

ANALYSIS OF THE APPLICATION OF THE PARTICIPATORY DESIGN ERGONOMICS METHOD IN A HOSPITAL UNIT

Cesar Augusto Pereira Denari

Universidade Federal de São Carlos
cesardenari@yahoo.com.br

Daniel Braatz

Universidade Federal de São Carlos
braatz@ufscar.br

Andréa Regina Martins Fontes

Universidade Federal de São Carlos Campus Sorocaba
afontes@ufscar.br

Esdras Paravizo

Universidade Federal de São Carlos
eparavizo@gmail.com

Renato Luvizoto Rodrigues de Souza

Universidade Federal do Triângulo Mineiro
rluvizoto@gmail.com

Summary

Most of the inadequacies at work are caused by the gap between the work project and the reality of the work situation. From the perspective of Activity Ergonomics, the worker must be the subject and not the object of work changes. This article aims to reflect on the applicability of the Participatory Method in Design Ergonomics based on its application in a hospital unit. The research is of an applied nature and has an exploratory nature, carrying out a case study. The results allowed us to verify that the application of the MPEC method helps to expand and detail information regarding the situation analyzed and promotes the involvement of workers in the stages of identifying possible problems and needs. The articulation of the tools proposed in the method allowed the construction of scenarios relevant to the needs of workers in the new environment to be designed. It is noteworthy that the application of the method led to the engagement of workers, reflection processes, and joint construction of requirements and solutions. It is concluded that the tools used in the method allowed the workers to make knowledge clear, resulting in the proposition of improvements aimed at a positive impact on operational performance and workers' health and safety.

Keywords: Work Project. Participatory Ergonomics. Activity Analysis. Simulation. Prototyping.

1. INTRODUCTION

A perspectiva da ergonomia da atividade visa compreender o trabalho de forma holística levando em conta aspectos físicos, cognitivos e organizacionais (IEA, 2020). A ergonomia encontra na interdisciplinaridade um de seus pilares, fazendo uso de conhecimentos produzidos em diversas áreas do saber (ABRAHÃO et al., 2005). A partir desta visão sistêmica, um processo participativo constituído de diferentes atores (usuários, gestores e ergonomistas) é uma das possibilidades de se desenvolver as análises e soluções de uma determinada situação de trabalho. Nesse contexto torna-se necessária a adoção de uma abordagem participativa, a qual possibilite a criação de um espaço de discussão e de construção de consensos, acordos e deliberações para o desenvolvimento da melhoria (BRAATZ et al., 2012).

Uma nova situação de trabalho, segundo Daniellou (2002), demandará que os conhecimentos produzidos na análise do trabalho sejam validados duplamente: tanto na construção técnica, baseada em métodos de análise da situação existente e avaliação das consequências sobre o trabalho futuro, quanto na construção social, a partir da criação de espaço que permite a confrontação de diferentes lógicas em torno da situação existente e proposição de melhorias, bem como negociação de soluções.

Todo ambiente ou artefato mobiliza durante sua concepção um conhecimento, uma representação, um modelo do funcionamento do usuário (Béguin, 2007). Diante da rápida necessidade de mudança, novos ambientes e artefatos de trabalho são desenvolvidos sem que haja um processo de compreensão e transformação eficaz. Nessas condições, muitos prejuízos podem acontecer, tais como: constrangimentos aos trabalhadores, desenvolvimento de doenças em decorrência do trabalho e até acidentes.

Diante deste contexto e utilizando a análise de uma situação real, o objetivo deste artigo é refletir sobre a aplicabilidade de um método participativo de ergonomia de concepção em uma unidade hospitalar de uma cidade do interior paulista.

2. THEORETICAL FOUNDATION

The theoretical foundation is divided into two stages. Initially, the terms ergonomics (including its domains) and participation are briefly defined. Next, a participatory method of design ergonomics is presented, which was used as a practical reference for the research.

