Tinker Air Force Base
Technical Online Training System Development

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Abstract

Increased Internet connection speeds and new web development tools have greatly improved the possibilities for interactive online training. This paper discusses an online learning system (www.tinker.ou.edu) that has been developed and implemented for Tinker Air Force Base to help instruct base personnel in both environmental management and C135 aircraft maintenance. With this training available on the web, thousands of base personnel are able to take the required courses simultaneously anywhere and at anytime. The developed system includes both website management tools and over 50 lessons that cover 50 hours of training. Various unique features are incorporated into this web-based training program, such as a flexible database management system (DBMS), user tracking and 3D simulation.

This paper also presents the server system that was developed to manage the lessons and the multimedia technologies used to construct the training content. The server uses SQL Server Database and Active Server Pages to manage all courses, lessons and user information. 3D and 2D simulations, video, animation, narration, text and graphics are integrated in the training system to present the training content with the support of multimedia technologies, such as Director and Flash.

Introduction

Although face-to-face instruction is the traditional learning method, web-based education and training has grown in popularity through the world for a number of reasons including convenience, low cost and easy access to current information. Websites like www.vtc.com [1] teach software operation online with QuickTime movies. Other websites, such as www.esafetyonline.com [2] offer Online Environmental, Health and Safety Training courses in Flash format. The embedding of multimedia technologies in e-training enables the learner to be exposed to more interactivity and promotes active, not passive, learning.[3]

Tinker Air Force Base (Tinker AFB) was interested in delivering environmental management training (EM) and C135 cabin pressurization (C135) courses via Internet for a number of e-training advantages. Probably the most important reasons is the ability to train thousands of

employees at the same time. Tinker is a large military base and needs to serve over 5,000 base personnel simultaneously, which is more difficult to fulfill by traditional face-to-face teaching than by web-based training. Furthermore, Tinker needs the training to explain abstract concepts and strict regulations while holding the attention of the trainees. Both of these needs are done by employing interactive simulations, animations and videos.

With both the EM and C135 online courses, base personnel are able to learn the concepts through the Internet at their own pace, schedule and at a low cost per user. The lessons can also be accessed both inside and outside Tinker AFB. If any modifications are made in the regulations, the administrator is able to update the training lessons, so that every trainee can view current material. Besides these advantages, the system also monitor's each user as they move through the lessons and how they respond to the questions in each lesson. The information stored in the online database can be viewed by the user and their managers. This helps inform managers where employees are having trouble.

The management of this learning website is administrated through a web browser so that multiple administrators can manage this system via the Internet from anywhere in the world at any time. Convenient management tools have been implemented including defining user type, specify access right, user tracking, lesson group assignment and more. In order to store user personal information and lesson material, as well as manage the training system, an online database is set up to store, modify and retrieve data. The Tinker online training database management system has been implemented by using SQL Server Database (Microsoft). Active Server Pages (ASP) is used as the server-side scripting language and is critical to pass data between the web browser and server database.

The training content focuses on two topics: environmental management training and C135 cabin pressurization. The environmental management training offers lessons in three subtopics. They are the National Emission Standard for Hazardous Air Pollutants (NESHAP) requirements and environmental regulations, the procedures of using the International Merchants Purchase Agreement Card (IMPAC) for the purchase of hazardous materials, and ISO14000 and ISO 14001 regulations. The C135 cabin pressurization course provides the pressurization test procedure for C135 series aircraft. Due to the large amount of training content in each topic, the training content is first grouped into modules, and then subdivided into lessons; each lesson is further composed of a number of objectives, which consist of a series of frames. Macromedia Director is used as the container to hold the lesson content for a number of reasons, supporting text, graphics, Flash movies, sound and 3D objects. Director also allows the use of an external share cast that holds buttons and Lingo scripts that are used over multiple lesson objects. This reduces the bandwidth that is needed when viewing multiple lessons. Director also permits, through Lingo script, streaming of 3D objects, audio, video and cast members. Since Lingo is a complete scripting language, it is relatively easy to learn. It also has 3D capabilities, but does have difficulties when generating complex 3D objects since there is no built-in 3D geometry editor and Lingo script can not compile as fast as c or c++.

