4.11 HUMAN FACTORS ISSUES ASSOCIATED WITH FLIGHT CREW ACCIDENTS AND INCIDENTS - STEVEN D. HARPER AND MARK J. DETROIT

Introduction

The Crew System ERgonomics Information Analysis Center (CSERIAC) was established in 1988 as a national source of human factors information. CSERIAC is a Defense Technical Information Center/Department of Defense (DTIC/DoD) organization, hosted by the Human Engineering Division at Wright-Patterson Air Force Base, and operated by the University of Dayton Research Institute. CSERIAC supports all facets of Human Factors Engineering and Ergonomics for human operated systems.

CSERIACs mission is to provide a quick and reliable source for analytical services, topical publications, software programs, and data bases pertaining to human factors. We collect, analyze, and disseminate information and technologies to support all parties within the government, industrial, and academic sectors concerned with human-machine systems.

Historically, CSERIAC has provided its customers with a broad variety of services and products. Products range from the *Gateway* newsletter (a free periodical published six times per year with a readership exceeding 10,000), to State-of-the-Art Reports (SOARs), covering a variety of areas of high interest to human factors practitioners, to sophisticated human factors engineering and analysis support for short and long term projects.

The aviation experience base at CSERIAC is extensive. In addition to our traditional Air Force customer base, CSERIAC has supported NASA and FAA with human factors analysis of aviation related projects. CSERIAC has experienced pilots and staff (ATP rated, Flight Instructors, military) with accident investigation experience and exposure to state-of-the-art military and commercial flight control and navigation systems. In addition, our staff (and the faculty at the University of Dayton) have extensive operational and research experience with aircraft and simulators covering general aviation, airline, and military operations. CSERIAC is also fortunate to have a member of FAA, Dr. Mark Hofmann, serving on our steering committee.

Discussion

Objective 1: Relevant human factors data

The identification of human factors data relevant to the investigation, and, more importantly, the prevention of aircraft accidents and incidents has been an issue since the birth of aviation. However, it wasn't until the late 1970s that the FAA and the NTSB began to formally recognize the limitations and performance capabilities of human operators as factors in accidents and incidents. Even now, after nearly 30 years of recognizing this important element, there are few computer-based tools or models available for human factors practitioners responsible for the identification of the causes of aircraft accidents. The development of new databases and access

to existing human factors information is an important step toward providing tools that can facilitate credible analysis of human performance.

In order to meet the needs of the users of the data, CSERIAC recommends conducting analysis to identify the information needs of the user population as well as investigating existing procedures and analysis methods. All factors relevant to accident and incident data could then be categorized according to a user's specialty (pilot, investigator, engineer, psychologist, etc.). Potential sources for this data include: NTSB, FAA, NASA, Military, Airline Pilots Association, Aircraft Manufacturers, Airlines, Insurance companies, etc. This analysis effort should also investigate other data sources and strive to uncover missing data elements. The results of this analysis will provide an understanding of current requirements for information and technologies available for accessing and processing it, identify areas of common interest, and facilitate the development of algorithms to tailor information searches for accident/incident investigators. It is important for the designer of any system to have a thorough grasp of the requirements of the user before attempting to implement a solution. It is equally important to assess the current methods for analyzing the data in order to build upon them. CSERIAC has extensive experience in determining and refining user requirements and analyzing technologies which can then be synthesized into design solutions. CSERIAC methods result in a design approach that is based on the needs of the user and aided by technology, rather than an approach which is solely driven by technology.

Objective 2: Human performance and error models

The principles of human information processing theory (Wickens, 1992) and some of the various mental workload assessment techniques may be useful in the analysis of aircraft incidents and accidents. Information processing theory provides a scientific framework for modeling strategies and methods humans use to process information. Human Reliability Analysis (HRA) techniques facilitate the probabilistic risk assessment (PRA) process for predicting when humans are likely to commit errors. Information from the human factors databases could be used to determine the inputs and outputs of the human and system. Fault Tree Analysis (FTA), Event Tree Analysis (ETA), and Root Cause Analysis might be adapted to model the throughput (or processing) of the human, within the context of system characteristics and environmental conditions. This approach would enable various scenarios to be evaluated and yield a higher confidence in identification of probable human causes of accidents or incidents.

