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The *Journal of Construction Education* (ISSN 1522 8150) was founded in 1996 by the Associated Schools of Construction, an association of 105 international colleges and universities with construction education programs. The purpose of the *Journal* is to provide an important process necessary for the preservation and dissemination of manuscripts that report, synthesize, review, or analyze scholarly inquiry. The *Journal* is an important way of our focusing international attention on and contributing to the understanding of the issues, problems, and research associated with construction education and training. The recognition of scholarly work within the realms of curriculum information, contemporary educational practices, educational research and instructional application development within construction departments, schools and colleges, and industry are the reasons for the *Journal's* existence. The *Journal's* mission is to provide construction educators and practitioners with access to information, ideas, and materials for improving and updating their understanding of construction education and training. It is also intended to help its constituency become more effective in developing the talents of learners within construction programs. This *Journal* is not only a living textbook of construction education, but also a perpetual and dependable learning source for construction professionals whether they are within academia or within industry. The *Journal* will be published tri-annually (Spring, Summer, and Fall issues). The divisions of the *Journal* include invited and editorially reviewed Book Reviews and Teaching Profiles, and blind peer reviewed Educational Practice and Research Manuscripts.

Any requests, suggestions, questions, or reports regarding this service should be directed to:

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The Journal of Construction Education

Spring 2003

Volume 8
Number 1
pp. 1 - 70

Editorial

Educational Practice Manuscripts

Other

Journal of Construction Education
Spring 2003, Vol. 8, No. 1, pp. 6 - 8

1522-8150/01/$3.00/Editorial

Publishing in Construction Education

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Introduction

This is my last issue as Editor/Publisher of the *Journal of Construction Education* and I am handing over the reins to a new editor, Mark Hutchings of Brigham Young University, who will continue delivering and improving the *Journal*. It has been an interesting experience that began in 1996 through twenty-one issues. I will remain, at least temporarily, as a shadow editor, as I help with the transition. In the future, I plan to contribute to the Journal by writing manuscripts. Other than that, I am going to work on my restoration of a 1970, 454, Chevelle.

Thank you, Thom Mills, my Associate Editor, for volunteering your time and expertise to this worthy endeavor so many ASC members and *Journal* readers have benefited from your efforts and continued support. I have also had the pleasure of working with a wonderful group who has served as Advisory Board members, thank you. Thank you reviewers for you're dedicated works, you with the authors, are the real force behind the *Journal*. It is because of these wonderful volunteers and contributors that it is very difficult to say goodbye.

I know it wasn't always easy, but we got through this inaugural effort together, as a team. Please give Mark your support and assistance, as well. In particular, I encourage more ASC members and construction educators to contribute, by writing more pedagogical manuscripts, by volunteering time to help Mark and the rest of the *Journal* volunteers.

Conclusion

To conclude my tenure I would like to revisit the initial editor's commentary (Williamson, 1996) as a means of describing the path we have taken while innovatively embracing electronic publishing in construction education.

The road to academic excellence has been going through a dynamic change brought to construction education programs by enhanced standards within the university environment. Scholarship has taken on new meaning. To be a construction educator, one must now generally hold a Ph.D. Not only has there been a change in academic qualification, but also we are now more than ever required to conduct research and report the results to our peers within the scholarly community. This was not always the case when the *Journal* published its first issue. The resistance to the *Journal's* existence has faded away as our world has changed.

The commentary identified three important functions of a journal beyond distribution of text:

1. Academic certification,
2. document archiving, and
3. research marketing.

Academic certification has been the most difficult task faced by this editor. Many within our academic community cannot identify a difference between construction practice and construction education. Maintaining a pedagogical standard within manuscripts has lead to author, reviewer and organization confusion. While submission documents clearly state the mission and purpose of the *Journal* as being pedagogy and the submission process requires the author to select between the divisions of educational practice and research, many manuscripts are submitted without reference to teaching, curriculum and educational research. We are slowly teaching and learning this stratification by maintaining the integrity of the *Journal's* mission through editorial and reviewer rejection of non-educational manuscripts. Review Board investigation by readers is the second largest web site hit category within the annual journal editor's report.

Document archival has met and exceed all expectations. If the reader will refer to the last Annual Journal Entries (Williamson, 2002) they will see that the archive receives the largest number of web site hits. To enable the *Journal's* physical transition the *Journal's* web site has been off line for a couple of days. During these down periods I receive one national and three international inquires as to where the *Journal* and its archives could be found. We are providing an academic resource and communicating to readers of national and international origin.

The unknown quantity is research marketing. I find it difficulty to believe that our practical industry counterparts will ever embrace scholarly work or support institutional research in construction education or training. We as construction educators have not found the educational nitch that will allow us access to the National Science Foundations emphasis in funding pedagogical research and funding growth. Therefore, I see this issue as the most critical issue facing construction educators and this *Journal* in the future. The *Journal* must place an increased emphasis exposing contributor works to education funding foundations.

The Journal has met the standard set by print media journals. I believe it has even exceeded that standard. The use of computer technologies and the Internet has continued to expand and electronic publication has benefited. External electronic and print publishers have approvingly commented upon the *Journal's* format. However, I believe that we have found the pothole in the road. The commentary I refer to here has two references that are hyperlinks to articles on the Internet. Neither link now works. I spoke of the importance of insuring that the *Journal's* archive being maintained intact in perpetuity, this is most important contribution the Associated Schools of Construction has made to this scholarly effort. They have guaranteed the archive maintenance within the very structure of the organizing and legitimized it within the ASC Bylaws.

As the Journal's editor, I attempted to place the highest priority on academic pedagogical collaboration, across institutional boundaries, serving innovative modes of scholarship exchange that accommodated the special needs of those in different and closely related context settings. The inherently multidisciplinary nature of construction education inquiry is well suited to the electronic publication format and media.

In conclusion, I wish to elatedly thank the membership of the ASC for providing me with the distinguished opportunity of service to construction education, my chosen life's endeavor and love.

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Construction Educator

Journal of Construction Education
Spring 2003, Vol. 8, No. 1, pp. 9 - 27

1522-8150/01/$3.00/Educational Practice Manuscript

Virtual Safety Training

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Safety training has developed in a variety of mediums and delivery vehicles. Workers now can train via video, digital video, CDROM, and even online. Our ability to package this information in useful, effective, and even entertaining delivery systems has increased the effectiveness of safety training (Overheul, 2001). The Multimedia Tool Box Talk is a web-based quick reference safety guide and training tool. The goal was to develop a web-based media guide where contractors across the nation can find free, clear, and concise information on various safety issues/topics. In addition, the intended outcome of this effort was to provide an efficient and effective way to locate and interpret crucial safety information while at the jobsite. This is accomplished through the use of things such as OSHA standard information, real life construction pictures, video clips, and frequently asked contractor questions. It can be a great resource to assist in safety planning, education and training for construction personnel.

Key Words: Construction Safety Training, Virtual Training, Multimedia Tool Box Talk, Web-based training.

Introduction

This paper will demonstrate that safety education does not have to be costly or time consuming. For this project, educational technology helped make a difference in a positive way. A web-based quick reference safety guide was developed. The purpose of this reference guide is not to reconstruct what OSHA has already established, instead provide an efficient way to locate and interpret crucial safety information. The goal was to develop a web-based media guide where contractors across the nation can have a free, clear, and concise reference guide on various safety issues.

Every year, 100 to 400 people are killed in the United States by trench cave-ins and 1,000 to 4,000 are injured. Construction job site incidents exceed that number by more than double. On average, workers that are killed by cave-ins are male, 20 to 30 years of age and have had no training. Most deaths occur in trenches that are 5 to 15 feet in depth. Deaths are usually attributed to suffocating, crushing, losing circulation or in some cases, being struck by falling objects (Underground Construction, 2000). Even so, there is something about construction that attracts, fascinates, and excites just about everyone. It is hard to walk past a construction site and not turn and look at what is going on. Some people come back the next day to watch. Others build careers out of this seemingly natural interest (Heulke, 2001).

Some of this attraction for construction might indeed be natural. Think about the similarities between our human construction activities and those of other social and communal mammals and insects. What might initially appear to be chaotic comings and goings of prairie dogs, birds, bees, and ants turns out to be the necessary ingredients for constructing elaborate systems of travel, storage, breeding, living, and sleeping spaces. Whether driven by innate biological impulses to produce honey or a 100-story skyscraper, the process is the same: a series of individual tasks add up to infrastructure, shelter, and the satisfaction of need (Heulke, 2001).

The construction industry requires steady nerve, good coordination and the ability to perform under difficult, often hazardous, circumstances, but construction work does not have to be hazardous (Construction Safety Talks for Supervisors, 1976). However, the risk of work-related injuries and fatalities for construction workers is greater than for any other U.S. industry (Wichita Business Journal, 2001).

Unfortunately, construction safety is often overlooked or sacrificed due to time or money restraints. Yes, safety costs money, but what is the alternative cost if safety is neglected? Construction safety deals with actions that managers at all levels can take to create an organizational setting in which workers will be trained and motivated to perform safe, productive construction work (Levitt, R., & Samelson, N., 1987).

The Portable Multimedia Tool Box Talk web page will be linked to http://cadc.frontpage.auburn.edu/content/ToolboxTalk/ for quick and easy access. A complete safety index relating to various safety hazards as outlined by OSHA was created. In this project, each subject within the index is called a "module". The following modules were fully developed:

1. Hand Tools
2. Electrical Shock Prevention
3. Fall Protection (Barriers)
4. Trenching/Excavation
5. Scaffolding
6. Ladders
7. Mobile Crane
8. Crane Signaling
9. Personal Safety Equipment

The content of this website was organized so the viewer can maximize his/her learning experience. The following are the steps one should take in viewing each module:

Step 1: A **Picture Library** has been created without any feedback for the user. The goal is to have the viewer look at the pictures and identify potential problems or to identify the correct method of installation.

Step 2: A **FAQ & Terms** page has been developed for the viewer to read and understand the questions and answers as it relates to OSHA's Federal Code of Regulations.

Step 3: A **Slideshow** presentation has been created for the viewer to see some of the common errors that occur on the jobsite. The presentation is an extension of the **Picture Library**; the main difference is feedback has been provided.

Literature Review

On December 29, 1970, President Richard M. Nixon signed the Occupational Safety and Health Act of 1970, also known as the Williams-Steiger Act in honor of the two men who pressed so hard for its passage. OSHA published its first consensus standards on May 29, 1971. Some of those standards, including permissible exposure limits for more than 400 toxic substances, remain in effect today. Others have been updated or expanded through public rulemaking, dropped as unnecessary or overly specific, or amended to clarify their intent. OSHA offers financially and risk free onsite consultation to help employers identify and correct workplace hazards (http://www.osha.gov/as/opa/osha-at-30.html).

In the 1980s, OSHA changed gears and started to prioritize and focus on minimizing regulatory burdens. OSHA's goal was to provide a balanced mix of enforcement, education and training, standard-setting, and consultation activities. Major new health standards introduced during the 80's included requirements to provide employees access to medical and exposure records maintained by their employers; hazard communication; and more stringent requirements for asbestos, ethylene oxide, formaldehyde, and benzene. Safety standards covered a wide range of issues such as updated fire protection and electrical safety, field sanitation in agriculture, grain handling, hazardous waste operations and emergency response, and lockout/tagout of hazardous energy sources (http://www.osha.gov/as/opa/osha-at-30.html).

OSHA in the third decade again shifted gears and started to re-examine its goals as part of overall government reinvention. OSHA looked for ways to better manage its resources and increase its overall impact in reducing workplace injuries, illnesses, and deaths. Basically, OSHA understood that the resources that they had were not being used in the most effective and efficient way. OSHA concentrated its efforts towards optimizations and efficiency. OSHA was focused on reducing red tape, streamlining standard-setting, and inspecting workplaces that most needed help in protecting employees all while trying to create a partnership atmosphere with the construction industry in order to change attitudes about OSHA and safety. The emphasis was on results. As part of its reinvention effort, the agency reorganized its area offices to provide rapid response to worker complaints and workplace tragedies, as well as to focus on long-term strategies to lower job-related fatalities, injuries, and illnesses. OSHA instituted a phone-fax policy to speed the resolution of complaints and focus investigation resources on the most serious problems (www.osha.gov).