Management Tools Development

The Tinker AFB online training system is an engineering learning website that allows only authorized users to study. Each user must have an unique user name and password to access the lessons. There are four types of users, including administrator, manager, regular user and guest. Guest accounts are designed for browsers who do not work for Tinker AFB but are interested in the training topics. Regular users are the main trainees who work for a specific directorate in Tinker AFB. Managers are the department leaders who are in charge of the regular users under their instruction. Since the managers are familiar both with the regular users and the requirement of the jobs in their department, they are authorized to assign learning materials for regular users. The administrator type of account can set up and control manager accounts and administer system wide features. These four types of users form the three tier relationship shown in Figure 1. With such a three-level organization, the administrators avoids the situation of managing every account, the managers gain the full right to control the regular users account in their department, and the regular users or guests can only access their account. Administrators and managers are responsible for managing users through the Tinker website. Although this website permits individuals to apply for guest accounts via Internet, the administrator account can turn off this feature so that only Tinker AFB authorized users can see the web content.
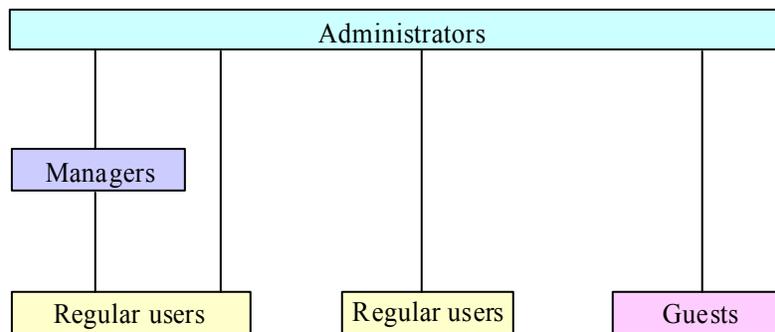

Figure 1. User type relationship

In the Tinker online training system, different authorized users are restricted to specific management tools in the website. For example, an administrator can supervise all accounts in the system, a manager can control all accounts in his department, while a regular user and a guest can manage their own account only. Table 1 compares the management tools among the four types of users. The announcement feature is designed for the management level people to post news about the training. The preferences feature is implemented to give the management level people the right to change the system options, such as customizing the lesson order for the training system. In other words, the administrator level users are able to change the lesson order from lesson 1, 2 and 3 to lesson 3, 1 and 2, so that the regular users' learning sequence is rearranged. The Manage Group feature gives the managers the ability of creating multiple lesson groups in which a number of lessons are included. By only assigning lessons needed for a specific type of employee, both the manager and employee save time by learning only job-required information. Also, a Directorate Group is implemented to provide the opportunity of

grouping users according to the supervisor. The Manage User option allows the manager to add authorized users into the system. User Progress provides a way to monitor all user performance through the web. The User List provides easy access to view or modify user information. The Manage Guest option allows the administrators to edit guest information. Also, to help facilitate the management level user to review all content quickly, special navigation tools are available to the administrators and mangers so that they can go through the lessons and objectives nonlinearly. Regular users and the guests, on the other hand, have to follow lesson content in a structured manner and cannot jump between objectives or frames until they have viewed them.

Table 1. The management tool comparison among different types of users

Management Tools	Administrators	Managers	Regular users	Guests
Access account right	All in system	All in his department	Own account	Own account
Post announcement	Yes	Yes	No	No
Preferences	Yes	Yes	No	No
Manage group	Create, edit, assign and delete	Create, edit, assign and delete	No	No
Directorate	Create, edit and delete	Create, edit and delete	No	No
Manage user	Yes	Yes	No	No
Monitor progress	Yes	Yes	Own account	Own account
User list	Yes	Yes	No	No
Manage guest	Yes	No	No	No
Access lessons	Nonlinearly	Nonlinearly	Linearly	Linearly
Access objectives	Nonlinearly	Nonlinearly	Linearly	Linearly

To implement the management tools, an online database system or file system was developed to store, modify, delete and retrieve information. The online database that works with the web-server has a number of advantages. First, a database ensures consistent data. In file processing system such as text files, the input format data is not constrained. However, a database will only accept data that agrees with the predefined data format. For instance, the data type for a phone number is defined as integer in the database, so if any user types in a letter, the database will reject it. Next, a database can retrieve data easily. Database data can be retrieved from tables by writing SQL statements referring to the attribute name. However, in a file management system there is no attribute name to refer to, thus it is hard to retrieve partial data from single files. When joining multiple files together and retrieving part of the entire datum, file processing environments do not offer a convenient method. Finally, database maintenance is easy. The database management system (DBMS) is able to periodically backup the database and data can be retrieved in case of damage. For example, the Tinker online training system databases are scheduled to be backed up everyday with no administrator involvement. However, with a file management system, these tasks must be performed manually, which leaves opportunities for errors.

