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Cognitive requirements in the redesign of a TRIGA RC-1 control room: The role of the operators' evaluations.

Abstract

When a control room undergoes to a redesign process it is of crucial importance to analyze how operators critically review it and which improvements they suggest. This is even more critical when presumably the same people will operate in the new "redesigned" control room: Consistency in the mental models possessed by the operators of the plant functions and of their control should be emphasized.

Consistency in the mental models can be assumed when redesign follows well-established guidelines drawn from experiences and studies carried out in very similar situations. However, this condition is not fulfilled when a nuclear research control room has to be redesigned, since available guidelines (e.g.; NUREG-0700) are based on studies conducted on nuclear power plant control rooms. These two types of facilities are of much difference as for activities performed in the control room, goals to be aimed at, costs and risks. As a consequence, the available guidelines cannot be safely applied to such a situation as the redesign of a TRIGA RC-1 control room.

So, data have to be collected in order to allow the operators to efficiently and easily adapt to the new control room by consistently "updating" their mental models. In the present study, these data have been collected through structured interviews, which consisted of a modified version of EPRI.

The results can be summarized as follows: 1) The operators critically reviewed the present control room and underlined the lack of "transparency" of the control system as for the plant's conditions and for the feedbacks about their own activities. 2) The operators' work analysis showed that they spend much of their time out of the control room. This means that, if the operators have to stay in the control room, they should be allowed to perform more and higher-level activities than those presently required, to prevent understimulation.

So, the redesign should allow and support the central control and maintenance, and other activities at local level

(i.e., out of the central control room), or improve the quality of control activities carried out in the central control room by allowing them to test hypotheses by using error tolerant system of experimentation.

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This essay aims at showing the results of a by-project of a research on the ergonomical requirements in the redesign of a TRIGA control room at ENEA. This by-project wants to indicate some suggestions on how to make modifications and improvements to the control room, considering the working experience of the qualified personell encharged with the functioning of the research plant.

The object and the goals of this project derive from a choice which is based at least on three considerations.

Firstly, among the methodological means of ergonomics useful for the design of control-systems, the use of guidelines becomes more valuable if founded on an analysis of the specific problems toward which the project is orientered.

The blind application of ergonomical standards in the elaboration of a project could paradoxically induce to those very projectual errors, which the same utilization of an ergonomical approach intends to avoid.

This general consideration becomes more important if the control room to be designed is -for its dimensions and use-

different from those of nuclear power plants, to which, indeed, most of the present guidelines are dedicated.

Finally, there is a third but not least consideration that in this research induces to look for specific methodological solutions. When the control room's realization is not "ex-novo", that is when the project wants to modify and improve a control room already functioning for several years at normal rate, it is useful to start from the existing one and necessary to consider both the constraints to be respected and the limits which can be overcome.

Obviously, this means that the know-how of the control room's personell is most important to define correctly these constraints and, before all, the limits born during the functioning life of the control room. The control room's personell represents, therefore, a primary source of suggestions and proposals for the control room's improvement.

Moreover, it is even more important the fact that the control room's modifications introduced during the redesign do not oblige the personell to change inconsistently the mental representations (as organized knowledge) formed

during the work experience in the preexisting organization of the control room.

In other terms, as far as it is unavoidable that the redesign of a control room implies some changes in the mental models which the operators have of their own activities, it is of crucial importance that these changes are consistent with the preexisting organization of their knowledge.

Two main methodological instruments have been utilized in this research in order to reach this aim.

Methodology

The data have been collected through a structured interview to the TRIGA room's operators and supervisors, utilizing an adapted version of structured questions prepared under the commitment of EPRI (cfr.; EPRI). The data collected during the interview have been elaborated and then compared to the results of the work analysis.

The personell interviewed

Four operators and four shift supervisor took part to the research.

Results

The structured interview

On showing the results of the 53 questions made to the operators and supervisors, we shall strictly utilize the part regarding the panels and control-devices.

In the present design of the control room, the control-devices and display-systems (for example, those for reading the parameters) are generally located in easily-to-reach positions. Nevertheless, the operators believe that there exists a useless dispersion of the control-instruments (for example, the gas and dust monitors are located at the back of the operator when he sits in front of the console).

Moreover, the different panels are not clearly identified and distincted, neither through a symbology or a signals' system that allows a subitaneous detection off the devices to be reached, nor through verbal labels.

In the TRIGA's case at ENEA, the lack of operative aids is worse by the absence of signals' indicators which show the normal functioning values.

On one side, that means that the operator is not helped in identifying the devices useful for the activities which he is performing.

On the other side, this implies that, during the performance, the operator is obliged to rely completely on an inner information's source. From this point of view, the risk (clearly denounced by the operators themselves) to make errors both during the recognition and the wanted device's detection phase and during the executive phase, appears to be clear.

According to the interviewed, there lack clarifying graphes and synoptical information in case of malfunctioning. The relative assistance procedures are scarcely specified; and the relative handbook is not easy to consult.

Moreover, the warning systems of breackdowns and abnormalities (i.e., the alarms) are aspecific; that is they do not adequately address the operator to ward the breackdown's nature.

That means that, in case of alarm, the operator on duty has to signal it to other operators who are not at the consol. These last, in turn, have to go into the reactor's room to

control by person (de visu). Hence, it is not possible an efficient remote control.

The work analysis

From the interviews' results we can desume that the operators' activities in the control room are actually timely limited and are qualitatively low.

The activities' "core" of the personell of the plant is performed out of the control room and mostly in the reactor's room.

That is due to the characteristics of the reactor that is used to perform experimental proof of tests requested by the staff of researchers. The service personell in the plant performs, therefore, aiding functions for the outer personell and maintenance services for the plant itself.

However, the work's low quality in the control room is certainly caused also by the paucity of the potentialities offered by the control and command instruments.

That means that it is possible to reduce the understimulation of the operator at the console, by making the control task more efficacious and efficient.

In other terms, if the operators have to stay in the control room (as the law prescribes) they should be allowed to perform more and higher-level activities than those presently required.

That means to improve the quality of control activities carried out in the central control room, by allowing them to test hypotheses by using error tolerant system of experimentations. To this purpose the redesign of the control room should allow and support the central control and maintenance at local level (i.e., in the reactor room).

