



## **ERGONOMICS IN PRODUCTION ENGINEERING: AN OVERVIEW OF PRACTICE AND TEACHING IN UNDERGRADUATE COURSES IN BRAZIL**

Guilherme Franco de Moraes<sup>1</sup>  
Rosimeire Sedrez Bitencourt<sup>2</sup>

**SUMMARY:** Production Engineering has contributed to improving the quality of products and processes, and one of its areas of study is ergonomics. However, despite the importance of this science for the professional practice of engineers, not everyone considers it in their projects. The objective of this study is to present an overview of the practice and teaching of ergonomics in production engineering courses in Brazil. To this end, the research was divided into two parts: i) survey of ergonomics applied in production engineer projects and; ii) survey of ergonomics subjects in production engineering courses at Brazilian universities. The scope was limited to federal universities that made information available online. The results showed that, among the study participants, none considered the cognitive and organizational aspects of ergonomics in projects. Regarding the survey of ergonomics disciplines, 212 disciplines from 69 universities were investigated. With the results, it was possible to identify that the ergonomics subject is not mandatory in 29.24% of the courses and is taught in a workload of less than 50 hours and in conjunction with other subjects in 33.81% of the courses. Another finding is that in none of the courses where the ergonomics subject is mandatory does the syllabus contain any evidence that the specialization domain “Organizational Ergonomics” is covered. Based on these results, there is a gap in ergonomics teaching. It is recommended that this study be continued, including private universities and other variables that contribute to a better visualization of this reality.

**KEYWORDS:** Ergonomics; Production engineering; Teaching

<sup>1</sup> Pontifícia Universidade Católica do Paraná, [guilherme.moraes210@gmail.com](mailto:guilherme.moraes210@gmail.com)

<sup>2</sup> Pontifícia Universidade Católica do Paraná, [rosimeire.bitencourt@pucpr.br](mailto:rosimeire.bitencourt@pucpr.br)

## INTRODUCTION

The crisis experienced in Brazil is reflected in different economic areas, impacting both the industrial and services sectors (BARBOSA FILHO, 2017). In this context, in the search for companies to become, or remain, competitive, some of the elements used in the practice of organizations have been the minimization of labor costs and the maximization of productivity. However, the search for cost reduction when done without due concern for ergonomic issues can lead to an increase in workers' workload and consequences related to human costs; in addition to costs for the work system with increased rework, errors and accidents (GUIMARÃES, 2004).

Situations like these contribute to a drop in productivity and increased costs, instead of the desired cost reduction. It is, therefore, a cycle that is not virtuous and must be combated. On the other hand, ergonomics can contribute to breaking this cycle in a way that is compatible with the reality faced by companies.

Ergonomics is a discipline that has a systemic approach to all aspects of human activity (IEA, 2000). According to the Brazilian Ergonomics Association, ergonomics is a science that seeks to understand the interactions between human beings and other elements or systems in order to optimize human well-being and the overall performance of this system (ABERGO, 2001).

It is worth noting that the scope of action of Ergonomics has expanded in recent decades, no longer focusing solely on the physical and incorporating the cognitive and organizational aspects into its domains of specialization (ABERGO, 2021). According to Hendrick (1995), in order to take account of the breadth of these three dimensions and be able to intervene in work activities, ergonomics must be applied in a holistic approach to the entire field of action of the discipline, both in its physical and cognitive aspects, as well as organizational, social and environmental, among others. Still according to Hendrick, it is necessary to promote good ergonomics, that is, one that is committed to results, also generating good savings.

In this context, it is understood that professional training in strategic areas for improving processes and new projects such as production engineering, for example, still needs to have a better developed human focus. The importance of promoting this change is reinforced by the new National Curricular Guidelines for the Undergraduate Engineering Course - DCN, as per Resolution No. 2, of April 24, 2019 (DCN, 2019). They establish the skills and profile expected in the graduate's training. Among the characteristics of the graduate's profile are: having a holistic and humanistic vision, being critical, reflective, creative, cooperative and ethical and with strong technical training; be able to recognize users' needs, formulate, analyze and creatively solve engineering problems; adopt multidisciplinary and transdisciplinary perspectives in their practice; consider global, political, economic, social, environmental, cultural and occupational health and safety aspects; act with impartiality and commitment to social responsibility and sustainable development.

Furthermore, the work of engineers is subject to compliance with a code of ethics. According to the Professional Code of Ethics for Engineering, Agronomy, Geology, Geography and Meteorology, developed by the Federal Council of Engineering and Agronomy - CONFEA/CREA (2019), violations of this code may lead to loss of professional registration. In its Article 10, item II, some of the positions vetoed to professionals are presented, among which are: neglecting the safety and health measures

at work under their coordination and imposing an excessive work pace or exerting psychological pressure or moral harassment on the collaborators.

