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Internet Based Training to Support a Changing Workforce

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Abstract

Changes are now underway at the Kennedy Space Center to re-engineer a smaller but more technically advanced and more productive workforce. A key component of this change is the training to give the workforce the skills needed to implement future space flight programs both effectively and efficiently. The Safety and Mission Assurance Directorate at KSC has developed training classes which are delivered over the Internet for its employees, and are available to all agency employees. The courses developed to date include An Overview of Non-Destructive Evaluation, Introduction to Statistical Process Control, Statistical Process Control, and Radiography. These courses are interactive and can be completed at the optimum pace for the students at any time or location with computer access to the Internet.

Overview

The re-engineering now underway at the Kennedy Space Center and across all of NASA is a familiar story. The processes that worked so effectively in the past, especially in manned spaceflight applications, are now too expensive to meet the new efficiency goals brought about by today's budget realities. The new challenge is to maintain or improve effectiveness while dramatically improving efficiency. This means developing new, lower cost techniques in all areas of spaceflight development and operations. New skills must be brought to the workforce to reach these new efficiencies and the means of supplying these skills must itself be accomplished as efficiently as possibly.

One area in which technology is delivering increased capability at steadily lower prices is information technology. Information technologies have made training at the desktop cost effective. Desktop training could augment or supplant existing training methods. Interactive learner control enhances training and facilitates Just-In-Time learning and reference. Web Interactive Training (Figure 1) uses time and resources more efficiently than many current training methods in use.

The WIT project uses the Web to deliver training directly to the learner's desktop computers. The primary users of the system are NASA (National Aeronautics and Space Administration) personnel at both KSC (Kennedy Space Center) and other NASA centers. The objective of the project is train a large base of NASA learners; efficiently and effectively, using state of the art technology to enhance learning. Training modules consisting of text, graphics, animation, video, simulations and tests are delivered over the Internet through a Web browser interface. This approach is expected to reduce training costs and associated travel and time-off task costs. The training is available 24 hours a day, seven days a week for learner convenience and follow-up job performance support after the training is completed.

The WIT project began in July of 1995 and has continued throughout fiscal year 1996 (October 1995- September 1996) and fiscal year 1997 (October 1996- September 1997). Four courses have been completed to verify and validate the design, technologies incorporated and developed. These courses include Nondestructive Evaluation (NDE) Overview, Introduction to Statistical Process Control course, Radiography-NDE and Statistical Process Control.

The current phase of this project is the development of two advanced courses. One will be Nondestructive Evaluation-Ultrasonics and the other will be Advanced Statistical Process Control-Design of Experiments. The project incorporates state-of-the-art multimedia technologies to meet the defined learning objectives.

Instructional Design

In order to develop an effective Web-based training system that accomplishes the goals of providing sound instruction over the Web, it is necessary to understand key instructional features that will contribute to the development and deployment of the WIT system (Alexander, 1995). Using multimedia in an effective way on the Web and especially in Web-based training applications is a challenge (Kilby, 1996). The project also defines a functional educational design model that takes into account the advantages and disadvantages of the Web The model for each instructional section generally follows an expansion of the Topic, Task, Test model (Chopping, 1995). For example a section might include: introduction and definitions, key concepts and theoretical foundation, practical application and case studies, an interactive simulation or practice exercise, and testing or evaluation.

The WIT system presents information in an interactive and informative way. The learners will engage primarily in guided discovery learning. Learners will have a clear learning objective presented and their path choices will be limited to pertinent information. A structured approach is determined in each course by instructional system designers and subject matter experts (SME's). The instructional objectives, content, and methodologies are used to determine the best approach for a particular subject area module.

The learner will have some flexibility in the depth to which they wish to explore the information, but an acceptable level of proficiency must be met to prove completion of a module. For example, in the Nondestructive Evaluation (NDE) Overview course, learners must take a test with results posted back to a database in order to advance to further sections by the specified path (Figure 5). There is some flexibility built in for the user to explore detailed information on a subject area. Further references and resources are provided as well as more advanced follow-on modules in a particular NDE method currently under development.

