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Ergonomic work analysis as an organizational analysis tool: a case study on Ergonomics teaching/learning practices in Production Engineering

Eliza H O Echternacht
eliza@dep.ufmg.br
Professora do Departamento de Engenharia de Produção – EEUFMG Coordenação LIPES- Laboratório de integração Produção e Saúde - DEP

Guilherme Henrique Barbosa dos Santos
sdb.guilherme@gmail.com
Graduando Engenharia de Produção - EEUFMG

Abstract: This article aims to reflect on the relevance of the Ergonomic Analysis of Work Activity method – AET (Portuguese abbreviation) in order to understand the organizational dynamics of production processes. It fall within the Ergonomics learning/teaching context of the Industrial Engineering undergraduate degree offered by the Federal University of Minas Gerais. Based upon a case study conducted by students of the Ergonomics discipline: Real Situations Study, in a snack bar/grocery store located in a neighborhood of Belo Horizonte, we will discuss didactic, methodological, and conceptual aspects that permeate the collective work as a research and intervention object in the area of industrial engineering.

1 - Introduction and Objectives

This article is part of the context of teaching/learning ergonomics in the undergraduate course in Production Engineering at UFMG. It aims to reflect on the relevance of the Ergonomic Work Analysis - AET method (Guerin et al, 1991; Wisner, 1990, 2004) for understanding the organizational dynamics of production processes, with human work at the core of this dynamic (De Tersac, G ; Maggi, B, 2004). This relevance is assumed given the potential for apprehension, made possible by the method, of the inseparable condition between the organizational aspects of production and the sense of adequacy of the instrumentality made available and accessible to operators to carry out tasks.

Specifically, we will start from a study1 carried out by a group of students of the Ergonomics discipline: Study of real situations2, chosen among others, for revealing in a privileged way the direction of the look at the collective dynamics of work and its derivatives in space, such as the layout and information flows.

This is a fundamental issue in the training of future production engineers, since the demands of current production contexts require the ability to analyze, in a systemic way, the relationships between organizational problems and their expressions in concrete operational conditions.

2 - The case study: context and methodological application

Students are guided during 1 academic semester (60h/class), plus 30h of field work, to apply the AET methodology (Guerin et al, 2001) in real production units, without restrictions in relation to the types of production processes, with the only requirement of access to the real work, through

interviews, conversations to collect verbalizations and validate data, in addition to general and systematic observations of the work. At the same time, the study of the method takes place, with references in Guerin et al (2001). In this case, the methodology applied strictly followed the following AET steps: (1) demand analysis, (2) analysis of production structures and the working population, (3) definition of focus and pre-diagnosis, (4) systematic analysis of work activity, (5) diagnosis and (6) validation and formulation of adequacy criteria.

The production unit is commercial, consisting of a cafeteria attached to a grocery store. It is located in a neighborhood of a metropolis, on an avenue with a large movement of cars and people, serving an average of 200 customers per day. It has a single owner and 12 employees.

2.1 - Demand analysis

The objective is to carry out the first observations and interviews in the production unit in question, looking for signs and symptoms relating to quality, health or safety problems, which can preferably be expressed through elements of the organization's performance. It is recommended to interview at least three different hierarchical levels of the company – including the operational level. In this company, there is currently no intermediate decision-making level between the owner and operators.

We started from the managerial demand – in this case, the owner's demand, comparing it with the operational point of view, obtained during three interviews carried out with four employees. Get oriented the faithful recording of the interviewees' speech, immediately after the visit and data collection.

The owner reports lack of motivation to manage the business, due to the stress of daily problems and the multiplicity of tasks that his role as owner/manager requires. These circumstances lead him to prioritize the tasks of purchasing products and inputs or executing payments, and to absent himself from the commercial management function. From an operational point of view, the interviews reveal the intensity and density of the work: memorization of orders, attention to customer behavior to avoid waiting, theft or default, details of the execution of multiple tasks, precarious instrumentality and frequent overtime. Confusion in taking orders, burning of snacks during frying, and difficulties in performing secondary tasks, such as controlling cash flow and replacing products. This is, in a first analysis, a demand for improvements in the organization's performance, aimed at reducing the overload and mental exhaustion that affect the owner and operators.

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[1] Ergonomic Analysis of Work in a cafeteria/grocery store carried out by Guilherme Santos, Jéssica Rangel, Camila Coelho, Daniel Mendes and Alessandro Melgaço from August to December 2015

[2] This subject has as a prerequisite the Ergonomics subject: 60 hours focused on the theoretical and conceptual contents of Ergonomics and the introduction to work analysis in real situations.

2.2 Analysis of the technical and organizational structures of production and the working population

It aims to describe the work process, from a technical and organizational point of view, and identify the main variables of the production system: working population, tasks, products, technical processes, means/instrumentality, contents and times of actual work. Semi-structured interviews with operators and general observations of real work situations were carried out at times of moderate customer movement, aiming for greater availability of operators to talk to students.

