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## **Interactive Multimedia Programming Allows Laser Safety Training to Be Adapted to User's Specific Needs**

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### **Abstract**

By combining written and spoken words, drawings, photographs, animation and video, computer based multimedia training can convey information very effectively and efficiently. Animation and drawings are especially valuable as means to present the abstract and complicated concepts involved in laser safety training.

This paper discusses an approach to multimedia programming for medical and industrial laser safety training, where the training content is determined according to both the user's specific laser(s) and application. For medical laser users these include dermatology, ophthalmology, low-level laser therapy, and surgery, while for industrial users, welding, cutting, and heat treating are specified. By adapting the content to the needs of the user, training duration and effectiveness can be optimized, as the user is not exposed to information that is not relevant for his or her application.

In order to accommodate different learning styles and speeds while offering a well coordinated presentation of the material, an innovative multimedia training scheme is used. The material is presented both in an interactive fashion, relying on short text segments, graphics and animation organized in sub-layers, and in a passive fashion, with the material presented in the form of spoken words, videos and animations much like an audio-visual show.

### **Introduction**

Due to the potential hazards associated with the use of Class 3B and Class 4 lasers, it is generally recommended and accepted policy that personnel working in the hazard area near the laser must be informed about laser and associated hazards and how to reduce the possibility of injury, i.e., they need to be trained.<sup>1,2</sup> Training for this purpose is often termed 'user training,' in contrast to the training of the Laser Safety Officer (LSO) or 'awareness training.'<sup>3</sup> User training is often performed by the LSO (who needs to be trained himself), although it is sometimes done by consultants, organizations offering laser safety training, or the manufacturer of the laser system. User training should not be a one-time event, but should be repeated, for instance, on a yearly basis. When a new laser is installed, it is usually convenient to train all personnel involved with the laser in one training session. However, once the laser is installed and the initial training is done, a new hire may be assigned to work with an already installed laser, and this person then requires laser safety training. It is also our experience that regular repetition of laser user training is often not done, due to the LSO's lack of time or because he feels that he is not trained well enough or does not have adequate training aids. In such cases it would be especially advantageous to have training materials

such as videos or computer based training available, which could be used at any time and would not require much of the LSO's time.

This paper describes an approach that defines the contents and structure of a computer based multimedia training program for the medical and technical laser user which provides both a high level of interaction and a high degree of adaptivity to the user's needs.

### **General Features of Computer Based Multimedia Training**

Early computer based training software (also referred to as CBT) was limited by the performance of available computers and often consisted of a textfile with few or no interactive features except to jump back and forth between the pages. In fact, as there was no capability to combine text with sound, graphics or video, these early programs could hardly be called multimedia presentations. However, the multimedia performance of PCs improved dramatically during the last few years, especially with the addition of digital video, and correspondingly the range and style of computer based multimedia training software improved.<sup>4</sup> Unfortunately, the production of all the necessary multimedia material (also called 'assets'), such as recording of voice and production of video and animation is time consuming and costly, and often the full multimedia potential is not utilized due to constraints on resources.

In terms of training effectiveness and performance, computer based multimedia training has the following advantages as compared to conventional training methods<sup>5</sup>:

- It does not require a trained trainer.
- It allows for individual learning speed and for the possibility to repeat material as needed.
- It includes a combination of text, graphics, video, animation and audio, which enhances effectiveness (if used according to pedagogical guidelines).
- It maintains a higher level of attention through interactivity and can include testing.
- It provides feedback on interaction (for instance if the user answered a question incorrectly).
- It can be tailored to meet the specific needs of the individual user.
- It is available at any time.

One advantage of typical small group training is that the trainer can answer questions immediately, and adapt his style and training content to the needs of the group. In producing multimedia based training software, user questions can be anticipated to some extent. Clicking on a 'hotword', i.e., an important word marked, for instance in another color, results in additional related information being shown. A glossary containing explanations of a range of terms and expressions related to the training topic also helps to provide these answers. In relation to the adaptation of the content to the user's need, the software can be programmed in a flexible way so that the person responsible for training the laser user can choose the particular content to be included. By contrast, the trainer of a small group cannot adjust for individual learning speeds or provide for individual repetitions. Often such training is held in a rather passive "schoolmasterly" fashion.

