



## ANALYSIS OF THE APPLICATION OF THE PARTICIPATORY METHOD OF ERGONOMICS OF CONCEPTION IN A HOSPITAL UNIT

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### Abstract

Many work inadequacies are caused by the gap between the work project and the reality of the work situation. From the perspective of Activity Ergonomics, the worker should 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 character, carrying out a case study. The results allowed us to verify that the application of the MPEC method helps in the expansion and detailing of 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 provided 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 explanation of knowledge by workers, implying in the proposition of improvements aiming at a positive impact on operational performance and on the health and safety of workers.

**Keywords:** Work Design. Participatory Ergonomics. Activity Analysis. Simulation. Prototyping.

### 1. INTRODUCTION

The perspective of the ergonomics of the activity aims to understand the work holistically, taking into account physical, cognitive, and organizational aspects (IEA, 2020). Ergonomics finds interdisciplinarity as one of its pillars, making use of knowledge produced in various areas of knowledge (ABRAHÃO et al., 2005). From this systemic view, a participatory process made up of different actors (users, managers and ergonomists) is one of the possibilities

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to develop analyses and solutions for a given work situation. In this context, it is necessary to adopt a participatory approach, which enables the creation of a space for discussion and the construction of consensus, agreements and deliberations for the development of improvement (BRAATZ et al., 2012).

A new work situation, according to Daniellou (2002), will demand that the knowledge produced in the analysis of the work be validated twice: both in the technical construction, based on methods of analysis of the existing situation and evaluation of the consequences on future work, and in the social construction, based on the creation of space that allows the confrontation of different logics around the existing situation and the proposition of improvements, as well as negotiation of solutions.

Every environment or artifact mobilizes during its conception a knowledge, a representation, a model of the user's functioning (Béguin, 2007). Faced with the rapid need for change, new work environments and artifacts are developed without an effective process of understanding and transformation. Under these conditions, many losses can happen, such as: embarrassment to workers, development of diseases as a result of work and even accidents.

In this context and using the analysis of a real situation, the objective of this article is to reflect on the applicability of a participatory method of design ergonomics in a hospital unit in a city in the interior of São Paulo.

## **2. THEORETICAL FOUNDATION**

The theoretical foundation is divided into two stages. Initially, the terms ergonomics (including their 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 Association of Ergonomics (IEA, 2020) defines Ergonomics as a scientific discipline related to understanding the interactions between humans and other elements or systems, and applying theories, principles, data, and methods to projects in order to optimize human well-being and the overall performance of the system. Its concepts can contribute to the planning, design, and evaluation of tasks, workstations, products, environments, and systems in order to make them compatible with people's needs, abilities, and limitations. In addition, the domains of specialization of ergonomics (IEA, 2020, ABERGO, 2020) can be highlighted:



- Physical Ergonomics studying the characteristics of human anatomy, anthropometry, physiology and biomechanics and their functions in physical activity, with man directing his efforts in adapting tools, weapons and utensils to his needs and characteristics;
- Cognitive Ergonomics, observing the operative movement of the mental capacities of the human being in work situations, being mainly related to the intensive presence of computer 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 domains of specialization of ergonomics, Dul et al. (2012) also reiterate that quality ergonomic interventions have three fundamental characteristics: they adopt a systemic approach, they are design-oriented, and they focus on two related objectives – operational performance and stakeholder well-being.

Wisner (1987) states that the worker should be the subject of his own study and not the object of it. Workers should be considered as specialists in their activities in the eyes of Ergonomics, because, better than anyone, they know where and what are the problems that exist (HENDRICK, 2008). Also for Hendrick (2008), dealing with participatory development is knowing that there will be a transmission of knowledge and expertise, having as tools the identification of the problem, documentary recording and group activities.

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

The sooner ergonomics is inserted in the project, the fewer the obstacles to the irreversibility of decisions and the greater the contributions by considering the different points of view of those involved in the design process (BÉGUIN; WEILL-FASSINA, 2002). Conception is considered as a process of determination and gradual elaboration of a work artifact/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 method of design ergonomics



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, and simulate and validate collectively constructed alternatives. The understanding of the technical system, prescriptions and activities carried out, as well as the design of the work, must happen collaboratively, using the 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, confidence and communication personality.

The development of the MPEC method articulates three main theoretical references: i) the articles of the 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 the MPEC articulates seven techniques, as can be seen in chart 1.

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

Techniques	Objectives and Description
<b>Activity Diagram</b>	Promote knowledge sharing and collective reflection in the early stages of the project. The main expected outcomes are: participant engagement, discovery of unconventional links between different issues and possible solutions, and promotion of empathy between the coordinating team and other design project participants.
<b>Photo Safari</b>	Discover information (especially 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 pictures of aspects related to operations, work organization, physical layout and equipment that they deem relevant to their own work.
<b>Workbook</b>	Conduct a survey of work-related information by the workers themselves. It is a compilation of images, drawings and even sketches of the area studied, organized in such a way as to facilitate future notes by the workers. Each worker receives a notebook, remaining with it for a period of one week to have time to carry out notes with blue or red pens (signaling positive and problematic situations with the colors).



