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Training the Masses – Web-based Laser Safety Training at LLNL

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Abstract

The LLNL work smart standard requires us to provide ongoing laser safety training for a large number of persons on a three-year cycle. In order to meet the standard, it was necessary to find a cost and performance effective method to perform this training. This paper discusses the scope of the training problem, specific LLNL training needs, various training methods used at LLNL, the advantages and disadvantages of these methods and the rationale for selecting web-based laser safety training. The tools and costs involved in developing web-based training courses are also discussed, in addition to conclusions drawn from our training operating experience. The ILSC lecture presentation contains a short demonstration of the LLNL web-based laser safety-training course.

Introduction

The Lawrence Livermore National Laboratory (LLNL) laser safety work smart standard (WSS) is based on the ANSI Z136.1 Standard for the Safe Use of Lasers. The WSS requires LLNL to provide ongoing laser-safety training for a relatively large number of employees (more than 300 per year) on a three-year cycle. Because regulatory oversight by the DOE/NNSA becomes continually more detailed, it requires an on-going need for attention regarding both the content and delivery method for laser safety training.

To meet these requirements, LLNL has had a laser-safety training course since at least the early 1990s. However the commercial computer based training (CBT) being used did not completely meet the needs of the Laboratory. Both the course materials and the method of delivery clearly needed updating to meet not just the regulatory need, but additional needs of the Laboratory in the 21st Century. These needs included:

- An ongoing capability to train large numbers of staff
- Training that is safety effective
- Training that is cost/time effective
- Training that would be interesting and directly involve students
- Training that would be easily adaptable to meet specific audiences

A variety of training methods have been used (or at least considered) by LLNL for health and safety training over the years. These include; lecture based training, synchronous collaborative distributed learning (SCDL), single station (or server based) CBT, read and sign booklets, and briefings or tailgate training. Experience has indicated that many of these methods were inadequate or inappropriate for use in laser safety training. This was particularly true because of the number of persons who needed to be trained. The following is a short discussion of the advantages and disadvantages of some of these training methods.

Lecture Training

With the right material and instructor, lecture training continues to be the "best" (or at least the most effective) safety training method, as it allows direct instructor/student contact to address training questions. Most importantly, it acts as a bridge between the safety professional and the student.

Unfortunately, there are real issues that prevent lecture training from being practical in all situations/settings. For instance, it is difficult and expensive to find and train good instructors. There is substantial expense in implementation of lecture training because of the time (cost) of sending students to classes. At LLNL, we also have a serious problem with available classroom space, so it makes it hard to train large numbers of students without giving many sessions. If you schedule many sessions, it often results in severe "instructor fatigue."

Synchronous Collaborative Distributed Learning (SCDL)

SCDL is a one-way teleconference lecture using a verbal "chat" function to maintain connection with the students. This approach expands instructor capabilities to teach at a distance, resulting in better use of instructor time. In addition, the virtual "classroom" can be of any size required, so classroom space is no longer an issue.

Unfortunately, there also problems with SCDL. First, there are expenses required to obtain the special hardware/software to perform SCDL. Classes still need to be scheduled, so it is not "on demand" training. The instructor "connection" with students is impacted adversely in comparison to traditional lecture training. If SCDL is used for remote site training, there can be a video bandwidth problem (outside of the LAN). Finally, student participation needs to be monitored because there is always the concern that students will log-on, but not really watch the teleconference.

Single Station CBT

Single station CBT suffers from a number of problems. It has limited capacity due to hardware, software and licensing requirements. It tends to be a poor value because it is usually leased rather than owned. It is

inflexible; commercial products tend to be too generic to meet individual site needs. It is also static; this is to say the proprietary software/content (legal) issues make it impossible to change to meet site needs. Finally, students find it boring (actually, they often hate it), so they may not pay attention.

Finding the Solution

In the end it was decided to go with web-based computer aided instruction (CAI) as the appropriate solution to the laser safety training need. First, being web browser based makes it hardware/software independent, limiting costs and the need for new equipment. It is true on-demand training with classes available 24/7 to meet user needs. This allows CAI to provide almost unlimited student capacity. It is a good value because, though there are expenses in the initial development, you own it, so it's much cheaper to use and modify over time.