The standards that were published during the 90's relied on a performance-oriented approach. Major safety standards included process safety management, permit-required confined spaces, fall protection in construction, electrical safety-related work practices, and scaffolds. "OSHA broke new ground in 1991 by introducing a blood borne pathogens standard to address biological hazards. OSHA also issued guidelines for preventing workplace violence in health care and social services work and in late-night retail establishments" (http://www.osha.gov/as/opa/osha-at-30.html).

In 2000, OSHA was broadening its educational and training efforts. OSHA introduced compliance assistance specialists to join every area office to provide safety seminars, training, and guidance to employers and employees upon request. More and more the agency used its website to provide information to its customers. Nearly 1.4 million visitors use the site each month for a total of 23 million hits. In addition to the website, OSHA is providing distance learning options via satellite and computer to provide broader access to worker safety and health training (http://www.osha.gov/as/opa/osha-at-30.html).

OSHA has changed drastically in the past three decades and has apparently made a difference. The U.S. occupational injury rate is 40 percent lower than when OSHA was created in 1971. Deaths from occupational injuries are at an all-time low, 60 percent lower than 30 years ago. Although progress has been made, its work is far from done (http://www.osha.gov/as/opa/osha-at-30.html).

Safety training has developed in a variety of mediums and delivery vehicles. Workers now can train on video, digital video, CDROM, and even online. Industry knowledge about ergonomics, biological hazards, industrial hygiene, and safe work practices has significantly grown. Our ability to package this information in useful, effective, and even entertaining delivery systems has increased the effectiveness of safety training. For example, we often take the personal computer for granted. The PC has been part of the safety revolution. One need only think of the ability for safety managers to keep up-to-date records on the safety training of all employees, and access this information quickly, to understand one positive change that has encouraged a culture of safety to emerge (Overheul, 2001).

Recent studies indicate online delivery of safety training will dominate the market by 2005. There are many benefits for going online and using Internet-based technology for safety training. In the emerging global economy, companies must proactively respond in order to educate their employees properly. To maintain a competitive edge and increase profitability, companies succeed by reducing delivery costs and using advancements in technology to stay ahead of the learning curve. Online learning provides safety training and information on demand, when it's needed (Overheul, 2001).

Some of the benefits of Internet-based safety education are the same benefits as training with interactive CD-ROM programs: reduced training time, eliminated travel expenses for learners and instructors, and reduced learning facility costs. Scheduling training becomes easier as managers can select times that better suit their schedule or the worker's schedule. Yet online training differs from CD-ROM in that workers can access the same training program from any computer with Internet access, and workers can train on a single program from any work site anywhere around the world. Finally, as with interactive CD-ROM, each worker is capable of training according to his or her own pace, and workers can bookmark programs and go back to finish them whenever they desire (Overheul, 2001).

Methodology

The Multimedia Tool Box Talk website is designed with the onsite construction professional in mind. The construction industry is a very fast paced and extremely hazardous industry. The goal of this project is to provide a quick reference safety guide where the onsite construction team can quickly and easily navigate and find answers to crucial safety questions. It was created based on a statistical analysis of the most frequently occurring construction related safety problems. OSHA has an all-encompassing safety website. This website was not designed to answer every safety question that one may have. It is important to understand that the Multimedia Tool Box Talk website is not a recreation of OSHA or the construction safety standards; it is simply a quick reference safety guide that offers a quick yet effective tutorial for the onsite construction staff.

Getting Started

The Multimedia Tool Box Talk website was created with Microsoft FrontPage 2000 and Abode Photoshop 6.0. Anyone with a basic understanding of both programs should have very little problem creating a site similar in scope and complexity. The theme that remained constant throughout the creation of this site was KEEP IT SIMPLE. This site could have been created with much more flare, but the content might have been overshadowed. Field personnel need the information not the aesthetics. The following sections will accurately account for the creation and content, which make up this site.

Content

The content for this website was obtained from OSHA's Federal Code of Regulations, as well as from OSHA's online safety index and numerous online safety sites, that were used as professional references. The first major challenge was to research and decide what subject matter should be included in the site. Once the information was accumulated, a total of 186 different subject matter web pages were created. For this website, each subject matter web page will be called a "module". Of the 186 modules that were created, nine modules were selected for research and development.

Navigation

Once the pages were created, the next major challenge was deciding how to organize and establish navigational controls throughout the site. Figure 1, shows how the navigation hierarchy was organized. Again, the governing thought throughout was to keep navigation simple as not to create barriers or confusion. If barriers exist due to complex navigational controls or complex designs, contractors will become disinterested and will not use the site regardless of the content the site contains.

Shown in Figures 2, 3, 4 and 5, are the home page, and the three indexes that were created: 1) Active Index, 2) Alphabetical Index, and 3) Project Index. Each index serves a specific purpose. The active index is used solely for navigation to the web pages that have been fully developed. The alphabetical index was created for contractors that have identified a concern and would like to navigate to the subject as quickly as possible. The project index was created for contractors that would like to review some safety procedures that pertain to a particular phase of the construction project. For example, if the contractor is preparing to break ground next week, the superintendent could easily review the module "Trenching and Excavation" under "Site Operations" before work actually starts.

