



The Space Congress® Proceedings

1994 (31st) Space Exploration and Utilization for
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Apr 26th, 2:00 PM - 5:00 PM

Paper Session I-B - Interactive Courseware Development at the Kennedy Space Center

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INTERACTIVE COURSEWARE DEVELOPMENT AT THE
KENNEDY SPACE CENTER

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Abstract: This paper describes the design and development of multimedia courseware for Space Shuttle System Engineers employed at the Kennedy Space Center. Design of the interactive courseware and courseware hour validation are discussed.

INTRODUCTION

The need to train Space Shuttle System Engineers to mastery levels in Shuttle system operating components, component interfaces and operating parameters had been determined by a series of needs assessments. The needs assessments concluded that the training needs of the system engineering population could best be met by a multimedia presentation of system operating characteristics. It was recommended that a multimedia courseware presentation be developed to include use of graphics and animations as well as motion and still videos of Space Shuttle system components.

This article describes the design and development of multimedia courseware used to certify and recertify Hydraulic System engineers on the Space Shuttle Hydraulic System.

AUDIENCE

The system engineers working at the Kennedy Space Center had been relying on individually developed "smart books" for reference to system component operation and interfaces. Many drawings and support schematics were prepared by the engineer for his/her own use. Materials were not prepared or organized into a standard training presentation. The multimedia presentation has provided a standardized system wide "smart book" for system engineering use.

COURSEWARE DESIGN

The Space Shuttle Hydraulic System Course is comprised of twenty-five individualized lessons each approximately one to two hours in length. Mastery of concepts/content presented within the lessons is evaluated in an end-of-course knowledge evaluation followed by a fault isolation scenario presentation. Each one of the lessons is grouped into one of four sub-system modules: Power and Control, Effectors and Actuators, and Thermal Control. The individualized lessons contain specific sub-system information on

the general physical, functional and interface descriptions of Shuttle Hydraulic System components. Each lesson contains a menu selection for firing room computer console launch processing information and Space Shuttle cockpit control panels.

The individual lesson consists of a presentation of front matter which includes lesson title screens, advanced organizer, and lesson objectives. Lesson instructional chunks are opened with a non-scored progress evaluation. If the progress evaluation is answered correctly the engineer is given the option to "take" or "skip" the instructional segment. If the progress evaluation is answered incorrectly the engineer must "take" the instructional segment. The lesson content material is presented through the use of text supported by color graphics/animations and still/motion video as appropriate to present Shuttle System operating characteristics. Upon completion of the lesson content material, an end-of-lesson evaluation knowledge evaluation must be mastered to show completion of the lesson.

Entry level engineers preparing for certification or engineers being cross-trained for certification enter the courseware at the lesson level. When all lessons are complete, the engineer completes the end-of-course knowledge based evaluation items to show mastery of the content learned. When the knowledge based evaluation items are mastered a set of randomly generated failure scenarios are administered. Remediation is provided by the courseware computer managed instruction to provide review segments for evaluation items and scenarios not initially mastered.

The design of the courseware permits certified system engineers completing recertification requirements to enter the courseware through a proficiency pathway. If the engineer is familiar with system operating parameters and characteristics, he/she is routed through the proficiency pathway by the courseware computer managed instruction. This end-of-course evaluation is designed to permit the engineer working on recertification to test-out of the required support lesson objectives by correctly completing a series of randomly generated evaluation items and failure indication scenarios.

The scenarios are presented as "practice" simulations in the isolation of failed and improperly operating Space Shuttle system components. The randomly generated scenarios are structured with introductory material designed to familiarize the engineer with the conditions existing prior to a particular vehicle processing task. An advanced organizer is presented prior to all fault scenarios. The advanced organizer provides system conditions prior to the start of the problem and specifies the maximum solution time for successful completion of the scenario

presented. The scenarios begin with the presentation of a primary Ground Operations Aerospace Language(GOAL)Screen. The GOAL Screen presented is one in a series of computer screens, programmed in GOAL, used to monitor Space Shuttle system operating parameters. The primary GOAL Screen is updated for a period of 30 seconds in order to present current operating parameters. There is no student interaction permitted during any of the Goal Screen update periods.

