Ergonomic Simulation: The Work Dimension in the Integrated Operations Centres Design in the Oil Industry

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Abstract. This study aims to reflect on how the work dimension can be considered in Integrated Operations (IO) projects through a work simulation from a participatory ergonomic perspective. This research presents a case study of an Onshore Collaborative Centre (OCC) design, where an Ergonomic Work Analysis and three Ergonomics Simulations cycles were performed to support the discussions with workers and managers to create design solutions. The results show the organization of a participatory ergonomics approach in IO projects, which includes the structuring of the participatory dynamics in the design process from the Ergonomic Work Analysis and Simulations. The simulation is a method that can transform work into an important factor both in modifying the project and in technical choices. It also allows for the inclusion of different actors and their perspectives. However, for the simulation to be an effective means of participation, it is necessary to have an integration between the work analysis and the expectations of the project.

Keywords: Ergonomic simulation · Participation · Design process · Integrated operations

1 Introduction

1.1 The Work Dimension in Integrated Operations (IO) Projects

Integrated operations, as a new model of work, has emerged from the initiatives of several oil and gas companies to improving operational performance and reduce costs. According to Haavik [1], the petroleum industry domain, with harsh environment and remoteness of operations, induce requirements for low offshore staffing and high degree of sensor-based monitoring, combined with support and management from remote centers of coordination.

Projects of this nature have impacts on different operating units, such as the advent of operations support rooms, which has been transforming offshore and onshore work

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towards greater integration. To this end, several teams in Onshore Collaborative Centres (OCC) began to analyze data, recommend process optimization and predictively monitor possible equipment failures on board. To Moltu and Nærheim [2], this type of rooms makes operations and maintenance work more feasible between the onshore-based operation unit and the offshore operations.

Some studies indicate that such collaborative rooms encourage cooperation, integration of teams in real time, more intense flow of information and knowledge within the asset, leading to a new organizational culture [3, 4]. There is a prerogative that work processes become integrated and collaborative from the available technology and physical environment.

Although studies emphasize the importance of considering human factors and the end-users participate in IO projects and in the change process, this participation is focused on their experiences as input to the experts [5] and on the training and preparation through an intensive program of change management [6], mainly focused on the probable resistances coming with the project implementation [7].

From an ergonomic point of view, more than involving training, meetings and consultation, participation "is seen as providing the opportunity for real, early and full involvement of the people involved (operators, supervisors, etc.) in the making of decisions about their jobs, systems, workplace and organization" and "such involvement will include the ability to influence, or to control, such decisions or the relevant decision makers" [8].

This study aims to reflect on how the work dimension can be considered in Onshore Collaborative Centres design through a work simulation from a participatory ergonomic perspective. For such purpose, this paper presents a case study of an OCC design, where an ergonomic work analysis and three simulations cycles was performed to support the discussions with workers and managers from Brazilian oil and gas industry to create design solutions.

1.2 Participatory Ergonomics

A participatory ergonomics approach to workplace assessment and design will aim at modifying the representations of work that are involved in design and not simply bring new bricks of knowledge to the designers [9]. According to the authors, introducing a participatory approach in the design process requires a social construction, for a clear negotiation between the parties, and technique, which consists in the definition of methods that allow a confrontation between different types of knowledge.

Among these methods, work simulation appears as an ubiquitous method to participatory ergonomics approach in the design process, which involves dealing with un-predicted variability, mobilizing personal and collective resources, experiencing con-traditions and debates about values between human actors [10]. Simulating work situations is a work oriented method that puts workers and others stakeholders at the center of the design process [11–14], allowing work to be a decision-making criterion, similar to economic and technical criteria, which are often the only criteria taken into account [12].

However, the aim of the simulation is not to prescribe the right way of performing the tasks [14]. In this sense, it is impossible to fully anticipate and predict the future,

because activity is constructed by a given operator as a response to a given context [10]. Nonetheless, the simulation brings the possibility of staging and manipulating certain elements that are considered significant to achieve a goal, and to drop other less interesting ones [15].

In this study, an ergonomic participatory approach based on methods such as analysis and simulation of work was used, from the perspective of activity ergonomics approach. The analysis of the activity makes it possible to understand the difficulties that workers encounter in their work and the adjustments that they implement to deal with the variability [16]. And the simulation, when considering the activity point of view, allows to stage some idea or design hypothesis through a model, a mock-up or a prototype, in order to experience and learn from them, to identify what is causing problems and troubles, and to suggest a possible resolution to depict [10].

