ERGONOMIC INTERVENTION IN PETROLEUM PLATFORMS IN BRAZIL: ACTION STRATEGIES AND THE ROLE OF THE ERGONOMIST

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This paper illustrates the intervention strategies adopted for petroleum platform projects in Brazil. Special attention is given to the role of the ergonomist within the project teams. The specific knowledge of the operational activities acquired during the visits to functioning petroleum platforms help acquaint the ergonomist with the management of the project. The integrating characteristic of the work brings to light that many of the problems encountered by the operators are related to the lack of coherency between different knowledge areas (architecture, structure, processes,…). The ergonomist takes an interest in the system and not in its parts, which leads him/her to create spaces for negotiation and decision in such a way as to foster confrontations between, very often contradictory points of view.

Petroleum platforms, projects, ergonomics

1. Introduction

In the last decade a number of *offshore* petroleum production units have been, and, still are underway in Brazil. The latter are projects of strategic importance to the country, since the entry into operation of new platforms has represented a significant increase of the country's production, and since 2006 has meant self-sufficiency in petroleum.

The technological investment, especially the extraction of petroleum in deep waters has enabled this production increase. However, this technological development does not occur in a homogenous way. On the one hand, the production technology has advanced considerably, making feasible the extraction of petroleum at a depth of more than 2000 metres. On the other hand, the project of several different types of workplaces, such as control rooms, engine room, pump house, mess rooms, infirmaries, maintenance workshops, laboratories among others, have only more recently been incorporating knowledge from ergonomics for the improvement of working conditions.

The need to follow, normally exiguous, chronograms, for this type of project, leads to the use of previous projects as a starting point for the next projects, without the necessary appraisal of the usability and adequacy of the different living accommodation units and reproduction of the types of activity that would be undertaken in them. According to Béguin (2004), the human models used by the engineer designers are incomplete, either due to lack of knowledge of the workplace conditions (ecological gaps), or due to insufficient definition of user objectives (gaps of problem definition).

In this paper three interventions undertaken in petroleum platform projects will be presented. All three interventions were carried out in ship platform projects: 2 were

FPSO's (Floating Production Storage Off-loading) and 1 FPU (Floating Production Unit).

2. Ergonomics in the Control room project of an FPSO

In this intervention the participation of the ergonomics team was exclusively focused on the control room project of this FPSO. An Anglo-American company that was responsible for this stage of the project hired the ergonomics team at the detailing stage of the project. It is important to mention that this project gave origin to two FPSO's (P-43 and P-48). Two old tankers of the same size would be totally dismantled, one built in Brazil (P-48) and the other in Singapore (P-43).

Engineers and technical staff of the Brazilian petroleum company accompanied all the project development and its execution. The responsible for the instrumentation area and the control room, had already worked on platforms in the past and had already been designated as future OIM (Offshore Installation Manager) of the P-43. In terms of project management, the strategy employed was to involve future members of the operational team right from the beginning of the project until its execution.

This was the first Brazilian platform project to have an ergonomics team participating in a Control room project. This participation occurred for a period of 6 months, from January to June 2001.

2.1 Methodology

The methodology employed can be summarized in the following way: (a) analysis of ergonomic norms, especially norms ISO 11064 and the revision method developed by NPD *(Norwegian Petroleum Directore)*, (b) meetings and interviews with operators and engineers for context comprehension and (c) visit to two FPSO's (P-31 and P-37) to accompany the work activities in the control rooms. The operational activities of the production, nautical and utilities teams were observed. Each visit lasted 5 days. On the visit to P-37 a model of the future operator control rooms was used for the appraisal of layout options.

2.2 Main results

The analysis of reference situations supplied the main elements to react to the initial proposal of the draftsmen. The communications (frequency and content) between the different teams, the number of people present in the control rooms in the typically different situations, the usage of control systems, the different types of radio communication and other instruments, offered decisive arguments for the construction of a proposed solution. For example, the intensity of the communication between operators of the production team and nautical operators, in the situations of off-loading oil, reinforced the necessity for bring these teams closer together.

In the visits undertaken for the reference situations, it was also established that terminals of the control systems, as well as, shelves and cupboards for documents, had devices to secure the contents and protect them from falling. The platforms, especially FPSO's in deep waters are production units that roll and heave according to the conditions of the sea.

One of the critical points in the platforms visited was related to the relationship integration between the field operators and the control room operators. Field operators need a support room (shelter) near the production unit with acess of a digital terminal system. Through this station, the field operators can have access (visual) to the main informations of production process and make the permission of work for maintenance

teams. Many safety regulations constraints and limits the possibilities of solutions and the contemplation in the project of operator needs (Duarte, 2008).

