necessarily instead of, but at least concurrent with, hardware research.

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EXTENDING THE POTENTIAL OF OFT's

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The operational flight trainer (OFT) has made for itself a secure place in military aviation training. The OFT is designed to simulate the aircraft so that training in the OFT will positively transfer to the aircraft. However, we find a wide divergence of opinion as to the extent to which the OFT simulates the aircraft. Those who are concerned with the physical or mechanical aspects of similarity maintain that the level of simulation is extremely high. Those who are concerned with the extent to which the OFT represents the aircraft environment hold that the level of simulation is extremely low. In this latter regard the Air Force, some years ago, investigated for a number of aircraft accident situations the sensory cues experienced by the pilot. When the flight simulator was examined to determine how many of these cues could be provided, it was found that very few of them were available in the simulator.

If we examine the uses to which the OFT is put we find that it is mainly used for procedures and instrument training. It appears clear that the OFT does not adequately represent all of the tasks that are required in actual flight. The question I wish to raise is how the OFT can be made more representative of the aircraft without undue increase in cost.

The Center has, within the past few years, sponsored a number of studies which bear on the problem of extending the potential of the OFT. Guy Matheny (1) (2) (3) has investigated the effects on pilot performance of reducing the level of fidelity of simulation. As part of this work an exploratory study of the feasibility of adaptive training techniques was conducted.

Joseph Ruocco (4) (5) has studied the effect of combined cockpit motion and visual display on performance in carrier and runway approaches. Alan Burrows (6) investigated the problem of visual time sharing with particular reference to the detection of intruder aircraft. Hugh Bowen (7) did a study to develop means of assessing pilot proficiency in the OFT.

While these research efforts resulted in a number of implications for training in OFT's they also resulted in uncovering needs for further research and development efforts. These are listed below:

a. Recording and analysis of eye movements. In the simulator research of both Ruocco and Burrows the importance of training pilots in eye scan methods is evident. However, present techniques for analysis of eye movements leave much to be desired. It would be desirable to develop a means of recording and anlyzing eye movements which would not hinder the pilot, would not be affected by movement of the eyelids and which would produce x and y voltages to be fed directly into a computer. This last would eliminate the necessity for the laborious analysis of film records.

b. Cockpit motion. It has been demonstrated that cockpit motion complemented by a visual display facilitates pilot performance. Cockpit motion is seen as a general means of alerting the pilot to the changing attitude of the aircraft rather than as a source of specific information. Given this as true, cockpit motion need not necessarily duplicate the amplitude of aircraft movements and "G" forces developed in flight, suggesting that a motion system involving only small excursions would be adequate for training purposes.

c. Visual display. Current efforts in the development of visual displays have been directed at extremely wide angle real-world representation. It would appear that there is merit in considering the development of a narrow angle display which would serve for training in such areas as landing approaches, detection of intruder aircraft and aerial refueling.

d. Adaptive training. Effort should be concentrated on the development of adaptive training regimes, which would allow the trainee to proceed at his own best pace. There is a great deal of development to be done in this area in determining size of difficulty steps and error tolerance levels.

e. Simulation of Aerodynamics. It has been demonstrated that systematically reducing the level of aerodynamics simulation does not result in inferior performance. Additional work is needed here to determine in what manner the fidelity of simulation can be reduced in order to effect worthwhile economies in computer hardware and associated software.

f. Scoring equipment. Whatever is learned in the flight simulator should have the effect of improving performance in the aircraft. There is need for scoring equipment to provide quantitative information that trainee performance is improving. This information is important for determining transfer effects, for quality control, for determining nature and length of training sessions and, as feedback to the trainee, for increasing the rate of learning.

A number of measures are available for assessing proficiency in the flight simulator. These include:

Control inputs measured at stick, rudder and throttle.

System performance measured as deviations from the flight pattern. These measures may be either intermediate or terminal; i.e., point of touchdown or carrier wire engaged.

Procedural sequences measured in terms of accuracy and time.

Instructor ratings

Trainee opinions and comments. These are included here since they frequently provide insights into training difficulties and OFT utilization.

g. Trainee station. The earliest OFT's consisted of a trainee station and an instructor station both configured to the cockpit of the aircraft. In recognition of the fact that the instructor's job differed, his station changed over the years to provide him with displays and controls appropriate to his functions. Advances in training technology, such as prompting, cueing and knowledge of results, are now suggesting to us that the trainee station would benefit by the addition of instrumentation never found in operational aircraft.

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