Creating Web-based Multimedia Training
For Subject Matter Experts

Thomas C. Ouimet, MPH, MBA, CIH, CSP
Robert A. Rusczek, CIH, CSP

Introduction

Workers are often overwhelmed by the training we provide them – both in the numbers of different courses offered as well as the quantity of course content. In addition, there is often a complete disconnect between when training is provided (such as when hired or annually on a particular date) and when the information is actually needed to solve a problem or to safely perform a task. And of course there is the high cost associated with providing face-to-face training. Web-based training and communication techniques can address these issues by providing essential information to workers when they need it (just-in-time) or when convenient for them to review it. This type of content can be easily updated and distributed globally from a central location. Although these technologies cannot replace all existing health and safety training, they can make a significant dent.

To date, the creation of web-based multimedia training has been the domain of independent commercial vendors, and their products tend to be generic. Recently, computer hardware and user friendly software tools have been developed that allow subject matter experts such as safety professionals to author multimedia web-based programs.

Why Produce Your Own Web-based Training Material?
There are a number of good reasons for developing your own web-based training. The first and probably the most important reason for most safety professions is the need for a product that is site specific, that covers local policies and procedures and features the images and perhaps interviews of local employees and management. Although many commercially available web-based training products allow customization, none will allow you the control of content achievable when training is created in house. A second reason is the creative control one has over the content, allowing very innovative programs. For example, one can create a combined training program covering lockout tagout, confined space, and electrical safety for a specific employee population at the awareness level. By integrating the training it can be delivered more efficiently and just covers the content applicable for the specific employee group. A product like this is not available commercially. Commercial vendors package each training program separately, following OSHA regulations, and often include too much information for training at the awareness level. A third reason is that a commercially available training product may simply not available on a topic of interest to your employees. Tom works in an academic institution with many research laboratories. Other than very basic training material on chemical and bloodborne pathogen use in laboratories, commercially available training is non-existent. To fill the void, he has created numerous training programs such as, "Working Safely With Organolithium Compounds," and "Working Safely With Risk Group 2 Biohazardous Agents" which are used by thousands of employees each year. There

simply is not a big enough market for commercial vendors of web-based training to develop this type of content and it is so specialized that they do not have the knowledge to do it.

The Critical Steps in Designing Training (Instructional Design)

There is an accepted process for developing training programs, which if followed, produces effective training material. This instructional design process consists of a series of steps and should be followed no matter how the content will be delivered (e.g., classroom lecture or web-based training module). The steps in instructional design process are:

1. Perform a needs assessment
2. Establish training objectives
3. Specify training content and media
4. Account for individual differences
5. Specify learning activities
6. Evaluate training
7. Revise training

The development of training should always begin with a needs assessment. This step defines the knowledge, the skills gap, or what the individuals receiving the training need to learn to work safely. Once the need is defined, specific training objectives are written that describe what it is that training participants will be able to do following the training. These objectives are written to fill the gap or training needs. Once the training objectives are defined, the training content required to bring training participants from their current knowledge or skill level to the higher level defined by the training objectives is outlined and created. The instructional designer then determines the best way to present this information to training participants taking into account the different learning styles of adult learners. This may include lectures, small group activities, self-directed review of resource materials, web-based training, etc., and typically involves a combination of these approaches. Please note that the process is circular. The effectiveness of training is to be routinely evaluated and this information used to revise and improve the training. All training developed by safety professions should undergo this process regardless of how it will be presented or distributed. A reference (Piskurich, 2006) at the end of this paper reviews this process in detail.

What Type of Training Is Appropriate for Web-based Training Applications?