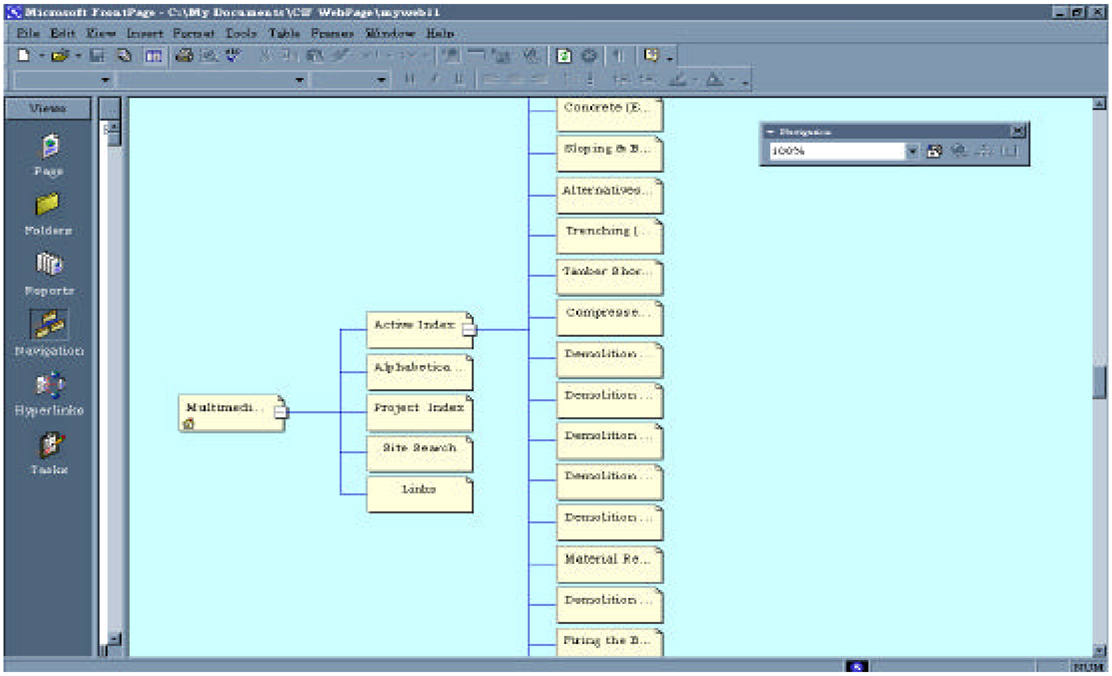

Figure 1: Site Navigation Hierarchy

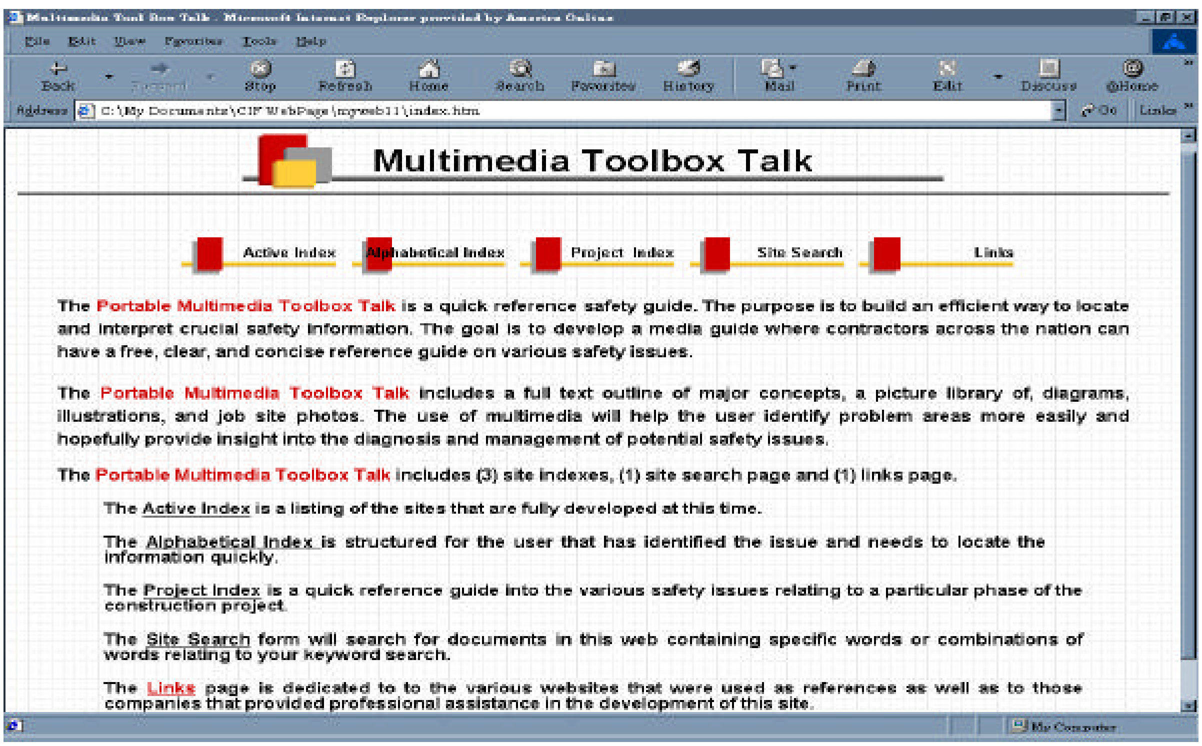

Figure 2: Home Page

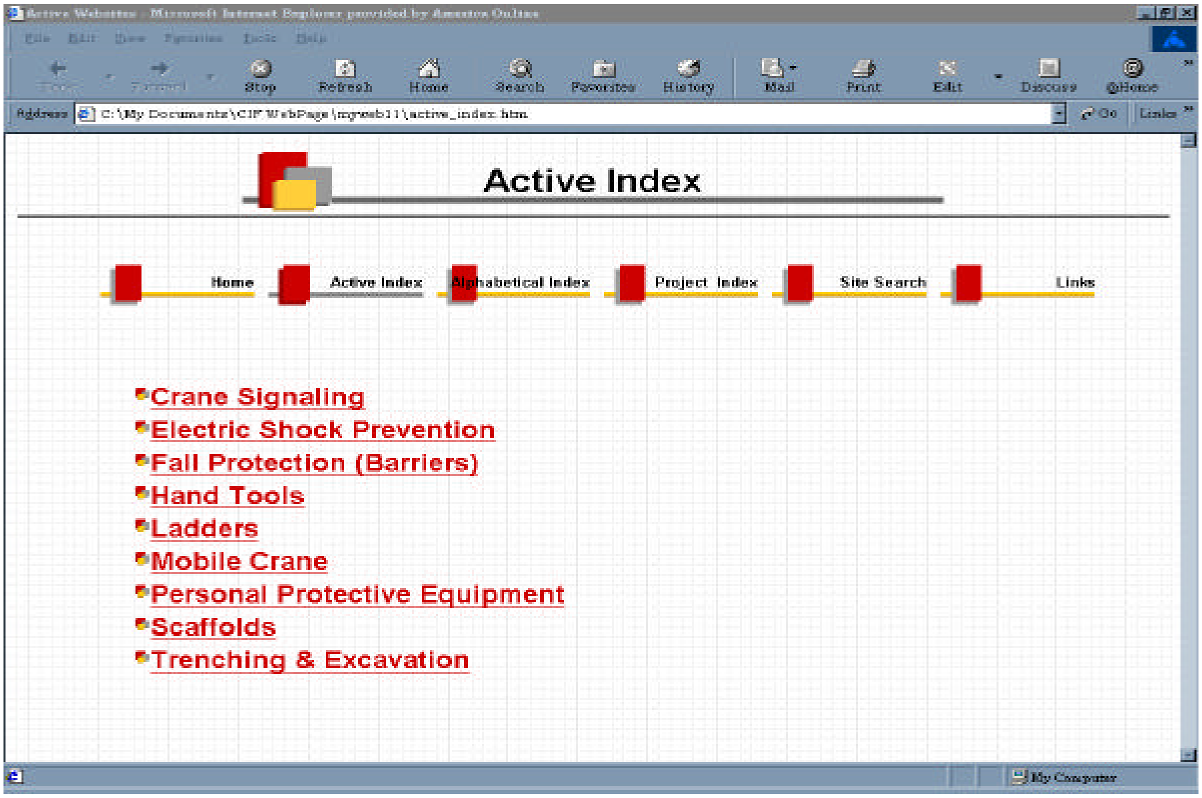

Figure 3: Active Index

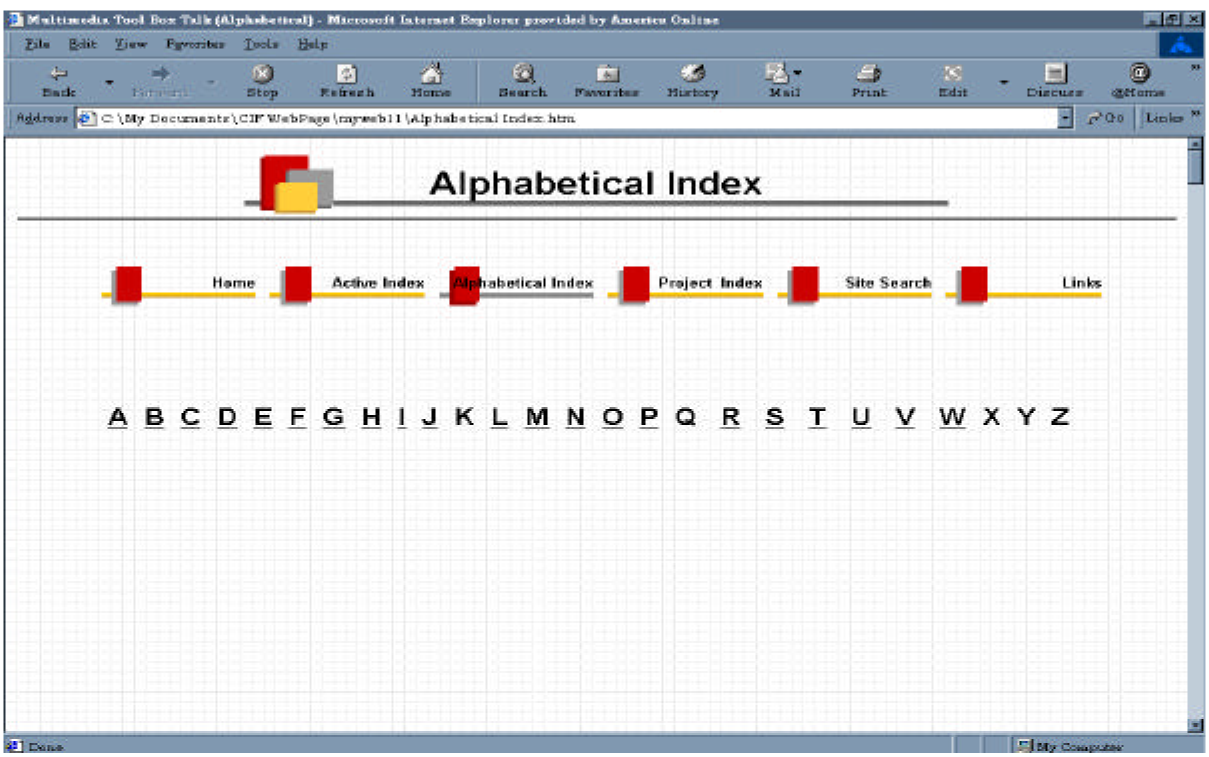

Figure 4: Alphabetical Index

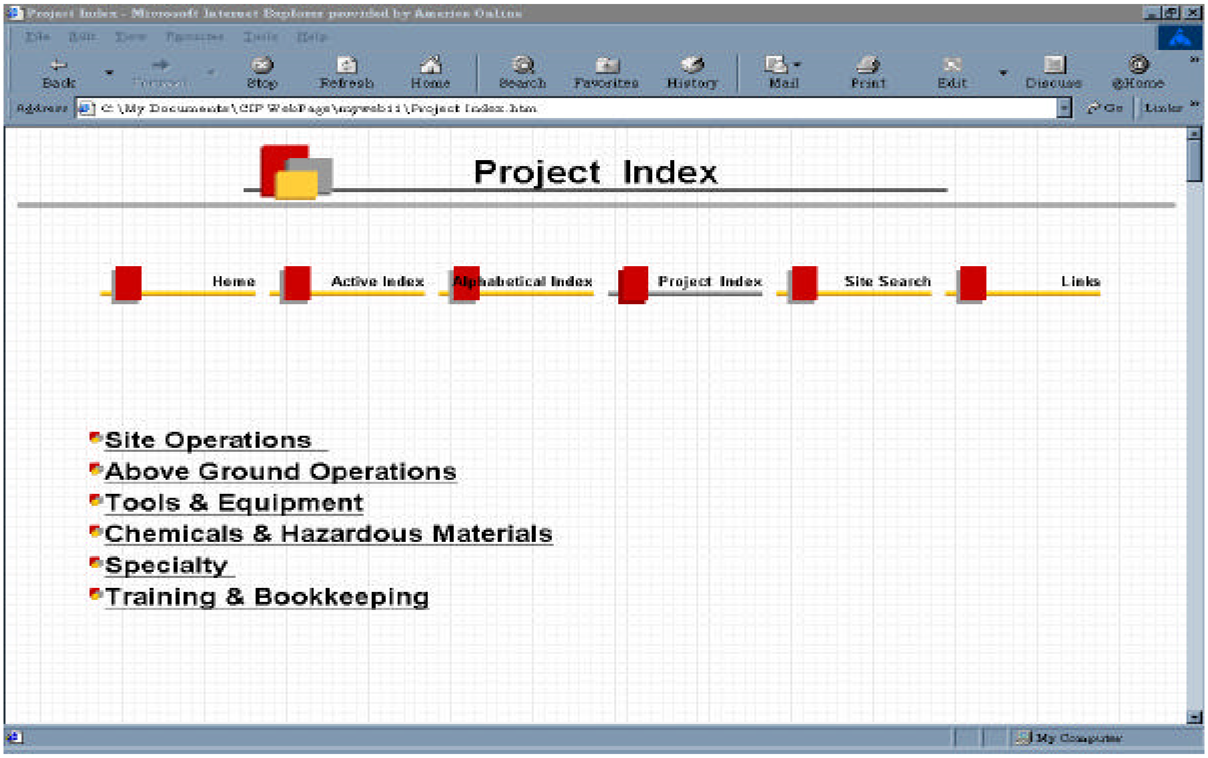

Figure 5: Project Index

This site also includes a Site Search page. This feature was added to further help the user to identify and retrieve the exact information that is needed. Instructions have been added so the user may use several different search language combinations. For example, a user has to simply type in electric shock prevention in the search dialog box and then click on Start Search. This help feature will return all pages that contain the words electric shock prevention.

Developing the Modules

There were nine modules that were developed fully for this website. They include: Crane Signaling, Electric Shock Prevention, Fall Protection (Barriers), Hand Tools, Ladders, Mobile Cranes, Personal Protective Equipment, Scaffolding and Trenching & Excavation. The modules include a picture library, slideshow presentation, and a frequently asked questions page. The modules have been organized so the viewer can maximize his/her learning experience. The following are the actual instructions that are included at the beginning of each module:

> **Step 1:** A Picture Library has been created without any feedback for the user. The goal is to have the viewer look at the pictures and identify potential problems or to identify the correct method of installation.
>
> **Step 2:** A FAQ & Terms page has been developed for the viewer to read and understand the questions and answers as it relates to OSHA's Federal Code of Regulations.

Step 3: A Slideshow presentation has been created for the viewer to see some of the common errors that occur on the jobsite. The presentation is an extension of the Picture Library, the main difference is feedback has been provided.

Picture Library

The Picture Library is considered the backbone of the website. The goal was to bring actual project conditions to life by showing photos of problem areas encountered on the job. This site could not have been accomplished without the help from Beers Construction Company and Brasfield and Gorrie. A total of 503 pictures were collected from these companies. The next task was to scan all of the photographs to create a digital image. The digital images were edited with Adobe Photoshop 6.0. The best feature of this program is the ability to reduce the file size of an image. For example, the average size for all the scanned images were 1.5 megabytes, after the image was edited the size usually reduced to 45 kilobytes. This was a major concern due to the fact that many contractors still use a regular telephone connection or 56K connection. If a contractor attempted to open a 1.5-megabyte picture on a 56k connection, it would take 15 minutes to open. When editing photos the ten-second rule was used. If a photo took longer than ten seconds to open a photo, the file size of the image had to be reduced. The following is the process that was used to reduce the file size of the digital images.

The first step is to select the image to edit. Once the image is open, choose the file, and select Save for Web from the cascading file menu as illustrated by Figure 6. By clicking on the Save

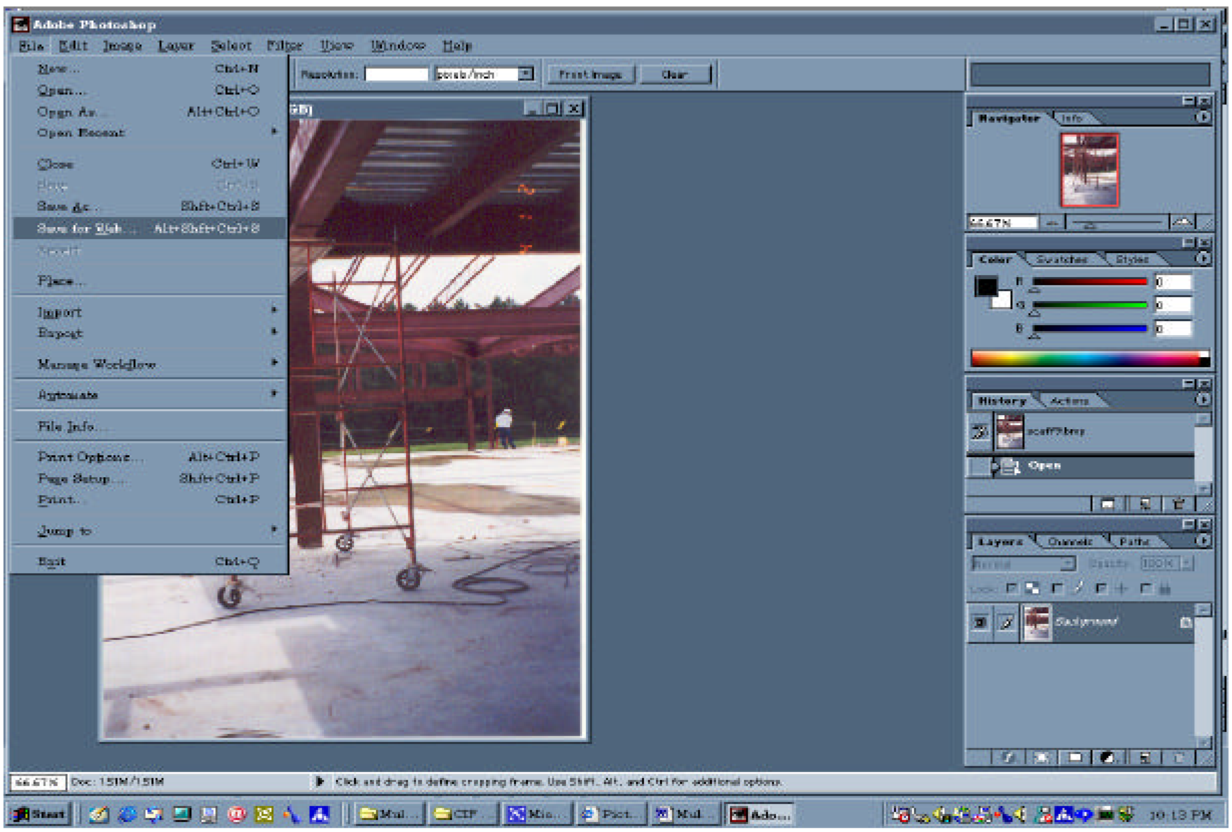

Figure 6: Save for Web

for Web option, the user has the option of three different quality photos. The image size for this picture ranges from 1.5 megabytes as the largest to 24.33 kilobytes for the smallest. A unique feature that Adobe provides is showing how long it will take to open a 1.5-megabyte image with a 56k connection. Also, the user has the option to either progressively load the picture from the web, meaning that the picture will show up instantly and will continually become clearer as the download completes.