In addition to these justifications, others can be added in order to contribute to demonstrating the importance of ergonomics and related disciplines in professional training, for example, for future production engineers, such as: the high number of worker absences and workplace accidents work, according to the Yearbook on Occupational Accidents (2019). It is understood that in many of these contexts, production engineering professionals can also contribute in a positive and preventive way, as long as they have the appropriate skills.

Although the need to consider human factors is established, there is no specification of how these skills can be developed or, at least, what would be the minimum acceptable in the training of these professionals so that such skills can be considered minimally developed. It is also unknown how the ergonomics discipline has been taught to these graduates in Brazil. In other words, which aspects of ergonomics are considered in the respective disciplines and whether these are limited to the theoretical part or involve the development of skills based on practice.

In this way, the present study seeks to understand how ergonomics subjects are taught in production engineering courses at Brazilian universities, in addition to identifying an overview of how production engineering professionals have applied ergonomics in practice in their projects. It is believed that with this understanding, countless other actions can be initiated in order to contribute to the training of these and other graduates who will use ergonomics in their professional practice.

## **Objective**

The objective of this study is to present an overview of the practice and teaching of ergonomics in production engineering courses at Brazilian universities. Due to time constraints, it was decided to limit the scope of this research to federal universities with production engineering courses and that made information available online.

## **MATERIALS AND METHOD**

To achieve the proposed objective, this research was divided into two parts: i) survey of ergonomics practice by production engineering professionals and; ii) survey of ergonomics and related subjects in production engineering courses at Brazilian universities.

In the first part of the research, as a method to improve understanding of the content, interviews were carried out with production engineers in order to identify their experiences and their point of view on the practical application of ergonomics. The initial idea was to apply this form to all production engineering professionals affiliated with ABEPRO. However, after different contact attempts, the researchers did not receive any response from the association. In this way, a convenience sample composed of professionals in the area of Production Engineering was used. In this way, the questionnaires were distributed among contact networks of engineering professors. In total, 18 professionals returned the survey. It is worth noting that this sample does not represent the population and the analyzes presented only describe the experience of the professionals who participated in this research.

In the second part, with the delimitation of the scope to federal universities with production engineering courses and that made information available online, in total, 212 disciplines from 69 universities in all states were investigated. Furthermore, this scope of analysis was limited to gathering the following information: content, workload and obligation. It should be noted that, for this project, no mechanisms for checking and validating the information obtained were implemented.

In this survey, the following information from ergonomics subjects was considered: workload, mandatory requirements and content based on the subject's syllabus. Study topics, prerequisites and other information were not covered in this scope of research due to the difficulty in accessing this information. It is worth noting that in addition to this information, other information can contribute to the survey of an overview of ergonomics teaching, however, it was decided to address other universities, courses and information in future research.

## RESULTS

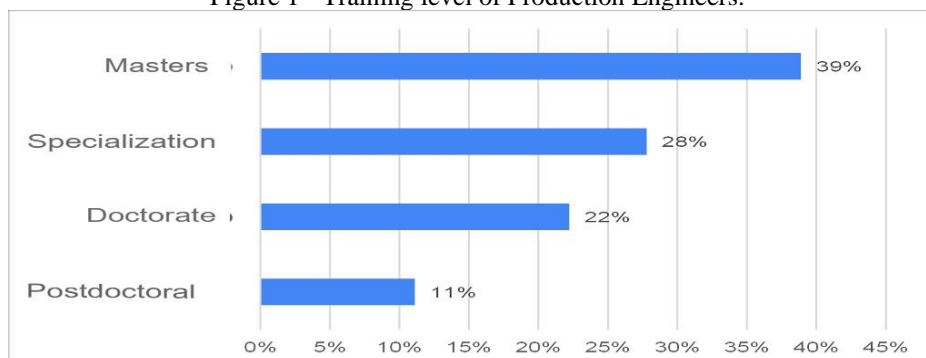
The first part of the results presents the survey that sought to understand how production engineering professionals perceive the importance of ergonomics in their professional performance and how they use it in practice. To this end, a questionnaire was developed using the Google Forms® tool. The details of this form are presented below.

### Survey of how ergonomics is considered in practice

This form, in addition to seeking to characterize the respondents, also sought answers to the following questions: What level of training is the person being researched at, how long have they been working in the area of Production Engineering, how important the participant considers ergonomics, how many projects he carried out in the area of Production Engineering, how many of these projects were carried out using ergonomics and were these aspects considered in the projects.