Certain types of learning can be effectively conveyed in a web-based format. Types of learning are often categorized into the cognitive, psychomotor and attitudinal domains. Cognitive skills are the best suited to delivery via web-based training because they can be communicated to learners using language, text, numbers and images. The cognitive domain includes intellectual skills such as memorizing terms, concepts and procedures, problem solving, applying rules, and evaluating information. Much of safety training at the awareness level involves learning in the cognitive domain and therefore is especially well suited for web-based training. The learning of psychomotor skills requires the learner to engage in physical activity, use muscular actions, and practice a skill. Learning to drive a forklift is an example. Since psychomotor skills require repeated practice and feedback for mastery, they are not well suited for delivery via web-based training. However, if the learning objectives call for mastering some basic information about forklift operation and maintenance (cognitive skills), perhaps a combination of hands-on training and a web-based training approach (a blended learning approach) could be used. The development of attitudinal skills requires the learner to modify attitudes, reflect on his or her values, or perhaps explore alternative perspectives. Instructional material must build on what the learner knows or believes and direct them toward more appropriate behavior perhaps with praise, recognition, or modeling appropriate behavior. This is very difficult to accomplish in a web-based training format

and is typically accomplished in live training sessions through role playing and case studies. However, once again a web-based training program could present foundation material, perhaps corporate behavioral safety expectations and how a new behavioral safety program will function, prior to live sessions intended to improve employees' attitudes toward safety. One must take into account the type of learning that must take place when determining if web-based training is appropriate either alone, in a blended approach, or not at all.

Overview of Production Process

There are three steps to the production process when creating web-based training programs with software authoring tools appropriate for subject matter experts. The three steps are (1) pre-production, (2) production, and (3) post-production. During pre-production, the content necessary to fulfill the learning objectives is defined and organized into a logical sequence, often illustrated with a flow diagram. This is the path that training participants will follow as they progress through the material. A narrative, which will become the voice over, is written and a storyboard developed. The storyboard identifies the visual elements and interactions that will be associated with the narrative. During production the media that will make up the training program is captured. The media comes in a variety of forms and includes audio (the narration), images, video clips, and perhaps animations. Finally, in post-production the media developed in the production phase are authored into the training program using a software tool that allows the synchronization of these assets, the creation of paths though the content, and interactions between the training content and the user. We will now explore each of these development phases in more detail.

Pre-production

The first step in the pre-production phase is the defining of the content that learners need to master in order to fulfill the learning objectives. Essentially one works backward from the end product (what one will be able to do after being trained) to the content and activities that will take each learner there. Sketching this out on a blank piece of paper and then drawing a line through the content, arriving at the learning objective is a good way to conceptualize the content and its sequencing. But there are other considerations regarding the content to be incorporated. Too often safety professionals overwhelm the training participants with facts, regulatory jargon, and the minutia of safety programs that do not enhance their ability to perform their job safely. One of the advantages of creating online training programs is that training material can be coupled with other content, such as tools (checklists, SOPs, APPs, posters, permits, forms, etc.), that assist in the performance of a task, and resources (links to safety programs, regulations, guidelines, informational websites, etc.) that provide a broader understanding of a topic. One can cull out the essential training material (that which workers need to carry around in their heads to perform the job safely) and combine it with an orientation to a tool set (reviewed just prior to conducting the task) and a set of resources that enhances the employee knowledge, if desired. The training program, tools and resources are made available to employees on the internet at all times. In most cases, breaking up the content into

Exhibit 1 - Biohazard PPE Removal

training content, tools and resources, simplifies and condenses the training content. An example of how an effective tool can simplify training content is the poster in Exhibit 1. Instead of attempting to train each employee exiting this high containment biohazard laboratory in the proper sequencing of their personal protective equipment removal, a poster was developed and positioned at the exit that illustrated with images and described with words the proper doffing sequence. The training content consists of showing employees the poster, requesting they follow the sequence illustrated, and identifying where the posters have been located, a much easier training task. Wherever possible simplify the training content by augmenting it with tools and resources.

Once the content is defined it now must be sequenced to optimize learning as well as give learners some flexibility where possible. We are all familiar with creating a PowerPoint presentation - a series of slides are developed that are viewed and discussed sequentially. There is only one path through the content. This is fine with instructor led programs, but adult learners like to have some control over the sequencing of content in web-based training programs. This can be done if the content contains logical modules that are independent of other content. The independent modules are accessed using menus. When the content in one of the modules is completed the learner is returned to the menu to view other content. Any content that must be mastered first is shown prior to the menu. Multiple menus can be incorporated into training programs creating a branching structure.   Structuring a training program in this way not only allows learners to make choices about the sequencing of content but also allows quick access to content if a learner returns to the program in the future. Creating a flow diagram is a great way of visualizing the branching structure of a training program.