The next step in the development of this site was the actual creation of the picture library. Once the pictures were edited, it was a repetitive action. FrontPage simplifies this process by allowing the user to search for the pictures to be inserted. In order to save space and reduce the layout to one page, all of the pictures that were inserted were thumb nailed. This means that the pictures were reduced in size, but are hyper linked to a larger clearer image. This took a great deal of time to do since each picture had to be inserted one at a time. A total of 414 pictures make up the picture libraries for all nine modules. Figure 7, on the next page shows a typical layout of a picture library and a thumbnail picture after it has been chosen to view by the user.

Frequently Asked Questions

The content for the Frequently Asked Questions section was derived from actual statistical analysis of the most common problems that OSHA officials encounter through onsite field inspections by using the areas with the most frequent OSHA violations. This information was invaluable to the completion of the project. Without this information, content would have been arbitrary and meaningless. This information helped to build credibility for the content that was added to the site. After accumulating this data, OSHA's Federal Code of Regulations titled Labor, Part 1926, which was revised July 1, 1999, was used as the main reference. The purpose of this section was to turn OSHA standards into commonly asked questions.

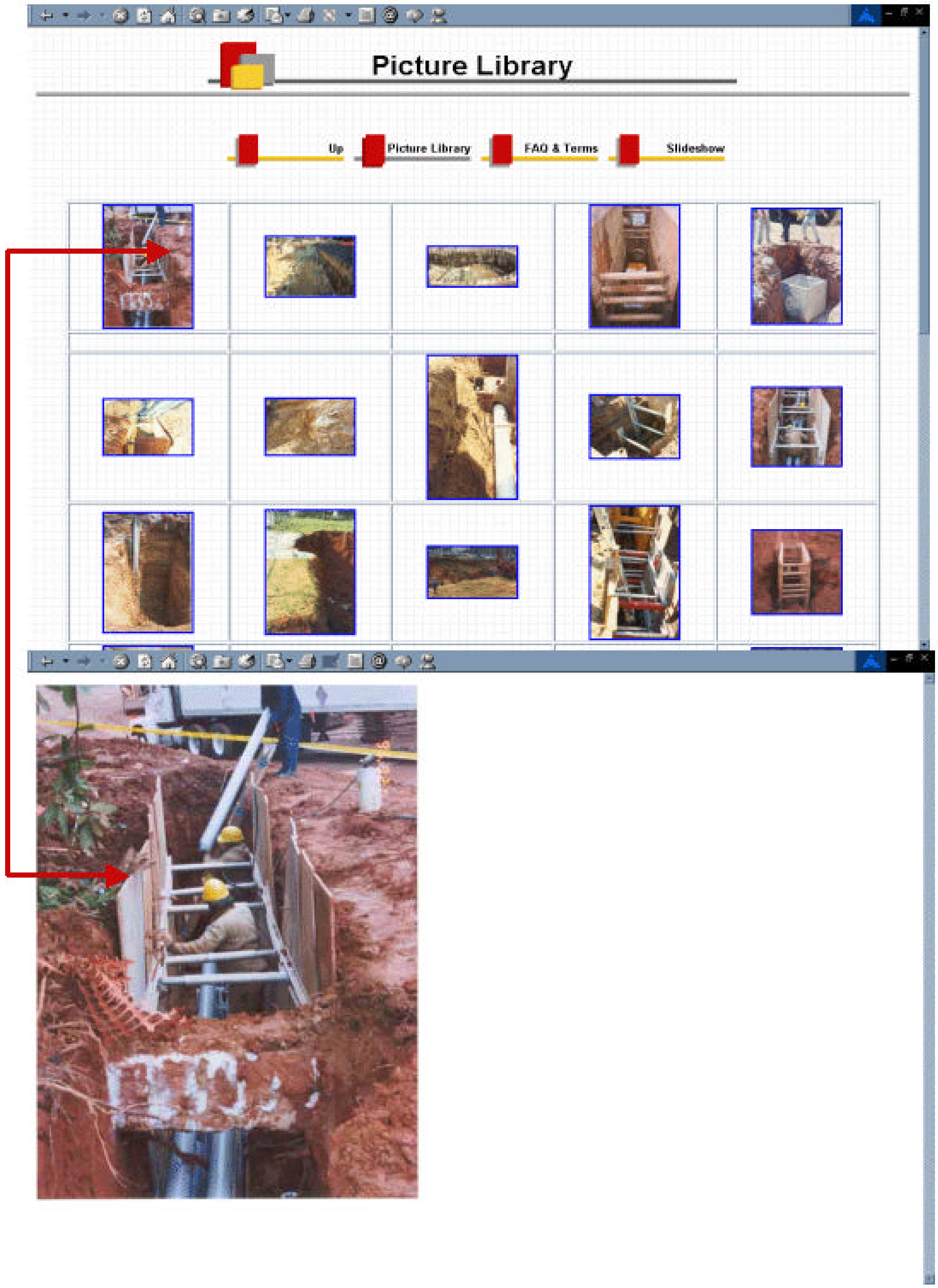

Figure 7: Picture Library & Sample Thumbnail

The purpose of the Slide Show Presentation section is to provide the construction professional a chance to review a set of pictures with specific feedback related to the picture. A picture is worth a thousand words, especially when the picture identifies deficiencies or problems that could possibly turn into a life or death situation for an employee. All the slideshow presentations are fairly short in length. The duration of each slideshow ranges from 2 to 5 minutes. The duration of the slideshow was important. In order to maintain and keep the construction professional's attention; the slideshow had to be specific and quick. The slideshows were created with Microsoft PowerPoint 2000. The creation of the presentations was basically problem free, however, the trick was how to import and open the presentation within FrontPage. The next section will present the actual creation of a html slideshow and how to import and open the slideshow within FrontPage:

Step 1. Create the PowerPoint presentation.

Step 2. Once the presentation has been saved for the last time, choose File, and then Save as Web Page (Figure 8).

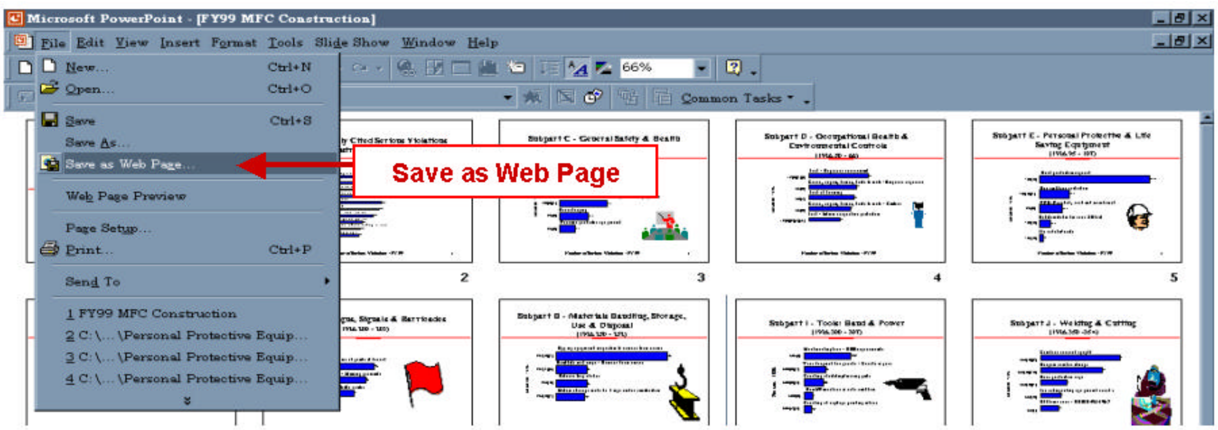

Figure 8: Save as Web Page

Step 3. As seen in Figure 9**,** clicking on Save as Web Page will bring the dialog box up. At this point the user is given the option to save the html formatted presentation. It is a good idea to create a new folder that will hold only the html files. This is recommended because FrontPage imports everything that is contained within a folder. If the same folder is used, the original PowerPoint presentation will be imported. Once the new folder has been created, simply click Save and the html files will be created. Note the slideshow presentation will not work unless it has been saved as a web page.

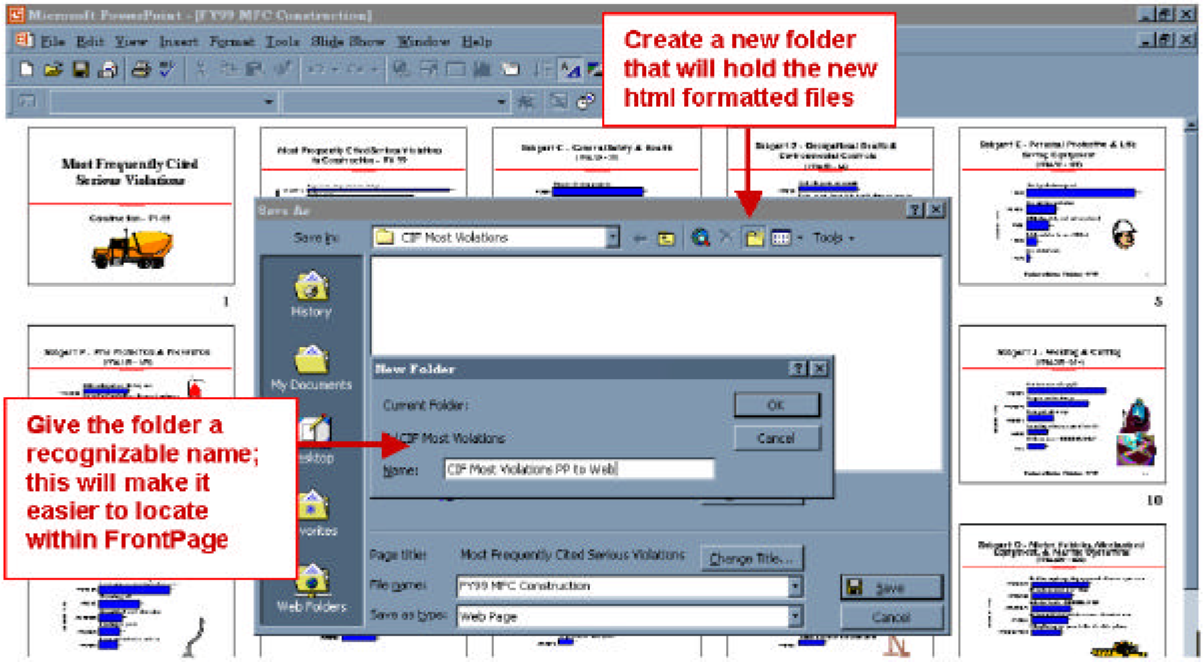

Figure 9: Saving Instructions

Step 4. After the presentation has been saved as a web page, locate the folder where the files were sent. Figure 10, shows the folder should contain one folder and a html formatted file. It is important that both files stay together. The folder contains the individual slides that make up the presentation and the html file is the actual start prompt. This file starts the slideshow.

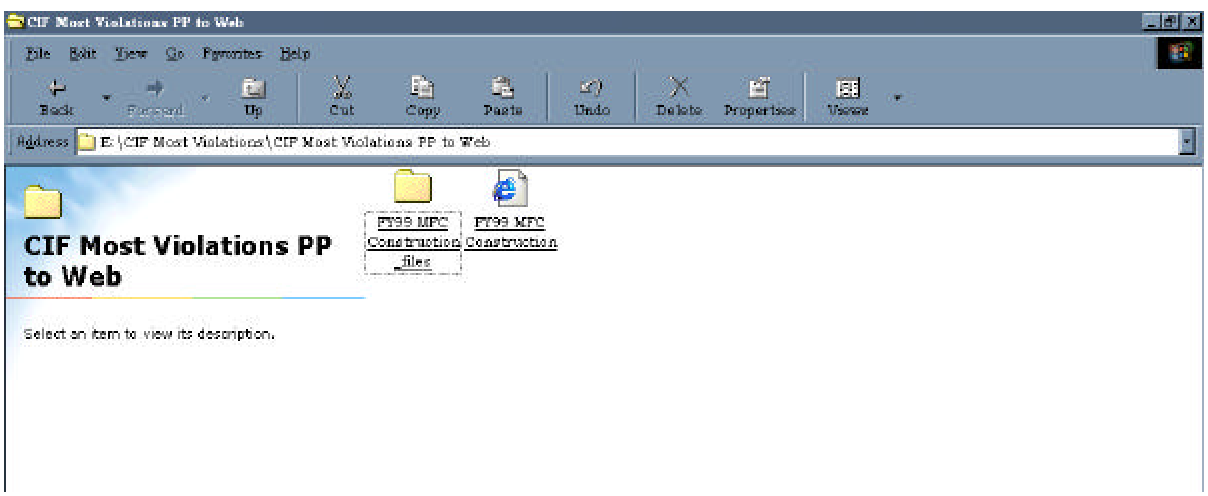

Figure 10: Locating the New HTML Files

Step 5. Figure 11, illustrates the next step after locating the files is to import the entire folder into FrontPage. This is relatively easy, simply open the web page, click on File, then choose Import from the cascading file menu.