2 Methods

This research presents a case study of an Onshore Collaborative Centre design, where an Ergonomic Work Analysis and three Ergonomics Simulations cycles were performed to support the discussions with workers and managers to create design solutions. The subsequent analysis of the ergonomic design process used in the case study aimed to understand how Work Analysis and Ergonomics Simulations can contribute as participatory methods in IO projects.

2.1 Case Study Context

This research was carried out in one of the oil production units of the studied petroleum industry, from February 2017 to April 2018, which operates in the exploration of the pre-salt area. To optimize operation in this environment, with platforms about 280 km offshore and in ultra-deep water at depths of 2,200 m, for example, the unit needs increasingly structured support onshore.

To this end, the production unit initiates several onshore support initiatives for offshore production and starting an OCC, following the trend of operational integration of the international oil and gas industry. With the expansion of the pre-salt operation and the arrival of new platforms by 2021, the production unit started the OCC restructuring project to expand its capacity to support maritime operations.

The design of the new OCC would move its place of operation, currently in separate rooms, to a large center that would be located in an old, unoccupied restaurant and kitchen in the same building. The aim was that the new OCC would be able to accommodate the increase in staff and to allow for reinforced interactions between teams, making the integrated support character effective.

2.2 Case Setting and Participants

The participants in the study are composed by the existing OCC teams, which are: 3 predictive monitoring cells of equipment and systems on board offshore platforms; 1 logistics support team; 1 operational support team, which controls the gas network

and provides emergency support for offshore operations; 1 support team for gas flow planning and optimization; 1 infrastructure support team for the OCC itself and the IO management team, which were the project demanders.

The first stage of the study of work, the phase of prior analysis [17], sought to understand the work globally, its main tasks, as well as the main interactions between teams, inside and outside the OCC. The objective was the construction of integration hypothesis between the OCC teams, represented by a sociogram, which would guide the construction and the simulation of layout proposals. To this end, the existing process mapping documents made available by the company were analyzed, and open interviews and non-systematic observations were conducted with the OCC teams.

After the validation of the integration hypothesis with managers and workers, the ergonomics team returned to the field to further study the work. According to Maline [17] and Daniellou [14], the objective of deepening work analysis within the framework of a simulation approach is to identify typical work situations. It is a projective, scenario-making phase, and depends on prior analysis, as a scenario is no more than a case of assembling variables with certain criteria, identified during the previous phase and belonging to all areas of the situation to be conceived.

Maline [17] highlights that a scenario respects the systematics of a work situation. In the OCC project, the following variables were analyzed: (1) elements of the work activity; (2) elements of the task to be performed; (3) monitoring and platform support characteristics; (4) characteristics of the organization; (5) incident types and emergency situations; and (6) elements of the time course.

The simulation phase was organized in 3 stages. The first stage started discussions with teams and managers about two layout alternatives generated by the ergonomics team from the study of work. The main objective was to select one of the two proposals for discussion in the next simulation sections. The resources used were paper schematic floor plans and pens for interventions by workers and managers.

The second stage was held at the exact location that would be transformed to house the new CCO. The resource used was “game board”, which is a rigid board, with the vinyl-printed schematic floor plan for writing and erasing, with pieces representing the workstations that could be moved. The board was used as a support for discussion about the organization of spaces.

As a result of the second stage of simulation meetings, an ergonomics team reproduced the layout associated with a three-dimensional (3D) package for use in the third stage of simulation meetings, that took place 20 days later. Like to the second stage, the meeting was held in the environment to be modified and the game board, the floor plans printed on paper including and the 3D model images, was used as support.

During the simulations, the ergonomists presented the project that was developed and made questions regarding the space and the work activity to be performed in it. The questions were based on typical work situations, structured in the study phase of the teams’ in-depth work. The team of ergonomists had the main function of being mediators and the main objective was to lead the participants to reflect on their own work and present their space organization proposals.

The ergonomists’ mediation had to adapt to the different situations during the simulations, with each new layout proposal made by the participants, information about the

work situations was again put "in play" for discussion, as the propositions of reflection on the work without the influence of technical devices and the reflection on how emergency situations would be conducted, for example.

3 Results

The results of the work analysis and simulations are presented in this section, divided into two parts. First, we present the result of the work analysis that allowed the generation of the first layout alternatives and the mapping of the work situations used in the simulations. Then, the layout evolution in the different phases of the simulations, contextualized by the content analysis of the discussions held by the participants. Here, the example of monitoring teams is used to illustrate this development.

3.1 The Role of Work Analysis

First, with the Work Analysis, it is possible to characterize the existing integration between the OCC teams. The creation of a sociogram allowed visualizing the relational and communication intensity within the team, and among other teams. Recording the different frequencies of interactions between cells guided the grouping and the required proximity between teams in the space design. The nature of integrated work guided discussions with project managers to validate the sociogram. Based on the work analyzed and the integration groups identified, the ergonomics team started the first OCC layout studies.