It is flexible and kinetic. By using commercially available development software and your own content, it allows easy, quick changes (without legal issues) to meet individual site needs. Finally, student tracking and record keeping are easy and efficient using automated databases.

The Course Project

In 2002, the LLNL Laser Safety Officer (LSO) began a project with the Safety Education and Training Section (SETS) to review and update the existing materials and investigate moving them from stand-alone computer based training (CBT) to server web-based training. The project was begun in the fall of 2002 and was completed in the spring of 2003, when the course went on-line.

Development and review of course materials was a collaborative effort between the LLNL LSO, the LSO for the National Ignition Facility (NIF) and SETS. The SETS contribution included two instructional designers and myself.

Course Structure and Content

The new web-based CAI course was designated as HS5200-W "Laser Safety." Course design was broken down into a series of 12 stand-alone modules that, in combination, made up the level of detail we felt was necessary to meet the laser safety needs at LLNL. The course modules cover the following areas:

- Course Introduction (with accident simulation video)
- Laser Fundamentals
- Laser Accidents
- Laser Bio-effects
- Non-Beam Hazards
- Laser Safety Tools
- Administrative Controls
- Personal Protective Equipment
- Fiber Optics Safety
- Regulations
- Lasers at Remote Facilities

The course structure and content was intentionally aimed at a research environment. For instance, the accident simulation video in the course introduction is taken from an actual laboratory laser incident. As would be expected, the topic areas are traditional in laser safety training, so a special effort was made to present the material in an interesting and involving manner.

Course Presentation

Course content is presented in several layers. The base content layer contains screen text and static layered graphics. The second layer is a voice-over narration intended to augment and reinforce the screen text. A third layer of video and animated graphics is used on various screens to add visual interest and to emphasize specific information. The overall effect is intended to maintain the visual and auditory interest of the student over what is, admittedly, quite a long and complex course.

Course screens were built in Macromedia Flash® to assure cross-platform and cross-browser compatibility while allowing low-bandwidth streaming over the web. The screens are easily resized, allowing improved viewing by the student for various size video monitors.

Student/Course Interaction

From the beginning, the course was designed to allow maximum student flexibility both in use and in interaction with the course screens. The course is available 24/7 from any laboratory computer. Because the course is quite long, students may open the course, complete any number of modules then close the course should they not have time for completion. When they reopen the course, they are asked if they want to continue where they left off or if they would rather explore the course on their own. This approach allows a student to revisit modules if they need to.

Available from each screen is an interface containing a series of buttons that control drop-down menus. These menus allow direct access to various course

components, as well as additional information to assist the student. These buttons control:

- A guide to additional laser safety resources
- A guide to navigating the course interface
- A glossary of laser terms
- A menu allowing access to individual course modules
- Where to get help with the course
- How to exit the course

Except for the introduction, each module contains a pre-test to allow testing out of that module. During each module there are various questions, matching exercises, etc. that encourage student interaction and reinforce information being presented. At the end of each module there is a quiz to test the information retention of the student and reinforce what has been learned. All course use and testing is tracked by a computer database to maintain student records.

Operating Experience

Overall, the CAI course has been extremely well received by the employees at the laboratory.

In the past 3 years, about 930 LLNL staff have completed laser safety training, mostly by lectures and CBT that pre-date the CAI course. Prior to the CAI course, SETS received numerous complaints voiced by students aimed at the CBT training. These complaints have completely disappeared since the CAI course was introduced in 2003.

The course development costs were estimated to be about $30,000 (or about $33 per student). These costs were estimated at below 15% of the cost of an equivalent (untailored) commercial product.

Conclusions

It possible to train large numbers of people in laser safety, but it can be very difficult to use traditional methods like lecture, traditional CBT, etc. for this purpose.

Web-based CAI appears to be an appropriate and cost-effective method to meet such large training needs. Although it has proven very cost-effective, the real advantage of CAI is the ability to tailor it exactly to the needs of an organization. Finally, students like the flexibility and creativity of CAI, so they tend to participate more and be less resistant to training.

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