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*Published in:*  
ICOCO 2010 Conference Proceedings

*Publication date:*  
2010

[Link back to DTU Orbit](#)

*Citation (APA):*

Souza, C., Duarte, F., Maia, N., & Cordeiro, C. (2010). Ergonomic guidelines based on usage for offshore control rooms design. In ICOCO 2010 Conference Proceedings (pp. 148-155). Loughborough: Institute of Ergonomics and Human Factors.

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# **ERGONOMIC GUIDELINES BASED ON USAGE FOR OFFSHORE CONTROL ROOMS DESIGN**

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Ergonomics has been involved in offshore platforms design, aiming at introducing work logics in the workplace conception process. As an important element in the operation of offshore platforms, control rooms studies usually focus on the improvement of working conditions, even in platforms already in operation. The objective of this paper is to present some guidelines for offshore control rooms design. These guidelines were generated from six ergonomic intervention cases in offshore control rooms with one to eight years of operation. Common characteristics, related to the use of the space, that were observed on different platforms, were identified by the ergonomic work analysis of operating control rooms. These characteristics resulted from the experience of the operation teams, instead of norms or manuals, providing an extensive and detailed knowledge of the process and practical experience, which are usually not documented for the designers.

## **Introduction**

The ergonomic interventions methodological approach highlights the importance of users' participation in the construction of proposed solutions and principles. The elaboration of guidelines for offshore control room design intends to guarantee that designers have access to required relevant information in relation to the real needs of the users. In practice, ergonomics has already been present in control rooms design, since it is a key environment for the platform operation, from where the whole process is controlled and strategic and productive decisions are taken. However, ergonomics is only often introduced at the end of the design process (detailing design or even during construction), when there are already some irreversible conditions and changes are usually not possible anymore.

The first control room design projects considered anthropometric aspects from classical ergonomics, but did not yet address cognitive aspects, such as the interfaces between operators and command displays or the interaction among operators. From this perspective, new principles emerge for new projects, as well as for the redesign of existing control rooms.

This paper presents some basic principles and guidelines in ergonomics elaborated from interventions in six offshore control rooms. The platforms are in operation in the Campos Basin, in Rio de Janeiro, Brazil, for a period of one to eight years. There was a demand for an analysis and redesign of these control rooms raised in the Health, Safety and Environment (HSE) sector of a Brazilian oil exploration and production company to improve working conditions. Similar work has been developed at Statoil. For the past seven years, this company has developed a human factors design process based on ISO 11064: Ergonomic Design for Control Centers (Pont and Thronsen, 2009).

Once there is, many times, a lack of necessary operational experience from designers, experience transfer is the main source of practical information to the projects development (Pagenhart et al., 1998). According to the authors, the most effective experience transfer has specific and concise information. Based on norms and general recommendations knowledge, previous control rooms design experience, and work analysis in control rooms now in operation, it was possible to identify some common typical characteristics. These characteristics gave origin to basic principles that can serve as guides to control rooms design projects (either new rooms or under renovation ones) on other offshore platforms.

### **Ergonomics interventions aiming the (re)design of work spaces**

The central question for ergonomics in design projects is predicted use. By analyzing existing, similar situations (Daniellou, 2005), it is possible to pinpoint characteristic actions which allow relevant issues to be raised and discussed. This allows priorities to be defined, which play a decisive role in the choices made by designers. This approach is based on the Ergonomic Work Analysis (EWA) effectively performed in reference situations, by means of analysis and work observation methods (Guérin et al., 2001). It also enhances the capacity to predict and reduce uncertainties regarding the efficiency of future functioning throughout the design process.

In every ergonomic intervention, an essential characteristic is that it aims for action; the situations object of action may or may not be the same situations as the object of analysis. In this way, the distinction between “correction ergonomics” and “conception ergonomics” is reduced since any ergonomic intervention in an existing situation aims to contribute through the definition of a more favorable future situation (Daniellou and Béguin, 2007). For control room design, a lot of information to be applied to design projects has already been related in several standards, such as ISO 11064 (2000) which is specific for these environments. As the standard points out, the ergonomic analysis for the control room (re)design must begin with the analysis of existing situations.

This allows the raising of relevant issues that should be addressed since the beginning of the projects. The activity analysis can still reveal rigidity points, and poor functioning, which is incompatible with the evolution of the intended system, allowing for an evaluation of what is being proposed still in the design phase (Martin et al., 1995). The objective, according to these authors, is not to increase the amount of information, but to guarantee that there will be relevant and necessary information for the designers to understand what the project really is. The knowledge developed by ergonomics about the functioning of man and his relation to objects, environments and work instruments has already been shown in manuals (Grandjean, 1998; Iida, 1990; Salvendy, 1987) which aim to serve as a basis for engineering designs.

However, such manuals are never, or hardly ever, used in offshore design projects, according to Pagenhart et al. (1998). Despite the large amount of information, many relevant facts for designers are not included. Many of these manuals and guidelines take for granted, implicit or explicitly, that designers will read them and find out for themselves how to design spaces according to users' capacities and limitations (Chapanis, 1996). According to the author, the mistake is that engineers and designers do not read these manuals and, when they come to read them, do not understand the guidelines and do not know how to design to address them.

