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CREW DECISION MAKING UNDER STRESSS. J. Orasanu. NASA-Ames Research Center, Moffett Field, CA 94035

INTRODUCTION. Flight crews must make decisions and take action when systems fail or emergencies arise during flight. These situations may involve high levels of risk, information uncertainty, and time pressure, factors that contribute to stress. Full-mission flight simulation studies have shown that crews differ in how effectively they cope in these circumstances, judged by operational errors and crew coordination. The present study analyzed the problem solving and decision making strategies used by crews led by captains fitting three different personality profiles. Our goal was to identify more and less effective strategies that could serve as the basis for crew selection or training. METHODS. Twelve 3-member B-727 crews flew a 5-leg full-mission simulated flight over 1 1/2 days. Two legs included 4 abnormal events that required decisions during high workload periods. Transcripts of videotapes were analyzed to describe decision making strategies. Crew performance (errors and coordination) was judged on-line and from videotapes by check airmen. RESULTS. Based on a median split of crew performance errors, analyses to date indicate a difference in general strategy between crews who make more or less errors. Higher performing crews showed greater situational awareness--they responded quickly to cues and interpreted them appropriately. They requested more decision-relevant information and took into account more constraints. Lower performing crews showed poorer situational awareness, planning, constraint sensitivity, and coordination. The major difference between higher and lower performing crews was that poorer crews made quick decisions and then collected information to confirm their decision. CONCLUSION. Differences in overall crew performance were associated with differences in situational awareness, information management, and decision strategy. Captain personality profiles were associated with these differences, a finding with implications for crew selection and training.

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COGNITION AND PROCEDURE REPRESENTATIONAL REQUIREMENTS FOR PREDICITIVE HUMAN PERFORMANCE MODELS

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Models and modeling environments for human performance are becoming significant contributors to early system design and analysis procedures. Issues of levels of automation, physical environement, informational environment, and manning requirements are being addressed by such man/machine analysis systems. The research reported here investigates the close interation between models of human cogntiion and models that describe procedral performance. We describe a methodology for the decomposition of aircrew procedures that: supports interaction with models of cognition on the basis of procedures observed; that serves to identify cockpit/avionics information sources and crew information requirements; and that provides the structure to support methods for function allocation among crew and aiding systems. Our approach is to develop an object-oriented, modular, executable software representation of the aircrew, the aircraft, and the procedures necessary to satisfy flight-phase goals. We then encode, in a frame-based language, taxonomies of the conceptual, relational, and procedural constraints among the cockpit avionics and control systems,and the aircrew. We have designed implemented a goals/procedures hierarchic representation sufficient to describe procedural flow in the cockpit. We then execute the procedural representation in simulation software and calculate the values of the flight instruments, aircraft state variables and crew resources using the constraints available from the relationship taxonomies. The system provides a flexible, extensible, manipulable and executable representation of aircrew and procedures that is generally applicable to crew/procedure task-analysis. The representation supports developed methods of intent inference, and is extensible to include issues of information requirements and functional allocation. We are attempting to link the procedural representation to models of cognitive function to establish several intent inference methods including procedural backtracking with concurrent search, temporal reasoning, and constraint checking for partial ordering of procedures. Finally the representation is being linked to models of human decision making processes that include heuristic, propositional and prescriptive judgement models that are sensitive to the procedural context in which the valuative functions are being performed.

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BEYOND THE COCKPIT: THE VISUAL WORLD AS A FLIGHT INSTRUMENT. W.W. Johnson, M.K. Kaiser, and D.C. Foyle. NASA Ames Research Center, Moffett Field, CA 94035-1000.

The use of cockpit instruments to guide flight control is not always an option (e.g., low-level rotorcraft flight). Under such circumstances the pilot must use out-the-window information for control and navigation. Thus it is important to determine the basis of visually guided flight for several reasons: 1) to guide the design and construction of the visual displays used in training simulators; 2) to allow modeling of visibility restrictions brought about by weather, cockpit constraints, or distortions introduced by sensor systems; and 3) to aid in the development of displays that augment the cockpit window scene and are compatible with the pilot's visual extraction of information from the visual scene. The authors are actively pursuing these questions. We have ongoing studies using both low-cost, lower fidelity flight simulators, and state-of-the-art helicopter simulation research facilities. Research results will be presented on: 1) the important visual scene information used in altitude and speed control; 2) the utility of monocular, stereo, and hyperstereo cues for the control of flight; 3) perceptual effects due to the differences between normal unaided daylight vision, and that made available by various night vision devices (e.g. light-intensifying goggles and infra-red sensor displays); and 4) the utility of advanced contact displays in which instrument information is made part of the visual scene, as on a "scene-linked" head-up display (e.g., displaying altimeter information on a virtual billboard located on the ground).

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USING AND DESIGNING PROCEDURES; LESSONS LEARNED FROM AVIATION. A. Degani. San Jose State University Foundation, San Jose, CA 95106. E. L. Wiener. University of Miami, Coral Gables, FL 33124

Procedures drive almost every task and sub-task on the flight deck of a commercial airliner. Failure to conform to Standard Operating Procedures (SOP) is frequently listed as the cause of violations, incidents, and accidents. Moreover, according to a study of 93 commercial aviation accidents, the leading crew-caused factor in aviation accidents was "pilot deviation from basic operational procedures" (Lautman and Gallimore, 1988). However, in most cases procedures and checklists are designed piecemeal, rather than based on a broad philosophy and on policies for operations. A framework of philosophy, policies, procedures and their relationship to the actual practices on the flight-deck is suggested. Initial results of an ongoing field-study to investigate the usefulness of these concepts will be reported.

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Lautman, L. G., & GALLIMORE, P.L. (1988) . Control of the crew-caused accidents. Seattle: Boeing Commercial Airplane Company.

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AIRCREW REACTIONS TO COCKPIT AUTOMATION, E. L. Wiener. University of Miami, Coral Gables, FL 33124

The modern, highly automated taransport cockpit has brought a new era of highly efficient flight. But it has also introduced new problems of situational awareness, remoteness from the basic airplane, and concerns about possible loss of manual flying proficiency. This paper will discuss the "good new/bad news" of cockpit automation.

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MILITARY AIRCRAFT ACCIDENTS, CURRENT SAFETY ISSUES. R. A. Levy* (Air Force Safety Agency) and D. T. Fitzpatrick* (Army Safety Center) Co-chairman.

This panel will consist of five presentations on human factor (operator) issues in military aircraft accidents, focusing on immediate and future concerns. The U.S. Army will discuss the underlying causes of aircraft accidents during Desert Shield/Storm as compared to the non-combat environment. The U.S. Navy will review the trends and causes of Naval aviation accidents and the effect on current training. The U.S. Air Force will present the problem of human factors in the logistical arena. The Canadian Forces will discuss their proposed system to collect and analyze human error data from aircraft accidents. The Royal Air Force will describe recent studies concerning emergency egress equipment.