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ERGONOMICS PROVIDING HUMAN RELIABILITY IN AN OIL REFINERY

FÁBIO MORAIS BORGES
Email: fabiomoraisb@ct.ufpb.br
Universidade Federal da Paraíba

NILTON LUIZ MENEGON
Email: menegon@dep.ufscar.br
Universidade Federal de São Carlos

SUMMARY
The role of humans in the maintenance and recovery of production systems is an increasingly constant subject in research and studies related to complex systems projects. Using data obtained in doctoral research, the article aims to provide elements that present how Ergonomics can promote Human Reliability in an Oil refinery in Brazil.

INTRODUCTION

Studies and research in areas such as Organizational Psychology, Sociology of work and Ergonomics itself have brought to light the importance of considering the worker as a fundamental actor in any production process. This has highlighted a field of study with growing importance within Organizations, Human Reliability. The human being with all his characteristics and particularities, guaranteeing Operational Reliability. In this way, the idea that the normality of the system is due exclusively to devices, machines, computers, sensors, in short, to Technical Reliability, is expanded. The human factor gains notoriety and is no longer seen as a weak link in the system.

As Pomian, Pradère and Gaillard (1997 apud Duarte, 2002) state: "the operational reliability of the system is compromised when the savoir-faire and innovation potential that production people have acquired over time in service is disregarded". Human Reliability is therefore disregarded. Maintaining a system in normal operation is related to the performance of technical and human components in dealing with system abnormalities. The possibility of recovering from these abnormalities is what dictates the degree of Operational Reliability. According to Leplat and Terssac (1990): "the operational reliability of a system is reduced not only by the occurrence of technical failures or human errors, but also by the impossibility of recovering them". It is necessary to eliminate the strict concept of human error. And thus, understand a conceptual axis, presented by Schwartz (2004), which defends the inconstancies of the human factor as a consequence of the rigidity of the anticipation system.

When moving to complex systems, this discussion gains more importance. The constant analysis of work situations in an Oil Refinery reveals that at all times, operators respond to variations in production or its condition through strategies and actions, with the aim that the functioning of the system is maintained within a normal state. This is where the point of view of

Ergonomics underlies the ideas of Human Reliability. Intra and interpersonal variability is necessary and must be reversed in ways of adapting the distance between what is prescribed and what is carried out. But to what extent can Ergonomics – especially activity – contribute to Human Reliability? This article seeks to present support to confirm whether Ergonomics could favor Human Reliability in a complex and dynamic system such as a Refinery.

THEORETICAL REFERENCE

Human Reliability

Dealing with Human Reliability is not such a new subject. Several studies have already raised questions related to the human factor, its role, characteristics and perspectives in production systems (FADIER, 1996; LELLES, PEETERS and DUARTE, 2001; BUBB, 2005; FAYE, 2007; ROCHA et al., 2016). And given the

importance of in-depth knowledge about the risks present within an industrial system, the role that workers have is gaining notoriety, as practical experts of the system in which they work in order to identify and correct deviations in the system before it collapses. More than a point of congruence between physical, cognitive, cultural factors, hierarchical pressures and several others, the human being is, in his work, a source of decisions, an eminent vector of reliability, managing the variability, intrinsic to any system of production in order to maintain or recover its stability.

One of the most complete and widely used definitions is the one contained in the Technical Prevention Standard (NTP-360) of the Centro Nacional de Condiciones de Trabajo (CNCT), in Spain. It defines Human Reliability as the "body of knowledge that refers to the prognosis, analysis and reduction of human error, focusing on the role of the person in the design, maintenance, use and management operations of a socio-technical system" (SPAIN, [199-]). The term can be found in other research and bibliographic materials and used by other authors in different ways. As the probability of succeeding in an action (SWAIN and GUTTMAN, 1983; PARK, 1987) or successful completion of a mission (ROOK, 1962; NICOLET and CELLIER, 1985).