2.1. Ergonomics and Participatory Design

The International Ergonomics Association (IEA, 2020) defines Ergonomics 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 the human well-being and overall system performance. Its concepts can contribute to the planning, design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with people's needs, abilities and limitations. Furthermore, the areas of ergonomics specialization can be highlighted (IEA, 2020, ABERGO, 2020):

- Physical Ergonomics studying the characteristics of human anatomy, anthropometry, physiology and biomechanics and their functions in physical activity, with man directing his efforts to adapt tools, weapons and utensils to his needs and characteristics;
- Cognitive Ergonomics, observing the operational movement of human beings' mental capabilities in work situations, mainly related to the intensive presence of computational systems and their reflections on man;
- Organizational Ergonomics, dealing with aspects related to the improvement of work and production systems, organizational structures, processes and administrative policies, based

on new work realities in view of technological advances and competitiveness (ABERGO, 2020).

Across the areas of ergonomics specialization, Dul et al. (2012) further reiterate that quality ergonomic interventions have three fundamental characteristics: they adopt a systemic approach, are design-oriented and focus on two related objectives – operational performance and stakeholder well-being.

Wisner (1987) states that the worker must be the subject of his own study and not its object. Workers must be considered as experts in their activities in the eyes of Ergonomics, as they know better than anyone else where and what problems exist (HENDRICK, 2008). Still for Hendrick (2008), dealing with participatory development means knowing that there will be dissemination of knowledge and expertise, using problem identification, document recording and group activities as tools.

The term participation refers to the process by which station workers contribute to management decisions that affect work through four stages: objectives; decision-making; problem solving; and planning and conducting organizational changes (SOUZA, 1994).

The sooner ergonomics is included in the project, the lower the obstacles of irreversible decisions and the greater the contributions due to the consideration of the different points of view of those involved in the design process (BÉGUIN; WEILL-FASSINA, 2002). Design is considered as a process of determining and gradually elaborating an artifact/work situation and the actions of the actors in the work process, so that there is coherence with the needs of the proposed solution and its use (BÉGUIN, 2007) .

2.2. Participatory design ergonomics method

The Participatory Method in Design Ergonomics (MPEC) presented by Braatz et al. (2019) is oriented towards the participation of different professionals to understand problems, develop innovative solutions, prioritize and direct design efforts, in addition to simulating and validating collectively constructed alternatives. Understanding the technical system, prescriptions and activities carried out, as well as the work project, must happen collaboratively, using a set of tools and techniques, which can be used individually, in small groups or with all participants. These practices aim to allow participants to experience different degrees and ways of participating in the project, ensuring that they are able to contribute to it, regardless of the degree of affinity, trust and communication personality.

The development of the MPEC method articulates three main theoretical references: i) the articles by Danish researcher Ole Broberg on participatory ergonomics, especially his studies on participatory ergonomics in design processes (BROBERG et al., 2011; BROBERG, 2008; BROBERG, 2007) ; ii) a doctoral thesis (BRAATZ, 2015) that investigates how ergonomics and design are interconnected in the Brazilian context and explores the uses of some means of simulation; and iii) the incorporation of two

participatory tools used by Brazilian companies - the Affinity Diagram (TAGUE, 2005) and an adapted version of the quality function deployment tool (AKAO; MAZUR, 2003). The application of MPEC articulates seven techniques, as can be seen in table 1.

Table 1. Techniques for applying MPEC (from Braatz et al., 2019)

Techniques	Objectives and Description
Activity Diagram	Promote knowledge sharing and collective reflection in the early stages of the project. The main expected results are: participant involvement, discovery of unconventional links between different issues and possible solutions and promotion of empathy among the team coordinator and other participants in the design project.

