

Human Factors Program Plan for Host and Oceanic Computer System Replacement (HOCSR)



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1. Background

The Federal Aviation Administration Central Computer Complex Host (CCCH or Host), receives, processes, distributes, and tracks information on aircraft movement throughout the National Airspace System (NAS). By 1999, many of the hardware components of the system had reached or were near the end of their commercial support life and were not certified as year-2000 compliant. The Host and Oceanic Computer System Replacement (HOCSR) program will replace all computer-related hardware components of the Host and the connected peripherals at 20 Air Route Traffic Control Centers (ARTCCs). In addition, the HOCSR program will replace the computer hardware components of the Oceanic Display and Planning System (ODAPS) and the Offshore Flight Data Processing System (OFDPS) at the three Oceanic facilities. These computer systems are also facing obsolescence, difficult spare parts availability, and questions of year-2000 compliance.

The HOCSR program is structured into four phases. The first phase of HOCSR has been completed. Phase 1 replaced the main processors of the Host, ODAPS, and OFDPS with the IBM 9672 RA4 computer, commonly known as the G3. Existing system software was run on this new system in emulation mode (emulating the old IBM 370 system architecture). Phase 1 also replaced the Series/1 communications processor at the Oceanic sites.

Phase 2 of the program upgrades the system software. The existing software of all three systems will be modified to operate in the native IBM 390 environment rather than the emulated IBM 370 environment. For the Oceanic sites, Phase 2 involves updating the software to allow for compatibility with the System 390 architecture.

Peripheral devices will be replaced in Phases 3 and 4. In Phase 3, the Direct Access Storage Device (DASD) will be replaced with a dedicated storage subsystem, which includes a monitor and control (M&C) capability. The M&C capability will be designed to have an open architecture that will, over time, be used to integrate M&C tools for other systems and equipment. Phase 3 also includes the replacement/addition of network equipment. Phase 4 introduces a general storage subsystem and replaces the Keyboard Video Display Terminals (KVDTs) and printers.

HOCSR is defined as primarily a hardware replacement program but software changes will be necessary to support the replacement hardware and peripherals. New software will also be introduced for M&C functions.

This Human Factors Program Plan describes the human factors work already conducted in support of the HOCSR program and identifies future human factors activities. This plan may be updated to reflect changes in program goals or strategy.

2. Phase 1

Phase 1 introduced new hardware and software to both the En Route and Oceanic environments. This changed the way users interact with the physical equipment as well as how they monitor and control the equipment.

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2.1 En Route and Oceanic

The Host processors were replaced in both the En Route and the Oceanic environments. Monitor and control functionality was implemented through a desktop computer application, the Hardware Management Console (HMC). In contrast to the existing command line interfaces, this application required user interaction that was new to many field personnel (e.g., window management and using a mouse).

We conducted a human factors and ergonomics assessment of the G3 processor and the HMC in March 1999. Nine Subject Matter Experts (SMEs) participated in a structured walkthrough where they used the G3 and HMC to perform common tasks.

The SMEs and Human Factors Specialists (HFSs) identified several issues during the assessment. The issues dealt with areas such as auditory alarms, user interface, and safety. The principle concern raised at the assessment was one of adequate training and hands-on experience with the system. The results of the assessment were provided to the HOCSR Program Office.

2.2 Oceanic

The Series/1 Replacement (S/1R) introduced additional new hardware and a monitor and control (M&C) application to the Oceanic domain. The M&C functionality is implemented through a menu-driven application that runs on a laptop computer located in the S/1R cabinet.

We conducted a usability assessment of the S/1R in August 1999. Eight SMEs participated in a structured walkthrough where they performed common tasks on the S/1R and provided feedback to HFSs. The assessment also included an observational study and structured interviews.

The participants and the HFSs identified several issues related to areas including consistency, action confirmation, and hardware. A Human Factors working group was established and tasked with developing issue resolutions.

3. Phase 2

Phase 2 is a software upgrade that has somewhat different effects on the En Route and the Oceanic domains.

3.1 En Route

Phase 2 removes the emulation software and upgrades the system software to operate in a native mode. This upgrade brings with it several changes to the system. The biggest change for the user is in the area of NAS Monitor input messages. The syntax of some existing messages will be changed, new messages will be added, and several messages will be deleted. There will also be a change in the display format of the configuration summary.