The guidelines developed and presented in this paper intend to address such a need. Without defining or detailing a design solution, the aim is to extract and describe the existing relations among spaces and work activities observed during the follow-ups. In this way, information about use is provided to the designers as well as its implications for environment design, without presenting a final solution. The consideration of variability and diversity of the existing situations is essential for generalizing the performed observations. The objective of ergonomics, therefore, does not consist in reducing the diversity or variability of situations, but in characterizing and considering them in the technical, organizational, and social plans (Daniellou and Béguin, 2007). Thus, the analysis of existing situations can support the creation of new solutions for the space (Conceição et al., 2008).

According to Daniellou (2004), the ergonomic intervention is based on a double construction: 1) a technical construction, from methods that ensure the congruency of the facts (analysis of existing situations); and 2) the social construction, from the diffusion and discussion of the descriptions produced in conjunction with the company's different actors. The intention is to contribute to projects even prior to starting, that is, since their basic studies, by observations of the usage at reference situations.

## **Methodology**

The interventions that gave rise to this work occurred between 2007 and 2008 at six offshore platforms in operation in Rio de Janeiro – one fixed, two semi-submersibles, two Floating, Production, Storage and Offloading Units (FPSO), and one Floating Storage and Offloading Unit (FSO). As mentioned above, these interventions originated through a demand for the redesign of a semi-submersible platform control room, from which one of the operators had been on leave for health problems related to working conditions. These ergonomic interventions had two main phases: 1) the analysis of the current situation of the control rooms in operation; and 2) the elaboration of the guidelines and recommendations for the redesign of the existing control rooms. After these phases, the guidelines elaborated for the renovation of these control rooms were combined and re-written aiming future control rooms design projects.

The analysis and evaluation of the working conditions in each control room were performed in two or three days onboard - always by two researchers. Two factors made the analysis feasible in such a short period: the experience and knowledge accumulated in the analysis of other control rooms and the comparison among the several control rooms. Based on the Ergonomic Work Analysis, the researchers accomplished: 1) follow-up on the activities in different shifts and with different operators; 2) meetings and interviews with operators, coordinators, and their respective platform managers; 3) identification of monitors and systems, radios and telephones necessary in each console (besides the verification of the measures – as built – of

the visited control rooms); and 4) visits to the other facilities that provide support to the control room – such as equipment environments, shelters for field workers, among others.

From the methodological perspective, we analyzed how users, from their daily work experience, adapted their environment to the usage. For the needs identified by users, we tried to identify objective aspects of the working conditions that should be transformed for future projects. Of equal interest to this study was the identification of positive aspects of the current situation that should be kept in future projects. For the platform that gave rise to the interventions, the initial studies were developed and the options for changing the control room layout, furniture, and environmental conditions were evaluated. Meetings with users onshore and onboard were conducted by video conferencing. Direct users' participation was of great importance in the discussion of possible solutions.

### **Principles and guidelines for offshore control rooms design based on work analysis during ergonomic interventions**

A remarkable characteristic of control room operation is the interdependence among several environments. Thus, beyond focusing on the activities of operators, the analysis was performed in a systemic way, integrating various work-related environments to the work in the control room. The characteristics highlighted in the results of the ergonomic interventions are presented below, as well as the guidelines for the design of future offshore control rooms based on this analysis.

The operation environment was not the only one to be analyzed. Other areas were also observed, such as the field operators' support rooms (or even the improvised shelters, having as one of its objectives the work permit preparations), equipments rooms (whose temperature control demand is different from the one suited to attend human comfort), technical support offices (coordinators and automation engineers), restrooms and coffee shop near the operation environment. Some of the guidelines, in relation to these other environments follow:

- The prevision of shelters for field operators (from different teams: production, nautical and facilities) in the process area is important. Account needs to be taken of eventual computers use, control system terminal consultation and the daily preparation of work permits. The displacement of these activities to their own environment, near the production area, significantly reduces the number of people circulating in the control room, favoring the working conditions of control room's operators, who must be constantly vigilant.
- The localization of the manager and the coordinators offices near the control room is desirable, but without direct physical links to avoid unnecessary circulation in the operation environment. For the same reasons a conference room near the control room is recommended, mainly to deal with critical situations where the proximity of the operation is fundamental.
- The positioning of a restroom (women's and men's), and a coffee shop, near the control room is essential, since the operators cannot be absent from their positions for long periods of time.
- The separation between the operational and the equipment environments is important. Machines generate heat and noise, and the temperature of the air conditioning for their

proper functioning is too low for human occupation. Besides, the risks of shocks, or other “accidents” that may damage the equipment or jeopardize the functioning of the system, are reduced when outside permanent circulation routes.

- The flow of people in the operational area of the control rooms also deserves special attention, since it must be limited to what is referred as operational activities. It is desirable that all activities that can be performed outside of this environment are located in their own environments in order to reduce interferences and maintain a suitable environment for the level of attention required to the operational activity.