The perception that human beings have of the system's conditions, aided by their own senses (hearing, smell, touch and vision), enables them to construct an effective representation of the real state of the system, something unavailable in technical systems. And that is directly proportional to the experience he acquires through the practice of work, what ergonomics calls savoir-faire (FALZON, 1994; REUZEAU, 2000; BELLIÈS, 2002). It can thus be said, paraphrasing Norman (2006), that behavior is determined by the combination of information in the head with that in the world. It uses characteristics typical of human beings, such as anticipation, adaptation – something difficult for technical systems – prediction and the ability to learn to deal with the most diverse variations during its work. "The activity of operators does not translate, therefore, into mere surveillance of the installations: they constantly anticipate malfunctions and use strategies to restore process stability" (DUARTE, 2002).

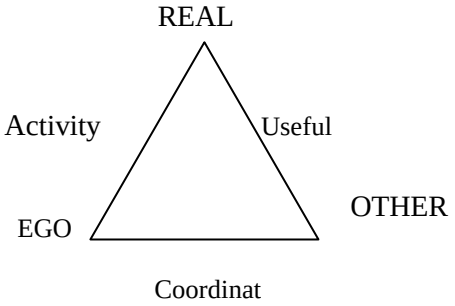
Activity

Within the sphere of work, the activity represents the center of congruence of the different logics involved. The worker has to manage personal, collective and company objectives. All this within an environment that is often not favorable to this management. Although you can count on the work collective, each person perceives the situation differently, which leads to different ways of acting and solutions to problems with the same characteristics. This characteristic of the human being is called

signification by Vygotsky and refers to “what things mean”. “Nothing has significance by itself, nor do they mean the same thing to different individuals; meaning is socially and historically produced” (ZANELLA, 2001). Activity is, therefore, always “performed and experienced in a unique, personalized and differentiated way and marks the distance between what is prescribed and what is actually carried out” (BORGES, 2004). Thus, the activity, according to Leplat (2000), is a coupling between task and worker.

Mauss apud Dejours (2005) expands this vision and illustrates this concept in Figure 1. For him, work will always be inscribed under the judgment of its social usefulness. The social utility of work implies the need for coordination. And subjects interact within a division of labor. It follows that the activity will always be conditioned by prescriptions that integrate it into a set of other interrelated prescriptions.

Figure 1 – Working concept



Source: Mauss apud Dejours, 2005

The activity must, therefore, be thought of as an element of mediation between the worker and their work environment, directly or indirectly through artifacts. And, in this sense, the interaction is bilateral.

METHOD

Starting from initial research that sought to design projects to adapt production situations in an Oil Refinery, it was noticed that a large part of the inconsistencies that existed between what was prescribed or requested from operators and the actual work situation were circumvented by them by through actions that demanded skill and knowledge originating, in principle, from empiricism. There was, therefore, a need to categorize these actions, study them in more depth and understand how the Ergonomist could incorporate these actions in projects related to the demands presented by the Company or raised by analysts.

A photographic record was then made with more than 2,000 photographs and footage that took more than 25 hours of recording. All material was carefully analyzed in order to obtain elements that characterized maintenance or system recovery actions by operators.

This article presents only some discussions generated from the analysis of these data, the result of a doctoral thesis. Therefore, the methods used in the analysis of this data, the sequence, the cases in which elements of Human Reliability can be perceived will not be presented, as they are not the focus of the article.

The discussion below aims to answer the initial question of having Ergonomics as an element to promote Human Reliability in an Oil Refinery.

RESULTS

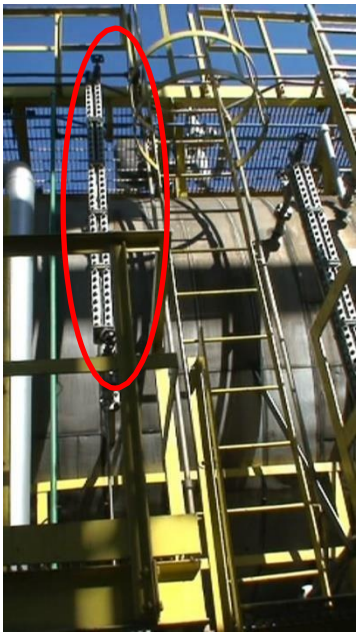
The possibilities of Ergonomics favoring Human Reliability in a Refinery are complete. The performance of human beings, in a production system, is related to the possibilities of carrying out their task with as few constraints as possible and making the most of their competence. Maintaining a wide regulation space also makes it easier to correct problems that lead to operational instability. All of this can be achieved through ergonomic action. The availability of elements that help the operator to be a factor in system reliability is a consequence of good analysis and effective design from the point of view of meeting the needs of the task.