Three strong characteristics of the system are revealed: (1) Faced with the absence of a managerial figure and a specialized division of prescribed work, operators adopt operational strategies mediated by versatility and successive collective rearrangements. These are mutual adjustment schemes that provide agility in the process of dividing work in service and support tasks. (2) The precariousness of the working tools necessary for managing information involving multiple tasks, which results in difficulties in controlling customer orders, payments and theft, and replacing goods. (3) The layout: diversity of merchandise on display; diverse flows of people and goods; product and price information recorded by hand on vibrantly colored posters; the snack bar in the background; visual barriers to operators entering and exiting customers on site. A whole aesthetic typical of the “neighborhood commerce” of this metropolis.

The working population is aged between 18 and 35 years old, and is predominantly female. Working time in the unit is between 1 month and 2 years, the most experienced. Most people have completed secondary education. Salary range between R$900.00 and R$1100.00/month. Overtime is common.

2.3 - Focus definition and pre-diagnosis

Such elements drive the instruction of this demand against the understanding of the organizational conditions for the efficiency of operational regulations carried out through the mutual adjustment adopted by employees. The formulation of a pre-diagnosis seeks to synthesize the factors that modalize work and trigger effects on the operational methods and performance of the organization. It also guides the continuity of the study, as a basis for choosing the elements that will be subjected to forms of systematization to validate the diagnosis.

The guidance here directs the attention to the instrumentality made available to operators, especially related to the information flows necessary for the efficiency of the collective and for the physical layout, taking them as important factors for understanding the elements of overload that affect this working population.

2.4 - Systematic activity analysis

The choice of characteristic situations that will allow understanding the flows of information in the physical space in question considered face-to-face communication as the means of explaining the information necessary to trigger the operative sequences. These are aimed at customer service and other support tasks, maintaining stocks, organizing and cleaning the space, advertising merchandise and prices, etc. The guidance points to the cafeteria as a focus for systematized observation, given the complexity of the versatility required there: customer reception, interpretation and registration of orders, preparation of drinks and hot food, registration of consumption, calculation of price and payment and registration of payment .

The observations were planned at two times: a Monday during peak hours, between 5 pm and 7 pm, and a Saturday, between 2 pm and 4 pm. The positioning of the 4 student observers was organized as follows: 1 student focused on the diversity of customers, 2 students focused on the service trajectory of two operators, 1 student attentive to unforeseen events and atypical situations. The group's focus is on communications between operators and customers and

between operators.

2.4.1 - The diversity of customers and information flows

Customer flows relate to their goals: at the cafeteria, at the grocery store, or both. Hence the diversity of information flows necessary for service, especially in payment, before or after the purchase.

Customers	On Monday	On Saturday
Bought snack bar products	59	40
Bought grocery products	4	18
Product was stolen	1	1
They gave up on the purchase	1	1
Paid in advance	25	8
They paid later	40	42
Total	**65**	**60**

The table above quantifies these elements: Customer demands differ during peak hours, Monday and Saturday. In the latter, there was a 32% reduction in the number of cafeteria customers and a 450% increase in grocery store customers, compared to peak hours. This data impacts, on Saturday, the greater proportion of customers who paid after purchasing products. During the observations, two scenes of merchandise theft were witnessed (which went unnoticed by the operators) and two dropouts, due to the queues.

2.4.2 - Customer order information in the cafeteria and its capture by operators

The following situations show the difficulties in interpreting orders and the potential errors that can occur resulting in rework. The information is recorded in the operators' memory and its flow depends exclusively on oral communication and hearing in a noisy environment.

Situation 1: An employee who receives the customer shouts twice: “Three pizzas, one cheese and one meat”. Another employee listens and repeats it to whoever is frying the pastries. The employee who fries the pastries confirms the order with the person serving, repeating three more times without them hearing: “Three pizzas, one cheese and one meat?” It was necessary for the customer waiting for the pastries to shout: “I ordered three pizzas, one cheese and one meat!” When the person responsible for frying was replaced, it was necessary for the former person responsible to communicate all the orders recorded in memory. The ready order is communicated to the customer by saying – “Meat out!”. Sometimes the product remains on the counter.

Situation 2: A bottle of “mate-leather” was ordered. The cashier gave the order for the bottle to be picked up, but the order was interpreted as “coconut water”. If it weren't for the interference of the customer who understood and corrected the error, there would be a waste of a product and a longer wait for the customer for the order, due to rework. A few minutes after delivering the order, the cashier remembered to ask: “Excuse me, did I give you the note?” The “note”, which was a simple note of the order, was then delivered, but not used.

2.4.3 - The layout

The observations allow us to see the diversity of customer flows in the current layout, which makes it difficult for operators to control customers leaving without payment and facilitates this behavior for some customers. It is the operators' task to organize, check and replace the merchandise on display, in addition to preventing possible theft. However, the current physical

arrangement does not facilitate the visualization of the area where the goods are located and the people entering and leaving the establishment, a fundamental condition for preventing theft and defaults.