Drafting a Narrative
The narrative is the backbone of the training program, similar to the live presenter in a traditional instructor led program. The narrative must cover all of the content in the program as well as explain the navigational functions of the program, how to get questions answered, and explain any resource or tools incorporated into the program. The narrative must be carefully prepared to provide accurate subject information, and be understood by the trainees. A narrative prepared for college students should be different than for one prepared for blue collar workers with English as their second language. It should be prepared present tense, and words like "should" and "recommended" should be left out because they may confuse the trainee as to the exact safety requirements. For example, if the facility's policy is that safety glasses are required at all times, the narrative needs to state "safety glasses must be worn at all times," not "you should wear your safety glasses." Although it may be tempting at times, the narrative must not create safety policies that do not exist as it will only create confusion and weaken the overall safety program. For instance, if there is no facility policy that contractors visibly wear badges, don't state in the narrative that badges must be visible at all times.

The narrative can be incorporated into the program as text but most often in multimedia programs the narrative is audio read by a narrator. This allows the learner to listen to the narrator and frees the eyes to explore the program's visual content - images, charts, animations, etc.. If the program will be narrated it's important that the narration be written in short simple sentences. A narrative may be well written, but when spoken some content may sound confusing or awkward. It is therefore best to read the narrative out loud, ideally to a few persons with knowledge of the subject matter. You will find yourself constantly simplifying your writing. The narrative will provide you a rough idea of how long the presentation will be - a page of text typically can be read in three to four minutes.

Using your flow diagram, break the narration into sections that correspond to the different paths created through the content and create short transitional paragraphs were necessary (e.g., at a menu where the learner must make a choice and must be given instructions on how to proceed and what to expect). If exercises or interactions will be incorporated at various points in the program, these will also require explanations and therefore short narrative descriptions. Once you have a good draft of the narration it's important to step back and review its content to make sure that it supports and is consistent with existing policies, is agreed to by all appropriate stakeholders and is clear and concise. Once it's approved its time to create the storyboard.

Creating a Storyboard
The storyboard associates the visual components of the program with the narration. A good way to do this is to place your narration into one column of a two column table and in the adjacent column list the visual elements you plan to show while the narration is playing. The visual elements are most often images, illustrations, or video. The visual element must support the key concepts being conveyed in the narration by illustrating visually the points made. Content is acquired quicker by learners when information they acquire through the auditory and the visual channel is consistent and therefore easily merged in short-term memory. Once you have identified the visual elements of the program in this way, create a list of the media you must develop or obtain for the program. This will often be a list of photographs and video clips you will go out into the field to obtain during the production phase of program development.

Although creating a narrative and storyboard seems quite complex there is a good chance you have created them in the past. If you develop presentations using PowerPoint and use the speaker notes function, you are essentially creating a narrative and storyboard. The PowerPoint slide represents the visual elements and the speaker notes the narration. This is in fact a great way to develop your first web-based training program. Cut your narration into sections and paste them into the speaker notes section of the PowerPoint slides. Then develop your visual component in the slide itself. This presentation can then be imported into a number of software authoring programs to create a web-based training program. This will be discussed in more detail in the post-production section of this paper.

Production
Now that narrative and visual elements of the program have been defined it's time to create and develop the media that will be authored into the program.

Creating images and graphics
The quality and content of the visual components is critical to producing an effective multimedia presentation. The pre-production storyboard process created a list of videos, pictures and graphics to be taken. Now it's time to organize and strategize the actual taking and making of these components. Now a days, high quality still and video cameras are relatively inexpensive and easy to use. It's best to take photos and video at high resolution / high definition, as one can always generate lower resolution images and encode video to lower bit rates for insertion into presentations, but of course a low quality photo or video cannot be edited to high quality.