During the platform construction stage, several disagreements related to the specific proposal of the ergonomic team could be identified. For the Brazilian petroleum company the proposed solutions for the Control room were detailed and considered as specifications to be followed by the executing team. The detailed specifications prepared by the ergonomic team constituted a minimum guarantee to assure the ambience quality of the construction. For the Anglo-American company, the solutions proposed should be considered as "*guidelines"* and not as project specifications, to assure the greatest margin of manoeuvre during the execution stage.

Regarding the inexperience of the ergonomic team in projects related to the naval construction industry, the Anglo-American company and the Brazilian petroleum company considered the new design of the control rooms innovative. The main characteristics of the new control room design are the following: (a) a circular arrangement which favours the integration of different operating teams (production, utilities and nautical), with a central area for meetings which are held at shift handovers and for special operations; (b) furnishings that are adapted to the various typical work situations, and that enable more than one operator to use the computer terminals (which happens in emergencies and in special operations such as off-loading); (c) the separation of the operating room from the instrumentation room which is normally noisier; (d) computer monitors fixed to the work surfaces with arms (which increase available space, avoiding falls when the FPSO rolling motion is more pronounced and that allow required flexibility of positioning); (e) acoustic insulation for the ceiling, walls and raised floor; (f) indirect lighting in order to avoid reflections on the screens and (g) windows to take advantage of available natural light (with blinds).

3. Ergonomics integrating a design team from the beginning of the FPSO project

This was the first intervention whereby an ergonomics team was invited to take part in a project team in its initial phase. It has become a discipline alongside so many others: structure, architecture, naval systems, instrumentation, security, etc.

When the ergonomics team initiated the project, some decisions had already been taken; the use of a previous project as a base had already been defined, thus the characteristics of a number of workplaces had already been pre-defined. The defined scope for the ergonomics studies increased in relation to the previous project and contemplated: Control room, galley, mess room, infirmary, laboratory and workshops. These studies were initiated by the analysis of the plants of the proposed workplaces taking into consideration: height, location of the workplaces, access and movement.

3.1 Methodology

The main methods used were: (a) visit to P-43 (already in operation); (b) analysis of documentation: plants, norms, technical specifications and project guidelines; (c) meetings with operators of different areas and with draftsmen and (d) analysis of the experience with previous projects (P-43, P-48, P-52 e P-54).

3.2 Main results

One problem emerged when it was decided to reuse some previous design solutions, for instance the verticalisation of the accommodation units. As the height of the accommodation unit is an important factor related to working conditions in view of the movements and the constant physical requests that they imply. Thus, the relative

location of the different workplaces was the focus of analysis, especially the relative position of the infirmary. Although from the point of view of usage, the most adequate location was closer to the plant process (where the operators are located and there is a higher risk of accidents), the guidelines of the project prevailed and the location was defined next to the heliport, on the highest floor of the accommodation units.

In the case of the control room, the initial layout that was presented to the ergonomics team was redesigned. In general the recommendations used in project P-43 were adopted, that favoured the integration between operational teams.

The construction of shelter to support the field operators, located next to the plant process was the object of conflict related to security regulations in the same way as in project P-43. In spite of having been specified as a shelter, it is still considered small to accommodate the different operational teams.

For the analysis of the galley and mess room, the greatest difficulty of the project referred to flux movement: the entry of food and the flux of users. The floor that referred to the location of these workplaces was redesigned according to studies and observations made in the reference situations and according to previous experiences of the team by ergonomic team.

The maintenance workshops (mechanical, electrical and instrumentation), tooling and store room were projected separately. The ergonomic study incorporated these workplaces as a whole, given the interdependence between the differents teams. Thus, the integration of these workplaces was proposed with the creation of a common office to all staff, mechanical, instrumentation, and electrical teams.

At the end of this base project *(feed)*, proposals were made for the process plant. In view of the time and recourses limitations, only recommendations related to the location and access to valves were made. Recommendations were developed for the height and location of valves due to the critical aspect of this operation and the frequency of usage of the same. It is important to mention that more specific recommendations for the plant system and its sub-systems need continuity during the length of the project. Only in the detailing phase, the engineers and technical staff for the piping can locate the main devices and equipment of the production process.

The greatest difficulty in the construction of the ergonomic recommendations was related to: (1) the disagreements between the necessities of the users and the guideline or base projects (that should have been questioned beforehand) and (2) contradictions between different project guidelines.

The participation in the initial phase of the project was a great learning experience not only due to the knowledge acquired in relation to the *offshore* activities in a general manner, but also, the opportunity to integrate ergonomics like any other of the design professional practices. The fact that the ergonomics team accompanied the day-to-day development of the project, exposed this team to a number of situations, such as: difficulty of making oneself understood; the difficulty to negotiate ergonomics guidelines in the light of all the other disciplines; the need to understand the rationale of the different disciplines and the inherent difficulties in the creative and organizational process of a large scale project.