Fig.1 represents the level of training of the professionals who participated in the research, all of whom graduated in production engineering at graduation. Of the total respondents, all had at least specialized training, 27.8% with specialization; 38.9% with a master's degree; 22.2% with a doctorate and 11.1% with a post-doctorate.

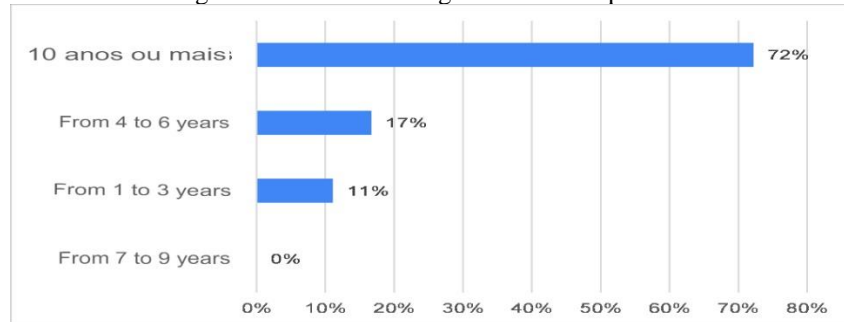
Figure 1 - Training level of Production Engineers.



Source: the authors, 2020.

Fig.2 shows the duration of the participants' experience in the area of Production Engineering. Among the people evaluated, the majority have been working in the profession for more than 10 years, with 72.2% having worked for 10 or more years; 16.7% aged 4 to 6; 11.1% work for 1 to 3 years in the area of production engineering.

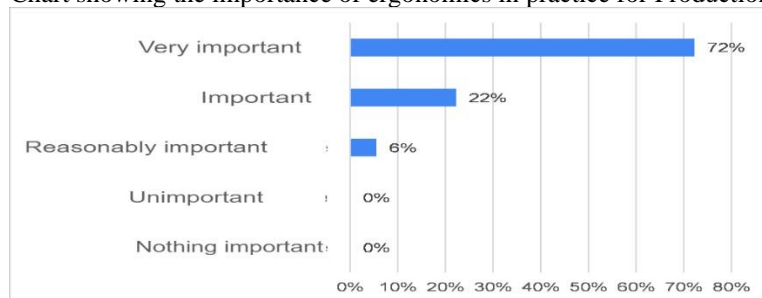
Figure 2 - Production Engineers' time in practice.



Source: the authors, 2020.

Fig. 3 addresses the importance of ergonomics in the professional practice of the engineers who participated in the study. In the perception of most respondents, the application of ergonomics in the practical work of the production engineer is considered very important, specifically: 72.2% consider it very important, 22.2% consider it important and 5.6% of people consider it reasonably important.

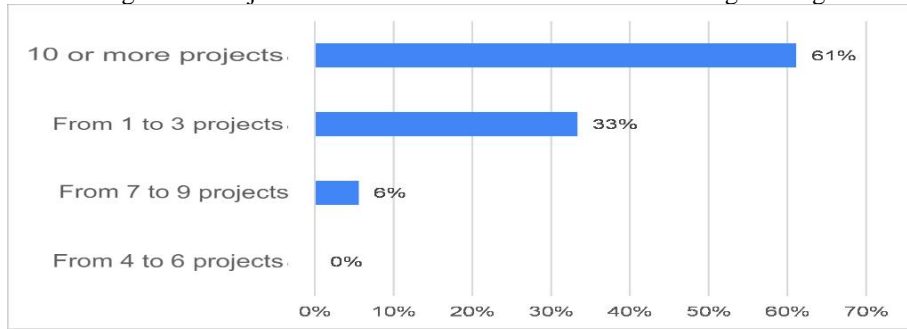
Figure 3 - Chart showing the importance of ergonomics in practice for Production Engineers.



Source: the authors, 2020.

Fig. 4 represents the number of projects carried out in professional practice by participants in the area of Production Engineering. All professionals who participated in the survey reported having already participated in a project in the area of production engineering, with: 61.1% having already carried out 10 or more projects; 33.3% carried out between 1 and 3 projects and; 5.6% performed between 7 and 9.