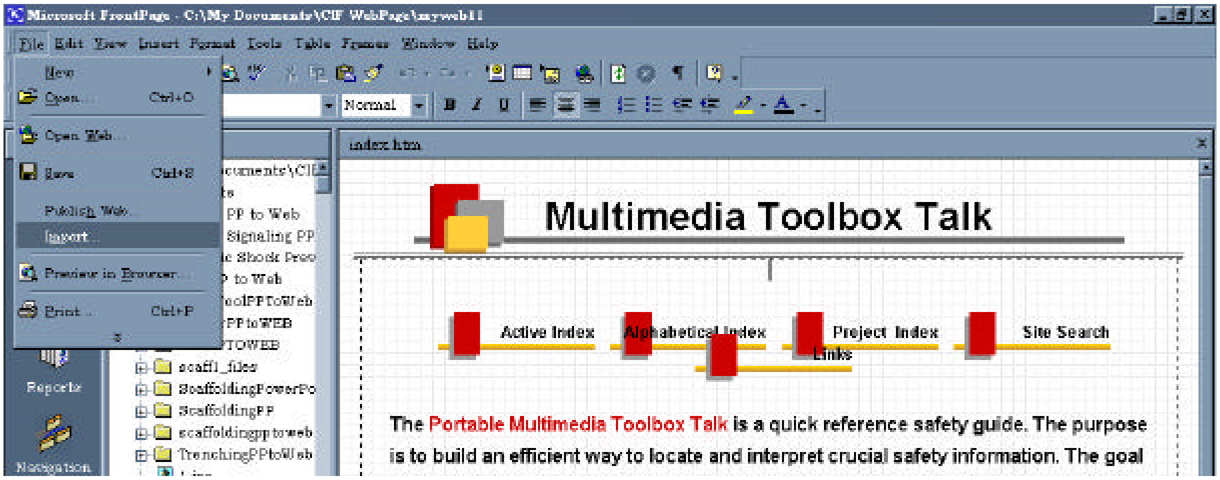

Figure 11: Importing the Slideshow into FrontPage

Step 6. At this point a dialog box will come up asking to either import a file or an entire folder. Import the entire folder that was created. Choose the Add Folder option and another screen will appear. This screen allows the user to locate the folder that is to be imported. Once the folder has been selected click "Ok" and the folder will be imported into FrontPage.

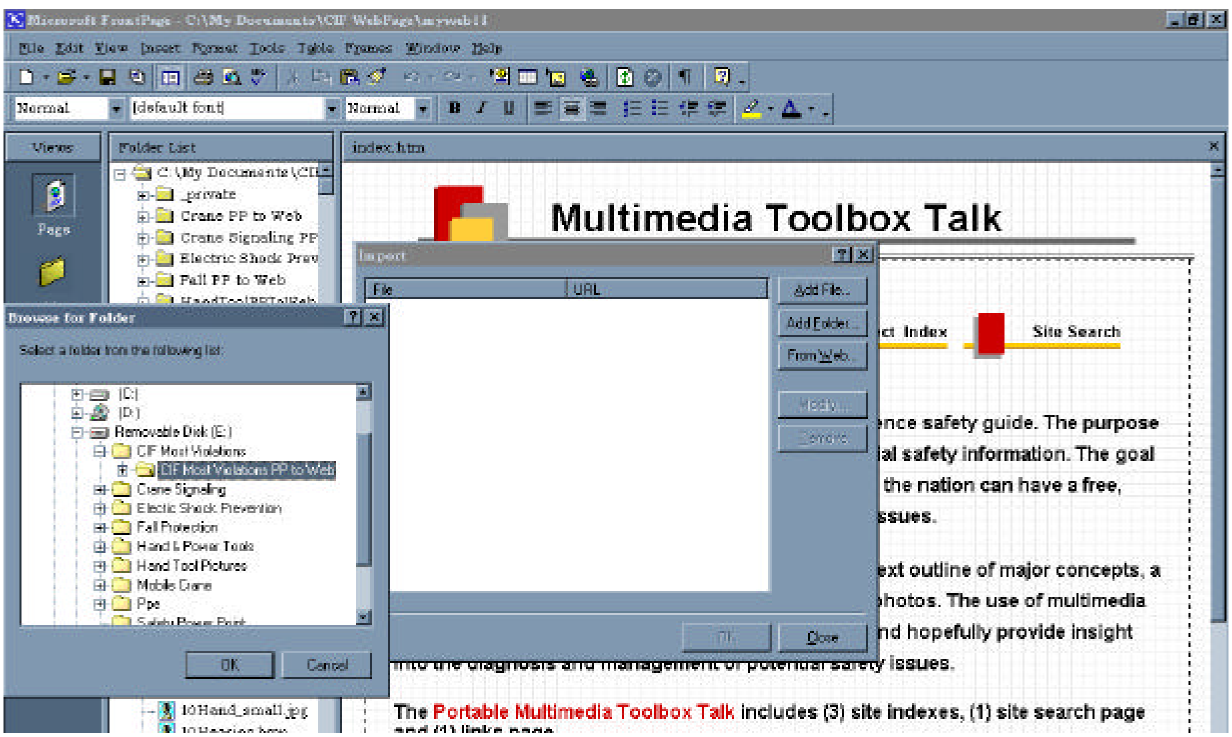

Figure 12: Importing the File into FrontPage

Step 7. The next step is to locate the imported folder, shown in Figure 13. Scroll down to the bottom of the page. The previously imported folder will appear. Simply drag and drop the html-formatted file into the page where it needs to appear.

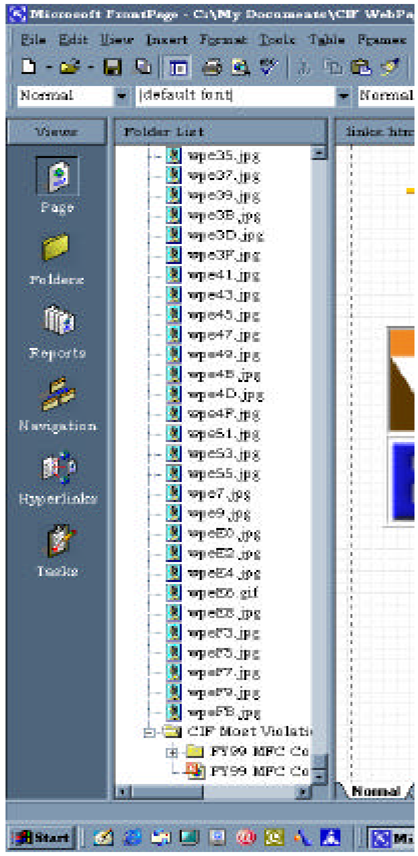

Figure 13: Locating the Imported File

Step 8. As seen in Figure 14, the final step is to drag and drop the file into a web page. By doing this a hyperlink will automatically be created. This hyperlink will automatically run the slideshow presentation that has been created.

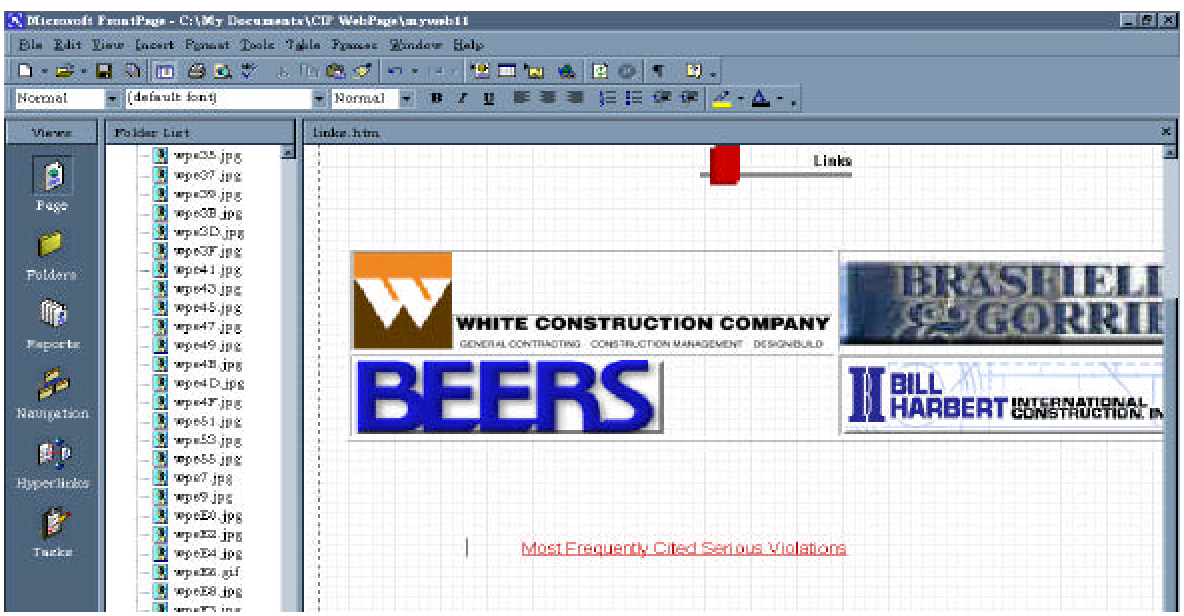

Figure 14: Creating the Slideshow Hyperlink

Step 9. Once the hyperlink has been created, the slideshow can be viewed within FrontPage. The presentation can be viewed one of two ways, either manually or through time elapse transitions. To have the presentation run automatically, the presentation must be formatted within PowerPoint before it is saved as a web page.