Technical Disciplines

There are many technical considerations and approaches to this project. The majority of the effort involved advanced HTML scripting, hardware and software setup and design. This effort also includes instructional system design, digital photography, scanning, media conversion, audio and video recording, compression, animation, formatting, scripting, programming, and beta testing. The process includes research and implementation of late-breaking technologies like streaming digital video for topic introductions, CGI interfaces for forms and testing feedback, Shockwave simulation modules, Java and other advanced client/server features.

Unique Attributes and Innovations

Simulations

The simulations developed for the NDE modules are designed to simulate a real-world process in a simple, elegant manner while minimizing the learner's download time. (Each simulation is approximately 30 kilobytes in size.) These simulations incorporate repetition, learning by example, and positive feedback (Campbell, 1995). Each simulation follows the same general model as the Eddy Current Simulation shown in Figure 4, where the student searches for discontinuities that are randomly scattered throughout a test object. The Eddy Current simulation shows a sample plate on the right and the feedback screen on the left. These simulations were designed and developed using Macromedia Director and its native programming language, Lingo (NASA, In Press).

Testing

Testing will aid in comprehension of the information presented on NDE and SPC and reinforce the most important points in the section of training presented. Test answers are cataloged in a database to show student progress and adequate completion. Learners are presented with a short multiple-choice quiz. The quiz is randomly generated from a database of questions and is different every time the student takes the quiz. After submitting his or her answers, the student is immediately presented with his or her score, a brief explanation of the answers, and a link to the place in the course where that topic was covered. Feedback and remediation are immediate providing excellent response and reinforcement (NASA, In Press). Learners cannot cheat. The program prevents them from returning to the same quiz and retaking it. The testing database was written in Perl and partially converted to Java. Eventually the program will be entirely converted to Java for ease of future expandability and possible cross-platform server deployment (NASA, In Press).

Security and Student Tracking

The system is only available to the NASA Centers unless special password authorization is granted by NASA. The courses may be opened up to a broader audience in the future at NASA's discretion.

Current activities include enhancing the learner tracking to include a placeholder for reentering the training space at the same point of exit from the last use. This will avoid unnecessary navigation and the disorientation often associated with large hypertext systems.

A good computer managed instruction database to track completion of sections is an essential component of the WIT system. Instructional designers will have a much clearer idea about the effectiveness of the instruction from the answers received. Tracking could be automated to send an electronic mail reminder to individuals who need to finish instruction by a certain date for certification.

Performance Support

Some of the interactive calculation simulators like the normal distribution calculator shown below (figure 6) provide performance support after the training. The system also contains an electronic version of relevant reference material and procedures used for each discipline. A search engine allows users to pinpoint specific information and get to it in seconds. This makes

the modules usable as a reference after the training has been completed. In this way, the same tool that is used for training can be extended to provide reference support to the application of the training on the job.

Future Developments

Future efforts involve advanced security functions, enhanced student tracking capabilities, additional performance support functions, adaptive learning through dynamic Web pages and objects, integration into centralized NASA training activities, front-end “push” technology, synchronous instructional communication aids (videoconferencing and live bulletin boards) and research in Just-In-Place training using mobile communication technology.

Recent advances in technology make adaptive learning principles possible to implement within a Web-based training system. Through the use of object oriented design techniques and embedded JAVA it is possible to deliver variations on the training based on learner experience, browser/system capabilities, preferences and learning style.

Summary

This project has successfully demonstrated that technical training can be delivered over the internet. This new capability does offer answers to some of the problems that motivated the project such as:
Reduction in travel time and cost
Elimination of mimimum class sizes to hold classes.
Difficulty in scheduling class times in concert with work schedules
Problems with too many workers away from job at the same time.

While the training is offered at many locations around the country, there is a single version on the server to maintain and update. This offers significant improvement in configuration management requirements over distributed materials such as hardcopy or video.

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