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Variability management: A still to be noticed role of workers

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ABSTRACT: Despite the efforts in reducing or eliminating variability, it is possible to assume that it remains as an inherent aspect in any production system. Activity-centered Ergonomic analyses have been showing the importance of operating strategies to deal with variability found in organisations and to accomplish the production goals. The aim of this paper is to show the relevance of variability situations in the analyzed context. It also aims to demonstrate that the role of workers in dealing with such situations is not recognized inside the organisation, not even by the workers themselves. The research was based on action research strategy, and the main method applied was the Ergonomic Analysis of Wok Activity. It was conducted in a manufacturing company, part of the automotive chain.

1 INTRODUCTION

Variation is an inherent characteristic of any system. According to Fujita (2006, p.19) "no system (i.e., combination of artifact and humans) can avoid changes". He states: "changes occur continuously throughout a system's lifetime ... this should be regarded as a destiny" (Fujita 2006, p.19).

Considering organisations as socio-technical systems, it is possible to argue that changes in organisations can be originated from humans and from its artifacts. Regarding the former, the diversity and variation among individuals is well known—the inter-individual diversity. In addition, it is possible to consider intra-individual variability, due to short-term variation, such as circadian cycles, or for example, variations because of aging. Considering the technical components of organisations, it is possible to identify many sources of variation: differences among products and services, machines and equipment, differences in materials from different suppliers, differences in production goals and their executing conditions.

Guérin et al. (2007, p.78) classify the variability in companies in two major categories: (i) normal variability, that is expected to be found due to the type of work performed, e.g., differences between taxi journeys, the different requests of clients, different products on a same production line, and so on; (ii) incidental variability, such as a poorly finished part or component which cannot be assembled, a tool that breaks, or a file missing data.

Management techniques and technological improvements have been developed to eliminate or minimize variation in organisational settings. They aim to keep the processes stable and consistently operating at the target level of performance with only normal variation. Some examples of such efforts are statistical process control methods, quality tools and automation investments. Obviously, the impacts of such efforts in improving the efficiency and performance of the systems cannot be ignored.

However, some may argue that such efforts are useful when dealing with part of variability that can be foreseen, and therefore controlled. According to Guérin et al. (2007), there is another type of variability that has a random aspect, and therefore, cannot be predicted and completely eliminated. This reinforces the assumption that variability is an intrinsic aspect of any system.

Some pertinent questions emerge from this assumption: If variation cannot be completely eliminated from organisations, i.e., there is always residual variability in a system, who is responsible for dealing with it? And how is this usually done?

Activity-centered ergonomic studies have been demonstrating that usually the workers of the operating staff, also called operators, are those responsible for dealing with variability. Some analyses have highlighted how workers deal with variations in the production processes, developing alternative behaviors, the so-called "operating strategies". Some authors advocate that without the operators' role, the production goals would not be accomplished (Garrigou et al. 1995). However, this is not easily recognized by managers or well integrated within the formal structure of organisations, and it is still

common to find managers or other staff members that view operators as mere "procedure followers".

Recent studies in Resilience Engineering (Trotter et al. 2013, Reiman 2011) have demonstrated an increasing interest in such strategies, which have been treated as "improvisations". The central idea of this conceptual framework is that the development of these behaviors is not only a source of risk and violation, but also can have a positive influence in human performance. However, the positive aspects of improvisation have not been tipically investigated.

The goal of this paper is to show the relevance of variability situations encountered in the analyzed context. It also aims to demonstrate that the role of workers in dealing with such situations is not recognized inside the organisation, sometimes not even by the workers themselves.

2 CASE CONTEXT

The variability situations were collected from research conducted in a manufacturing company, part of the automotive chain. The study focused on the calendering process, an intermediate process that produces continuous sheets from rubber compounds incorporated with reinforcing materials such as textile fabrics or wire cords. The calendering process is an important step in the production of tires, because the quality of the sheets is critical to tire performance. In this factory, eleven different products, divided in two types, according to the reinforcing material used are produced in the calendaring process.

