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Facilitating Researcher Use of Flight Simulators

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INTRODUCTION

Researchers conducting experiments with flight simulators encounter numerous obstacles in bringing their ideas to the simulator. This paper reports on research into how these simulators could be used more efficiently. The study involved: (1) analyzing the Advanced Concepts Simulator software architecture, (2) analyzing of the interaction between researchers and simulation programmers, and (3) proposing a documentation tool for researchers.

DISCUSSION

I. Analysis of the Advanced Concepts Simulator Software Architecture

The Advanced Concepts Simulator (ACS) is designed to model flight station concepts for a 1995 transport aircraft. The ACS provides a platform for research into a wide variety of flight management systems technologies and pilot/cockpit interfaces. The implementation of the ACS involves about a dozen computers and nearly one million lines of software. The first use of this simulator is scheduled for 1991.

Given that the normal mode of use for a flight simulator is to change an aircraft subsystem and gather performance data from that change, it is imperative that a simulator be modifiable. The following recommendations are made for changes to the ACS software in order to accommodate modifiability: (1) in the short term, substantially reduce the number of global variables, repartition some of the software modules, and produce up-to-date system documentation, and (2) in the long term, move to modern software engineering technologies (i. e., Computer Assisted Software Engineering tools for real-time systems, object oriented approaches, etc.).

II. Analysis of the Interaction Between Researchers and Flight Simulation Systems

Researchers' interaction with simulation systems is unique. Researchers are not system "users" in the traditional sense (pilots are the "users"); researchers are not "programmers" or "analysts" (even though much of the work involves programming and systems analysis). The interaction between researcher and simulator is described in Figure 1. Analysis of this interaction revealed four problem areas:

1. Design Specifications -- Many research projects involve complex algorithms and/or pilot-cockpit interfaces. Producing specifications for the programmers is extremely complex and expensive. Researchers and programmers often engage in a protracted process of exchange and compromise before a display design is completed. Another approach has the researcher actually programming the system on a PC and the program becomes the specification to the simulator programmers.

2. Simulator Documentation -- No accurate documentation on how the simulator works is currently available. Researchers generally agree that having information about what models are used within the simulator, data flow between modules, and how modules are organized could be of great benefit.
3. Pilot Orientation -- Briefing manuals for other simulators have been developed; however, pilot orientation will be more extensive on the ACS in order for the pilot to become acquainted with the "advanced concepts".
4. Researcher Collaboration -- In conducting an experiment, a researcher produces much "informal results" for which there is no forum currently available.

III. A Proposal for a Documentation Tool for Researchers

A documentation tool which addresses the four problems listed above must have the following characteristics: accurate, easily (or automatically) updated, well organized, provide rich means for access to the information, easy to use, encompass a variety of types of information, help generate ideas, flexible/robust -- easily adapted for unplanned uses, improve with use, and encourage active participation (researchers contribute as well as receive information). Also, for such a tool to be effective researchers must be committed to contributing to the information base ("I Know" becomes "We Know").