While there are many well known DBMS, such as Oracle, SQL Server, MySQL, Microsoft Access, etc., this project selected SQL Server due, in part, to its ability to service over 5,000 users while still be reasonably priced. The SQL Server is also designed and optimized for Windows NT which also runs the web-server for training system [4]. Secondly, although both SQL Server and Microsoft Access are mid-size DBMS, the SQL Server can store more data than Access. Also, Microsoft Access can serve only 64 connections where as the SQL Server is capable of supporting up to 1,000 current connections. Oracle works well for large size databases but it is expensive. MySQL is also a good choice, but Tinker needs a commercially supported database for future maintenance.

In order to store data in a database, ASP is used to send data between the web browser and the database. ASP is also used to dynamically build HTML web pages based on the learners' input. For example, when a user finishes an objective, the user's score is passed from the Director Shockwave file to an ASP script which uses SQL to send the results to the SQL Server database. SQL then sends back the next objective number to the ASP script through which that objective's Director Shockwave file is opened and can be viewed by the user.

Training Content Development

In order to explain EM and C135 concepts clearly, the website employs media such as 3D and 2D simulation, video, animation, narration, text and graphics to present training material. With 3D simulations, learners can see renderings, which mimic the real world. The 2D simulations generally are in form of a game. They let the learners experience the operations and procedures similar to the real situation. Figure 2 is an example of 3D and 2D simulations. All the simulations are created in Director using Lingo script which has the ability to control the simulation or animation with respect to the users' actions. Video is also used to show the correct method of dealing with a specific problem. The videos are in Flash format so that they can be streamed in Director. Animations shown in Figure 3 illustrate an example of showing the technical details of how a valve works. Flash is used to create all animations so the results are vector-based that can be scaled and the final file size is small. Instead of displaying pictures frame by frame, vector graphics generate each time the animation plays according to geometrical formulas which tell the user's computer how to draw the graphic on the screen. Graphics bring color, visual impact, and precise information to the learner. The narrations give instruction and explain concepts in detail. Narrations are synchronized with text, which displays the main idea of each frame. To ensure understanding, several evaluation questions are given at the end of each objective. After the learner complete the questions, the number of correct answers is sent to the database to track the user's progress. The user, in addition to administration and manager level users, can view the overall results of answering the questions.
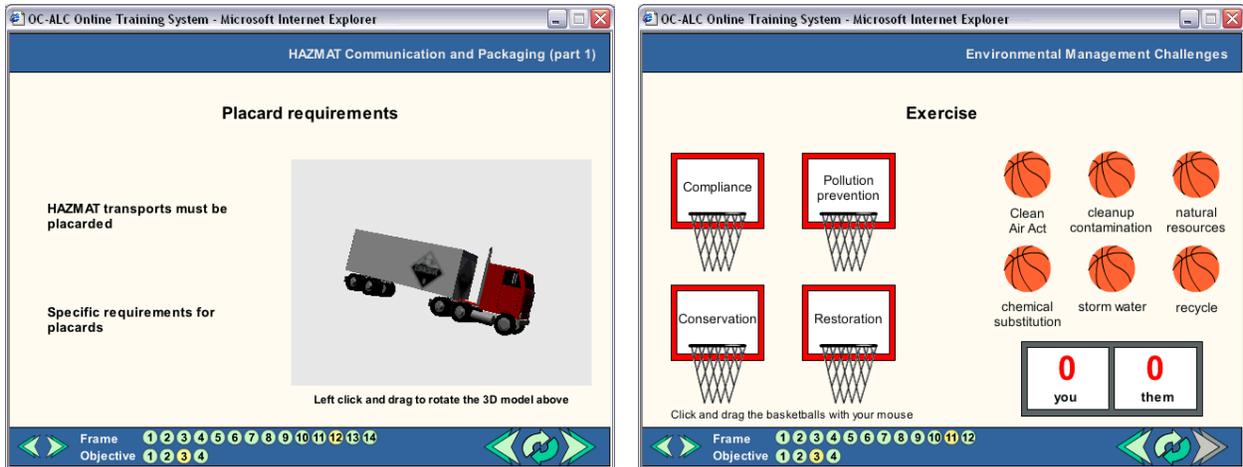
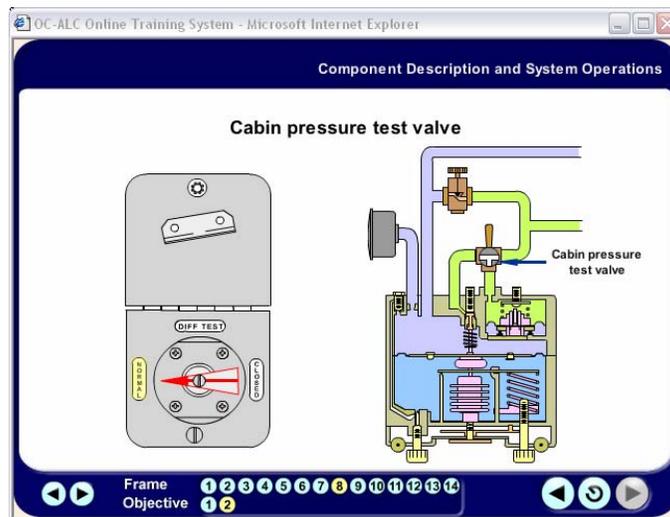Figure 2. 3D and 2D simulation example

