling equation for finite populations. In this context, the statistical calculation was employed as a reference parameter to establish the ideal sample size in relation to the total number of graduates in the determined period. Although the final number of participants is determined by the number of responses received, the equation makes it possible to situate the scope of the collected data and discuss its representativeness within an established margin of error and confidence level, minimizing possible interpretation biases (Cochran, 1965; Cruz, 1978; *apud* Lopes, 2003).

Based on a sample taken from the total population of 167 graduates, it was determined that the questionnaire should be administered to 59 participants. The sample result is statistically representative, ensuring that the data obtained have a reliable degree of accuracy in relation to the characteristics of the total group.

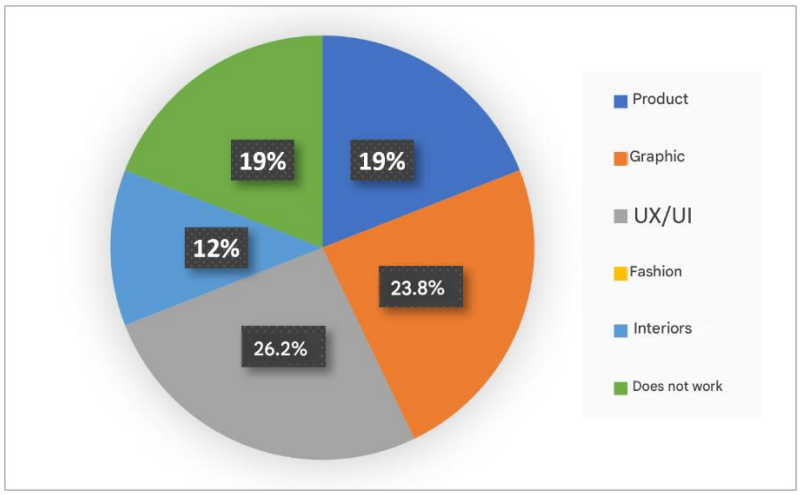
Following the definition of the sample size, the percentile calculation was used to present the relevance and reliability of the data with greater statistical rigor, since the confidence intervals provide greater detail in the evaluation of the average scores (Williams; Bornmann , 2014).

Corresponding to the sample value, with response times varying between {20, 25, 35, ..., 50}, when using the 35th percentile time from the sample size of 59 participants, the percentile obtained corresponds to exactly 20.7.

5 Results and discussion

The results obtained through the questionnaire revealed a predominantly specialized sample profile. Data analysis revealed that the professional trajectory of UFCG Design graduates is not linear, but rather a resilient adaptation to the institution's methodological foundations. Although 76.2% of the 42 participants who responded stated that they work directly in the field of Design, this concentration of professionals in the sector becomes fundamental to ensuring the reliability of subsequent results, since the responses may reflect the vision of professionals already working in the market and familiar with the nuances of the studied area. Analyzing the formative trajectory of the respondents, represented in Figure 2, a relevant phenomenon of professional migration was noted: although 26.2% of the sample currently work specifically in UX/UI Design, followed by Graphic Design with 23.8%, these two areas together represent 50% of the sample, highlighting a massive migration to sectors that demand digital interfaces and visual identity. The concentration of professionals in these segments is an interesting point; although their original training is in Product Design, only 19% of respondents remain working strictly in this area. This phenomenon validates Dantas's (2016) perspective, which argues that the "incompatibility between the course's vocation and the local productive vocation" can act as a catalyst for graduates to seek opportunities in related areas.

Figure 2- Area of activity of graduates



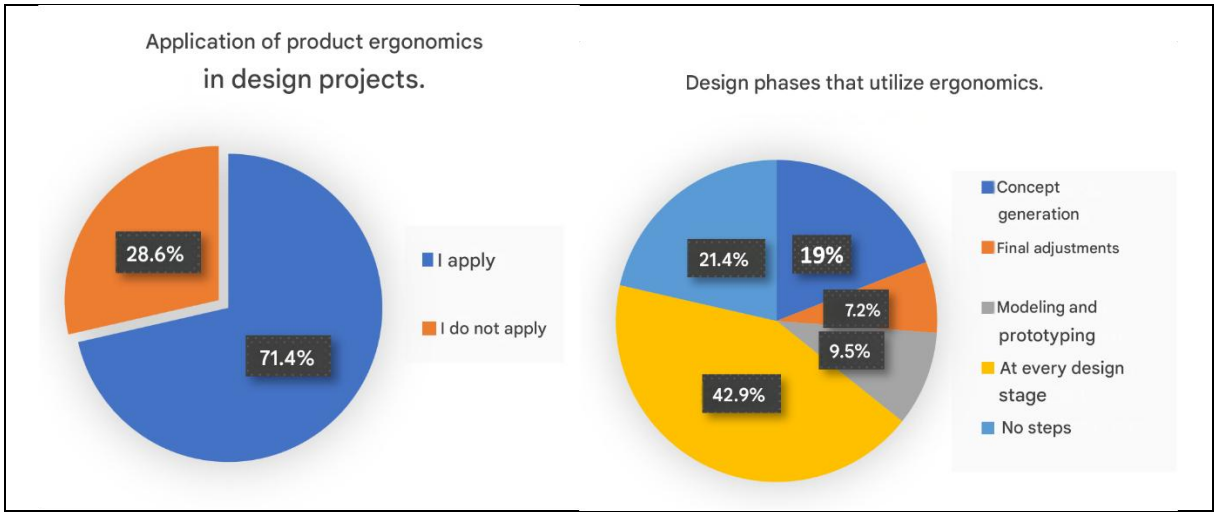
Source: Prepared by the author.