4. The FPU project appraisal

This intervention occurred at a very late stage in the P-53 platform project and was undertaken between March and September 2006. The ergonomic team began its

work when the platform was initiating the construction stage, in a shipyard in Singapore. The objective of the intervention was to appraise the solution proposed by the project teams for the following workplaces: maintenance workshops, store room, infirmary, galley, mess room, laundry, hospital, control room, turbo-generators, electrical panel room, pump house, engine room, emergency generator room.

4.1 Methodology

From the point of view of the methodology, this appraisal was based on: (a) analysis of the documentation (plants and technical specifications), (b) meetings involving the future users and draftsmen having as support the plants and the making use of specialist software to visualize the model in 3D for the workplaces under analysis and validating the recommendations with the users (*design review meetings*).

3.2 Main results

The involvement of future users in the analyses undertaken was essential for the identification of the typical work situations that should occur in each of the analysed areas. The main difference with other interventions was related to the methods employed in some of the *design review meetings:* The usage of an electronic model. The model allowed for a better understanding of the solutions proposed by the designers and for a debate with the operational personnel, i.e. the future users. Due to the electronic model it was possible to visuale problems, which were not perceptible from the analysis of the plants and technical specifications, especially the position of the valves, the access to equipment and the need for handling devices (*mechanical handling*) for the removal of equipment for maintenance.

During this task, some recommendations were implemented (especially those related to the changes in internal *layouts*), but others, however, could not be implemented immediately, due to the advanced stage of execution of the project.

5. Discussion

A first assumption that we can make from the practice of ergonomics in the mentioned projects is related to the scope of the interventions. If at the first interventions, the scope was restricted to the design of control rooms, more recently several other workplace and its enviroment issues have become part of the ergonomic intervention domain, such as: maintenance workshops, the infirmary, heliport, the laundry, the galley, the mess room and several other parts of the plant process area (turbo-generators, utilities areas, electrical panel rooms, engine room, emergency generator and pump house).

The three interventions presented were based on the methodology of the ergonomics approach to the professional activity (Beguin 2004). Apart from resorting to existing norms, both international and national, in the area of offshore projects, a stage of fundamental importance for the comprehension of the problems and the building of solutions was the analysis of real working situations and the involvement of users during the design activities. Simulation techniques and the usage of physical models complemented the interventions undertaken.

As is already known from international literature (Daniellou, 2004), the late beginning of ergonomic interventions create difficulties for the implementation of any recommendations in view of the costs and necessary time schedules. When the interventions occur right from the beginning of projects, the possibilities of taking action are favourable. However, the necessity of the continuity of ergonomic

interventions throughout the whole project is also an important issue, including the effective participation in the execution phase, as occurs with the other specialist areas of the project (structures, power generation, acclimatization, automation, etc).

These interventions allow for a better understanding of the collective dimension of the interconnection of the activities that occur in large-scale projects. The design process is a colective work. No one on their own has the available scope and knowledge of the problems to be resolved and has the competence to resolve them. The complexity is reduced differentiating the tasks and distributing the different actors according to their competencies. Simultaneously, this principle is the source of new complexity. Whatever the object to be conceived it cannot be thought of as a simple overlap of technical systems: it is necessary to integrate the different parts and for this purpose the actors should attune themselves. Given the great diversity of actors with distinct objectives, disagreements and disputes are common.

There is, however, a distribution of tasks amongst specialists, who are autonomous as to the methods and procedures that they employ in their spheres of competence and a demand for articulation and for convergence.

In this respect, two distinct roles appear as important for intervention in ergonomics. In the first place the ergonomist is an "actor of the design" along with a number of other draftsmen. Common discipline knowledge is mobilized, and specific knowledge of the functioning of petroleum platforms acquired during the visits to the reference situations. He or she is an *expert* together with several other actors, however, with a weaker status than the naval engineers and architects. Due to that it is necessary to make ergonimist contribution known. Thus, a number of explanations are given in real time about what ergonomics is.

A second role arises, when the ergonomist participates right from the initial stages of the project. Several factors bring the ergonomist close to the project management. In the first place the need to enrich the objectives of the project. Another factor is related to the integrating characteristic of the operational activity, which the ergonomist comes to know, when he analyses the reference situations. These two factors give the ergonomist a political role that brings him close to the head of the project. Several examples show that the problems found by the operators are related to the lack of coherency between the different knowledge areas (architecture, structure, processes…). It is this systemic dimension that the ergonomists also bring to the projects. The ergonomist takes an interest in the system and not in its parts, which leads to the creation of spaces for negotiation and for debate with the other specialists and actors that carry necessarily different points of view and interests. Thus, apart from the ergonomic competencies themselves, the ergonomist resorts to the transversal competences, which are inherent to the management of projects. In this sense, are we still speaking of ergonomics and the ergonomist?

6. References

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