The calendering machine, a calender, is a heavy-duty machine equipped with three or more chromeplated steel rolls, which revolve in opposite directions, at specific speeds (Rodgers & Waddell 2005). Beyond the steel rolls, other accessory equipment ensure the production process: let-off stations and creel rooms for unwinding the reinforcing materials; extruders, heating and feeding mills for preparing the rubber compound; accumulators for avoiding machine slowdown; heating and cooling drums; tension controllers and so on. A number of measurement and control systems guarantee the quality of the final sheets.

The overall equipment, including the accessory systems, measures around 84 meters in length, 16 meters wide and 8 meters high. It weighs 150 tons., consumes about 395 kW/h and produces more than 50,000 meters of material/day.

Calendering production follows a 24/7 schedule, requiring 5 work shifts. Each calendering work shift is formed by 6 machine workers. The work in the calendar is divided among the operators, who are allocated in 5 different areas of the equipment. Of all the operators that work on the machine, 25 are company employees, and around 4 are outsourced workers.

3 METHODS

The variability situations were identified in the context of an ergonomic intervention, which was based on an action-research strategy (Stringer 2007). The intervention consisted of two phases, in accordance with the Future Work Activity method (Daniellou & Garrigou 2002). The first phase aimed at characterizing reference situations and the Ergonomic Analysis of Work Activity (Guérin et al. 2007) was the main method applied.

Field studies enabled the research party to familiarize itself with the technical process, progressively gaining the workers trust (De Keyser 1992). They also assisted in mapping the workers activities, including their actions and their visualization and communication needs (Wisner 1987). This phase also included the identification of problems experienced by the workers and the risks involved in the work setting.

Data were collected through systematic observation of the work activities and the machine routines. Open and semi-structured interviews, spontaneous and concurrent verbalizations were also used as data-collection techniques. Data collection also included the analysis of the relevant documents available, such as company specs, work instructions and safety procedures.

When the variability situations were occurring, data were being recorded in real-time: the place and the time of the occurrence, the number of workers involved in the situation and the actions performed by each one, the communications established among them, and so on. Later, the workers were questioned about what they had done, why they had carried out such actions, the frequency of the specific occurrence or similar situations, etc. All data were recorded in a logbook.

The field research lasted for seven months, comprised between November 2010 and June of 2011. It took around 41 data-collecting days, each day consisting of approximately 6 hours of direct contact with the machine operators. As the company works in rotative shifts, all the shift groups were involved in the research. In order to include the weekend shifts, data collecting was also performed during weekends.

4 RESULTS

Although variability situations were expected to be found from the beginning of the research, they proved to be of great importance in the analyzed context. They were observed throughout all the data collection days and happened in every work shift. Table 1 presents the overall data from such situations.

Table 1. Variability situations occurrence.

Variability situations observed	146 situations
Data collection days	41 days
Variability situations/day	Min. 1, Ave. 3.6, Max. 8
Hours of data collection*	200 hours
Frequency of occurrence	43,8 min
Percentage of occurrences during the set-up or start-up	24,7%

*approximately.

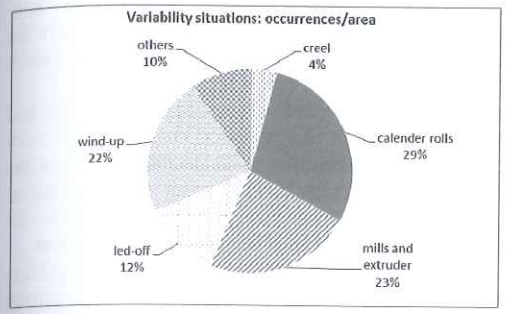

Figure 1. Areas of occurrence.

The situations were caused by a wide range of sources: changes in raw materials, breakdown of accessory equipment, and unexpected machine errors that resulted in a complete stop of the machine. The results presented in Figure 1 show that variability situations also occurred in all of the different areas of the machine.

5 DISCUSSION

The number of variability situations observed demonstrates their relevance in the analyzed context. However, a deeper analysis of such situations reveals the importance of the role of the workers in dealing with them.