Photo Safari	Discover information (mainly images and short descriptions) from reference situations (internal or external). The coordinating team can organize visits by workers to the reference site, so that they can take photos of aspects related to operations, work organization, layout physique and equipment that they deem relevant for their own work.
Workbook	Conduct a survey of work-related information by the site's own workers. It is a compilation of images, drawings and even sketches of the area studied, organized to facilitate future notes by workers. Each worker receives a notebook, keeping it for a week to have time to make notes with blue or red pens (signaling with the colors positive and problematic situations).
Project Prioritization Matrix	The coordinating team must prepare a first draft of possible requirements based on the results of the other tools. From this, the objective of this technique is to prioritize the project requirements in conjunction with the participants.
Dream Job	Allow participants to collectively reflect, discuss and express their desires and expectations regarding possible improvements in their workplace. Participants are encouraged to disregard technical and/or financial constraints to discuss and explore possible solutions without preemptively dismissing them. Various configurations are possible for present the ideas and concepts generated, including sketches and drawings.
Simulations and prototypes	Test and carry out experiments with different project configurations, using physical or computational tools. Simulation of future situations is essential for workers to understand the impacts that the project will have on your activity.
Conceptual Design and CAD	It aims to ensure that the project result takes into account the various aspects discovered by the group during the project stages and facilitates understanding by those responsible for implementing the project (reducing the chance of re-interpretations or filling in possible gaps in the conceptual project). Computer-aided design tools (e.g. AutoCAD) are used to develop concepts that synthesize the results of the techniques previous scenarios into viable scenarios that can be discussed collectively.

The method provides for a certain sequencing, however it does not understand that the applications of different techniques and tools occur in a linear manner, on the contrary, some of these must occur in an interactive and iterative manner.

3. RESEARCH METHOD

This research is applied in nature and has an exploratory nature, as according to Gil (2002) the aim is to achieve greater familiarity with the topic of study. As a research method, the case study was adopted, which deals with a methodological procedure emphasizing contextual understandings, without forgetting representativeness, understanding the dynamics of the context in order to gather detailed and systematic information about a phenomenon (YIN, 2003).

The object of analysis was the Blood Center of a hospital in the interior of São Paulo. Furthermore, it is worth highlighting that this research is derived from an extension project, which could contribute to the service routines and operability of the sector in question. The work follows a qualitative approach and the case study was conducted according to the structure proposed by Miguel (2007) and using the tools and articulation proposed by MPEC (BRAATZ et al., 2019).

4. RESULTS AND DISCUSSION

In 2006, the transfusion agency of the health unit analyzed in this research began its activities, which involved receiving blood components collected and processed in another municipality. The following year, the project to implement the complete Hemotherapy Service

began.

Initially, the physical area was adapted and subsequently the staff was changed to continue the assembly of a Collection Unit. In 2008, there was a UCT - Collection and Transfusion Unit, enabling all blood collected by donation at the UCT to be sent daily to the Regional Blood Center to be processed and analyzed in the laboratory. Furthermore, the UCT now also has an outpatient clinic, where therapeutic bloodletting and transfusions are performed on patients who do not require hospitalization.

As activities progressed, the operation of the Hemotherapy Service enabled the implementation of three new laboratories; of Processing, Immunohematology and Serology, where the donated blood would be processed and undergo immunohematological and serological tests, there being, therefore, no need to send the blood collected here to another Institution.

Based on this growth, the unit establishes the "blood cycle", in which all blood is collected, processed, analyzed and released for transfusion into patients, thus allowing for logistics with greater agility in the capacity to serve patients in need of transfusion.

Currently, on average, 500 to 600 blood components are transfused per month, resulting from approximately 20 daily donations. It is worth mentioning that one of the Hemocentro's intentions is to increase the capacity to serve a greater number of donors, without placing a burden on the processes and donors in terms of the quality of care and processing of blood components.

The Blood Center has 13 employees, whose functions are: manager, nurses, doctor, nursing technician, biomedical technician, laboratory technician and customer service assistant. The population has an average age of 27.3 years (± 4.08) and is made up of 8 women. The average working time at the Blood Center for this population was 3.71 years (± 2.66) and in the current position it was 2.67 years (± 1.37). The results presented below were used to understand the applicability of a participatory method in a specific situation. It is noteworthy that the demand for the intervention arose from mutual interest between the health unit and a research group from a public university

in carrying out an extension project that had the potential to positively transform the work situation that was the object of study. The intervention took place over a period of 2 years.

For presentation and analysis of the results, it was decided to present them separately according to the proposed MPEC steps/techniques: Activity Diagram; PhotoSafari; Workbook; Project Prioritization Matrix; Dream Job; Simulations and prototypes; Conceptual design and CAD.

