THE OHIO STATE UNIVERSITY

Cognitive Engineering in Aerospace Applications

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Progress Report
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"Cognitive Engineering in Aerospace Applications"

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Project Overview

This report describes the progress that has been made with respect to the objectives and goals of the research that is being carried out in the Cognitive Systems Engineering Laboratory (CSEL) under a Cooperative Agreement with NASA Ames Research Center (Cognitive Engineering in Aerospace Applications, NCC2-592, Principal Investigator: David D. Woods).

The major objective of this project is to expand the research base in Cognitive Engineering to be able to support the development and human-centered design of automated systems for aerospace applications.

This research project is in support of the Aviation Safety/Automation Research plan and related NASA research goals in space applications.

Situation and Mode Awareness Within The "Glass Cockpit"

A series of empirical studies on pilot-automation interaction on the B-737-300 has identified as one of the major problems pilots' difficulties with tracking the status and behavior of the automation, i.e. pilots' difficulties with maintaining mode awareness. The methodological approach and the results of these studies were recently summarized in the NASA Contractor Report No. 177617 entitled "Cognitive Engineering in Aerospace Application: Pilot Interaction with Cockpit Automation" (August 1993).

Based on the assumption that a decrease in mode awareness is not inherent in automation but rather a consequence of its specific implementation, a comparative study looking at the highly advanced and powerful automated systems on the flight deck of the Airbus A-320 was initiated in cooperation with Northwest Airlines in June 1993. The goal of this study is to identify and analyze difficulties specific to the operation of the A320 automation and to find possible ways of supporting mode awareness through modifications of the design and training for advanced technology in general and for the Airbus A320 in particular.

As a first step in this line of research, Ms. Nadine Sarter had the opportunity to attend NWA's initial two-week training for the Airbus A-320. This training consists of both classroom lessons, computer-based instruction, and a few first sessions on the fixed-base simulator of the A-320. This training allowed Ms. Sarter to familiarize herself with the automated cockpit systems on the aircraft in preparation for the planned research.

As a second step, we have just finished a survey of all NWA A320 pilots (n=750) to find out about their experiences with respect to the training for and the line operation of the A320 automation. This survey started on September 1, 1993 and so far, 169 pilots have responded. We are currently evaluating their responses which will serve as one source of input on problems and possible countermeasures related to the operation of the A320 automation. In combination with our observations of ongoing training and of jumpseat

observations of line operations of the A320, these data will ultimately lead to an experimental study of factors and circumstances that affect pilots' ability to operate and monitor the automation.

The next step in this line of research will be a meeting with representatives of Northwest Airlines in January for a briefing concerning the training-related results of the survey and for planning a simulator study of mode awareness on the Airbus A320.

Situation Awareness Beyond the Glass Cockpit - The Impact of DataLink

In a different line of research, we have started to look at different concepts, designs, and procedures that have been proposed for the envisioned digital communication medium for air traffic control called 'DataLink'. We are interested in identifying and predicting any deficiencies that are likely to have an impact on pilots' and controllers' ability to maintain awareness of the traffic and communication situation.

To get an overview of the different proposed DataLink implementations, we have recently visited NASA-Ames Research Center to observe ongoing experiments looking at the feasibility and operation of one particular implementation of DataLink on the flight deck of the ACFS (October 26 and 27). We also had the opportunity to visit the MITRE Corporation and attend a demonstration of their DataLink implementation for air traffic controllers (November 11). We plan to continue our survey of different proposals for DataLink to compare their information contents and presentation.

Recent Publications

N. B. Sarter and D. D. Woods (1993). Cognitive Engineering in Aerospace Applications: Pilot Interaction with Cockpit Automation. NASA Contractor

Report CR-177617. NASA-Ames Research Center, Moffett Field, CA, August.

N. B. Sarter and D. D. Woods (in press). "How in the world did we ever get into that mode?" Mode Error and Awareness in Supervisory Control. Human Factors - Special Issue on Situation Awareness.

N. B. Sarter and D. D. Woods (in press). Pilot Interaction with Cockpit Automation II: An Experimental Study of Pilots' Model and Awareness of the Flight Management System (FMS). International Journal of Aviation Psychology.

D. D. Woods and N. B. Sarter (in press). Evaluating the Impact of New Technology on Human-Machine Cooperation. In J.A. Wise, V. D. Hopkin, and P. Stager (Eds.). Verification and Validation of Human-Machine Systems. Springer Verlag, NATO-ASI series, pp. 133 - 158.

D. D. Woods, L. Johannesen, N. B. Sarter, and R. I. Cook (in press). Behind Human Error: Cognitive Systems, Computers, and Hindsight. Crew Systems Ergonomic Information and Analysis Center (CSERIAC), Dayton, OH (State of the Art Report).

D. D. Woods and E. M. Roth (in press). Symbolic AI-Based Computer Simulations as a Tool for Investigating the Dynamics of Joint Cognitive Systems. In J.-M. Hoc, P.C. Cacciabue, and E. Hollnagel (Eds.), Expertise and Technology: Cognition and Human-Computer Cooperation. LEA.

D. D. Woods (in press). Cognitive Demands and Activities in Dynamic Fault Management: Abduction and Disturbance Management. In N. Stanton (Ed.), Human Factors of Alarm Design. London: Taylor & Francis.

D. D. Woods (in press). The Price of Flexibility in Intelligent Interfaces. Knowledge-Based Systems.

Invited Presentation

D. D. Woods and N.B. Sarter (1993). Pilot Interaction with Cockpit Automation: Implications for What is Human Error. Briefing to the National Transportation Safety Board, Washington, D.C., October 4, 1993.