Examination of the proximity-compatibility principle in the design of displays in support of fault management

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Abstract

The proximity-compatibility principle (PCP) proposed by Wickens and Carswell (1995) is examined on the basis of experimental results obtained with the process-control micro-world AUTO-CAMS. The PCP postulates a performance trade-off in display design that implies that display features that support information integration may degrade focused attention. In AUTO-CAMS, information integration is required when operators, in case of system failures, have to engage in fault identification by mapping multiple anomaly symptoms to single root causes. Focused attention is demanded by one of the secondary tasks that require the operators to selectively read out gauge values while simultaneously ignoring other display elements. The AUTO-CAMS display was supplemented with an integrated display to support information integration implying the cost of deteriorating the focused attention task. In addition, two levels of automation of a model-based fault management reasoning agent were examined. In 70% of the trials this support was reliable. In the remaining trials, difficult double-faults occurred where the agent's support became "brittle" in terms of identifying only one fault correctly, missing fault identification at all because of symptom masking, or giving a false fault identification. Only during 'brittle' trials both PCP predictions could be confirmed: (1) The information integration task of fault identification was improved with the integrated display while the secondary focused attention task performance was deteriorated compared to the support with the non-integrated display. Means to cope with this trade-off problem are discussed.

Introduction

In many high-risk working environments such as piloting an aircraft, air traffic control, or process control, operators have to process huge amounts of data that emerge in a dynamic, distributed, and real-time environment. This may involve extracting low-level sensor data to be matched against some criterion or scanning multiple data sources, often presented in different modalities, to be integrated into meaningful assessments with respect to a higher-level task goal. Making all relevant

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