4.1. Activity Diagram

For this activity, all workers were invited to the first workshop and the results were analyzed in real time among everyone present (synchronous activity). Workers were instructed to write down problem situations on sticky notes and then apply them to cardboard. Furthermore, the organization of this information occurred by categorizing it as physical, cognitive or organizational issues.

– according to the ergonomics domains presented previously and synthetically explained to the participants.

The result of this technique generated information regarding activities, processes and critical situations such as: changing employees every twenty screenings and collections, system failures, issues related to the snack provided to donors, organization of material, excessive sorting on busy days, heat in sorting and reception, communication between system and worker, reducing pre-sorting activities would make service faster, purchase and delivery of materials, cleaning, structure and system that must be improved, faster service in campaigns, air conditioning of the sector pre-screening, structural problems of the building (especially the ceiling), chairs with problems, thermal comfort of the screening room, accessibility of the entrance door, exclusive access to the blood bank (indication of a solution), change of the management room (making a pre-screening room) and headaches from being in screening all the time.

The variety and level of depth of the questions raised allowed us to learn more about the situation analyzed from the perception of the workers themselves, with the main role of the analysts in facilitating the discussion. It was also possible to present the project, the team involved, the stages of the study and, in particular, the importance of everyone's participation in the process.

4.2 Photo-safari

Photo-safari was the second activity developed, the first being asynchronous. Thus, participants received instructions (including a deadline) to record in photos elements present in their day-to-day work that they considered to be decisive for their performance and well-being.

The application of the technique resulted in 26 different images from eight workers involved in the activity. Upon returning the images, it was possible to verify that the majority of those involved (6 workers) highlighted the conservation of equipment. The structure of the hospital unit and the comfort of donors were also highlighted in the images.

Again, the diversity of themes covered by the images and the voluntary participation of the majority of workers in an activity without the presence of researchers were considered positive results in relation to the method used.

4.3 Workbook

The third activity also had an asynchronous nature, but with greater preparation from the team of analysts/researchers. The layout of the Workbooks was based on images collected by the workers themselves in the previous stage (Photo-safari) and were later printed in A3 size and delivered one unit to each of the 8 workers who were working directly in the areas analyzed. All workers used the Workbook for 1 week, recording the problematic and/or positive situations that were experienced, related to the images in the Workbook. The notebooks were analyzed and a total of 50 records were verified in the 8 Workbooks available.

Subsequent analysis of the recorded notes indicated that 72% (n=36) of the recorded information was related to negative points. Regarding the positive points, despite constituting 28% (n=14) of the citations in the Workbook, these points were considered essentially the qualified team of professionals (57%), good service to donors (29%) and use of TV when possible for distraction and entertainment of donors (14%).

Analyzing the results obtained at this stage, the engagement of workers in an asynchronous activity and the diversity obtained from the comments made stand out again. It is also worth mentioning that, for the first time, this activity could be carried out in any space and time – and without the need for identification. This strategy was crucial for everyone to feel comfortable in pointing out positive and negative points with a greater level of sincerity, in the researchers' perception.

4.4 Project Prioritization Matrix

The fourth technique applied based on the MPEC method was a prioritization matrix diagram inspired by the QFD method that seeks to give users a voice. This stage is implemented in person and with all participants together. In preparation, the research team suggests an initial number of Work Requirements (determining elements for the work that were synthesized from the information highlighted in the previous steps) and Project Requirements (ways of changing the Work Requirements, e.g. structural adaptation, acquisition of equipment, etc.). Both requirements are discussed collectively to insert new ones and exclude/change proposals by researchers.

After consolidating the Work Requirements (considered as the “what” that are important) with the participants, a discussion is held about the priority of change for each one with scores ranging between 1 and 5. It was possible to observe that the maximum score

(5) was involved with the blood donor chair/armchair and the ventilation/air conditioning of the rooms, that is, the workers determined that for the process of designing a new space it is necessary to prioritize these two points. However, other points were highlighted as important in the evaluation of a new environment, which involved: space for sorting, space available for collection, space for snacks for employees and donors, new waiting beams and waiting time and space for donors of blood.

