Cognitive and Affective Components of Mental Workload: Understanding the Effects of Each on Human Decision Making Behavior

by

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Human factors and ergonomics researchers have recognized for some time the increasing importance of understanding the role of the construct of mental workload in flight research. Current models of mental workload suggest that it is a multidimensional and complex construct, but one that has proved difficult to measure. Because of this difficulty, emphasis has usually been placed on using direct reports through subjective measures such as rating scales to assess levels of mental workload. The NASA Task Load Index (NASA/TLX, Hart and Staveland [1]) has been shown to be a highly reliable and sensitive measure of perceived mental workload. But a problem with measures like TLX is that there is still considerable disagreement as to what it is about mental workload that these subjective measures are actually measuring.

The empirical use of subjective workload measures has largely been to provide estimates of the cognitive components of the actual mental workload required for a task. However, my research suggests that these measures may, in fact, have greater potential in accurately assessing the affective components of workload. That is, for example, TLX may be more likely to assess the positive and negative feelings associated with varying workload levels, which in turn may potentially influence the decision making behavior that directly bears on performance and safety issues. Pilots, for example, are often called upon to complete many complex tasks that are high in mental workload, stress, and frustration, and that have significant dynamic decision making components -- often ones that involve risk as well.

Studying Workload and Dynamic Decision Making. There has been little systematic research investigating the potential relationship between changes in workload and decision making behavior, particularly risk-taking behavior. The major effort of this summer project has been to design laboratory experiments to systematically examine this relationship. If subjective measures of workload actually assess the affective components of workload more so than the cognitive components, then these measures should prove useful in relating workload to risk-taking and risk-avoiding tendencies. TLX, for example, has a frustration/stress dimension that would allow one to measure the affective nature of an individual's subjective experience of workload, either positive or negative.

There is a vast psychological literature that suggests that because we are limited information processors, the cognitive components of decision making are flawed and biased. By far the most significant work is that of Kahneman and Tversky [2] which has shown very dramatically that individuals can make opposite choices between a pair of competing alternative if the

situation is merely framed differently. Specifically, when choice alternatives are framed in terms of what could be gained, people are generally risk-averse. That is, they will often choose a sub-optimal sure gain in order to avoid or reduce risk. However, when the same situation is framed in terms of what could be lost, people are often risk-seeking -- that is, willing to take a chance on a sub-optimal gamble in order to avoid a sure loss.

There is also compelling evidence that decision making processes can be influenced by one's affective mood state. For example, Isen, Nygren, and Ashby [3] have shown that a positive mood state can lead decision makers to exhibit conservatism in risky choice situations. They become overly sensitive to potential losses and make decision in such a way as to avoid losses. People in negative moods also exhibit a cautious shift toward risk-aversion in their actual choices, but they do so apparently through a different mechanism. These individuals tend, when evaluating alternatives, to focus on negative outcomes and give them more weight in the decision process.

Clearly, such findings on these decision biases and on mood state are potentially relevant for pilots as they relate to predictions of how risky decisions might be made under varying levels of workload. The goal of this summer research was to design a series of studies using the Multi-Attribute Task Battery (see Arnegard & Comstock [4]). The MAT is a PC-based battery of tasks that incorporates activities analogous to those performed in flight. Figure 1 illustrates the video monitor display of the tasks included in the MAT -- monitoring, tracking, auditory communications, and resource management. Studies will be done using the MAT in an attempt to examine the effects of positive and negative affect or mood on actual MAT performance as well as on perceived performance and workload levels. In particular, we are interested in whether strong differences that have been previously found in more restrictive laboratory settings using simple gambling behavior will generalize to decision strategies used in the dynamic components of the MAT monitoring and decision making tasks.

References:

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Multi-Attribute Task Battery

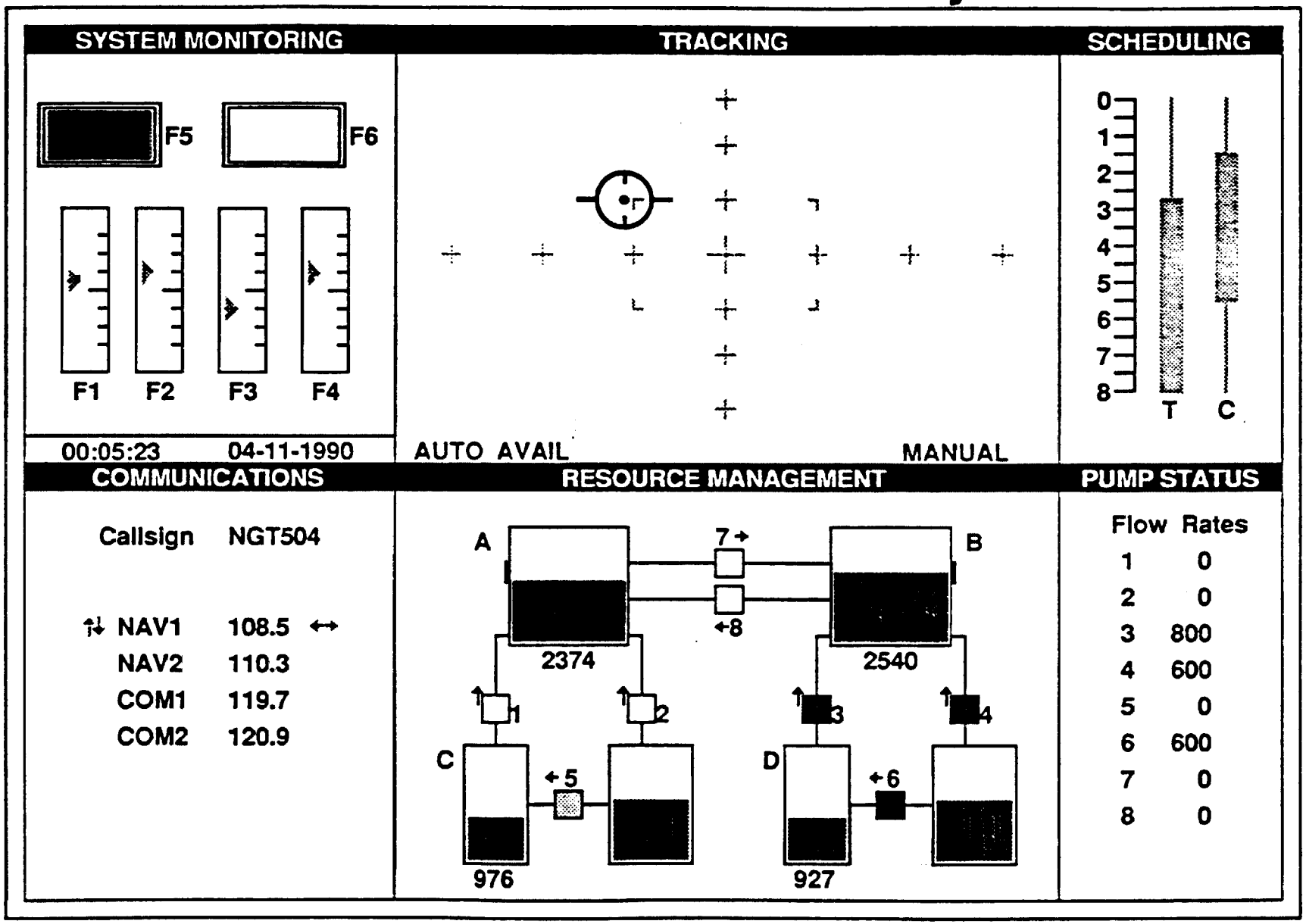

Figure 1