The scenarios each run for a period of 10 minutes. This total solution time available is presented at the beginning of each problem. The time remaining can be accessed by the engineer from a pull-down menu in each interactive period. Interactive periods permit the engineer to interrogate the system status by utilizing various "tools" provided on the pull-down menus. The engineer can access these "tools" from the Primary GOAL Screen. These instructional aids include pull-down menus used to status various cockpit switch indications, sub-system schematics, digital audio playback of information from other launch team members, and additional support GOAL Screens. All displays and switch positions are in a static condition that represents the system configuration at the end of the update period. The scenario can be solved during any interactive period. If the engineer does not detect a failure he/she selects continue to indicate that all system parameters are within the proper limits and that no failure indications exist. When the engineer detects a failure he/she selects the detect failure button and proceeds to an isolate failure screen.

This screen provides schematics for identification of the most probable failed system component. The engineer "clicks" on a section of the schematic to select an area to view, and then double clicks for a close-up view used to isolate the failed component. The engineer is then presented with a list of the most probable failures and selects the one indicated by the schematic. If the failure is isolated correctly, the engineer's problem solving ability is rated based on the number of "tools" selected appropriately or inappropriately. In some cases, the use of the "tools" is inappropriate to isolate the failure presented. Therefore, the scoring routing does not assign as many solution points if the "tools" are accessed inappropriately. The solution skill level is presented to the engineer based on the correct identification of the failure within the run time of the problem and his/her navigation skills through the "tools." Solution levels are rated as expert, sharpshooter, marksman, pass, and fail. If the engineer does not solve the scenario correctly within the allotted time, he/she is presented problem remediation frames identifying the failure indication and the failed component. Then, the engineer is directed to report to the training administrator further remediation.

Engineering management can enter the course through either the end-of-course evaluation or lesson level courseware depending on their level of experience and expertise with system components and failure indication scenarios. Management does not need to master the end-of-course scenarios or knowledge level evaluation items unless required for certification or recertification.

Additionally, lesson material (i.e., graphics, animations) can be accessed by the engineer for reference. Graphics and animations provide a reference source for "system expertise" in the content area presented. Screens can be printed and used to aid in the interpretation of system operating characteristics. The courseware provides an on-line electronic encyclopedia for the description of the system components and operating characteristics.

COURSEWARE DEVELOPMENT

The courseware described above is being developed by IBM/CAE and monitored by Lockheed Space Operations Company for the National Aeronautics and Space Administration (NASA). The contract has been in place since October of 1990 and will be complete in August 1994. Currently, 60 hours of courseware has been completed and validated by the acceptance procedure outlined below.

COURSEWARE HOUR DEFINITION

For the validation of the content of an hour of delivered courseware, a courseware hour definition was developed. This definition was developed to aid in the determination of the content to be accepted as valid for each delivered hour of courseware. For purposes of the courseware development described, a courseware hour was defined as the delivery of a total of 60 minutes of primary learning sequences. Primary learning sequences include interactive instructional sequences using multimedia (i.e., video motion stills, digital video, audio, digital audio, graphics, animations and text). Instructional sequences presented as the primary pathway through the courseware were timed and evaluated for valid content presentation. Remediation segments were not included as part of the courseware hour validation and acceptance procedure.

COURSEWARE HOUR VALIDATION AND ACCEPTANCE TEST

Each hour of delivered courseware was validated through an acceptance test procedure. Completed authored lessons were administered to a group of four entry level subjects. Individual lesson start and stop times were recorded by the acceptance test

administrator. Each subject completed the lesson by taking the initial progress evaluation and selecting to "take" the instruction. The computer managed instruction data base tracked the subject's inputs and traces his/her pathway through the instruction. Through this process, each primary pathway was recorded as taken by the subject. When the subject recycled through the same instructional segment, due to an incorrect answer on the progress evaluation on the second try, the time required to take the remediation segment was subtracted from the total lesson completion time. This tracking procedure was used to establish the average time required for a remediation segment. Each subject's time required to take the lesson was averaged to determine the average lesson completion time.

End-of-course evaluations were validated based on the number of minutes required for a proficiency level subject to complete the overview, explanation screens and knowledge evaluation items. Scenarios were timed by the subject matter experts accessing the "tools" required to complete the scenario correctly. The average time required for the subject matter experts to complete the scenario was computed.

The courseware hour validation and acceptance procedure was completed for each hour of delivered courseware. This procedure provided a methodology to confirm the delivery of 60 minutes of primary instruction on the objectives presented.

CONCLUSION

The Hydraulic System Course has been in use at the Space Center since April 30, 1993. During that time approximately 200 students have taken various lessons and end-of-course evaluations. As reported on course survey forms and through individual interviews, the course material has been rated as an excellent resource for system engineering training. Additional courses for the Space Shuttle Liquid Oxygen System, Liquid Hydrogen System and Orbiter Mechanism System are in development.

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