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Complexity in Safety-Critical Systems

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In the Human-Machine Interaction (HMI) domain, many researchers are trying to model complexity. Complexity can be defined in air traffic control domain as the quantity, variety and interconnections inside a particular system [1]. Javaux and De Keyser defined cognitive complexity as the quantity of cognitive resources that a human operator must involve to make sure that tasks are executed with an acceptable level of performance [2]. The research problem is focused in the distinction between objective complexity and perceived complexity. A system can be internally complex or not and it could be perceived as complex anyway by its operator [3]. How can we simplify its use? This problem is important in safety-critical systems, where the human error is the main causal factor for almost 70% of accidents [4].

It is still not clear with aspects of a control room contributed to increasing perceived complexity and how this complexity affects the operator's performance. Recent studies in the nuclear power plant control rooms are trying to understand complexity sources following field studies with interviews with reactor personnel and use of a full scale simulator [5].

These researchers apply the Human Reliability Analysis (HRA), an incident report database with 22 commercial nuclear plant incidents and an elicitation questionnaire to identify a set of complex sources with the help of control room operators. This is an ongoing research in the assessment of human-system interaction complexity [6].

From the point of view of complexity-mitigation strategies there are a set of useful rules [7]:

- Study the attentional capacities of the human operator
- Interfaces may be optimized
- The system might be made more usable
- The user may be trained in the workings of the interface involving system and environment (trying to decrease the unpredictability)
- The system itself may be made more stable (encouraging cognitive stability)

Following Rob Tannen, the study of complexity is focused in product design [8]. In order to manage complexity, this author defines three approaches:

- Defeaturing (reducing complexity)
- Demystifying (using design to clearly communicate complexity)
- Distributing (allocating complexity between the user and the system)

In any case, it is difficult to model complexity and the human factors and ergonomics approach can be useful in this task.

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