As far as the operational environment itself is concerned, it has been noted that most recent rooms have windows (Figure 1). This is an important principle that should be kept:

- The existence of windows is recommended since they contribute to the environment’s illumination and proper functioning of people’s biological clock through the visible distinction between day and night. However, it is important to point out the importance of properly treating such windows in relation to fire safety (propagation of fire and explosions) and in relation to their impact on the thermal environment, acoustics and illumination levels of comfort.



**Figure 1: Control rooms with windows**

Even though there was a great variation regarding the number of operators, similarities were observed among platforms (Figure 2): 1) the operation consoles are positioned close to each other, due to the operators’ frequent interaction; 2) the supervisor’s work position is near the operation consoles; and 3) the work positions for the automation team, or even a small separate environment, are located near the operation consoles. These characteristics shall also be maintained and the guidelines for that are:

- The level of interaction among the operators must be studied in each case for the definition of the most adequate positioning among the operation teams (production, nautical, facilities and automation). Also the visual contact and communication among the operators must be encouraged to facilitate the exchange of information, many times necessary for the reliability and efficiency of the system.
- The supervisor’s workstation shall be positioned close to the operational consoles due to the high interaction among them, mainly during critical and emergency situations.
- The automation team usually needs a workstation near the operators in the operational environment and also a workplace with certain privacy for the work and optimization of the control nets. At the platform start-up, the need for calibration of instruments requires constant interaction between the operation and automation teams. During this period, and in special situations that may occur afterwards, the workstation near the operator’s consoles is more widely used. After the plant is stabilized, the automation team's work

focuses on the verification loops and developing solutions for specific situations that require privacy and concentration. In this case, the location of the workstation in the operating environment is not favorable to the automation team's activity. In summary, for the automation work team there is a need to make the collective and individual dimension of work compatible. Each situation has peculiarities that must be taken into consideration for this compatibility and determination of the positioning of these individuals.



**Figure 2: Control rooms with consoles positioned near each other, with the supervisor's work position near the operation consoles and the automation team work position inside the operation environment**

Regarding the operational consoles, it is already observed in most recent control rooms what is recommended in the guidelines: 1) each console accommodating up to two people as may occur in several situations such as units departure, training, maintenance, shift change, critical and emergency situations, among others; 2) space on the console counters to fit the equipment used during the operation (radios, camera's controls, etc); and 3) the use of LCD monitors attached to the consoles by articulated supports which allow for easy handling, as shown in Figure 3.



**Figure 3: Consoles fitting up to two people, with space for placing the equipment over the consoles and with articulated supports for the LCD monitors**

However, even on most recent platforms, problems could still be observed. In some control rooms, for example, the positioning of the CPUs is under the console counter (Figure 4). With this positioning, the free space for the operators at the consoles to move about is more limited. In addition, the equipment is a source of heat and noise, and should be away from the operators' work positions.



**Figure 4: CPUs positioned under the counters, limiting the space for operators' legs**

Finally, as previously mentioned, the validation of these needs and other design principles and guidelines by the users is fundamental for the transformation of the work conditions.

## **Discussion**

During a project, the integration of ergonomics aims to support the decision making of the responsible technicians starting from a realistic anticipation of the work of future users. This is accomplished through the provision of information for technical and organizational decisions, and offering evidence for the probable consequences on the future conditions of work. There is already awareness about the importance of paying attention to the functioning and the needs of future users. However, this only occurs in the final phases of design, when the men-machine and the operational positions interface characteristics are already defined.

The ergonomic interventions in design and redesign of offshore platform control rooms has become more frequent and proven effective in improving work conditions. Users' participation is fundamental to "success" as they provide an extensive and detailed knowledge of the process and practical experience, which are not documented for the designers or other actors (Pikaar et al., 1990). Today there is a growing demand for new projects of offshore units. In Brazil, mainly due to the discovery of new fields for oil exploration, many new platforms will be needed. Regarding this scenario, the development of guidelines for new control rooms design become decisive to achieve environments that will meet the users' needs and demands.

The viewpoint of the work, established on the basis of an ergonomic approach, allows the emergence of different logics which are always present in design projects, although not always considered. In addition to the knowledge obtained through the analysis of reference situations, it is necessary to review the existing standards, specially the standards specific to control rooms. Working from the situations identified during the work analysis, this knowledge of norms and recommendations helps the confrontation with and validation of these situations by users to be more advantageous and profitable.

The ergonomists' personal experience, or their "information library", is also an important dimension of their knowledge (Daniellou and Béguin, 2007). In ergonomic interventions such as the one presented here, as well as for the development of guidelines for new projects, this experience, according to the authors, permits the generation of exploratory hypotheses more easily. This will guide the search for information, identifying quickly what is "typical" and what is "specific" in each situation. Therefore the guidelines do not substitute the future involvement of ergonomists and their interaction with the future users who will participate in the projects. The guidelines only offer basic orientation so that the work of these future users



is considered from the very beginning of the basic design and also underline the importance of involving a specialist throughout the design process.

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