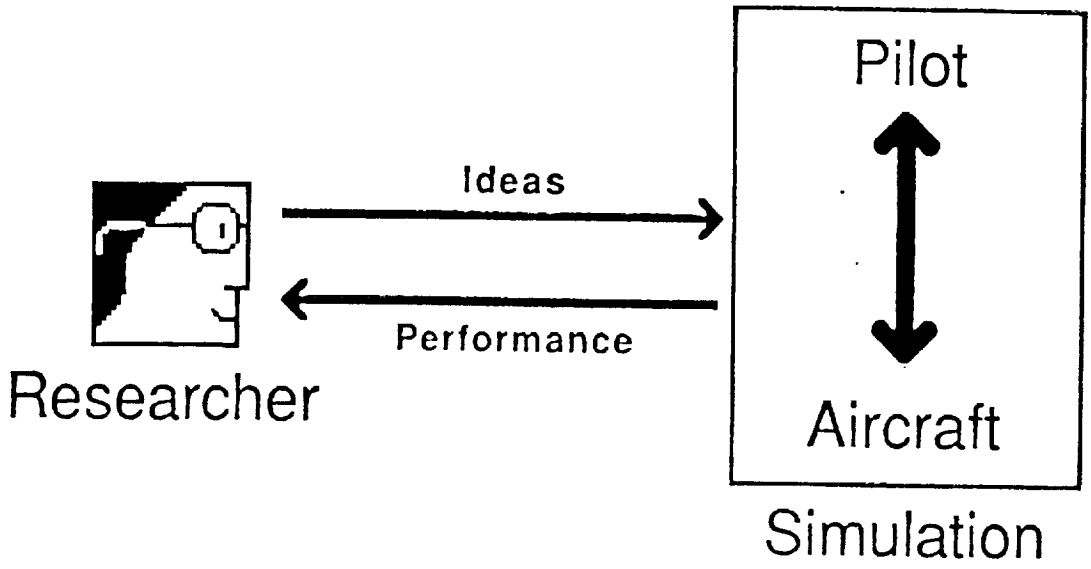
To address these required characteristics, a documentation tool has been proposed and a preliminary implementation has been performed. The documentation tool is a hypertext which contains the information about flight crew orientation, flight crew displays, data flow within the simulator, module hierarchy, what variables can be set by the researcher, what data can be automatically collected, researcher notes, simulation limitation, and planned modifications to the simulator. The tool provides for prototyping of cockpit displays which can be used as design specifications, pilot orientation materials, and description to other researchers in future experiments. Also, the tool includes management of researcher notes which can serve as a means to disseminate formal and informal results.

CONCLUSION

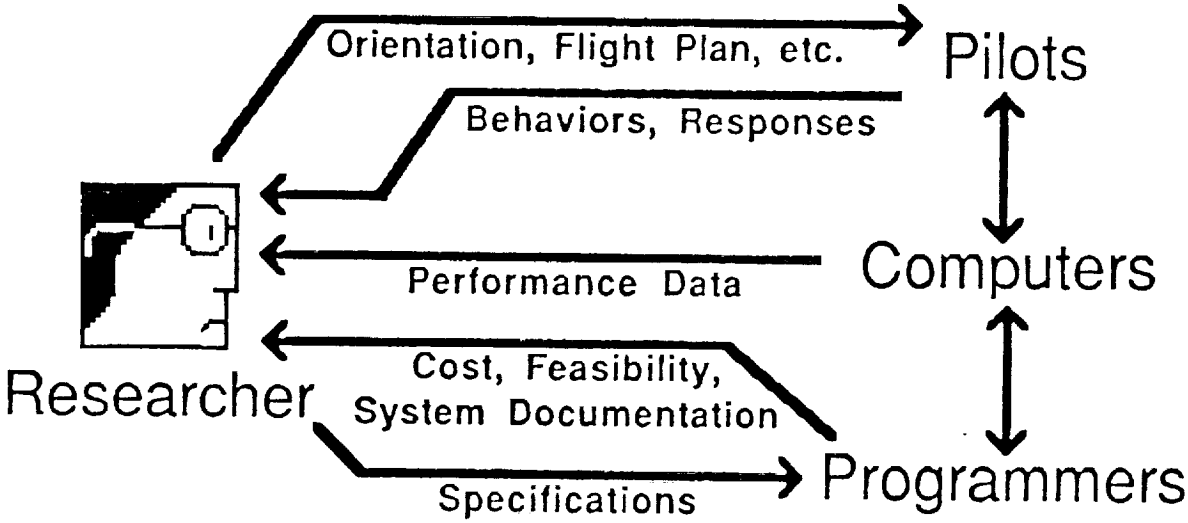
The following conclusions have been drawn from this research:

1. Effort must be devoted to "cleaning up" and documenting the ACS.
2. Communication between researchers and the simulation system is a major problem.
3. Communication among researchers of "informal results" is limited.
4. Hypertext can be used to facilitate researcher activities by providing prototyping, specification, and documentation of flight crew displays, facilitating communication among researchers, and providing access to information about how the simulator is implemented.

A plan for creating the documentation tool described here should include: formal design of the tool, implementation, and validation of the tool by using it in conjunction with a research project on the ACS.



What the Researcher wants?



(This is illustrative--not a complete description of information flow.)

What the Researcher gets?

Information Flow Between the Researcher and the Simulation System

Figure 1