The strategies developed by the operators to deal with the variability situations were of paramount importance to return the calendering process to a controlled condition, and accomplish the production goals. Such strategies aimed, in some cases, to anticipate and avoid future problems in the process. In other cases, they aimed at correcting an incident or a deviation that was not noticed in advance and restoring the production process to a normal condition. It is important to highlight the fact that such strategies were developed individually and also collectively.

5.1 *The recognition of the worker as a variability manager*

The role of the workers in dealing with the variability situations was not noticed in the organisation at the time of this research. This lack of recognition was found in different staff members, from different hierarchical levels, and was also found among the workers.

When describing the calendering process and the work performed on it, workers representations are similar to the stages described in the company procedures. According to them, the calendering process is composed by two stages: first, the set-up of the machine and start-up; and second, the stage of process controlling.

The importance of the set-up between two product types and the machine start-up was clear and well-known. This phase is considered the most critical in the process. However, the phase of process control was considered as valueless. A verbalization demonstrates the difference between the representations of the workers regarding both stages:

> *"the hardest part is the machine start-up, feeding more or less rubber in, also changing the fabric and rubber ... after, it is all rolling ... you only have to control it, nothing else ..."*

The idea about the differences in the work performed in each phase of the calendaring was also highlighted by one supervisor. He stated when passing close to the machine:

> *"so much is done there, then they just do nothing"*

However, as shown in Table 1, less than a quarter of the total number of variability situations observed occurred during the set-up of product type or start-up of the machine. More than 75% of the situations observed occurred during process control phase of the calendering.

5.2 *The process control phase as variability management*

At first sight, the workers discourse seems to undervalue the need of dealing with variations during their work. This is even more evident when referring to the process control stage. However, during the development of the research, this role was observed. When recording the situations and questioning about the occurrence of variability situations, the importance of workers' role in

managing the process variables was revealed. One of the workers' statements shows the existence of variations in the process:

"if nothing fails, that is all ... but as things fail ..."

Another worker stated:

"there are a lot of annoying tasks to do because it is not perfect ..."

The evidence of the random aspect of the variations can be observed in two verbalizations from two different workers. One operator stated:

"these kind of things happen"

However, another one stated:

"there are things that don't happen every day ..."

5.3 *Differences among the workers when managing variability*

Another important aspect revealed by the workers, was the difference among their individual strategies to deal with the variability situations. Some of the verbalizations demonstrate this aspect:

"each one works in his own way"
"each one has a specific timing for doing things ... but everything must go well ... there are lots of tricks, I don't even know all of them, and I have been working here for 4 years already ..."

5.4 *Some considerations about the research methods*

Despite the effort in quantifying the number and frequency of the variability situations, it is possible to infer that they are much less than the total number of situations experienced by the calendar operators in their everyday work. This is because of the limitations in the methods used in the research, which was based on direct observation and was conducted by only one researcher.

The dimensions of the machine and the division of the tasks among the operators cannot be ignored as data collection constraints. The more complex variability situations were easier to identify and therefore enter the data collection. This is because in such cases, more workers were involved and a greater need of communication arose among them.

However, it was possible to observe that many situations were solved by one of the workers without even being noticed by others. In such cases, it was a matter of luck for the researcher to have been close to the operator in order to be able to identify and understand why the situation occurred and then discuss it with him.

6 CONCLUSIONS

Variability can be considered as an inherent characteristic of any industrial setting. However, it is even more prevalent than is usually acknowledged (Garrigou et al. 1995).

Activity-centered ergonomic studies have been pointing that the management of variability situations by workers has paramount importance for achieving production goals. However, this role is not always acknowledged in organisations.

This paper reveals that variability situations had great relevance in the analyzed context. It also evidences the fact that there was no recognition of the role of the workers in managing such variations. This lack of recognition was found inside the organisation, including the workers themselves.

The recognition of the workers as variability managers can be a first step towards recognizing that work is not only following procedures, but also dealing with a great number of variables For sure, such acknowledgement can help in putting light on the importance of workers in accomplishing production goals, and in the development of more efficient risk management techniques.

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