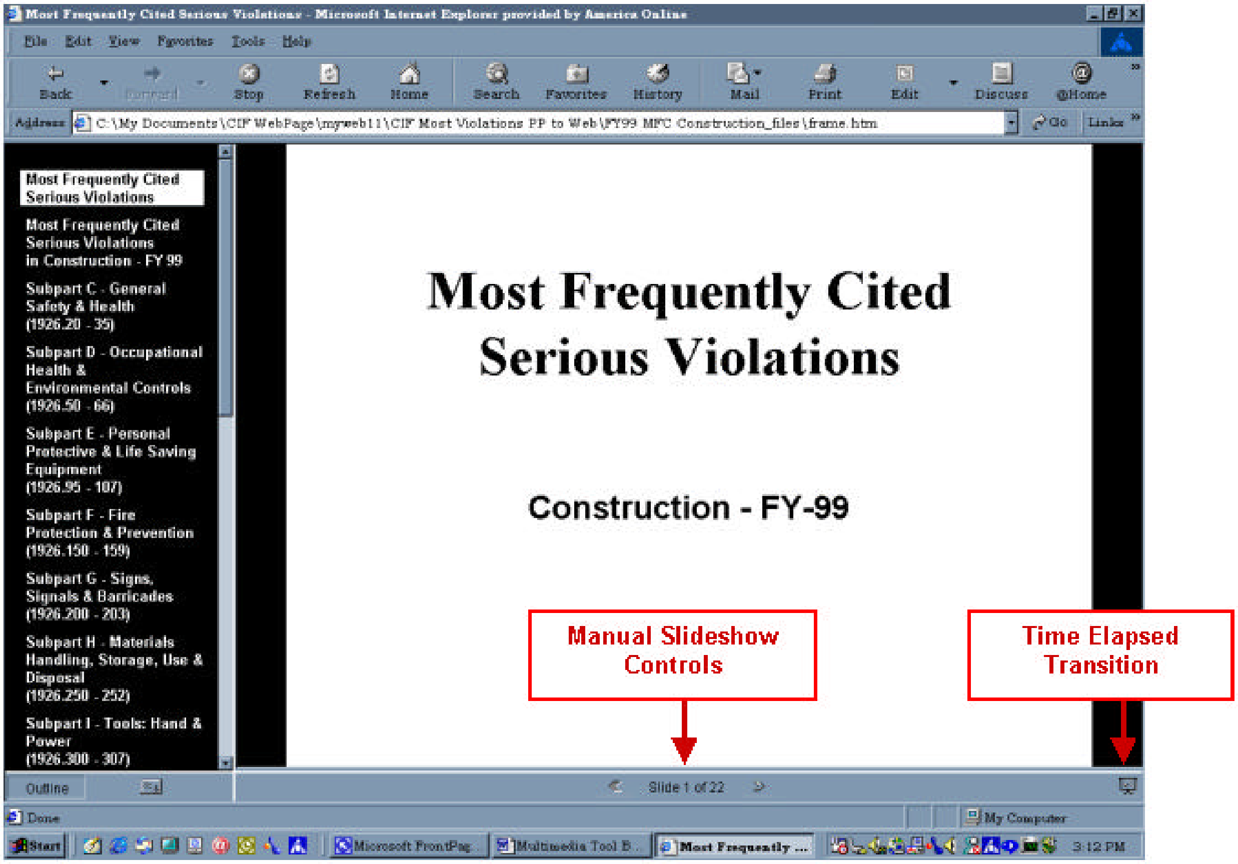

Figure 15: Previewing the Slideshow

Results

The creation of the Multimedia Tool Box Talk website was quite a challenge. This project was started in January of 2001. Several barriers had to be overcome in order to create a website that would provide meaningful content to construction personnel. Again, the goal was to produce a quick referenced tutorial website where contractors across the country could come and review free, clear and concise safety information. Overall, the site's navigational controls and content were organized so that contractors could efficiently and effectively help train and educate construction personnel about construction safety. The creation of the three site indexes, as well as the site search page, help to improve navigation through the site. The picture library was built to serve two purposes. First, contractors can review the pictures and identify potential hazards, and secondly, the pictures are formatted so the contractors can easily print, add comments and hopefully discuss the problems in detail with workers in the field. The statistical analysis of the most frequently cited serious violations from OSHA helped to solidify and reduce ambiguity in creating the “frequently asked question” pages. The addition of the slideshow presentations further addresses potential safety problems encountered in the field. The combination of a digital image showing a commonly occurring safety violation, along with OSHA’s safety standards, help to further explain and give recognition to problem areas.

It should be noted that not all of the modules that were created were equivalent in scope. For example, the module that was created for trenching and excavation is significantly more complex than the module that was created for hand tools. The trenching and excavation section is not a simple contractor tutorial. The goal was to create every module so that a quick review could be accomplished within ten minutes. This, however, was not the case with trenching and excavation. In order for a contractor to feel confident that all the information had been reviewed thoroughly under trenching and excavation, the contractor would need to spend close to an hour reviewing the picture library, the frequently asked questions, and the slideshow presentation.

The Multimedia Tool Box Talk website is organized in a particular manner. It cannot be stressed enough that if the contractor does not read the instructions on how to properly navigate through the site, his or her chances to reap the full learning benefit of the site will significantly be reduced. The contractor should review the picture library first to see if he or she can identify potential problems, then move to the “frequently asked questions” to understand what OSHA requires, and finally view the slideshow presentation. The slideshow presentation is the culmination of the picture library and the frequently asked questions. It combines a picture with the standard.

Conclusions

One way in which people change the world is by making new tools. As a dramatic example of changing the world by making new tools, think about the creation of the Internet. Changing the world in this way can involve changing people's minds, and can entail imposing one's will to some extent, but it is mostly about enabling other people to change by giving them tools to do so (Hillis, 2000).

The Multimedia Tool Box Talk is certainly a tool. The advent of the Internet has provided many people with an innovative tool in which to learn. The biggest advantage of the Internet is that learning is not dependent upon location, an institution or a person. Learning can be facilitated at home, in the office or on the road. Hopefully the tools that are learned through the Internet will provide opportunities to create new tools. The Internet is still undergoing an evolutionary process, much in the same way any new technology does. As more research and work is done on this Multimedia Tool Box Talk, it will also experience radical changes, hopefully these changes will promote and make an individuals’ learning experience much more beneficial. The following sections provide recommendations to try to build upon the Multimedia Tool Box Talk’s foundation.

Video is another means by which learning can be facilitated. It is the author’s recommendation that brief video clips be included within this site. For example, a video could be created showing contractors how to assemble scaffolding. By adding video two benefits are gained, the person or persons producing the video learn through hands on experience and the contractors are provided with a brief tutorial for workers in the field.

During the conceptual phase of this project, the scope of work could not then be fully realized. A recommendation is that complex modules be broken down into subparts. The trenching and excavation module is entirely too complex to have in one module and keep one's attention. This module should have been broken down according to soil type, equipments, and preventative measures. By breaking the larger, more complex standards down into smaller subparts the user might better retain what has been reviewed.

For website maintenance and future education, a recommendation is to incorporate this site into the curriculum for an undergraduate construction safety class. This site provides a modern way to make safety education interesting and hands-on. Students can take a hands-on approach by going to jobsites and taking digital photos of various work conditions. Once the photos have been taken, students could research in detail common problems associated with a particular safety issue. The students could also be responsible for collecting the video clips. On top of the safety training, the students will gain a better understanding of technology. By allowing the students to constantly add safety content to the site, it will continually be updated and maintained.

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Paradigm for Teaching Structural Technology

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Structural technology courses required in construction and architecture curricula must be taught differently from their parent structural engineering courses. Rather than focusing on the scientific details of the syllabus topics, structural technology courses should be concerned primarily with the structural engineering process itself – the continuity among the syllabus topics. To accomplish this, a paraphrasing of the theory of structures is presented in narrative fashion. In paraphrasing structural engineering, relative terms such as ‘about’ or ‘may generally be taken as’ are taken to be absolute values from which approximate results are developed and considered to be final solutions. This is sufficient for construction and architecture courses, because it is the role of the engineers to optimize problem solutions. Using this paradigm to teach structural technology, approximate but reasonable solutions to quite complex and broad-based engineering problems can be covered despite the reduced levels of math and science and the restricted number of courses dedicated to the study of structures in construction and architecture curricula.

Key Words: Structural Technology, Engineering Contents, Art of Engineering, Educational Paradigm

Introduction

Structural engineering is a broad field of study devoted to all aspects of designing, constructing, maintaining, and repairing structures. Most students preparing for professional careers in structural engineering are required to take extensive college coursework in mathematics, physics, and especially structural engineering. Likewise, most students pursuing degrees in construction and architecture are required to study structural engineering by taking several structural technology courses derived from engineering statics, mechanics of materials, timber/steel/concrete design, and perhaps, soils and foundations. These structural technology courses have lower level math and science prerequisites than do structural engineering courses.

The experience of twenty-five years of teaching structures to engineering students and especially teaching structural technology to construction and architecture majors makes it clear that there needs to be a much different approach taken in the study of structural technology compared with that of structural engineering. This view is certainly shared by others as well. In survey results of construction programs in the United States, "seventy eight percent of respondents believe that we should not be tied to the traditional engineering formats in teaching structures to our construction students. More diverse subjects should be covered with less depth" (Chini, 1995).

Most students of structural technology are not studying to become practicing structural engineers, so that a) their prerequisite courses differ from engineering course prerequisites, and,

b) their intended purpose for studying structures also differs. Though these different capabilities and needs of the structural technology students are obvious, they seem not to have any fundamental influence on the methods by which structures courses are presented to non-engineering majors. "Most professors that teach structures classes have an engineering background and tend to present structural concepts in the same way their professors presented the concepts to them" (Williams & Sattineni, 2002).

The objective of this paper is to draw the distinction between structural engineering and structural technology, and to suggest an appropriate paradigm for teaching structural technology for construction and architecture. This paradigm has significant implications concerning the style of presentation and expected learning outcomes of structural technology courses.

Paradigm for Teaching Structural Technology

To prepare engineering students for their professional careers, the typical engineering course syllabus is filled with rigorously detailed topics. For structural engineering, these courses include: statics, strength of materials, classical structural analysis (I and II), computer-based analysis, reinforced concrete structures (I and II), steel structures (I and II), timber structures, masonry structures, geotechnical engineering, foundation engineering, bridge engineering, structural dynamics, wind and earthquake engineering, and reliability of structures. With this enormous volume of detailed structures topics, there is little time available so that little effort is spent within a course focusing on the interrelationships and the continuity inherent to the subject matter.

Construction and architecture curricula also have a long list of required courses in their specific areas. Structural technology is, of necessity, only a relatively small part of these curricula, with perhaps from two to six structural technology courses required in the areas of statics and structural analysis, mechanics of materials, timber/steel/concrete design, and perhaps a course in soils and foundations. Especially in light of the many demands that ever-changing technology places on college curricula, construction and architecture departments must continually revisit a key question: "What is essential structural technology for construction and architecture and how should it be presented?" A detailed case study into the difficult planning issues raised when grappling with the question is presented in (Senior & Hauck, 2001).

A complete answer to this question constitutes an educational paradigm for teaching structural technology. From the dictionary, a paradigm is "a philosophical and theoretical framework of a scientific school or discipline within which theories, laws, and generalizations and the experiments performed in support of them are formulated" (Merriam-Webster, 2002). There are different paradigms commonly used to teach structural technology, and a brief discussion of the limitations of two such models follows.

Structural technology should not be considered merely as "structures lite" – a field of study that parallels structural engineering but which mostly ignores theoretical developments in lieu of devoting attention to demonstrating how to use simplified design tables and graphs found in various building codes. This paradigm is intended to be superficial in nature, as it deals with only a small part of the design process, like "What is the deflection in a specific beam that spans X feet and supports Y load?" Alternatively, a more meaningful question would be "How will we know if there will be excessive roof deflection if the ridge beam depicted in the architects sketch is used?" The underlying interrelationships and continuity of the design process is barely apparent with "structures lite".

Likewise, structural technology is not a disparate selection of "top 10" topics – a subset comprising the most interesting or most easily understood key topics chosen from the domain of all topics within the field of structural engineering. This teaching model is akin to a condensed review manual for a major standardized exam. One or two of the topics selected might focus on the derivation of key formulas like axial deformation and the flexure formula, for instance, but thereafter, other such formulas are presented with little or no background development. Also typical, having presented a key topic once, say the technique of tracking forces through a structure to determine member loads, thereafter its role in other key problems is ignored and, following this example, a later topic might be beam analysis that will begin with all loads given. As with "structures lite," little attention is given to continuity, but also, the advantages of repetition are lost with the "top 10" approach.

In the previous two paradigms of teaching structural technology, with so little attention given to developing a sense of continuity among the topics, the dynamic process by which new concepts and problem solutions evolve from interrelating previous ones is unobserved, yet this is the essence of structural engineering. With these models of teaching, students miss out on an experience of the ingenuity of applying math and physics to derive practical design formulas. The posing of narrowly focused questions bypasses opportunities to see the whole engineering process at work.

The following paradigm suggests a better approach:

> Teaching structural technology for construction and architecture, the professor provides the curious student with an appreciation of the engineering process and prepares the student to competently discuss structures in the engineering language. This language includes technical terminology, code specifications, hand sketches and engineering drawings, experimental observations, and basic mathematical and physical relationships. Structural technology is presented as a paraphrase of structural engineering theory and practice that is expressed in prose and simple mathematical style. Various narrative stories are crafted that make use of the power of analogy to illustrate the ever-broadening development of structural analysis and design theory that flows by means of the continuities among interrelated structures concepts. It is this dynamic flow of the engineering process that is the primary focus of the study of structural technology.

Flow of Things

In structural engineering curricula, with so many courses and with each one filled with detailed scientific focus on every one of the numerous syllabus topics, the continuity from the first course in statics through foundations and even further on to the more specialized subjects is not usually at issue. The underpinning of advanced topics by the more elementary ones is simply taken for granted as the emphasis is on covering as many advanced topics as possible. With each of the numerous courses, there is intensive drill work employing numerous homework problems to reinforce the subject matter of one topic, all to be repeated with the next topic. Progressing through all of the structures courses in this manner, the engineering student must generally overlook the forest in order to study all the trees.

