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EVALUATION OF COMPUTER-AIDED INSTRUCTION TECHNIQUES FOR THE CREW INTERFACE COORDINATOR POSITION

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The Crew Interface Coordinator (CIC) is responsible for real-time voice and procedural communication between the payload crew on the orbiter and the payload operations team on the ground. This function is dedicated to science activities and operations, and may also include some responsibilities for crew training. CIC training at Marshall Space Flight Center (MSFC) consists of mission-independent training, mission simulations, and line-organization training. As identified by Schneider, the program provides very good generic training, however position-specific training may be obtained in a very unstructured way. (4) A computer-based training system, identified as Mac CIC is currently under development to address this issue. Mac CIC is intended to provide an intermediate level of training in order to prepare the CIC for the more intensive mission simulations. Although originally intended as an Intelligent Tutoring System, Mac CIC currently exists as a hypertext-based application. The objectives of this research is to evaluate the current system, and to provide both recommendations and a detailed plan for Mac CIC's evolution into an Intelligent Tutoring System.

The goal of the Mac CIC system is to provide training on integrating CIC-specific knowledge and skills in an interactive environment. The system is executed on a Macintosh IIci microcomputer and utilizes text, graphics, video and digitized audio to present information to the user. The initial system design identified the following major modules: (4)

1) "Teach Me About" - provides a library of CIC-specific knowledge, including: Payload Operations Overview, Communications, Mission Timeline, Documentation and CIC Overview,

2) "Skills" (also referred to as "Practice") - allows the trainee to practice CIC-specific skills one topic at a time. It is intended to provide tutoring capabilities in addition to conventional Question/Answer drills.

3) "Scenarios" - provide a means for the CIC trainee to practice making decisions which require integrated knowledge and skills.

At the time of this writing, the major portion of the Teach Me About module has been constructed using SuperCard (Version 1.6). Little programming has been done regarding the remaining modules. The initial design envisioned the utilization of the NEXPERT OBJECT expert system shell as a platform for the Skills and Scenario modules. NEXPERT would be linked to the SuperCard application via its HyperBridge facility.

According to Dumslaff and Ebert, the three primary methodologies of computer-based training systems are traditional computer-assisted instruction, hypertext and intelligent tutors. (1) A large variety of hypertext-based training systems have been developed, and the present trend appears to favor this approach over the highly structured computer-assisted instruction. (2,) The decision to utilize SuperCard as the basis for the Teach Me About module is consistent with current work in the field.

Intelligent tutoring systems differ from the other methods of computer-based instruction by incorporating artificial intelligence techniques. The utilization of expert systems is a well-established means of doing this. (3) Although symbolic languages (e.g. LISP, PROLOG) or even conventional languages (e.g. C, PASCAL) may be used to develop an expert system, the selection of an expert system shell for the Mac CIC project was a correct decision. Expert system shells are pre-packaged inferencing mechanisms with auxiliary features so as to facilitate systems development. Essentially, they are expert systems without the domain-specific knowledgebase. The advantage of this approach is that it allows the project team to focus effort on establishing the knowledgebase, and not on constructing supporting software facilities. NEXPERT OBJECT is a multiparadigm expert system shell capable of using both objects and rules. It also provides both forward and backward search mechanisms along its inference net. NEXPERT's hybrid method of chaining tends to be an extremely efficient processor, as is found in most true expert system environments. Selection of of NEXPERT OBJECT provided the best balance of cost versus capabilities for this project. It is important to note that NEXPERT is a complicated application, and as with most other environments, training is not trivial. (3)

Although the overall design approach to Mac CIC appears to be correct, considerable work remains regarding the existing module and those still to be developed. The initial step in the development of these recommendations was to obtain feedback from actual CICs. A preliminary review of the existing Mac CIC system was conducted from June 7 to 9. The group included both experienced and novice CICs, thus providing a broad perspective. Suggestions were reviewed, and many form the foundation of the subsequent recommendations in this report.

It is envisioned that aspects of the Mac CIC system could be migrated in order to support the training of other POCC positions. (e.g. Data Management Coordinator (DMC), Operations Controller (OC), Payload

Activities Planner (PAP)). Analysis of the system indicates that most of the Teach Me About module is suitable for migration to these POCC positions, The CIC Overview and still to be developed CIC Golden Rules, however, are position-specific, as will be the Skills and Scenario modules. The approach taken for each of these, however, can be used for migration. This would essentially provide the framework around which domain-specific knowledge could be applied. This is particularly true if the recommended modular approach (separation of domain-dependent rules from instructionally oriented ones) is used for the construction of the knowledgebases.

The underlying strategy, behind this development plan, is to deploy an initial version of Mac CIC as soon as possible. Subsequent versions, each with additional functionality, would be phased in. This incremental approach is strongly recommended in the literature. While permitting the earliest possible deployment, this approach also allows post-implementation feedback from the students to be incorporated into later versions.

Implicit in the plan is the need to focus effort on a prioritized work list, based on what is directly applicable to the CIC function. Early in Phase 1, a management decision, on these priorities, is scheduled. This decision would be based on a review of the documented SuperCard linkages and the omissions identified. It is recommended that any further work on the Documentation and CIC Golden Rules components be deferred. Review of these indicates that much of this material has already been incorporated into other module components. The priorities should then list actual system corrections first, then modifications to existing functionality, again within the perspective of what is relevant to the CIC. The prioritized list would then be worked within the 4 1/2 week window allocated to reprogramming.

New facilities would then be developed for the Teach Me About module. The query capability would simply be a series of questions that would test the trainee's understanding of the material. The debriefing facility would provide both a series of questions, and a free-form display for eliciting the student's comments regarding the Mac CIC method of instruction. The preliminary student model would be an individualized file for maintaining a history of the student's comments and test answers. File update would be provided by the XCMD function resident in SuperCard. After undergoing verification and validation, the Teach Me About module would be available

for student use. Post-implementation documentation of any changes to the SuperCard linkages. would then follow.

Knowledge acquisition may begin upon completion of Phase 1. Since knowledge will be drawn from mission-specific videotapes and documents, these sources need to be made available by this date. Identification of the Specific Behavioral Objectives (SBO), i.e. the trainee learning goals, should occur early in the knowledge acquisition process. A Functional System Design of the module can then be derived based upon these goals. Programming, verification, validation and implementation of the module follow, based upon the agreed design. Teach Me About module test cases are rerun at this point to ensure that there are no unforeseen implications of installing the new module. Documentation of the SuperCard linkages is then updated to reflect integration with the NEXPERT knowledgebase.

Phase 3, development of the Scenario module, follows the same sequence of activities as Phase 2. The duration of Phase 3 is anticipated to be significantly less than Phase 2, since it primarily integrates knowledge previously acquired, and functions previously programmed. The scenarios developed initially would be "canned", i.e. all trainees would execute them.As a history of student responses is built up, the student model can be progressively refined and validated. Future iterations of the Mac CIC scenarios would be intelligently selected by the system based on the specific levels of proficiency, and the specific problems indicated in the enhanced student model.

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