<b>Project Prioritization Matrix</b>	<p>The coordinating team should prepare a first draft of the possible requirements based on the results of the other tools, based on this, the</p> <p>The purpose of this technique is to prioritize the design requirements together with the participants.</p>
<b>Dream Job</b>	<p>To enable participants to collectively reflect, discuss, and externalize their desires and expectations regarding potential improvements in their workplace. Participants are encouraged to disregard technical and/or financial constraints to discuss and explore possible solutions without preemptively ruling them out. Various configurations are possible to present the generated ideas and concepts, including sketches and drawings.</p>
<b>Simulations and prototypes</b>	<p>Test and experiment with the different configurations of the project, and may employ physical or computational tools. The simulation of future situations is essential for workers to understand the impacts that the project will have on their activity.</p>
<b>Conceptual Design and CAD</b>	<p>It aims to ensure that the result of the project takes into account the various aspects discovered by the group during the stages of the project and facilitates the understanding of those responsible for the implementation of the project (reducing the chance of reinterpretations or filling in possible gaps in the conceptual project).</p> <p>Computer-aided design tools (e.g. AutoCAD) are used</p> <p>for the development of concepts that synthesize the results of previous techniques into feasible scenarios that can be discussed collectively.</p>

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

### 3. RESEARCH METHOD

This research is of an applied nature and has an exploratory character, because according to Gil (2002) it aims at a greater familiarization with the theme 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. In addition, it is worth mentioning that this research is derived from an extension project, which was able to contribute to the routines of care 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 for the implementation of the complete Hemotherapy Service was started.

At first, an adjustment of the physical area was made and later the staff was changed to continue the assembly of a Collection Unit. In 2008, there was a UCT - Collection and Transfusion Unit, allowing all the blood collected by donation at the UCT to be sent daily to the Regional Blood Center to be processed and analyzed in the laboratory. In addition, the UCT also has an outpatient clinic, where therapeutic bleeding and transfusions are performed in patients who do not require hospitalization.

With the advancement of activities, the operation of the Hemotherapy Service made it possible to implement three new laboratories; Processing, Immunohematology and Serology, where the donated blood would be processed and undergoing immunohematological and serological tests, and there is 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 in patients, thus allowing logistics with greater agility in the capacity to care for patients who need transfusion.

Currently, on average, 500 to 600 blood components are transfused per month, from approximately 20 daily donations. It is worth mentioning that one of the intentions of the Blood Center is to increase the capacity to serve a larger number of donors, without placing a burden on the processes and donors regarding the quality of care and processing of blood components.

The Blood Center has 13 employees on its staff, whose functions are: manager, nurses, doctor, nursing technician, biomedical, laboratory technician and service assistant. The population has a mean age of 27.3 years ( $\pm 4.08$ ) and is made up of 8 women. The average length of work at the Blood Center in this population was 3.71 years ( $\pm 2.66$ ) and in the current position it was 2.67 years ( $\pm 1.37$ ). 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 the 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 the presentation and analysis of the results, it was decided to present separately according to the proposal of steps/techniques of the MPEC: Activity Diagram; Photo Safari; Workbook; Project Prioritization Matrix; Dream Work; 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 all those present (synchronous activity). The workers were instructed to write down problem situations on sticky notes and then apply them on a cardboard. In addition, the organization of this information occurred by categorizing it as physical, cognitive or organizational issues – according to the domains of ergonomics previously presented and explained synthetically to the participants.

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

The variety and level of depth of the questions raised allowed us to know more about the situation analyzed from the perception of the workers themselves, and the analysts had as their main role the facilitation of 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, being the first that had an asynchronous character. Thus, the participants received guidance (including a deadline) to record in photos elements present in the day-to-day work that they considered as determinants for their performance and well-being.

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

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

#### **4.3. Workbook**

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

The subsequent analysis of the recorded notes indicated that 72% (n=36) of the recorded information was related to negative points. Regarding the positive points, although they constituted 28% (n=14) of the mentions in the Workbook, these points were essentially considered 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 in this stage, the engagement of workers in an asynchronous activity and the diversity obtained from the comments made are highlighted 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 decisive for everyone to feel comfortable pointing out positive and negative points with a higher level of sincerity, in the perception of the researchers.



#### 4.4. Project prioritization matrix

The fourth technique applied based on the MPEC method was a matrix prioritization diagram inspired by the QFD method that seeks to give users a voice. The application of this stage takes place in a face-to-face format and with all participants jointly. As a preparation, the team of researchers suggests an initial number of Work Requirements (determining elements for the work that were synthesized from the information pointed out in the previous steps) and Project Requirements (ways to change the Work Requirements, e.g. structural adequacy, acquisition of equipment, etc.). Both requirements are discussed collectively for the insertion of new ones and the deletion/alteration of the proposals by the researchers.