Subsequently, on the understanding of team functioning, data analysis strategies and integration with other teams, the ergonomics team compiled the typical situations of the teams to construct scenarios in the final simulation meetings, contributing to the reflections about future work and the intended environment design with elements of real work.

3.2 The Role of Simulations

The three simulation cycles show how innovative proposals were created at each stage. The first simulations contributed to equalizing the knowledge of the project among the participants (operators and managers). For the second and third cycle of simulations, the use of a game board and a virtual model enabled a reflection on the layout of the workstations since it was possible to study new possibilities and modify the layout during the discussions about the operation space in different work situations.

Taking the case of the monitoring team as an example, the first and second simulation cycle has the influence of technical devices on most of the dynamics. The videowall guided the layout by both operators and management. The occupation is discussed more in function of a technical disposition than in function of the work, even with the work situations being put for the discussion. To encourage the change of logic, the ergonomists requested that only the work be considered, removing the concern of adjusting the layout according to a technical device.

Thus, monitoring operators reported how information exchanges were made to analyze a possible deviation, data searches in different systems, the possibility of grouping between two operators around a monitor for case discussion and training. These typical work situations were mostly held in informal corridor meetings between workstations.

In the third simulation cycle, operators proposed a new layout, which was discussed between the three monitoring teams earlier: *"(…) The videowall is impacting what the* [monitoring] *team is most important today, which is the interaction!"*.

The operators' proposal was to organize the workplaces in half circles so that operators could hold meetings at the center and still have some video viewing when they needed it. In this way, from the operators' point of view, they would be able to meet the needs of the team's integrated work and the requirements of the need to concentrate information on large screens placed by management and the IO team. Figure 1 shows the result of layout development in secondary and tertiary simulation.

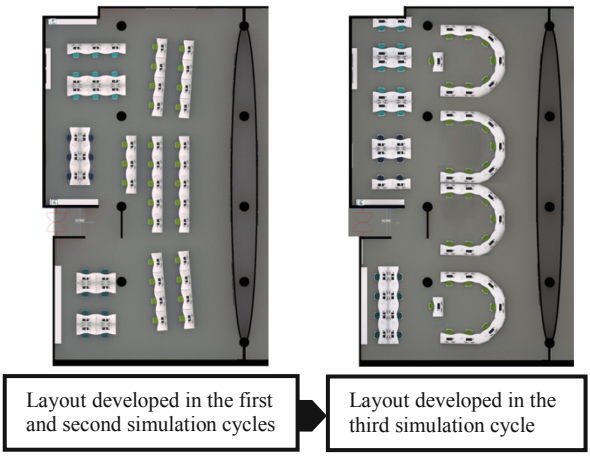

Fig. 1. Layout results developed with the participation of operators in the second and third simulation cycles.

4 Discussion

The results show that simulation is a method that can transform work into an important factor both in modifying the project and in technical choices. It also allows for the inclusion of different actors and their perspectives. However, for the simulation to be an effective means of participation, it is necessary to have an integration between the work analysis and the expectations of the project.

The analysis of the work and the simulation maintain dialectical ties during the conduction of the project. The work analysis allows producing knowledge of the work, which guides the choices that are made during the design. The detailed analysis of the activity allows the debates about the work in the simulations to concretely contribute to the transformation of the working conditions.

As an example of the monitoring team presents, operators organize small meetings to build a shared context about the state of the platform. Applying the "typical work situations" during the simulations made it possible to put the work on the scene, even when managers insisted on an integrated vision from large screens, such as video wall. Without a staging, based mainly on the elements of the activity, the discussion about the work would not take place and would have focused on technical devices.

The solution found by the monitoring operators, which aimed to meet both the technological demands of managers and the interaction through the meetings between workers, demonstrates how it is possible to deal with the differences between actors so different from the same project and create innovative solutions.

According to Béguin [18], the design is characterized by heterogeneous points of view; operators and designers can legitimately discourse-give. But these discrepancies are the driving force behind the modification of the characteristics of the object being designed, that is, the criteria are modified, the specifications adjusted, and the purposes redefined so that the solution is acceptable within the group.

5 Conclusions

New technologies do not bring and do not solve alone the collective dimension that is needed for implementing "Integrated operations". It is necessary to know and bring elements of work to the project. Ergonomic Work Analysis and Ergonomic Simulation as a participatory ergonomics approach allows reflection, new developments and, above all, brings the view of work as an important decision variable in the IO design process.

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