In the analyzed context, the potential lack of a manufacturing industry or the disconnect between academic projects and regional reality seems to force Product professionals to adapt their skills to the UX/UI Design and Graphic Design market, which often offers a more urgent local demand and faster acceptance. Therefore, working in related areas is not only a preferred option but can also become a strategy for adaptation and insertion into the job market, considering the limitations of the productive sector in Campina Grande-PB.

Regarding the application of ergonomics in projects, it was found that 71.4% of those interviewed use it. However, only 42.9% incorporate it in all stages of the project, as illustrated in Figure 3. This context partially diverges from the recommendations of Barbosa (2009), who argues that ergonomics and the design process should be integrated from the beginning. This

need for early application is also supported by Iida (1990), who states that ergonomic integration is essential from the initial stages of development.

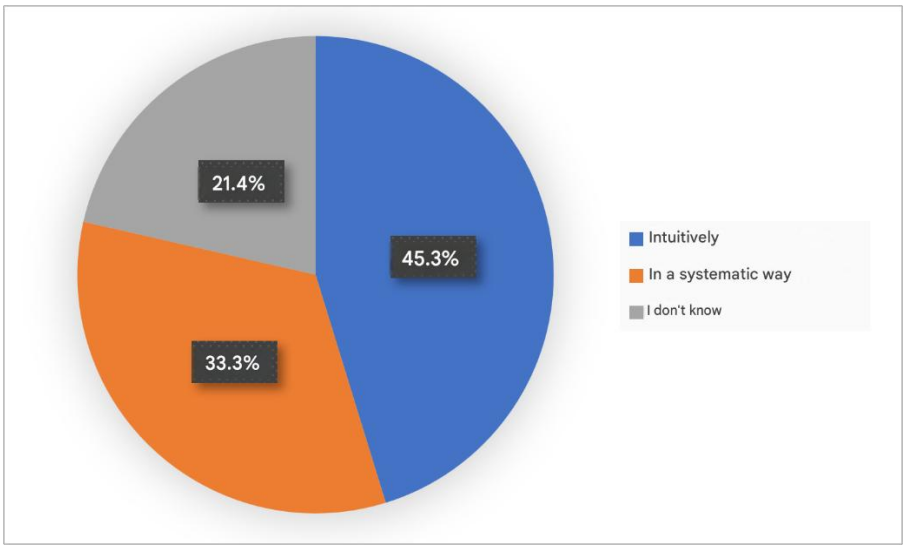
Figure 3- Application and phrases regarding the use of ergonomics in product design.



Source: Prepared by the author.

The curriculum for the Ergonomics component at UFCG aims primarily to improve reflective thinking and product analysis skills. However, the data presented in Figure 4 show a possible gap in the teaching-learning process of the individuals analyzed, since only 33.3% of professionals treat ergonomics with the necessary technical rigor, using it systematically in the development of their projects. In contrast, 45.3% apply these concepts only intuitively, while 21.4% do not even know how this integration occurs, thus highlighting a lack of technical rigor in most creative processes. Design decisions can often neglect structured methodologies in favor of subjective perceptions. From this perspective, structured design ceases to be an academic "luxury," becoming an urgent competitive advantage to ensure quality and cost reduction, challenging institutions to convert theory into applicable methodologies.