From analyzes of work situations carried out at the Refinery, which focused on ergonomic action, it was possible to obtain, just by slightly varying the focus of observation, a series of examples of Resilience actions – human beings reestablishing the normality of the system – carried out by operators, in which they use their experience and their ability to anticipate and predict. These are situations that present:

 Insufficiency or even absence of information, resulting in difficulty in representing the current state of the system;

As this is a very common type of situation in the Refinery, an example is presented. A pressure vessel level gauge of the Unit (Figure 2) is located at a high height, without adequate access to it. To read the vessel level, the operator has to climb onto a guardrail, holding on to ducts and equipment (Figure 3). And even so, due to these conditions, it becomes difficult to perform an effective reading. The Meter exists, but that is not enough. The possibility of obtaining information correctly and without exposing operators to the risk of accidents must be part of the package of appropriate conditions for Human Reliability to be guaranteed.

Figure 2 – Pressure vessel level gauge



Source: Author himself

Figure 3 – Operator reading the Meter

Source: Author himself

 Projects that hinder or impede the Resilience actions of

operators;
 Multiple factors that lead machines and equipment to operate incorrectly inadequate;
 In addition to optimization strategies, used by operators to confirm and assess the accuracy of the information provided by the system (equipment, sensors, monitors, etc.).

Although it is a method already widespread and widely used in Ergonomics, Activity Analysis for Resilience purposes has another focus. The purpose here is to assist in the design of more resilient situations, ensuring that the worker will be able to

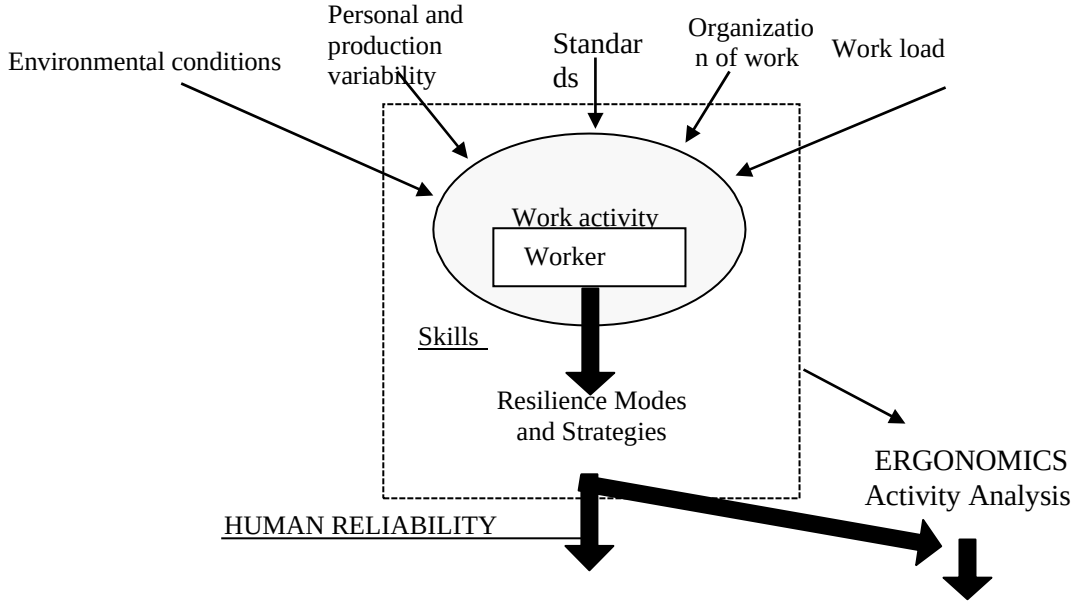
maintain or recover the normality of the system. A little different from the focus on Ergonomics, more focused on designing work situations adapted to the demands of the task. However, they are not mutually exclusive analyses. What we seek is to increase the scope of Ergonomics, incorporating the vision of Resilience into ergonomic action.