2.4.4 - Mutual adjustments

Operators adjust each other through speech, gestures and, mainly, shouts. Communications aim to share information relevant to the development of the work itself, such as customer requests - quantity and type of food to be prepared, and the division of tasks that occurs successively throughout the service. The most common tasks in the cafeteria are frying snacks, grinding sugarcane, preparing natural juices and smoothies, cleaning the environment and utensils and delivering snacks promptly.

The way in which the work will be carried out and who will carry it out is defined by the operators themselves, prioritizing customer service, as prescribed. In this context, mutual adjustment schemes arise regarding: (1) who will serve the customer; (2) what task each employee will perform; (3) how the working day will be changed depending on the circumstances. Thus, when the customer enters the premises, the employee who is not in direct service (it is likely that they are carrying out hygiene activities) is assigned to assist them through an alert expressed by any co-worker who has noticed the customer and operator availability. It is common for an operator who serves a customer who wants pastries, for example, to delegate this task to another operator who is already frying at the request of another customer. This process works harmoniously, as do time adjustments for meals, overtime and periods off and vacations, depending on the movement of customers and individual needs.

2.5 - Diagnosis

The precariousness or absence of instruments to aid immediate memory and for face-to-face communication between multipurpose operators involved in multiple tasks (1), and the absence of layout criteria that facilitate control of the flow of people and information in the physical space (2) they modalize operational modes dependent on immediate memory, permanent attention and orality, which increases the density of the work (Wisner, 1993). This leads to errors in interpreting orders, rework, food waste (burnt pastries, for example), unnoticed theft and defaults, difficulties in recording information about product output, with all the potential consequences for worse performance in this trade.

Individual operating modes are integrated into collective arrangements based on mutual adjustment schemes that provide, at the same time, efficiency in configuring the collective's competencies and densification of work with its potential consequences for workers' health.

2.6 - Validation and formulation of ergonomic adequacy criteria

In view of the objectives of this article, we will not dwell on the details of the ergonomic propositions developed. It is important to note here that the ergonomic adequacy criteria presuppose collective arrangements for the self-management of work and the mutual adjustments developed there by the operators, which implies projects to design an instrument that helps collective performance and reduces the density of work.

3 - Discussion

3.1 - The teaching/learning contexts: the didactic content inherent to the case study

From a didactic point of view, the case studied can be considered a kind of typical case, in the sense of its low technical complexity, which tends to highlight the work and ways of working that are configured in daily production, providing in a way The focus of the ergonomist in training on the collective dynamics of work is privileged. In this sense, the unique stance of the company's

owner/manager also contributes, who prefers to abstain from his regulatory managerial condition and claim operational management and the skills inherent to it, without, however, providing the necessary instrumentality for the demands of the work, compatible with expected performance.

The case studied also provides a series of conceptual exercises, because it exemplifies concepts already stabilized in the field of ergonomics and notions in interdisciplinary development, such as the notion of versatility and the collective's options for versatility, in this case.
The uniqueness of the case raises theoretical questions that relate face-to-face communication and space (Benchekroun, 2000), work density and work cognition (Wisner, A., 1993), collective regulations (Simões et al., 2012) and vertical and horizontal management of the system (De la Garza et Weill-Fassina, 2000), communication and structuring of collectives (Lacoste, 2000), collective competencies and regulations (Leplat et Montmollin, 2001) which, among several other issues, are relevant and pertinent to understanding the organizational aspects of production systems and can be viewed in real production situations in the daily life of this cafeteria/grocery store.

3.2 - The direction of the observer's gaze towards the collective dynamics of work and the apprehension of the organizational contents of production

Ergonomic Work Analysis – AET allows the ergonomist to create a chain of options that direct the view on real work, in different modeling options. Such options for modeling real work can meet the specialties of ergonomics in their physical and/or cognitive and/or organizational aspects. Studies of real productive situations and their current demands often require us to understand the integration between these aspects. Directing our attention to the organizational dimension of production and the work situations created there allows us to find meanings of physical and cognitive adequacy compatible with operational regulations. Regulations aimed at developing the necessary skills in specific production contexts with their unique organizational configurations

On the other hand, the option for modeling the organizational configurations of productive situations presupposes choice criteria and values associated with them (Schwartz, Y., 2004). The predominant values here are those that allow recognizing the operators' skills beyond the work prescriptions, that is, recognizing the engagement of real work as a human activity that shares means of work and also values that support the operators' skills. This is perhaps the greatest challenge of the ergonomics teaching/learning process, given the hegemony of a prescriptive view of work.

4- Conclusion

The case study presented allows us to reflect on the potential of Ergonomic Work Analysis as a teaching tool that allows students to verify the inseparable condition between the organizational aspects of production and the sense of adequacy of the instrumentality made available and accessible to operators to carry out tasks, here especially focused on information flows and layout.
This also leads to the realization of the necessary interdisciplinarity between two areas of study, Ergonomics and Work Organization, a condition for treating collective work as an object of research and intervention in the context of production engineering.

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