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Neuropsychological Aspects Observed in a Nuclear Plant Simulator and its Relation with Human Reliability Analysis

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Synopsis

This paper will discuss preliminary results of an evaluation methodology for the analysis and quantification of errors in manual (human) operation by training cognitive parameters and skill levels in the complex control system operation using Neuropsychophysiology and Neurofeedback equipment.

The research was conducted using a game (nuclear power plant simulator) that simulates concepts of operation of a nuclear plant with a split sample evaluating aspects of learning and knowledge in the nuclear area. Operators were monitored using biomarkers (ECG, EEG, GSR, face detection and eye tracking) and the results were analyzed by Statistical multivariate techniques. An important component in the evaluation of complex systems is the human reliability during operation. Human reliability refers to the probability of the human element perform the tasks scheduled during the defined period for system operation when tested under specified environmental conditions, and additionally not to take any action detrimental to system operation.

The neuro scientific study of human behavior has advanced greatly in recent decades and today is an invaluable tool when the goal is to study human behavior in various situations, allowing treatment of limitations of methods available for the analysis of the human factor contribution to complex control system operation by identifying and evaluating factors involved in decision making, as the influence of ergonomic factors in the criteria of acquired skills (training) and cognitive. Cognitive ergonomics refers to mental processes such as perception, memory, reasoning and motor response as affecting the interactions among humans and other elements of a system. Relevant topics include the study of mental workload, decision making, specialized performance, man machine interaction, stress and training as correlation between projects involving complex operating systems and human operator.

Taking into account the difficulties imposed by the human profile, the use of cognitive monitoring equipment is an interesting option for the full assessment in training and operating procedures, it is possible to identify and record the patterns of cognitive skills and acquired in each operator as foci attention, reaction ability, level of knowledge and motor actions, which may be assessed later by a monitoring group composed of the most experienced operators, psychologists and engineers linked to the process. After evaluation of operators with the methodology applied, the collected information can be used in a Human Reliability Analysis.

For analysis of the collected data from Eye Tracking, EEG (electroencephalogram), BPM (Cardiac Monitoring) and GSR(Galvanic Skin Response) it will take into account as a model the most capable and experienced operators, aiming to flatten all operators in a high standard of human reliability. It is necessary to observe moments of high workload, when there is a higher probability of micro incidents. Thus, the authors will try to observe state change situations such as shutdowns and planned matches, incidents assumptions and ordinary features of operation.

In this sense, the research related neuropsychological aspects can contribute to improving the techniques available in order to make it more realistic techniques that may eventually be employed in human reliability

analysis both in the context of quantitative approaches for regulatory purposes as well as refers to reducing the incidence of human error. Therefore, the research on neuropsychological aspects is a big step to improve techniques and analysis models of human reliability to meet the goal set for this research project. Because the amount of data and the analysis of complexity only initial results will be presented.

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Primary author: DO PRADO, Eugenio (Sao Paulo University)

Co-authors: PINHEIRO, Andre (Sao Paulo University); Dr SILVEIRA, July (Sao Paulo University); Dr MARTINS, Marcelo (Sao Paulo University)

Presenter: DO PRADO, Eugenio (Sao Paulo University)

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