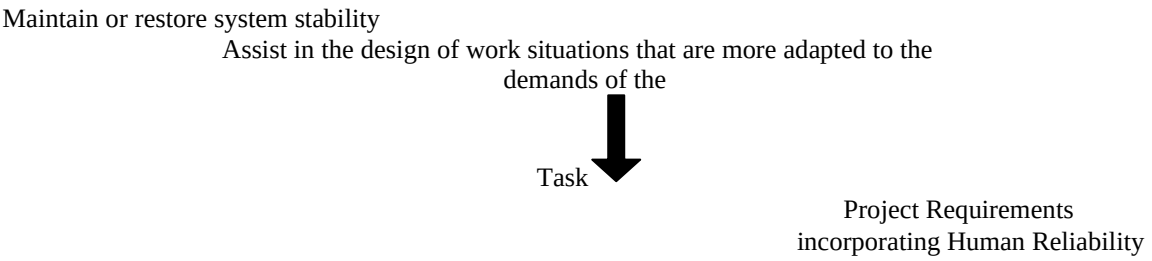
Maintaining focus on the work situation is one of the main pillars of Ergonomics. After all, this is where, effectively, the constraints manifest themselves and the different logics converge. This is also where operators use their competence to assimilate all this information and limitations and respond effectively, within the representation they construct. Guerín et al. (2001) point out this as the main difference between this method and other ways of approaching work. This search for work as it is effectively carried out also directs Human Reliability, within the logic of Resilience. "Resilient systems are those in which people deal efficiently with complexity and are successful in their actions, even under strong pressure" (WOODS and HOLLNAGEL, 2006). And this can only be observed in situated action, where the different objectives involved come together. These are personal safety, productivity, economic, time reduction and

effort, usefulness for the work group, among others, which must be aligned and managed in the work situation.

In ergonomics, at the end of the analysis, the aim is to transform work situations in order to adapt them to the demands of the task. This favors a better relationship between the worker and the demands contained in the tasks. Thus, it can be stated that the focus of Activity Analysis for Ergonomics is, as illustrated in Figure 4, on the relationship between worker and work situation, in order to help design work situations that are more adapted to the demands of the task. The objective of Ergonomics is the transformation of the work situation (GUERÍN et al, 2001; WISNER, 2004). And, even in degraded situations, with the most diverse variability and abnormalities, the worker builds heuristics that optimize production objectives and their personal objectives. The perception of everything that is mobilized in this process is not easily detected by techniques that are distant from the work situation. HRA techniques work with a quantitative approach, with little or no variability in the data set to be obtained. The work situation presents high variability, people also vary their behavior and actions, according to what is presented in the course of action. Therefore, understanding the real needs of operators must be sought through a qualitative approach, which varies in line with work variations.

Figure 4 – From activity analysis to project requirements





Source: Author himself

Activity Analysis, in addition to its fundamental role in Ergonomics, is the most appropriate method for surveying Resilience actions and strategies. This could be supported by the examples presented above. The initial focus of the analysis was on ergonomic action, however, at different times, what was most evident in the mobilization of operators was the Resilience purpose of their actions.

CONCLUSION

The Ergonomic Work Analysis used as a research and intervention method by Ergonomics presents elements that enable the Ergonomist to use, in particular, what was raised in the Activity Analysis, to incorporate Human Reliability actions in projects to improve working conditions . In Refineries, like other complex systems, these actions are routine and need to be incorporated into future projects.

REFERENCES

BELLIÈS, Laurence. La conception: processus d'élaboration et d'évaluation de représentations pour l'action. Tese (Doutorado em Ergonomie) Ecole Pratique des Hautes Etudes, Paris, 2002.

BORGES, Maria Elisa Siqueira. Trabalho e gestão de si – para além dos "recursos humanos". Cadernos de Psicologia Social do Trabalho, v.7, 2004.