This approach could be taken further with the current state-of-the-art of computer technology. Low fidelity (non-motion, part-task) simulations can be developed which would allow investigators to use the human factors data in conjunction with or without Subject Matter Experts (SMEs) (e.g., flight crews) to recreate accident or incident scenarios. The approach using SMEs would be much like that which is used today to recreate an accident scenario in a motion based simulator. The approach without the SMEs would basically use a computer optimized profile based upon either information processing models or queuing theory and would provide a capability to conduct some preliminary analyses before calling in the SMEs.

A side benefit of such a development effort would be the use of tools such as these to design of

new aircraft systems. Designers could get a better allocation of functions between the human operator and the system than is currently capable with a static design environment. In addition, the creation of lessons learned databases (accidents, design, maintenance, Crew Resource Management, etc.) would also influence future designs and greatly aid in determining flight crew error contributions to aviation accidents and incidents.

Objective 3: Conceptual interface

In order to develop an effective user interface for any system, the needs, capabilities, and limitations of the user must be fully understood. CSERIAC has considerable experience with Human-Computer Interface (HCI) from designing Graphical user Interfaces (GUIs) for accessing computer databases and to providing usability guidelines for software tools. CSERIAC's experience includes the development of an extensive internal database of human factors information, database development guidance and support for the US Air Force, creation of a CSERIAC "Home Page" on the World Wide Web, and extensive experience with a variety of databases to support our function as an Information Analysis Center for DTIC.

The need to access information is not much different for accident/incident investigators than it is for many other scientific disciplines. Most of the necessary data exists in one form or another. What is required is an integrated, computer based solution. Users of the data need the ability to access it from one place. A problem that has existed in the past is that much of the data is not text based. The text based data is relatively easy to process and store with electronic methods. The data that is not text based (photo, video, audio, among others) has been much more difficult to store in a central database. Further, data collection procedures in the field do not readily support traditional databasing methods.

The technology to create an integrated, computer based data collection, storage and retrieval system is mature. Many of the needed elements are grossly grouped within multi-media computer-based technology. CSERIAC has much experience with this new technology. To take advantage of multi-media technology, the current process for data collection, dissemination, and usage will have to be analyzed and modeled. This process often results in a number of changes in the process due to new capabilities made available by the technologies. One such change might be the streamlining of field collection procedures using electronic checklists and data input with Laptop PC’s. Further changes would include the storage of photo, video, audio, etc. data on electronic media. Access could be provided nationwide via the World Wide Web. The technology to display and work with the data in this manner exists today. Going a step further, human error prediction models, simulation tools, etc. could also be made available. Levels of access to the data would be controlled by an editable user profile that would be filled in automatically during the initial login phase. The user would provide background information and be granted access to information and tools at a level appropriate for his or her needs.

Conclusion

CSERIAC's charter is to provide human factors support and analysis for projects such as the FAAs initiative to provide accident and incident data to aviation professionals. CSERIAC is staffed with human factors professionals with experience in aviation operations, training, and accident investigation as well as in the access and display of computer based information. CSERIAC is capable of tailoring solutions to meet the unique human factors problems of our customers. In addition, CSERIAC can create a multidisciplinary team of professionals from government, industry, and academia to provide solutions based upon systems engineering principles.

We believe that the intent to provide easy access to human factors data relevant to accidents and incidents will greatly aid the analysis of aircraft accidents. Further, such a database, coupled with human performance models, will facilitate a better, more expedient understanding of the role of the human operator in an aircraft accident or incident. Finally, this initiative may be eventually provide cockpit design personnel with information that will enable the design of cockpits that reduce the probability of accidents and incidents. CSERIAC would be pleased to work with FAA to further develop this initiative and help to integrate it with the national plan for Civil Aviation Human Factors.

References

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Wickens, C. D. (1992). Engineering Psychology and Human Performance 2nd Edition. HarperCollins Publishers, Inc.: New York.