Performance in manual process control – mediation of time pressure and practice effects by the structure of control behaviour

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Abstract

An explanation of how practice and time pressure may affect performance in dynamic control tasks is offered in the Contextual Control Model (COCOM, Hollnagel, 1993): Performance depends on the orderliness of operator behaviour, i.e. how well control actions are planned in advance. Whether an operator can develop proper plans to guide his/her control actions depends on a number of contextual factors, e.g. the subjectively available time (which is decreased by time pressure) and the familiarity with the task (which increases with practice). COCOM further predicts that due to recurring patterns of actions, the structure of a sequence of systematically chosen control actions will be more regular than actions taken in a trial-and-error fashion without a guiding plan, which will show more random patterns.

The predictions of COCOM were tested in an experiment with 40 participants who manually controlled five parameters in a process control simulation. While earlier studies of COCOM relied on subjective ratings to assess orderliness, we examinded the regularity of the structure of control actions with emc_{dfr}, an objective measure of regularity which is based on information theory (Röttger, Klostermann & Manzey, 2007). Results show that both performance and the amount of regularity in the operator behaviour increase with practice and decrease under time pressure, and that regularity of control actions mediates practice and time pressure effects on performance. These are the first objective data to yield empirical support to COCOM's predictions regarding time pressure and practice effects on operator behaviour.

Introduction

In order to optimize the design of human-machine systems, it is necessary to predict, and thus to understand how operators act in various situations that may arise while they are performing their tasks. A possible way to gain insight into the processes of operator behaviour is to develop models of operators. Such models are often developed from a theoretical perspective and have a rather small empirical basis. A

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