BUBB, Heiner. Human reliability: a key to improved quality in manufacturing. Human factors and ergonomics in manufacturing, v.15 n.4, 2005

DEJOURS, Christophe. O fator humano. 5.ed. Rio de Janeiro: Editora FGV, 2005.

DUARTE, Francisco José de Castro Moura; SANTOS; Paulo. A configuração das telas de sistemas digitais de controle de processo. *In*: DUARTE, Francisco José de Castro Moura (Org.). Ergonomia e projeto na indústria de processo contínuo. Rio de Janeiro: Lucerna, 2002.

ESPANHA. Centro Nacional de Condiciones de Trabajo. NTP 360: Fiabilidad humana: conceptos básicos, [199-].

FADIER, Elie. L'intégration des facteurs humains dans la sûreté de fonctionnement: une nécessité pour la maîtrise des risques. Revue REE, v.8, 1996.

FALZON, Pierre. Les activités méta-fonctionnelles et leur assistance. Le travail humain, v.57 n.1, 1994

FAYE, Hélène. Les savoir-faire de résilience: gestion des écarts a la norme en production industrielle. Tese (Doutorado em Ergonomie) - Conservatoire National des Arts et Métiers, Paris, 2007

GUÉRIN, François; LAVILLE, Antoine; DANIELLOU, François; DURAFFOURG, J.; KERGUELEN, A. Compreender o trabalho para transformá-lo: a prática da ergonomia. São Paulo: Edgard Blücher, 2001

LELLES, Sérgio Luís Camillo de; PEETERS; Sandrine Estella; DUARTE, Francisco José de Castro Moura. Segurança e confiabilidade em refinarias de petróleo. *In*: Abergo 2001, Gramado. Anais... Gramado, 2001.

LEPLAT, Jacques. L'analyse psycologique du travail em ergonomie. Toulouse: Ed. Octares, 2000.

LEPLAT, Jacques; TERSSAC, Gilbert de. Les facteurs humains de la fiabilité. Marseille: Ed. Octares, 1990.

NICOLET, Jean-Louis; CELLIER, Jean. La fiabilité humaine dans l'entreprise. Paris: Masson, 1985

PARK, Kyung Soo. Human reliability: analysis, prediction and prevention of human errors. Elsevier: Oxford 1987

REUZEAU, Florence. Assister l'evaluation participative des systemes complexes: role des savoirs et savoir-faire des utilisateurs dans la conception d'un poste de pilotage d'avion. Paris: Conservatoire National des Arts et Metiers, 2000. Tese (Doutorado em Ergonomia).

ROCHA, R.; MOLLO, V. ; DANIELLOU, F. . Les espaces de débat sur l'activité réelle. In: Violaine Bringaud; Benoit Journé; Safietou Mbaye; Geneviève Saliou; Stéphanie Tillement. (Org.). Le Retour d'Expérience dans les organisations à risques. 1ed.Paris: Presses des Mines, 2016, v. 1, p. 87-99.

ROOK, L. W. Reduction of human error in industrial production. Report SCTM, 93.62., (14), Sandia Corporation, 1962

SCHWARTZ, Yves. Ergonomia, fisolsofia e exterritorialidade. *In*: DANIELLOU, François (Org.). A ergonomia em busca de seus princípios: debates epistemológicos. São Paulo: Edgard Blücher, 2004.

SWAIN, Alain D; GUTTMANN, H. E. Handbook of human reliability analysis with emphasis on nuclear power plant applications. NUREG/CR-1278.Washington, 1983.

WISNER, Alain. Questões epistemológicas em ergonomia e em análise do trabalho. *In*: DANIELLOU, François (Org.). A ergonomia em busca de seus princípios: debates epistemológicos. São Paulo: Edgard Blücher, 2004

WOODS, David; HOLLNAGEL, Erik. Prologue: Resilience engineering concepts. *In*: HOLLNAGEL, Erik; WOODS, David D.; LEVERSON, Nancy (Org.). Resilience engineering: concepts and precepts. Aldershot: Ashgate, 2006.

ZANELLA, Andréa Vieira. A apropriação da atividade no processo de ensinar e aprender a fazer renda de bilro. Revista Contrapontos (Itajaí), v.1, n.1, jan-jun, 2001.