Be creative with the types of video and photos you take. For example, a wide shot format picture or video pan may be appropriate for showing where exit doors are in work area, but not effective if the training topic is how to properly don PPE; a close-up photo or video would be much more effective. There are many types of camera shots and video camera techniques that can be utilized to enhance your presentation. Spending some time learning these possibilities and practicing them will pay dividends when it's time to begin the

production process. Still photos can have various effects applied to them in Photoshop or other photo editing programs. For example, arrows and words can be added to a photograph to attract a learners attention and emphasize subject matter; a yellow-colored circle placed around a machine's emergency stop button in a photo will provide a much better visual of its location than the photo alone.

It's not always possible to get the picture you want in the field to emphasis an important concept. In these cases an illustration can be developed using a software tool. The simple illustration in Exhibit 2 was created in about fifteen minutes using Microsoft Visio, one of many easy to learn and use software illustration tools.
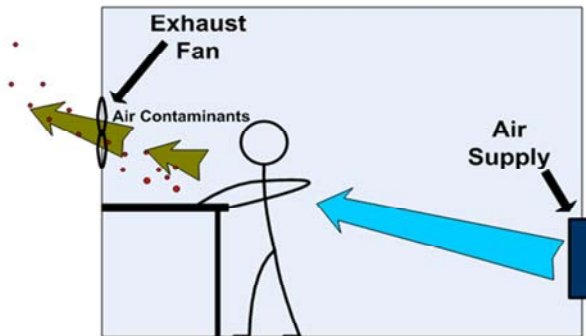
One caution is to not go overboard with the visual components. The subject matter can be diluted or downright lost if the visuals show fast action images that rapidly change and/or have too many effects applied to them - better to leave the "over the top" effects to Hollywood!

Exhibit 2 - Graphics Example

Capturing and editing audio

A common error is to overlook the audio quality while focusing on the visual aspects of the presentation, but the quickest way to turn off the trainees is poor quality audio. If learners can't hear, understand the narrative, or the narrative puts them to sleep, the multimedia authoring endeavor has failed.

There are two components to audio recording – the microphone and the digital recording device. In the last couple of years software has become available to convert computers, usually laptops, into digital recording devices. The technology was developed to facilitate the development of podcasts, but works astonishingly well for capturing the narration used in training. The software and a quality USB microphone can be purchased for about $100. You will want to avoid using an analog microphone that plugs into a PC's microphone jack. The quality difference between this and a USB microphone is significant.

Another approach to capturing audio narration is to use a portable digital audio recording device and microphone. High quality audio recording devices to which high quality microphones can be attached can be purchased for between $250 and $1000. These devices can be set to capture very high quality sound (48kHtz, stereo) in a variety of digital formats on solid media such as a compact flash. This allows the recorded audio to be easily transferred to a computer for editing. These recorders all support XLR microphones which are the industry standard. High quality XLR microphones can be purchased for $200 to $500 but this equipment is often available at substantial discounts on eBay.   The old saying "you get what you pay for" applies well to microphones. A good microphone will significantly improve your audio.

A critical audio production element is to select a person with a good voice. At one end, you don't want a monotone, meek voice to narrate, but at the other extreme you don't want someone screaming or shouting out the narrative. A person with a pleasant but authoritative voice is a good choice. Ideally, the narrator should be able to read considerable amount of narrative error free, with minimal undesired sounds, such as frequent throat clearing and mouth smacking, and mispronouncing words. The recording location also has to be carefully considered. Background noises need to be eliminated, and the room's reverberation level should be low as well.

No matter how good the narrator is some audio editing will be necessary. Audio editors allow you to cut and paste sections of the narrative or single words together in the narration very similar to the way a word processing program allows you to cut and paste text in a document. It is common to have a narrator read each paragraph of narration two or three times and then to construct a composite that contains the best sections of each of the readings. Audio editing also allows one to eliminate background noises and other extraneous noises. Software to edit audio runs from free to about $400.

Post-production
In the post-production phase of a web-based training program's development all of the media collected in the production phase is authored into a training program. In addition to the media, all user interactions, navigational features, external links, quizzing and reporting functions must also be integrated. A number of specialty software packages are available to do this but two stand out – Adobe Captivate and the Articulate Suite (Studio, Presenter, and Quizmaker) . These software packages were specifically designed to assist subject matter experts, such as safety professionals, create multimedia training programs. They have the ability to create very basic web-based training starting with a PowerPoint presentation, but also contain all of the features necessary to create very complex, highly interactive programs from scratch. This is a wonderful feature because it allows a novice user to create a program from a PowerPoint presentation immediately but allows more advanced users the ability to create more interactive and engaging content as they become more proficient.