With the prioritization of Work Requirements, Project Requirements were discussed, that is, the “how” it is possible to change/improve the “whats”. After this definition, the co-relationship of the “hows” with the “whats” was made in terms of how much one impacts the other. With these steps completed, it was possible to prioritize the Project Requirements to achieve the Work Requirements.

The results achieved at this stage could be analyzed based on the prioritizations and discussions carried out, with emphasis on the reflection by everyone involved on how the needs and desires for change are more or less critical and how they could be carried out, including how feasible each was. type of change (for example, when it comes to a small renovation or maintenance or the acquisition of high-cost equipment). In terms of participation, it is noteworthy that there was an increase in the number of participants in this workshop in relation to the number of participants in the previous stages (on average there were 8 people involved and increased to 12 people).

4.5 Dream Job

Held in the same workshop as the Project Prioritization Matrix, the Dream Work distinguishes itself by dividing participants into smaller groups. This strategy is interesting to increase the possibility of everyone's collaboration since those present were asked to prepare an idealized conceptual proposal (and based on the discussions recently held) that involved physical (layout and equipment) and organizational changes in the work environment.

In this activity, workers received the floor plan of the two floors of the workspace to make notes regarding possible situations they faced in their normal day-to-day work.

The information and proposals generated were later compiled, with the majority (around 60%) of the notes being related to the flow of processes and people in the environment. The suggestions even involved a significant restructuring of the spaces, with changes to both the entrance and exit. In addition, the replacement of some sorting and management, reception and snack rooms were also suggested.

Aiming to record the process and the established line of reasoning, the researchers recorded video and audio explanations about the changes and suggestions relevant to each conceptual proposal developed separately by the groups. With this information, it was possible to detect new processes that included everything from receiving donors to faster and more organized service, especially on days when the number of donors exceeded the average.

As it is a stage that demands great proactivity from those involved and at the same time allows greater participation from them in the construction of effective solutions for ergonomic intervention, this was considered to be one of the most critical and important of the entire process. If the results of the applied tool were not satisfactory, in addition to compromising the next steps, it would cast doubt on the results of the previous steps.

However, it was possible to observe that the three groups formed developed different solutions and worked for around an hour to discuss, materialize and present the concept that they consider to be the “ideal working environment”.

4.6 Simulations and prototypes

The Simulations and Prototypes stage can be considered as the one with the lowest degree of prescription of the entire method used in this research. The decision of which techniques and tools to use and how participation will take place are choices made by the team developing the intervention and will depend substantially on their “toolbox”, that is, the techniques they master and can employ.

For this research, we chose to use the FlexSim Healthcare software to build a virtual model that represented possible scenarios based on the changes proposed in the previous steps.

It is noteworthy, therefore, that the preparation of the simulation model took place asynchronously by the researchers who relied especially on the “Project Prioritization Diagram” and “Dream Work” stages to produce the virtual model.

The information obtained during the workshops allowed simulations to be carried out, considering everything from the restructuring of spaces with changes in the access areas of the hospital unit, to the configuration of the reception, pre-sorting, screening, donation and snack rooms.

Due to changes in the management of the hospital unit and, subsequently, the end of the extension project, it was not possible to advance in the evolution and participatory validation of the simulation model. The initial planning provided for a specific workshop to present the simulations and discuss possible alternatives.

4.7 Conceptual design and CAD

Just like the previous stage, the construction phase of the Conceptual Project can be considered with a greater degree of possibility of adopting different tools. In this research, the conceptual project was generated in AutoCAD software and most of the workers' suggestions were considered to create the layout proposal, especially in the division of sectors and spaces (position of partitions).

This proposal portrayed the layout of the new environments based on the syntheses of the Work of Dreams activity and served as a basis for the simulations. Again, as in the simulation phase, it was not possible to advance in the construction and participatory validation of a detailed conceptual project (which could serve as support for a future executive reform project) and thus, the results of this stage could not be analyzed with the desired depth.

4.8 Summary of the discussion of results

The method as proposed could be applied in a real intervention and presented results that point to a high degree of participation. The method applied highlights the different characteristics of each workshop, technique and tool that were used. Such diversity allowed participants to have different ways and opportunities to express themselves.