Figure 3. Animation example

To provide a consistent and reusable visual format, a series of presentation styles were implemented, as shown in Table 2. Lingo script dynamically controls the position of each media in the screen, thus the training content presentation is easy to create and modify.

Table 2. Web content presentation style list

Number	Descript	Example
1	Text only	
2	One picture at center	
3	Two pictures side by side	
4	Text on the left with two pictures	

One of the advantages of using online training is its capacity to integrate multiple types of media into the course. One challenge was how to overcome the bandwidth limit to provide quick access to information. The Tinker Online Training system solves the bandwidth limitation by applying various technologies including data streaming and using a shared caste in Director. In order to minimize the loading time, 3D, audio, and video use streaming technologies that are available in Director. In Director, 3D cast members contain model resources, models, shaders, textures and lights which can consume memory and takes time to download over the Internet. Using Lingo, a Director movie is able to stream and start using 3D cast members before the entire cast member has downloaded. To further reduce the bandwidth needs, video is converted from QuickTime format into Flash video whose file size is smaller and can be streamed inside Director. Due to the

complexity of engineering issues and explanation with long narration, large sound file size where unavoidable. To minimize long download times, sound files were cut into smaller segments and then streamed just before each segment plays.

Assessment

Tinker reviewed each module during the construction of the lessons. Modifications on training content and management tools were done based on Tinker's comments and suggestions.

The records in the database show that hundreds of base personnel are using the online training system. Figure 4 shows some of the users whose first name starts with L to O. Their user type, full name and directorate are also displayed. By clicking any user name, an administrator or manager level user can view that user's tracking page and view the user's progress and performance.

Figure 4 User list

Figure 5 gives an example of the user-tracking page which shows the viewer what modules have been completed. The Aerospace NESHAP module is the only module that has been assigned to this user and it has been completed (Figure 5). There are two questions in lesson 1 objective 1. This user answered one of those questions correctly. The total time the user spent in this objective was eight minutes and the last date he learned this objective was September 24 of 2003. With the above information, any administrator level user can see the training results, the date trained for that particular user and the time spent by the trainee for each objective.

Figure 5 User tracking page

Summary

Web-based engineering training is becoming a larger part of the distance learning because it is easy to access, less expensive, self-paced, facilitates updating of material, and offers unlimited learner and user tracking feature. The delivered online Tinker training was developed to train Tinker AFB personnel in environment management regulations and the correct method to test cabin pressurization systems for the C135 aircraft. Management tools give the administrators and managers the ability to manage users and track their performance instantly. The combination of text, audio, simulation, animation, video and images provide an interactive learning format. The data in the database shows that the Tinker personnel did learn concepts via this technical online training system.

Acknowledgment

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Biography

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Hengzhong Wen is currently a Ph.D. student of Aerospace and Mechanical Engineering at the University of Oklahoma. Her research work focuses on online training system development and implementation. She received her bachelor degree in Mechanical Engineering from Mechanical Engineering College of Beijing Union University. She received her master degree in School of Aerospace and Mechanical Engineering from University of Oklahoma. She worked as an instructor and mechanical engineer in Beijing Chemical Equipment Factory for seven years, and then as a chief engineer at Beijing Hanwei Engineering Blasting Company of High Technology for one year.

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