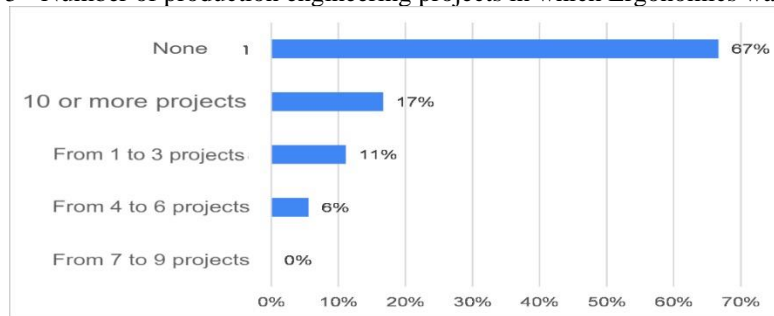
Figure 4 - Projects carried out in the area of Production Engineering



Source: the authors, 2020.

Among the projects developed by professionals, Fig. 5 represents the percentage of projects that considered ergonomics. In the majority of applied projects, respondents reported not having applied ergonomics in practice, with: 66.7% never applying ergonomics in their projects; 11.1% applied ergonomics to 1 to 3 of the projects, 5.6% applied ergonomics to 4 to 6 projects and 16.7% applied ergonomics to 10 projects or more.

Figure 5 - Number of production engineering projects in which Ergonomics was applied



Source: the authors, 2020.

Participants were also asked what ergonomic aspects were addressed in the projects. Table 1 presents these results, and in 100% of the projects in which ergonomics was applied only the specialization domain of physical ergonomics was considered. It is worth noting that one of the respondents pointed out the application of Time and Methods Study as ergonomics, however it was not clear in the response which human factors would have been considered in this study.

Table 1 - Ways to Approach Ergonomics in Projects

Requirements considered in the projects	Ergonomics
Posture and labor gymnastics practices: in 5s implementation projects	Physics
Chair / notebook stand for home office work	Physics
Posture and work station	Physics
Work station; in Kaizen Program Implementation Project	Physics
Worker comfort	Physics
Study of times and methods	It is not clear what human factors which were considered in the study

Source: the authors, 2021.

It is worth noting that there is a possible contradiction in the answers, because while most professionals say that ergonomics is very important, they in fact do not apply it in their projects or apply only a partial view, limited to the physical aspects of ergonomics. .

The results of this first part of the research contribute to justifying the importance of carrying out a survey on how ergonomics subjects have been taught in production engineering courses in Brazil.

### **Ergonomics at federal universities in Brazil**

The results of the second part of the research are presented below, and reflect an overview of ergonomics disciplines in production engineering courses at federal universities in the country that make information available online.

In order to provide a graphical representation of the results obtained, we chose to use map graphics that represent an indicator. This indicator was calculated based on the three analysis variables (hours, content and obligation) and these results are presented below. To calculate this indicator, the results could vary between 0 and 5, with 0 (no ergonomics subject included) to 5 (there is an ergonomics subject, it is mandatory, with a minimum workload of 50 hours, and considers the 3 domains of ergonomics specialization). However, none of the universities studied reached indicator 5, defined by the researchers, taking into account the available information.

Fig. 6 represents the ergonomics disciplines in production engineering courses in Brazilian states. In this Figure it is possible to identify, in lighter green colors, the states that received indicator 0 (zero) and in dark green the states that received indicator 3 (three), which was the highest score among the states. States such as Sergipe, Rio Grande do Sul, Rio Grande do Norte, Rondônia and Piauí appear as positive highlights in this survey.

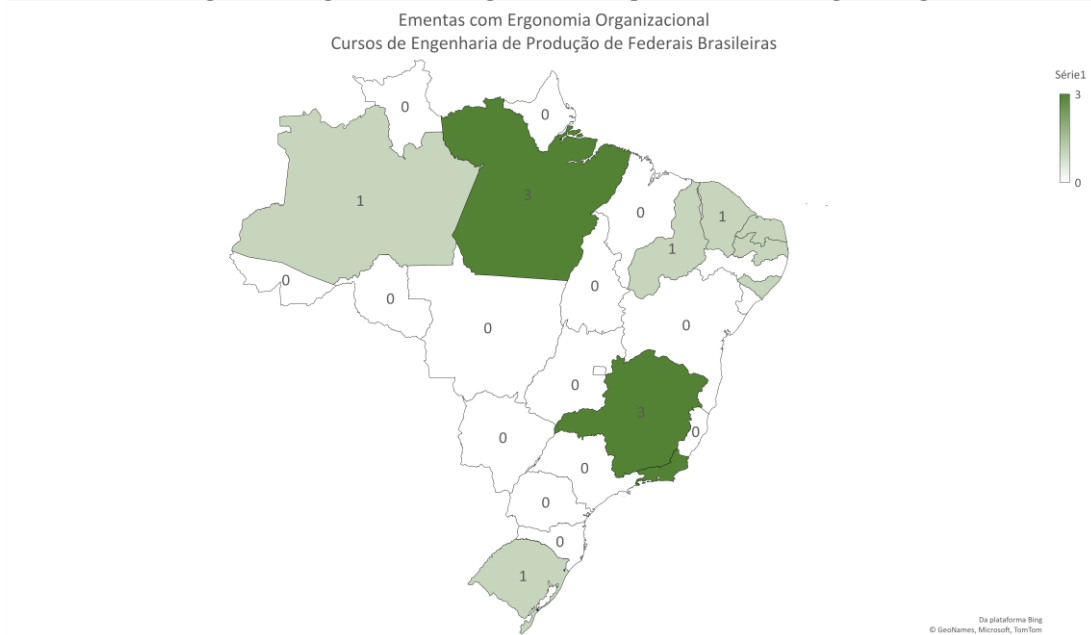
Figure 6 – Map of Ergonomics Disciplines in Production Engineering in Brazil.





