



## CONTRIBUTION OF CONCEPTUAL ERGONOMICS TO THE SAFETY OF OFFSHORE PRODUCTION UNITS

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### ABSTRACT

This study shows some ergonomic demands of operators that work in an oil platform. It was analyzed how the lack of ergonomic studies in design during the projects focusing in arrangement has negative consequences at work, especially related to accessibility to instruments and equipment. The identified users demands can be useful for the design of process plants more suited to operators' needs, avoiding the occurrence of work accidents, occupational diseases as well as reducing costs after the start of operation.

**KEYWORDS:** Project; ergonomics; accessibility to valves and instruments

### 1. INTRODUCTION

Concerns and actions aimed at improving working conditions in the oil industry, whether by employers, unions, or labor ministries, have been minimizing the impact on workers. Additionally, there is an increasing need to apply ergonomics concepts in new process plant projects to reduce dissatisfaction and risks in work environments.

When ergonomic aspects are considered in projects, ergonomists are tasked with evaluating the human-system interface to reduce the probability of human error, improper postures, and to improve comfort. However, in some cases, this involvement does not occur as expected, resulting in serious interface problems and limitations in making fundamental changes (HENDRICK, 2001).

During the project, many engineering disciplines are involved, such as process techniques, mechanical, electrical, civil, and instrumentation. Engineering is considered

□ efficient when all disciplines are fully employed and there is a perception of mutual empathetic behavior. However, budget constraints are dangerous for good integration, potentially causing conflict between areas in obtaining resources and construction stages (RESSINK and UDEM, 1999).

Accessibility to instruments and equipment has been explored more emphatically since it is a matter of greater relevance and requires more effort from the worker. The greatest difficulty lies in improving working conditions after the start of operation since sometimes changing the physical arrangement is unfeasible, causing the worker to adapt to unfavorable conditions, which is a factor in the occurrence of undesirable events. In this study, some accident cases were analyzed in which the worker's difficulty in accessing valves and instruments was observed. Even though it is known that there is not only one causal factor, poorly designed arrangements can significantly contribute to event occurrence.

According to Rensink and Uden (1998), by assessing the capabilities and constraints of the user during the conceptual phase of the project, many problems in the facilities' lifespan can be prevented. We might ask why preventive engineering of the human factor is not always used instead of curative engineering of the human factor. Some arguments could be cited:

- . Lack of competence among designers: Many professionals receive only technical education. There is a priority for the technology involved in the process over usability, meaning designers lack sufficient knowledge of the physical and mental behavior of people.
- . Lack of appropriate standards and guidelines: Many technicians lack knowledge of the physical and mental behavior of humans to understand the human-machine interface. Abstract guidelines and standards do not promote the integration of the human factor in the design. Ergonomists must take actions to translate ergonomic standards for use by technicians. This translation should focus on common operational and maintenance problems. Therefore, an analysis of the most frequent issues is useful, and existing rules and regulations from the governing body can help prioritize.
- . Image problem: Due to the unfamiliarity with the art of ergonomic engineering, which is still only associated with furniture design, many underestimate the power of applying human factor principles in industrial area installations.
- . Recognition problem: When the human factor is considered superfluous and of little added value, the criteria of the end user are developed during the detailed design phase, resulting in changes in scope and additional investments. These experiences reinforce the idea that implementing the human factor is costly and has a negative effect on the schedule.

In light of the above, it is necessary for the ergonomist to clarify the consequences of

certain technical or organizational decisions made and the methods to achieve certain objectives such as improving effectiveness and quality, reducing difficulties faced by workers, etc., which should be done through the work approach (DANIELLOU, 2004).

## **2. OBJECTIVE**

The objective is to analyze some ergonomic demands related to the lack of adequate access in the process plant of an oil platform and to determine how ergonomics can assist workers in performing their activities safely, thus contributing to the reduction of the risk of workplace accidents.

## **3. MATERIALS AND METHODS**

The population analyzed in this study consists of employees and collaborators of an offshore oil platform, specifically operators and technicians who access valves, instruments, and equipment in the operational area. Initially, a literature review was conducted in books, monographs, and articles related to the subject. The observational research method was used, with the taking of photographic records, in order to support the conclusions of this study.

Some accidents that occurred in maritime units whose root causes are related to the lack of adequate access were selected. Then, photographic records of real situations showing some resources used to minimize the encountered working conditions were made, including the Platform for Working at Heights (PTA). The study also analyzed how ergonomics in the design phase contributed to the improvement of some activities and work locations.

## **4. RESULTS**

### **4.1. Accidents caused by access difficulties**

Two events related to the improper positioning of valves and equipment and the lack or inadequacy of access were selected.

In the first accident, during the operation of changing the filter of the hot water pumps, a steel bar was used to close the filter lid, when the operator suffered the impact of the bar against the thumb of the left hand. Among the corrective actions taken were the creation of an aid device to perform the task of opening and closing the filter and improvement of access to the equipment.

Figure 1. Accident Simulation



In the second event, the worker, while closing a valve, lost balance and fell from a 40 cm high platform, suffering a contusion with misalignment of the wrist and abrasion on the anterior region of the arm. During the accident analysis, it was noticed the need for applying greater force due to the internal pressure of the system and that the valve was installed at a height of 2.15m from the skid base (valve maneuvering location). However, due to limited space to support the feet, the operator suffered the fall. Among the corrective actions taken was the installation of a grated floor to level the skid floors and the installation of a rod extension device, allowing the operator to perform the activity with proper posture.