After consolidating the Work Requirements (considered as the "whats" that are important) with the participants, a discussion is held about the priority of change of each one with grades ranging from 1 to 5. It was possible to observe that the maximum score (5) was involved with the blood donor's chair/armchair and for 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 pointed out as important in the evaluation of a new environment, which involved: space for screening, space available for collection, space for snacks for employees and donors, new waiting stringers and time and waiting space for blood donors.

With the prioritization of the Work Requirements, the Project Requirements were discussed, that is, the "how" it is possible to change/improve the "whats". After this definition, the "hows" and the "whats" were co-related 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 in this stage could be analyzed from the prioritizations and discussions carried out, with emphasis on the reflection by all those 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 type of change was (for example, when it comes to a small renovation or maintenance or the acquisition of high-cost equipment). In terms of adherence, 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 it increased to 12 people).

#### 4.5. Dream job



Held in the same workshop as the Project Prioritization Matrix, the Dream Work has the differential of dividing participants into smaller groups. Such a strategy is interesting to increase the possibility of collaboration for all, since those present were asked to elaborate an idealized conceptual proposal (and based on the discussions that had just taken place) that involved physical (layout and equipment) and organizational changes in the work environment.

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

The information and proposals generated were compiled later, and most (about 60%) of the notes were 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 rooms and management, reception and snack were also suggested.

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

Because it is a stage that demands great proactivity from those involved and at the same time allows for greater participation 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 engaged for about an hour to discuss, materialize and present the concept they consider to be the "ideal environment" of work.

#### **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 the present research. The decision of which techniques and tools to use and how participation will take place are choices of the team that develops the intervention and will depend substantially on its "toolbox", that is, on the techniques it masters and can employ.



For the present research, it was decided to use the FlexSim Healthcare software to build a virtual model that represented possible scenarios based on the changes proposed in the previous stages.

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 for the production of the virtual model.

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

Due to changes in the management of the hospital unit and, later, to 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 for the presentation of the simulations and discussion of possible alternatives.

#### **4.7. Conceptual design and CAD**

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

This proposal portrayed the arrangement of the new environments from the syntheses of the Dream Work 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 in the desired depth.

#### **4.8. Summary of the discussion of the results**

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



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

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

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

<b>Techniques</b>	<b>Participation Format</b>	<b>Activity Format</b>	<b>Inputs/Resources</b>	<b>Outputs</b>
<b>Activity Diagram</b>	Single group	Face-to-face workshop, 2h	Brief explanation of the objectives and office supplies (post-it, mainly)	Table with important points raised and categorized by the participants
<b>Photo Safari</b>	Individual	Participant-defined time and space (1 week to send the photos)	Brief explanation of the objectives and use of personal cell phones	Photos with situations that workers consider Determinants for your work
<b>Workbook</b>	Individual	Participant-defined time and space (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
<b>Project Prioritization Matrix</b>	Single group	Face-to-face workshop, 2h	Brief explanation of objectives, spreadsheet, multimedia projector	Spreadsheet with project requirements and prioritization aimed at transforming the work



<b><i>Dream Job</i></b>	Small groups	Face-to-face workshop, 1.5h (held right after the previous one)	Brief explanation of the objectives and office supplies (blank A3 sheets and with floor plan of the space, mainly)	Proposals for uses for spaces and new ways of organizing work
<b><i>Simulations and prototypes</i></b>	Single group	Face-to-face workshop, 2h (planned, but not held)	Brief explanation of the objectives, simulation model with different scenarios based on the Dream Work, multimedia projector	Validation of scenarios and guidelines for new simulations
<b><i>Conceptual Design and CAD</i></b>	Single group	Face-to-face workshop, 2h (planned, but not held)	Brief explanation of the objectives, conceptual design and CAD based on simulations and prototypes, multimedia projector	Validation of the conceptual design or guidelines for new simulations/prototypes or for new conceptual design

## 5. CONCLUSION

From the results obtained and discussed in the present research, it can be affirmed that the application of the MPEC method could cooperate both in the collection of a large amount of information and in the richness of details. The chaining of the 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 needs of the workers in the new environment to be designed.

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

Even the activities developed asynchronously, that is, without the presence of the 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 in 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. The vision of the process as a whole and the social construction during the project are fundamental for the success of participatory interventions. The different forms of participation – individually, in small groups, or with the full group – allow participants to learn from each other through the exchange of 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 the daily life of workers and the strategies developed by the workers. It is also noteworthy that the method used also aims to create a space to foster the development of workers.

Thus, it is believed that the MPEC is an excellent 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

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