Fig. 8 shows the states with universities that present ergonomics subjects in production engineering courses where it was possible to verify, through reading the syllabi, the existence of signs that the specialization domain of organizational ergonomics is part of the scope of teaching. It is possible to verify that the following regions apply this domain: Amazonas, Piauí, Ceará, Rio Grande do Norte, Rio Grande do Sul, Paraíba and Pernambuco. Also worth mentioning are the states of Pará, Minas Gerais and Rio de Janeiro where there are courses with subjects that address macroergonomics and the socio-technical vision.

Figure 8 - Organizational Ergonomics Map in Production Engineering



Source: the authors, 2021.

With the results, it was possible to identify that the ergonomics subject is not mandatory in 29.24% of the courses and is taught in a workload of less than 50 hours and in conjunction with other subjects in 33.81% of the courses. Another finding is that in none of the courses where the ergonomics subject is mandatory (70.76%) is there any evidence in the syllabus that the specialization domain of “Organizational Ergonomics” is covered.

Although this is preliminary research, these results reiterate the importance of more surveys like this being carried out and reflections being carried out on how ergonomics subjects have been taught in production engineering courses. It is noteworthy that the practical performance of ergonomics also takes place through the training of professionals from other areas and that the ideal would be a joint effort in investigations in all areas of training in which the ergonomics discipline is taught.

Furthermore, this research focused on theoretical training and not on practical training, but it can be mentioned that in terms of the syllabus of the subjects studied, the practical training of students was not explained.

The results, so far, highlight a gap in ergonomics teaching, which could impact the training of future production engineers. It is therefore recommended that this study be continued, including private universities, different means of accessing/checking data and

the consideration of other variables that contribute to a better visualization of the reality of professional training in courses that include the ergonomics discipline. Studies are also recommended that seek successful experiences in internationally recognized educational institutions so that the most relevant aspects are considered in the analyses.

## **CONCLUSION**

This research aimed to present an overview of the practice and teaching of ergonomics in production engineering courses in Brazil. To this end, the research was divided into two parts: i) survey of ergonomics practice by professionals and; ii) survey of ergonomics and related subjects in production engineering courses at Brazilian universities. Due to time constraints, it was decided to limit this research to federal universities that made information available online.

The results of the first part of the research highlighted the importance of ergonomics from the point of view of production engineers, with 72.2% of participants considering it very important to consider ergonomic aspects in projects in the area of production engineering. On the other hand, only 33.4% apply ergonomics in their projects. Of the total number of professionals who have already applied ergonomics to their projects in practice, the majority consider only the physical aspect of ergonomics and none of them have applied the specialization domains of cognitive and organizational ergonomics. It is understood that these results present a possible contradiction, because while professionals understand the importance of ergonomics, they do not consider it in practice.

In the second part of the research, the survey of ergonomics subjects in engineering courses covered 212 subjects from 69 Brazilian federal universities. These were evaluated taking into account the content, workload and obligation. With the results, it was possible to identify that the ergonomics subject is not mandatory in 29.24% of the courses and is taught in a workload of less than 50 hours and in conjunction with other subjects in 33.81% of the courses. Another finding is that in none of the courses where the ergonomics subject is mandatory does the syllabus contain any evidence that the specialization domain “Organizational Ergonomics” is covered.

It is concluded based on the information provided by these universities that there is a gap in the teaching of ergonomics, which could impact the training of future production engineers. It is therefore recommended that this study be continued, including private universities, different means of accessing and checking data and the consideration of other variables that contribute to a better visualization of this reality.

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