Table 2 presents a summary of the applications of MPEC techniques and the main characteristics that allowed greater worker participation.

Despite the results obtained, it is important to highlight that from a certain point in the development of the study, holding meetings became impossible due to the difficulties in establishing compatible dates on which university researchers, management and staff would be available. of the unit. In part, this was due to an increase in the number of donors at the time, in addition to a reduction in staff. Therefore, it can be inferred that one of the main limitations to the applicability of the analyzed method is the need for a significant number of synchronous meetings with broad participation of workers.

Another point noted by the research and which also has to do with the relatively long duration of the project is the difficulty created by changes in management positions that occurred at least 3 times throughout the research. Such changes required

researchers make an additional effort to explain and convince the importance of the project and the possible benefits arising from a participatory process.

Table 2. Summary of the applications of MPEC techniques in the hospital unit

Techniques	Shape of Participation	Format Activity	Inputs/Resources	Outputs
Activity Diagram	Single group	In-person workshop, 2h	Brief explanation of objectives and office materials (post-it, mainly)	Table with important points raised and categorized by the participants
Photo Safari	Individual	Time and space defined by the participant (1 week for send photos)	Brief explanation of the purposes and use of personal cell phones	Photos with situations that workers consider decisive for your job
Workbook	Individual	Time and space defined by the participant (1 week to respond)	Notebook with simple instructions containing the main photos obtained with Photo Safari	Notebooks filled with comments highlighting positive and negative aspects
Project Prioritization Matrix	Single group	In-person workshop, 2h	Brief explanation of objectives, spreadsheet, multimedia projector	Spreadsheet with project requirements and prioritization aiming work transformation
Dream Job	Small groups	In-person workshop, 1.5 hours (held immediately after the previous one)	Brief explanation of objectives and office materials (blank A3 sheets with a floor plan of the space, mainly)	Proposals for uses of spaces and new ways of organizing work
Simulations and prototypes	Single group	In-person workshop, 2 hours (scheduled, but not carried out)	Brief explanation of the objectives, simulation model with different scenarios based on Dream Job, multimedia projector	Validation of scenarios and guidelines for new simulations
Conceptual Design and CAD	Single group	In-person workshop, 2 hours (scheduled, but not carried out)	Brief explanation of the objectives, conceptual and CAD design based on simulations and prototypes, multimedia projector	Validation of conceptual design or guidelines for new simulations/prototypes or new conceptual design

5. CONCLUSION

Based on the results obtained and discussed in the present research, it can be stated that the application of the MPEC method was able to cooperate both in gathering a large amount of information and in the wealth of details. The chaining of tools, with the purpose of concentrating the main information in the eyes of the workers, allowed a sequence to be adopted in order to build scenarios relevant to the workers' needs in the new environment to be designed.

With this, it is reinforced that the role of participatory tools is extremely important, as it allows workers' knowledge to be made explicit, implying the maintenance and improvement of their health and safety. It is also noteworthy that the various benefits highlighted in the literature in relation to participatory processes were also noticed throughout the research. The engagement of workers, the reflection processes and the joint construction of requirements and solutions were evident during the meetings.

Even the activities developed asynchronously, that is, without the presence of researchers and carried out at different times over a period, had significant participation and brought important information to the project.

The method proved to be efficient for the hospital unit and important for the development of future environments of the present study, however, it is essential that new studies be carried out in different sectors to demonstrate its applicability and efficiency.

Finally, it is highlighted that the structure used in this research is more than a collection of tools and techniques. Viewing the process as a whole and social construction during the project are fundamental to the success of participatory interventions. The different forms of participation - individually, in small groups, or with the whole group - allow participants to learn from each other by exchanging experiences, perceptions, needs and knowledge with each other.

The structure is clearly based on the theory of situated ergonomics, centered on the analysis of the activity, by understanding the aspects of work prescription, the variabilities present in workers' daily lives and the strategies developed by workers. It is also noteworthy that the method used also aims to create a space to encourage the development of workers.