We conducted a human factors assessment that evaluated the effects of the Phase 2 changes on the users. Ten SMEs reviewed each change and provided feedback to the HFSs on how the changes will affect their jobs.

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Overall, we found Phase 2 changes to NAS Monitor input messages to be beneficial. Most changes provide users with shorter, more useful messages and add flexibility in message format. These improvements are in accordance with human factors guidelines for command language design. The principal human factors concern resulting from this assessment is with message changes that refer to the new system architecture.

3.2 Oceanic

For the Oceanic sites, Phase 2 also involves updating the software to allow for compatibility with the System 390 architecture. The changes affecting the user will be similar to those in En Route; there will be changes to system messages and the configuration summary. In addition, the S/1R alarm panel will be replaced.

This assessment will be coordinated with the Operational Testing and Evaluation of Phase 2 Oceanic at the William J. Hughes Technical Center in June 2000. The Usability Assessment will focus on how the system changes implemented as part of this upgrade affect the users.

4. Phases 3 & 4

In Phases 3 and 4, many of the peripherals (i.e., printers, network equipment, etc.) will be replaced. These phases are still in their early stages of development. The following sections describe human factors activities that can be used throughout the development process. The descriptions include a rough estimate of how much time is required for each activity.

4.1 Analysis of Use

For any piece of equipment that is being replaced, it is important to understand how it is currently used in the field. An analysis should be conducted addressing the following questions:

- a. What is the equipment used for in the field today?
- b. Who uses it?
- c. Does it provide unique functionality?
- d. How often is it used?
- e. Are any of its features particularly liked or disliked by the users and why?
- f. What additional function or feature would make the user's task easier or more efficient?

This type of analysis requires several field visits. Each visit should take approximately two days to complete.

Note - A high level analysis of KVDT use has already been completed. A more detailed follow-up may be necessary.

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4.2 Specification Input

Human factors input should be included in the specification development process. This includes providing human factors guidelines as specifications for new equipment, and writing additional specifications based on the Analysis of Use.

This activity is ongoing during specification development.

4.3 Product Selection

After several vendors have been identified, human factors can help in the selection process. A structured walkthrough assessment with human factors psychologists and field personnel can be used to evaluate compliance with the human factors portions of the specification and with general human factors principles. This assessment would also help identify any human factors issues or concerns that may exist for the various product options before a selection is made.

This type of activity typically involves a month or two of planning and one week for the assessment.

4.4 Rapid Computer-Human Interface (CHI) Prototyping

Rapid prototyping is an iterative process that usually involves a team of human factors specialists and users developing and evaluating a CHI. The advantage of using rapid prototyping over developing solutions on paper is that the users can get a good idea of what the product will look like and experience the human-computer interaction. Several prototyping tools are available to provide various levels of fidelity.

Rapid prototyping can be used at different points in product selection. If the users have requirements or expectations of what the user interface should look like, rapid prototyping can be used early on to demonstrate user CHI requirements and to develop product specifications. The prototype can accompany the specification as an example of the CHI.

Rapid prototyping can also be used to resolve design problems after contract award. If CHI issues are identified during product selection, rapid prototyping can be used to develop solutions.

The duration of a rapid prototyping activity can vary depending on how many issues need to be addressed, the prototyping tools being used, and the number of iterations needed to develop an acceptable solution.

4.5 Human Factors Review

If changes are made to a product after selection, a human factors psychologist should evaluate the changes as to how they may affect the user and to ensure that human factors design guidelines are met.

The duration for this type of support may be ongoing.

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4.6 Work Area Design

Human factors issues sometimes arise during product implementation. Human factors psychologists can provide guidance in resolving issues such as equipment placement and accessibility. If needed, advanced modeling tools are available.

The duration for this type of support may be ongoing and depends on whether advanced tools are needed.

4.7 Usability Assessment

It may be necessary to conduct a human factors assessment of the replacement equipment before it is implemented in the field. This would be a structured walkthrough with participants from the field, as well as human factors psychologists. The assessment would focus on the ability of the equipment and associated interfaces to support user tasks and on the compliance of the equipment to human factors design guidelines.

This type of activity typically involves one to two months of planning and one week for the assessment. If procedure scripts are necessary, they can typically be developed within this time frame.