Figure 2. Valve Location in Relation to the Skid



In the analyzed events, we can observe that when the project is conceived with flaws, the worker devises alternatives for task execution. The listed events are some demonstrations with undesired consequences of known problems. In Figures 3 and 4, there are examples of other operation points in locations with difficult access. Given this scenario, the safety professional must have a decisive role in every workplace where there are no appropriate access means, whether by recommending the installation of chain mechanisms in valves,

permanent or temporary accesses (scaffolding), or the use of automated platforms.

Figure 3. Inadequate Access 01



Figure 4. Inadequate Access 02



#### 4.2 Mechanisms and Equipment Used

Since permanent accesses require the development of a project and material and human resources, and temporary accesses need to comply with a series of current standards and recommendations contained in safety manuals and company standards, some alternatives were chosen, such as the use of Elevated Work Platforms (EWP), as shown in Figure 5. However, this type of resource has limitations due to the difficulty of use, and as a result, some equipment becomes underutilized. During an experimental phase, it was noted the difficulty in reaching operation points and in use due to the platform's floor.



Figure 5. Automated Platform



Another alternative is the use of valves operated with the aid of chains, as shown in Figure 6. This type of valve is widely used in industrial areas with limited space for accessory installation.

Figure 6. Chain-operated valve





### 4.3 The effects of ergonomics application in projects

The ergonomics aims to increase efficiency, reliability, and quality of industrial operations. The success of a company regarding safety begins with the continuous improvement of equipment and working conditions through macroeconomic policies.

Regarding ergonomic design, we can mention the changes that occurred in the design phase of the studied platform, when another maritime unit was used as a reference situation. On this occasion, the improvement in the elevation of valves and pipelines on the main deck by approximately 400 millimeters is highlighted, along with the installation of deluge valves (Automatic Deluge Valve - ADV) along the edges on both port and starboard sides. This change provided greater safety for workers moving through the area. On the other hand, other points of improvement were not anticipated in the project, such as the ease of access to the CO<sub>2</sub> battery room, which is arranged in two rows facing each other, creating difficulties for replacing and maintaining the 45 kg cylinders. As a result, during their movement, there is an increased risk of accidental CO<sub>2</sub> discharge in a particular environment or accidents involving limb presses.

Figure 7. CO<sub>2</sub> battery room



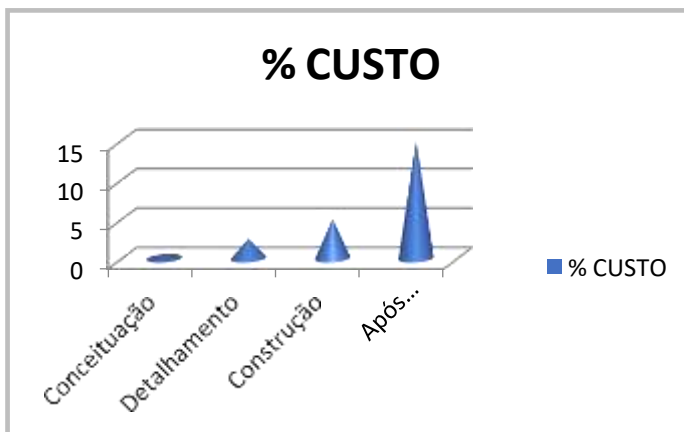


According to Rensink and Uden (1998), the benefits of an ergonomic approach are felt both financially and in improving working conditions. Based on historical records, it is possible to identify that good planning can result in a reduction of:

- 25 to 5% of the capital expenditure;
- 1 to 10% of project time; and
- 3 to 6% in the life cycle cost of the facilities.

A study on the application of ergonomics principles in project development (AUBUM ENGINEERS, 2001 apud GUIMARÃES, 2002) suggests that if implemented in the conceptual phase, the cost increase is only 0.5%; in the detailing phase, the increase ranges between 2 and 3%; in the system construction phase, it may reach 5%; and if considered after the project completion, costs may represent 10 to 20% of the total project cost. The graph in Figure 8 illustrates how the costs of ergonomic actions increase significantly as they are implemented later.

Figure 8. Cost of ergonomic actions as a function of the project phase



## 5. CONCLUSION





In the study presented, it is observed that the concept of ergonomics is not generally applied in projects for new installations. Consequently, many non-conformities are encountered during the operational phase of process plants, resulting in worker dissatisfaction and, eventually, accidents. It is also evident that offshore units with little operational time present problems that could have been observed and corrected during the design phase. It is important to emphasize that costs can be mitigated if ergonomic studies are initiated early in the conceptual phase or in the definition of guidelines.

Even if there are modifications to the process plant, with the incorporation of new products or technologies, it is essential to observe and analyze the physical discomfort conditions that operators are subjected to and the methods being adopted to mitigate design flaws. Techniques used for accessing locations that were not designed for such purposes are often not carried out safely, or the available resources are not efficient. Therefore, an ergonomic approach in new industrial plant projects is of utmost importance..

## **REFERENCES**

DANIELLOU, F. A ergonomia em busca de seus princípios: debates epistemológicos. São Paulo: Edgard Buclher, 262 p., 2004.

GUIMARÃES, L. B. de M. Abordagem Ergonômica: a análise Macroergonômica do Trabalho. *In:\_. Ergonomia de processo. Porto Alegre: FEENG-PPGEP/UFRGS, v. 1.(Série monográfica em ergonomia), 2002.*

HENDRICK, H. W.; KLEINER, B, M. Macroergonomics: An introduction to Works System Design. Santa Monica, CA: Human Factors and Ergonomics Society, 2001.

RENSINK, H. J. T; UDEN, M. E. J. V. Human factors engineering in petrochemical projects. Part I, Petroleum Technology Quarterly, 1998.