Thus, it is believed that the MPEC is a great starting point from which professionals and researchers can equip themselves to carry out participatory projects that take into account the well-being, comfort, health and safety of workers, without disregarding the needs, desires and restrictions of the organization to which they are linked.

6. DISCLAIMER

The authors are solely responsible for the information included in this work and authorize the publication of this work on the ABERGO 2020 scientific dissemination channels. The XX ABERGO Proceedings will be licensed under a Creative Commons License.

7. REFERENCES

ABERGO - Associação Brasileira de Ergonomia. Disponível em: <http://www.abergo.org.br/internas.php?pg=o_que_e_ergonomia>. Acessado em 26 mar. 2020.

- Abrahão, J.I. et al., 1999. "Teoria e prática ergonômica: seus limites e possibilidades". Brasília: Editora Universidade de Brasília,
- Béguin, P., 2007. "O ergonomista, ator da concepção". In: FALZON, P. Ergonomia. Capítulo 22, São Paulo: Edgar Blücher.
- Béguin, P. e Weill-Fassina, A., 2002. "Da simulação das situações de trabalho à situação de simulação". In: Duarte, F(org.). *Ergonomia e projeto da indústria de processo contínuo*. Rio de Janeiro: Lucerna, p. 34-63.
- Braatz D., Paravizo E., Campos M.V.G., Mazzoni C.F. e Sirqueira C.A.G., 2019. "Developing a Framework for a Participatory Ergonomics Design Processes: The MPEC Method". In: Bagnara S., Tartaglia R., Albolino S., Alexander T., Fujita Y. (eds) *Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018)*. IEA 2018. Advances in Intelligent Systems and Computing, vol 824. Springer.
- Braatz, D. et al., 2012. "Simulação humana digital na concepção de postos de trabalho: estudo comparativo de casos". *Gestão & Produção*, v. 19, n.1, p. 79-92.
- Braatz, D., 2015. *Suportes de simulação como objetos intermediários para incorporação da perspectiva da atividade na concepção de situações produtivas*. 247 p. Tese (Doutorado em Engenharia de Produção) - Programa de Pós-Graduação em Engenharia de Produção, Universidade Federal de São Carlos, São Carlos.
- Broberg, O., 2008. "Quando o projeto participativo de espaços de trabalho se encontra com o projeto de engenharia em eventos de colaboração mútua". *Laboreal*, v. 4, n. 2, 47-58.
- Broberg, O., 2007. "Integrating ergonomics into engineering: Empirical evidence and implications for the ergonomists". *Human Factors and Ergonomics in Manufacturing*, 17, 353-366.
- Broberg, O., ANDERSEN, V. e SEIM, V., 2011. "Participatory ergonomics in design processes: The role of boundary objects". *Applied Ergonomics*, v. 42, p. 464-472.
- Daniellou, F., 2002. "Métodos em ergonomia de concepção: A análise de situações de referência e a simulação do trabalho". In: DUARTE, F. *Ergonomia e projeto na indústria de processo contínuo*. Rio de Janeiro: COPPE/RJ: Lucerna.
- Dul, J. et al., 2012. "A strategy for human factors/ergonomics: developing the discipline and profession". *Ergonomics*, v. 55, n. 4, p. 377-395, 2012.
- Hendrick, H.W., 2008. "Applying ergonomics to systems: Some documented "lessons learned". *Applied Ergonomics*, v. 39, p. 418-426.
- Miguel, P.A.C., 2007. "Estudo de Caso da Engenharia de Produção: Estruturação e Recomendações para sua Condução". *Produção*, São Paulo, v. 17, n. 1, p. 216-229.
- Souza, R.J., 1994. *Ergonomia no projeto de trabalho em organizações: o enfoque macroergonômico*. 124f. [Dissertação de mestrado]. Departamento de Engenharia de Produção da Federal de Santa Catarina, Florianópolis.
- Tague, N.R., 2005. "The Quality Toolbox", 2nd Ed. Milwaukee, Wisconsin.
- Wisner, A., 1987. "Por dentro do trabalho. Ergonomia: método & técnica". São Paulo, São Paulo.