Converting a PowerPoint presentation – Basic Use of Training Authoring Tools
PowerPoint is a presentation standard in the business world, and some authoring programs, such as Adobe Captivate, provide the option of using a PowerPoint presentation as the starting point of multimedia presentation. One advantage of this is that the text, typically in bullet format, can be prepared, and the narration text added to the "notes" section of each slide. Visuals can also be added to the PowerPoint slides or later in Captivate or Articulate. One advantage of this option is that stakeholders can review this storyboard-like draft and make any suggested changes in PowerPoint, always much easier to do earlier than later in the production process. Captivate allows "backwards" editing in PowerPoint, meaning that even a polished Captivate file can be edited either one slide at a time or the entire project back in PowerPoint without leaving the Captivate program.

Building From Scratch - Advanced Use of Training Authoring Tools
More advanced users of authoring programs can develop training programs from scratch, incorporating a unique interface, email links, resource links, branching navigation, and numerous user interactions. This is done by breaking up the narrative into discreet sequences and placing each sequence in the timeline of a slide. The slide is often referred to as a stage and objects, such as text, images, video, animations, etc., are added and removed from the stage in sync with the narration. This is done by positioning the media on a timeline with the audio track and adjusting

the media's start and stop points to correspond to what is said in the narrative. A host of stock interactions such as pre-programmed buttons and rollovers (text or images that pop up when a mouse is rolled over an object on the stage) can be added to the stage and navigational menus and quiz questions can be added between slides or stages. For the most advanced users, special scripts can be written and applied to the stages that further control navigation or what is visible on the stage. Although seeming complex, these advanced features of authoring programs are within the grasp of tech savvy safety professionals and can be used to create very sophisticated training programs.

Guidelines for Incorporating Multimedia into Training

A set of guidelines have been developed for incorporating multimedia into training. The guidelines are based on a model of how humans acquire and process media and are intended to improve the acquisition and retention of training content. The guidelines, described in detail in a book in the reference section (Clark, 2008), are summarized in Table 1. When developing web-based training it is extremely important to follow these guidelines.

Table 1. Guiding Principles for Incorporating Multimedia into Training

Principle	What to do or not to do	Rationale
Multimedia	Use both words (text and audio) and graphics (drawings, charts, graphs, maps, photos, animation or video).	People are more likely to understand material when engage in active learning. Multimedia encourages learners to engage in active learning by making connections between verbal and pictorial representations.
Contiguity	Place corresponding words and graphics near each other.	When separated on the screen, people must use their scarce cognitive resources just to match them up. This leaves less to mentally organize and integrate the material.
Modality	Present words as audio narration rather than onscreen text whenever the graphic is the focus of the words and both are displayed simultaneously.	Learners may experience an overload of their visual channel (trying to read subtitles and watch a foreign film).
Redundancy	Presenting words in both text and audio narration can hurt learning.	Learners may pay so much attention to the printed words that they pay less attention to the accompanying graphics due to an overloaded visual channel.
Coherency	Adding interesting material, but not essential, can hurt learning - Avoid extraneous sounds (background music); Avoid extraneous pictures and graphics; Avoid extraneous words	Working memory is highly limited and unnecessary sounds, graphics or text can overload the cognitive system.
Personalization	Use a conversational style (first and second person	People work harder to understand material when they feel they are in conversation with a

	constructions) and virtual coaches.	partner rather than simply receiving information. Virtual coaches provide hints, worked examples, demonstration, explanations, and stories.

Distributing Training and Recording Participation
Now that the program has been assembled with the authoring program it's time consider how you will record successful participation in the program and distribute the program. Each software authoring tool handles this a bit differently, but each has similar options.