From Zen and the Art of Motorcycle Maintenance (Pirsig, 1974):

> "Science works with chunks and bits and pieces of things with the continuity presumed, and [an artist] works only with the continuities of things with the chunks and bits and pieces presumed? the lack of artistic continuity [is] something an engineer couldn't care less about."

This statement is a bit absolute in tone, but it is nonetheless quite profound. Of course artists must concern themselves with the bits and pieces from time to time, and engineers probably experience and appreciate the underlying continuity and flow of the engineering process. But generally speaking, what the artist most keenly understands and the engineer will occasionally experience is that, as the song says, "The rhythm is gonna get you." It is while immersed in the practice of engineering using all of the bits and pieces of the engineering language that the underlying continuity of things – the dynamic flow, or art – will be experienced by the engineer. In The Existential Pleasures of Engineering (Florman, 1976), it is said, "At the heart of engineering lies existential joy."

Constructors and architects are not licensed professional engineers, but this does not preclude them from an experience of the art of engineering practice. Because they will practice structural engineering in a very limited way, if at all, it is important that the art of engineering be a major focus throughout their structural technology coursework. With respect to the study of structures, constructors and architects do not share the same needs, abilities, and interests of the professional engineer. Their need is less filled with detailed explanations of specific topics (chunks and bits and pieces) and more with gaining a sense of the engineering process (continuities of things) – a broad view of the science and engineering of structures.

With limited structures coursework, it is more important that the structural technology student gain a sense of the engineering process, than, say, a keen ability to solve equilibrium problems or construct shear and moment diagrams (of course they will also study these concepts). With limited time and prerequisite coursework, a condensed version, or paraphrase, of the field of structural engineering most effectively allow structural technology students to experience the process of structural engineering analysis and design.

Paraphrased Engineering

In paraphrasing structural engineering theory, terms such as 'about,' 'generally', 'may be approximated as,' etc., may be treated as absolutes, and the analysis and design approximations that result are treated as though they are the final solutions. In this manner, considerable time is freed-up that can be used to pursue topics in greater depth. By using less time and mathematical effort dealing with the detailed tasks necessary to work the ‘bits and pieces’ into the “exact” solution, the continuities of things gain more prominence.

For example, in foundation engineering the design of a footing typically requires using Terzaghi bearing capacity equations to determine the theoretical soil bearing stress. This involves a multi-step iterative procedure that requires determining equation constants from separate graphs based on soil properties. The result is that the whole process of determining just the allowable pressure under the footing constitutes a complete problem for an engineering student. However, generalizing from the formulas, we may develop rules-of-thumb that approximate the allowable pressure to be, for clayey soil, the unconfined compression strength, and for sandy soil, 250 times the Standard Penetration Test blowcount.

By using such rules-of-thumb in combinations with others (establishing typical design loads for various structure types, for instance) and employing basic engineering principles like tracing loads through structures and pressure equals load intensity, far more meaningful and yet still short answer questions can be posed. Instead of “Determine the allowable bearing pressure for a footing,” we can pursue more meaningful inquiries like “Compare the required footing size for a three story steel office building with 30 ft. by 30 ft. bays if it is to be built a) on a medium density clay, and b) a dense sand.” The answer to the latter question will be as brief as that of the former, but instead of a detailed footing analysis, the student completes an entire structural design – a process beginning with determining design loads and ending with grounding them into the soil through the footing.

Prose Narratives

Because the focus is on the flow of the structural engineering process, the paraphrased engineering language is presented in narrative fashion. Mathematical developments within the text seldom exceed the complexity of simple algebraic equations. Using everyday prose, brief narratives are employed to develop concepts and present a view of the engineering process, such as the following:

“Your neighbor Bill has come to you with a problem. The contractor that built his house has used 2 x 8 floor joists to span fourteen feet and placed sixteen inches on center. The joists have already sagged more than 1 inch, and seem to be continuing to deflect. Bill has purchased some fourteen foot 2 x 4's and plans to jack the floor joists back into their original position. After the 2 x 8 floor joists are raised to their original position he plans to screw a 2 x 4 to the joist as shown. He also plans to screw the sub floor to the joists so that the plywood will act in conjunction with the beam. Bill wants you to tell him which orientation is most efficient for the 2 x 4’s, and how much all this work will improve the situation” (Williams & Sattineni, 2002).

When several concepts are to be combined in analysis and design situations, the narratives can be real or fictitious stories specifically chosen or fashioned to demonstrate how the various elements of the engineering language are interrelated to solve a problem-at-hand. The efficacy of stories for conveying ideas is a time-honored tradition, and we might note the impact that parables (brief stories) used in the Bible has had in delivering important themes throughout the ages.

A similar educational situation exists where students are required to take a few semester courses of a particular foreign language, say French. They are not expected to emerge from their studies as fluent speakers of the language; while some may go on to do so, most will emerge with an experience of the basics of the language, and a sense of things *franchise*. The students experience the language through basic skills exercises centered on recognizing words and forming sentences, then they are presented with stories that incorporate these elements in a context that helps to provide a feel for the language. The story might, for instance, recount a fictitious episode in which Louise and Jacques are taking a train trip from Paris to a small vineyard in the French countryside.

Stories are powerful because they can be crafted to emphasize key lessons at hand while also providing a sense of how the inherent language is used. Stories help to invoke the imagination and so more mental effort is at work to grasp the nature of the dynamic flow of things. In the case of the foreign language story, the imagination can help to give the student a sense of what it feels like to be a French patriot, just as it can give a constructor or architect a sense of what it is to be practicing the art of engineering.

Accentuating Continuities

It is important to draw attention to the continuity of things and the power of analogy whenever possible. Consider the following narrative describing relationships among structural members and systems:

> "? we see how the simple beam moment to the arch rise/cable sag ratio, M/s, is used to determine the force, H, which acts along the axis between the supports of arch and cable members. We will see later in the book that for a beam of length, L, and stiffness, EI, the ratio of simple beam moment, M, to corresponding deflection, D, (deflection is the slight amount of sag caused by transverse load) is a constant given by $M/D = 10EI/L^2$

We will also discover later that the critical buckling load, which is the largest axial force that a straight column can support without failing by buckling, is given as $F_{CR} = 10EI/L^2$, the same as the ratio of M/D of a beam. Thus, all of the common structural elements, beams, cables, arches, and columns, may be studied by means of beam analysis. Don't be surprised if the same isn't true of entire structural assemblies" (Dishongh, 2001).

The importance of continuity is that it facilitates the dynamic flow that leads to the creation of new insights about structures and/or novel problem solutions. As it turned out, while working with the beam/cable/arch interrelationships above, the author discovered a new and elegantly simple approach for presenting the topic of slender column analysis and design called the Universal Column Formula (Dishongh, 2002). This presentation of slender column behavior seamlessly interrelates classical theoretical column analysis formulas with the practical design formulas found in current code specifications, offering educators and practitioners alike a new way to look at columns.

Stylistic Facets of the Paradigm

Determining the topical contents of a series of courses in structural technology is a straightforward task. There are many textbooks available in this area including (Shaeffer, 2002), (Dishongh, 2001), (Ambrose & Parker, 2000), and (Engels, 1984) to name a few. These works contain some or all of the important topics – the chunks and bits and pieces – comprising the language of structural technology. These topics need not be listed here, as the reader is probably familiar with the tables of contents of these texts.

The specific goals of different curricula will lead to an emphasis of some engineering topics over others. For instance, architects will tend to be less concerned with bridge engineering than construction managers and programs that focus on commercial and industrial construction will likely emphasize steel and concrete structures, while timber and masonry are more important in residential construction programs. This is no problem as there is more than enough information to meet the needs of everyone with more being developed every day, so like a popular snack chip advertisement says, "Don't worry, we'll make more."

How the bits and pieces are to be presented so as to bring forth the underlying dynamic flow – the art – of the engineering process is not so simple a matter. It matters less *what* is presented than *how* it is presented. The degree of care of the professor and the students, the style of the textbook, and the relevance of the intended learning outcomes have the most important influence on the quality experience of the art of engineering.

Professors and Students

Careful attention towards the subject matter on the parts of professor and students is of such primary importance that, without it, there can be no envisioning the art, let alone any appreciation for it. The professor of structural technology courses will usually have an academic and practical background in the fields of civil or structural engineering. The professor may be a member of the construction or architecture department with full-time duties teaching structural technology courses, but it is more common for the professor to be a member of an engineering department and have only part-time duties teaching structures "service courses" to non-majors. While volumes may be written comparing the merits of one of these situations over another, the quality of instruction is simply a matter of the care that the professor brings to the course material.

Equally as important as the care on the professor's part is the curiosity (careful observation) that the students must bring to the subject matter. To facilitate student interest, the professor will want to demonstrate the art of structural engineering as the natural course of things. Explanations of problem solutions should include lots of references to analogous situations already covered and numerous questions about the fundamentals being used. Students tend to worry over the bits and pieces and chunks – the formulas and the shortcut procedures and the categorizing of problem types – in order to develop sure-fire recipes for solving each category of problem. The professor must resist their desire for the material to be presented in a cookbook fashion, and take every opportunity to accentuate the continuities inherent to the flow of the engineering process.

Teaching Materials

The narratives that form the basis of teaching structural technology are not likely to make it to the New York Times' bestseller list, but they can be interesting and somewhat motivating for students, especially if accompanied with a physical model to help explain things. See (Arumala, 2002) for an interesting discussion of hands-on "student-centered activities to enhance the study of structures." The reader has no-doubt noticed the interest levels associated with coursework-related television programs that show from time to time on The Learning Channel or public television. The narrative-style of these programs is just about what the paradigms for teaching structural technology should be like, and videos about structures from these sources would certainly make fine teaching materials.

This also suggests the style of structural technology textbooks. Their authors should envision the textbook as a sort of transcript (with accompanying illustrations and/or photos) of a television series on structural engineering complete with additional exercises for the reader to practice some of the things discussed. The text should be self-contained, existing as a single volume to be used throughout all of the structures courses to facilitate the continuity from the beginning fundamentals to the last subjects covered in the curriculum. So when discussing the load on one of a cluster of piles beneath a tall bridge pier, the professor should encourage the student to flip back to eccentric loads and combined stresses to see how the loads combine to affect the critical piles.

There are certainly other instructional media available. The use of internet-based instructional materials to augment classroom lectures has been growing; for instance, see (Burt, 2002) for a report on preliminary results of one such attempt to enhance students in their structural analysis studies. The use of software to facilitate students' abilities in conceptualizing basic elements of the engineering language, such as moments of inertia, is reported in (Williams & Sattineni, 2002). And in the course of conducting a survey of structures courses offered by ASC construction educators (Chini, 1995), the following prophetic comment was noted:

> "There seems to be a need for better discipline-specific textbooks and more context based problems/solutions. A recommendation to develop a library of digital images of construction sites, problems, examples, etc., between ASC schools seems interesting and the Committee of Undergraduate Education should look into that "

Expected Learning Outcomes

Of course there are expected learning outcomes that serve to guide and to provide a goal for students. The questions and problems posed to students through homework exercises and course exams are the traditional means of directing and evaluating students. Emphasis on the continuities of things and using paraphrased structural engineering has implications regarding the amount of assigned work and the nature of the questions and problems that are covered.

If each new topic is developed in context with others that have already been covered, then the number of exercise problems required at various steps along the way need not be as large as for engineering courses where topics are usually presented as stand alone bits and pieces. In this way, upcoming narrative concept developments and stories build on previous lessons and so they will incorporate all of the elements just covered, and with emphasis on the continuity of things, the stories are crafted so that the most fundamental relationships keep recurring. The most fundamental of the elements of structures language – those that come first in structural technology courses – will receive the most repetition, ensuring that the traditional repetition role of homework drills is not bypassed.

For example, the concept of tributary areas and load paths should be introduced early in the first course of structural technology. Thereafter, all of the problems described in narratives can be presented in their fullest context by starting each narrative with the most basic engineering task – that of determining the loads on a structural element – as was exemplified in the footing example mentioned previously. Thus, in the course of things, the student will have applied the tributary load and load path concepts many times, just as students of foreign language apply new concepts to develop ever more complex sentences, which must still include the fundamental elements of subject and verb.

With a style of presentation that emphasizes continuities of things, exercise and test questions will tend to be quite broad in scope and usually quite interesting, especially compared to the focused homework and test questions typically posed to engineering students that require mathematically rigorous solutions. The significance of each newly introduced element of the structures language is better appreciated when placed in context to other related elements in a complete story. Because the engineering language elements have been paraphrased in structural technology, they require less time and effort to employ, and so many elements can be interrelated in a single question, with the result of fewer but more engaging questions required to demonstrate the flow of the structural engineering process.