During the past year we worked to define the content and structure of a multimedia-based laser safety training program for laser users in medicine, industry and laser research. An innovative multimedia training scheme was developed to optimize the use and presentation of multimedia assets in terms of order and content, with three primary features:

- 1) redundant presentation of the information in two forms to provide both a user-controllable presentation rate and an interesting passive flow of information

- 2) regular tests or quiz pages in order to maintain a high level of user attention
- 3) a structure which can be adapted to the specific needs of the user.

### **Innovative Multimedia Didactic Concept**

The training content is structured in chapters, and for each chapter the training material is presented to the trainee in two redundant but independent fashions or parts: the *interactive* part and the *consecutive* part.

The interactive material is structured in pages, where each page covers a specific subtopic of the chapter. The relevant concepts and the main information are presented in the form of brief texts and illustrations on the “surface” of the page, and more detailed information is accessible by clicking on graphics to start an animation or by clicking on text to access further illustrations and text. Here the concept is “width first, then depth,” providing an overview of the subtopic followed by detailed information which can be accessed according to individual learning speeds. A quiz page follows every few interactive pages, consisting of relatively simple tasks mainly structured as multiple choice questions relating to those pages.

Both correct and incorrect answers result in corresponding messages to the user. It is not necessary to answer correctly in order to continue with the training, as the main purposes of these frequent questions are to provide feedback for understanding the training content, to emphasize the main point of the few pages just covered, and to keep the trainee interactively involved. That is, the emphasis is on active, not passive learning.

In addition to the interactive part, the consecutive part provides a linear passive audio-visual “movie” for each chapter, as the information is contained in video-clips, animations, animated keywords and spoken text, organized in a more dramatic fashion. This methodology has the advantage of limiting time-dependent assets such as spoken words to the consecutive part, which is presented automatically and can therefore be designed and structured as a smooth flow of information. In the interactive part, the user can choose the speed of all learning steps and the presentation of assets. If time-dependent assets such as spoken sentences were combined with the written text or illustrations, there is always the potential for an “audio-visual discrepancy,” where the information contained in the visual assets does not complement but rather blocks or dominates the intake of audio information presented at the same time. Additionally the need to present the material in small packages (so that they can be easily repeated) would result in a lack of flow of time-dependent assets and the presentation of the material would appear uncoordinated which could eventually lead to distraction or confusion. However by using redundant interactive and consecutive presentations of the material for each chapter, these difficulties can be avoided and different learning styles accommodated. In addition to the interactive and consecutive part, an extensive glossary is linked with the training content.

The training material can be utilized in either of two modes: training mode and free access mode. The training mode is of course intended to provide laser safety training in an orderly and progressive manner. In the training mode, at the end of the program a final test must be passed in order to successfully complete the training. In this mode, the final test is only accessible when all the content has been covered. The free access mode is intended to provide an informational basis for individuals such as governmental workers, managers, and the LSO, who might want to complement their own training or review some of the information following general training. It should be emphasized that the course material is not sufficient for LSO training, nor is it complete enough to provide the sole training resource for personnel to be trained as LSO, either in detail or training content.

### **Concept for Adaptable Training**

During the definition phase of the content of the medical training package it was realized that the knowledge base to be conveyed is quite different for the different medical specialties. For instance, a laser surgeon must be aware of the potential hazards of material expelled in the laser plume; however, this is not relevant to an ophthalmologist. Therefore, in the case of medical laser safety training, the intent was to provide for specific training needs in the following medical specialties:

- Surgery
- Ophthalmology
- Dermatology
- Low Level Laser Therapy (LLLT)
- “Others”

The “Others” choice will provide similar training to that covered for the “Surgery” option, as this is the medical specialty with the broadest training content.

Only some of the training content will be tailored to the area of specialization – for instance, information regarding such basics as the nature of laser radiation, possible injuries to the eye, and information regarding eye protection will be common to all specialties. Therefore, the organization of the content must only account for differences where they are relevant, such as when the “shape and size” of typical medical lasers are shown, as schematically depicted in Figure 1 below.