An essential feature of any safety training program is the ability to record participation and to perform at least a rudimentary evaluation of learning. Most of the software authoring tools for creating training offer robust quizzing options. Quiz questions can be inserted throughout the training and tallied, or given at the end of the program. The questions can be of a variety of types including the traditional multiple choice, true/false, fill-in-the-blank, and short answer, but also include matching or associating items in a table, and clicking on hot spots (perhaps to identify the unsafe condition in an image). Feedback on quiz questions can be provided and learners can be redirected to specific content based on their answers (perhaps to remedial material if they answer a question incorrectly).

Capturing an individual's quiz score to document participation can be somewhat difficult. If your company has a learning management system (LMS) that is "SCORM" (Sharable Content Object Reference Model) compliant one simply outputs the training program in a format that is uploaded to the LMS. This is a simple export option setting in the authoring software; the LMS does the rest.   For those without a LMS, most training authoring tools also include an email option where the quiz results can be emailed to a specified address. This information must be uploaded to a database which can be very labor intensive. There are two additional workarounds that have been successful. In at least one authoring program, Adobe Captivate, the email reporting code that the program generates can be altered and redirected to a server side database. To do this the services and expertise of an IT professional will be required, but it is not particularly difficult. A second alternative is to acquire third party web-based quizzing software that captures the results in a database and then simply have all the quizzing and recording tasks performed by that third party program. A link is created on the last slide of the training program to direct the training participant to the quiz. Capturing quiz results and recording participation is one of the more significant hurdles to overcome when implementing web-based training programs in small and medium sized companies.

The most common method for distribution is to convert the program into a Flash file and then embed that file into a web page or HTML page. The web page and associated Flash files are placed on a server and training participants simply access the web page to initiate the training. The link to the training can be distributed in emails or simply linked from other web sites. In order to view the training, the computers accessing the content must have the free Flash application loaded. There are no special server requirements. Until recently, almost all devices that could access the internet could play Flash files and therefore this method of distribution worked extremely well. However, several new devices, specifically Apple OS devices such as the iPad, do not support Flash. Android-based tablets do support Flash. Since these devices are becoming more ubiquitous and preferred by users for training, authoring software manufacturers are scrambling to develop a solution. The solution will be a change in the format of the file created by the authoring software. In addition to a flash file

output option, future versions of authoring software, such as Adobe Captivate, will output the training program in a special type of HTML called HTML5. HTML5 supports multimedia and interactivity and will play on all devices currently in the marketplace. This output feature is currently under development and will be implemented over the next couple of years.

Other options for distributing training programs include outputting the training as an executable file (.exe or .app), embedding the Flash file into an Adobe pdf file, and burning the web page with embedded flash file (which was used to distribute the program on the internet) to a CD or DVD. Most computers are set up to accommodate these files. However, each of these distribution methods have one major drawback. They actually distribute the training program and therefore any update to the program requires that the program be redistributed to each end user. With a web-based distribution system, described above, updating the training files on a single server essentially updates all present and future users.

Production Costs

The costs associated with producing your own web-based training fall into three categories: (1) the cost of the software to author the program and edit the media (images, video and audio), (2) the cost of the equipment to collect media, and (3) the time to produce the training. There is of course a learning curve associated with acquiring the skills necessary to develop training and use the various software packages but this is moderate, particularly if one starts by converting PowerPoint presentations. The one-time cost associated with the purchase of software would range between $500 and $2,000 depending on the software purchased and the institution you represent (academic institutions are given steep discounts). The one-time cost associated with equipment purchases (still/video cameras and audio recording equipment) would range between $1000 and $5000 depending on the equipment purchased. But if one has access to a computer microphone and digital cameras and used freeware editing software, the initial cost would simply be the cost of the authoring program (such as Adobe Captivate or the Articulate Suite). Once one becomes familiar with the training production process and a software authoring tool, it takes approximately four to five hours of development time per minute of instructional content. If one is converting an existing PowerPoint slide presentation, the development time would be far less and on the order of two hours of development time per minute of instructional content. These costs are easy to justify when one considers the high cost of alternatives such as instructor led training.

References

Clark, R. and Mayer, R. 2008. *E-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning.* San Francisco: Pfeiffer.

Piskurich, G. 2006. *Rapid Instructional Design: Learning ID Fast and Right.* San Francisco: Pfeiffer.