Figure 4– Ways of using ergonomics in projects

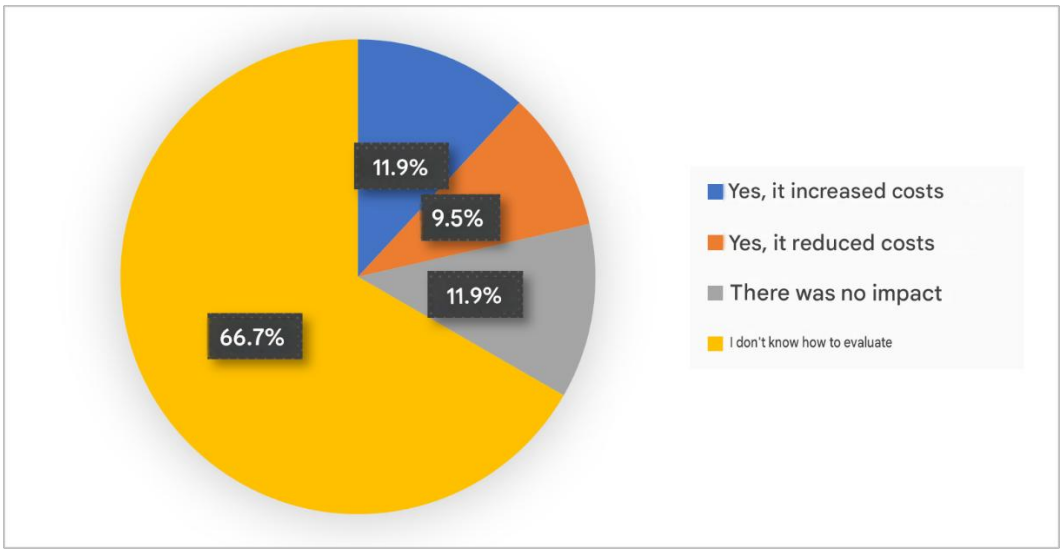


Source: Prepared by the author.

The analysis of the data obtained in Figure 5 reveals a disconnect between the curriculum and the practical perception in the training of professionals, since 66.7% of the participants stated that they did not know how to evaluate the financial and design impact of ergonomics. A point of concern was identified in the technical knowledge which, if not addressed, could impact the expected results, as it contradicts the course's objective of enabling students to propose effective ergonomic recommendations. Although the course aims to offer ergonomic analysis skills, this may not be in line with the intended objective at the moment, and in relation to the perception of strategic value defined by authors such as Blaich , cited in the Moraes article and described by Pequini (2005). The latter emphasizes and states that the application of ergonomics in design decisions is fundamental to increasing reliability and reducing uncertainties.

Regarding the financial impact, the data reveals a divided perception among respondents: while 11.9% indicated that the implementation of ergonomics in projects increased production costs, an equivalent portion (11.9%) observed no economic change. Conversely, 9.5% of participants highlighted that the adoption of ergonomic methods resulted in an effective reduction in product development costs. These indicators show that most alumni still view the discipline in an abstract way, and not as a method for optimizing resources and mitigating project risks.

Figure 5– The use of ergonomics impacts project costs.



Source: Prepared by the author.

In 1990, Iida already stated that increasing industrial competitiveness on a global scale tends to lead companies to offer products with high quality standards, considering ergonomic requirements as strategic elements to gain a competitive advantage. From this perspective, we can affirm that ergonomics has gone from being an exclusively operational concern to establishing itself as a pillar of market intelligence. In a context of hyper-competition , the technical quality of a product is the basic requirement, while "ergonomic quality" is the factor that determines consumer choice. By creating interfaces, tools, or environments that consider human limitations and abilities, companies reduce the costs of errors and increase the perception of value, converting user well-being into a direct indicator of commercial success and global survival.

6 Conclusion

The studies analyzed reveal that, in general, the 42 graduates from the Design course at UFCG (Federal University of Campina Grande) who responded between the period 2015.1 and 2019.2 have a fragmented knowledge in the field of ergonomics, indicating that the teaching of ergonomics may not be efficient for practical application in product design projects.

The limitations encountered in this study are associated with the lack of research analyzing the teaching-learning process and applicability of ergonomics in product design. However, there were challenges in obtaining responses to the questionnaires, as this is a non-probabilistic convenience sampling study, depending on the availability and interest of the participants. Due to this factor, only about 72.4% of the participants in the minimum sample of 59 were able to respond. The purpose of understanding how ergonomics is used in product design and its operational costs was met through the results, which show that systematic ergonomic practice is practiced by a minority (33.3%) of the graduates. Less than half of the participants (42.9%) implement ergonomics in all design phases, and more than half (66.7%) of the respondents are unable to assess the impact that ergonomics has on reducing costs in project development.

However, there is a need to expand studies and systematize teaching practices in the ergonomics curriculum component, focusing on practical application in product design, so that future graduates become professionals capable of developing more ergonomic products.

In addition to this, it is essential to promote a more robust incentive for the creation of theoretical studies, investigations into the teaching-learning process, and practical experiences that favor the implementation of ergonomic methods and techniques in product design, research development, and interdisciplinary initiatives. This will contribute to increasing the academic credibility of the field, training professionals capable of excelling in the design of new products.

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