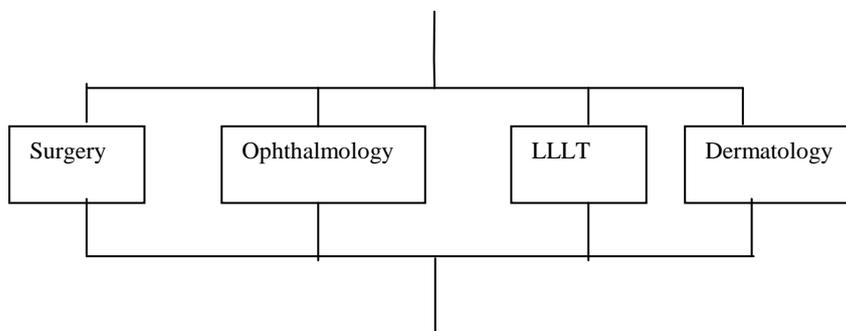


Figure 1. Flowchart of program structure to account for content specific to the different medical specialties, where each rectangle represents a content page with associated multimedia material pages. LLLT is Low Level Laser Therapy.

In addition to the specifics of different medical specialties, some hazards are associated only with certain laser types within that specialty and are therefore not relevant for other lasers. For example, toxic gases are a hazard specific to the excimer laser and toxic dyes are associated only with the dye laser. In order to provide specific relevant course material, the trainee is asked to indicate specific lasers from a list provided at the beginning of the training material.

- Excimer
- Dye
- Other

The specific issues associated with these laser types are contained in one or several pages, which are shown if the corresponding type of laser has been chosen (see Figure 2). If “Other” is chosen, these pages are not shown.

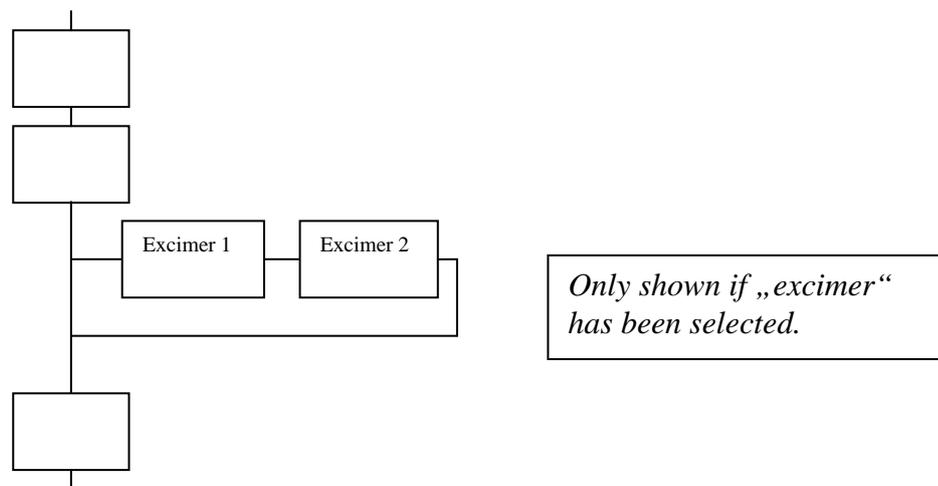


Figure 2: Graphical representation of programming structure for showing material only relevant for the choice of laser.

The average duration of the laser safety training program is intended not to exceed 45 minutes for low level laser therapy and about 90 minutes for general surgery. The structure will be set up so that it is possible to interrupt and then resume the training program at a later time with all the information from the previous session saved in a personal file.

Similarly, for the industrial training program, the hazards associated with specific industrial applications, such as UV radiation for welding and high probability for reflections with heat treating, will be specifically discussed. It is planned to provide training for the following specific applications:

- Welding
- Cutting
- Heat treating

## Summary

An interactive multimedia medical laser safety training program is being produced, with the training content determined both by the user’s area of specialization and specific laser(s) used. An innovative multimedia training scheme is used, which presents the information in two parts, one intended for interactive learning with the user controlling learning speed and access to information, and the other intended convey audio-visual information in the non-interactive style of a movie.

The training program is intended to help the LSO provide necessary training for laser users, and also as a resource for those already trained but desiring a review of laser safety concepts. By adapting the content to the needs of the user, training duration and effectiveness can be optimized, as the user is not exposed to information that is not relevant for his or her application. Following completion of this program, an industrial version will be produced, again with content determined according to the user’s specific needs.

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