Conclusion

The paradigm for teaching structural technology for construction and architecture presented herein is to some degree already employed in most structural technology courses – this is inevitable and well it should be. The attempt here has been to elucidate the benefits of maintaining a focus on the process of structural engineering when presenting the technology to students, and to establish this dynamic, this art, as the key point of focus. Department chairpersons and even departmental accrediting agencies of construction and architecture programs may wish to take note of issues raised here to perhaps give guidance for curriculum development that ensures optimal benefits from the limited time spent in the study of structural technology.

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Preparing Instructional Objectives and Educational Goals for Construction Management Courses

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Understanding the basic paradigms needed in preparing instructional objectives and educational goals for any given construction management course is the focal point of this article. The intent is to provide the reader with a linchpin that is necessary for planning and developing sound instructional objectives and educational goals in a construction management curriculum.

Keywords: Teaching, Instructional Objectives and Construction Education

Introduction

Why are instructional objectives or educational goals necessary in a Construction Management Curriculum? Four of the main reasons are: First, without a clear understanding of the intended learner outcomes for a course, the selection of the teaching methodology, instructional materials, evaluation of learners, and course duration has no logical basis for implementation. Second, the learner needs to understand the purpose of the course, the final expectations of the course, the system used in evaluation (grades), so they will be able to organize their efforts for the course. Third, without clearly knowing what the learner's final expectations are, any test or examination developed by the instructor may be misleading and unfair. And fourth, the main reason relates to the instructor's ability to organize the course to impart their intended educational purpose.

The planning process needed in developing a course with clear measurable instructional objectives and educational goals allows the reduction of overlap, misunderstanding or misleading course titles and allows for careful review of construction management courses that provide desired learner outcomes. *In construction terms, the contractor does not select the construction equipment for a project until they know the type of construction project.*

What are Instructional Objectives and Educational Goals?

The concept of "objectives and goals" (behavioral objectives) were developed by R. Tyler (1949), while the term "goals approach" was made popular by N. Gronlund (1991). R. Mager created a significant impact with his approach to preparing instructional objectives. Typically educational goals use broad general terms such as: to understand, to know, to apply, to appreciate, and so on. While instructional objectives are measurable terms such as: to solve, to build, to recite, to identify and so on. In D. Jacobsen, P. Eggan and D. Kauchak's textbook *Methods of Teaching,* a combination of these paradigms and goals approach is suggested. This method of describing educational goals in this author's opinion provides the best planning tool for any professor in the construction management curriculum. Some examples of each are noted below.

Objective (Mager):

1. Given 25 construction definitions on the major parts of a building a freshman in construction management will be able to successfully answer 20.
2. Given 5 estimating questions on calculating the cubic yards of concrete in a monothlitic slab, beginning estimating students will successfully answer 4.
3. Given 10 contract law cases, the junior level construction management student will identify each that contains a breach of contract by the owner.
4. Given a set of plans, surveying students working in groups of three will correctly lay out a residential building with string lines and batter-boards to within 1/4" every time.

In following Mager's paradigm above, the system requires a great deal of specificity and does not state the educational intent of the professor.

Educational Goals:

1. Beginning estimating students will solve written problems, from a set of plans on the amount of concrete, rebar, chairs and grade stakes.
2. For scheduling students to learn how to develop a CPM for a commercial project.
3. For a surveying class to understand the steps in laying out a building
4. Students in the History of Construction class will understand how the build environment affects the culture of a society.

Educational goals can be introductory statements or complete sentences. They address three key planning needs for a construction management course: First, who is the audience; second, what learning task is required; and third, what learning is inferred rather than observed. Goals should be written as simple and precisely as the professor can determine.

In educational goals, the focus is on broad statements using terms that are typically abstract, while instructional objectives focus on answering three questions.

1. What is the performance? Which means what will the learner be able to do after the experience.
2. What is the condition? Which means under what circumstances is the performance expected to occur.
3. What is the criterion? Which means what type of evaluation is the professor using and what is considered acceptable.

The mission of establishing instructional objectives and educational goals provides the planning needed by a professor. They answer the critical questions.

1. What do I want my students to learn (to know, to understand, to appreciate) and

2. When and how will I know my students have learned the above?

What are the Taxonomy of Educational Objectives and Domains?

Much has been written about the Taxonomy of Educational Objectives using the affective, psychomotor and cognitive domain (see references). As facilitators of learning, a linchpin for categorizing learning is needed to develop instructional goals and objectives. Learning begins at a very early age from physical tasks such as tying shoes, buttoning a shirt, catching a ball, and eating. Next intellectual tasks such as parts of a car, items in a home, the alphabet, and simple math are learned. Finally, human values, attitudes, and feelings are learned, for example, a favorite color or number. While all of the above is learning they certainly are not the same type of learning. In education we describe these domains as: Affective, Psychomotor and Cognitive.

- *Affective*: Growth of values or attitude.
- *Psychomotor*: Development of muscle and coordination.
- *Cognitive*: Imparting intellectual skills and knowledge.

In a construction management curriculum we strive to impart all three of these domains. It is critical that each professor understand each domain in order to correctly provide the academic challenge of developing courses in the construction management curriculum. How many times have students taking a course and upon completion complain the course title and objectives are incongruent and course objectives were not clearly understood nor met. A better planning and understanding of the domains, educational objectives and educational goals creates a foundation for success.

The affective domain simply teaches attitude and value. While attitudes are feelings of like or dislike towards objects, people or environment, they are learned from experience. Professors normally hope for a positive attitude toward their class and learning experience.

The psychomotor domain focus relates to muscle development and coordination. This domain probably has the least impact in the construction management curriculum. However, some courses in field surveying, testing labs, computer labs, and materials labs would certainly require development of certain motor skills in order to achieve the results expected by the professor.

The cognitive domain is the most common domain used in all construction management curriculums. Its primary focus is on the transferring of knowledge to a learner.

While each domain has been defined it is critical that each professor understand that all three of the domains are interrelated and important in the development of instructional objectives and goals.

Example of using Instructional Objectives and Educational Goals

A sample course instructional objectives and educational goals follow. The syllabus is not complete, only the portions identifying instructional objectives and educational goals.

Construction Science Course
Survey: Construction Layout
4 Semester Hours

Objectives and Outline

Course Description

The fundamentals of plane surveying including the use and care of equipment. Precise measuring of distance, basic theory and practice of leveling, angles and bearing, principles and use of transit, curves, topographic and construction surveying are taught with class and field experience.

Course Objectives And Methodology

The student will have knowledge of surveying theory to establish a basis from which construction surveying applications are derived. The major objective of this surveying course is to impart basic knowledge and skills in the practice of surveying as it relates to construction project application.

The methodology employed to impart this knowledge will include lectures, text reading assignments, field orientation problems and assignments, demonstrations, and examinations.

The course contains five major areas. Each area progresses from easier topics to more difficult ones. The major objective of this surveying course is to impart basic knowledge and hands on training in the use of traditional surveying equipment-tape, transit and level.

Each unit has several instructional objectives that will be covered on examination or field assignments. Note instructional objectives prior to reading the assignments.

Required Text

Kavanagh, B. Surveying with Construction Applications, 3rd Ed. Englewood Cliffs, New Jersey: Prentice-Hall, 1997.

Area One

Surveying Fundamentals - This unit covers an introduction to surveying and the surveying task of controlling errors to achieve desired accuracy.

Instructional Objectives Chapters 1 and 2:

1. Given stations and elevations of two points, the student should be able to determine the slope between them.
2. Be able to list the six information items required in a field notebook.
3. Given an explanation of a source of error, the student should be able to decide whether or not measures should be taken to eliminate it based on whether it is systematic or accidental.
4. Given the necessary equipment, the student with a partner, should be able to tape on sloping ground, holding the tape and plumb bob in the various positions required for taping horizontally, employing voice signals, and recording entries in the field notebook. Distances should have an accuracy of 1:3,000.
5. Given a tape correction, the student should be able to correct a given measured distance to the nearest one/sixteenth of an inch.
6. Given an average temperature, the student should be able to correct a given measured distance to the nearest one/sixteenth of an inch.
7. Given a difference in elevation between two points and the slope distance between the two points, the student should be able to compute the horizontal distance to the nearest one/sixteenth of an inch.

Area Two

Leveling and Surveying Equipment - This unit covers horizontal/vertical distances which are the fundamentals of plane surveying.

Instructional Objectives Chapter 3 and 4:

1. Given the necessary equipment, the student with a partner, should be able to complete a level circuit of four turning points with an error not greater than .01 foot.
2. Given an architect/builder's level, the student should be able to demonstrate the proper procedure for setting it up and for reading the rod.
3. Given a level rod, the student should be able to select a satisfactory turning point, to hold the rod properly, and to wave the rod properly.
4. Given a series of rod readings as seen through the architect/builder level (either slides or pictures), the student should be able to read them correctly.
5. Given field data, the student should be able to keep complete notes, including an arithmetic check.
6. Given an object to be used as a benchmark, the student should be able to write an adequate description.

Area Three

Measuring Angles - This unit covers angular measuring. Distance and direction are required to establish relationships between points.

Instructional Objectives Chapter 4 and 5:

1. Given a transit of a type decided by the instructor and a point the size of a nail head, the student should be able to set up the transit over the point.
2. Given a transit the student should be able, over a point and two additional points, to turn an angle between the two points to the left or right as directed.
3. Given a transit the student should be able, over a point and one additional point, to determine the vertical angle to the point from a horizontal line.
4. Given a field notebook and horizontal and vertical angle data, the student should be able to enter satisfactory notes, including a sketch.
5. Given a total station, students will be able to set up and use equipment.

Area Four

Traverse - This unit covers traversing which is measuring the lengths and directions of successive lines. The traverse provides an accurate framework the surveyor needs to locate objects from convenient points on the framework and to relate them to each other quickly, without mistakes and without accumulating errors.

Instructional Objectives Chapter 6:

1. Given several bearings and azimuths, the student should be able to convert bearings to azimuths and azimuths to bearings.
2. Given angles and distances verbally as they would be read in the field, the student should be able to record complete traverse notes, including a sketch.
3. Given complete field notes for a traverse, the student should be able to:
   a. Plot the traverse to scale
   b. Determine angular error and adjust the angles
   c. Determine bearings of all courses based on the bearing of one course in the notes
   d. Determine latitudes and departures for each course
   e. Determine accuracy of the survey
   f. Determine corrections for each station
   g. Adjust the traverse

Area Five

Construction Surveys and Layout - This unit will provide the key areas required in this course. The surveyor is responsible for identifying the property line and the builder is responsible for the construction stake out. Layout errors have critical importance in the construction industry.

Instructional Objectives Chapters 8, 9, 11 and 13:

1. Given outside dimensions of a building and its distance from a parallel line, desired offset distance and a point for the transit setup, the student should be able to prepare a sketch showing all dimensions needed to lay out the building by the baseline and offset method.
2. Given the same data, the student should be able to calculate angles and distances to lay out the building by the angle and distance method.

3. Given a transit setup over a point, back sight and distance to set a construction stake, tape, hammer, stake and nail, the student should be able to act as instrument man, rear tape man or head tape man in setting a point for construction control.
4. Given elevation of construction stake, finished grade and desired grade rod length, the student should be able to determine the distance above or below the construction stake to build a batter board.
5. Given a transit, stakes, batter board, nylon line, nails and a set of blueprints the student should be able to stake out the building for construction to within one/eighth inch accuracy.

Summary

With clearly defined objectives and goals, not only will the students have a clear understanding of the requirements to satisfactorily complete the course, but fellow faculty can be clearly understand the courses. The linchpin benefit from this paper is the ability to properly integrate between courses in the construction curriculum. These goals and objectives provide a distinct direction for each course thus eliminating gaps or duplication of contents in the curriculum.

In preparation for teaching a course in construction management curriculum it is recommended that each professor carefully determine and state clearly what are the instructional objectives and educational goals of that particular course. From that determination, create and develop a set of experiences that will meet the planned intended educational goals. The planning, implementing and evaluating methods used in any construction management course will always establish the value of the final product – the successful student.

In conclusion, the instructional objective for this article is to become familiar with the development and use of instructional objectives and educational goals so that when creating a course in a construction management curriculum the professor will be able to correctly perform this planning task.

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Appendix A

Key Definitions

Learning: Defined as a change in behavior caused by a permanent experience rather than growth.
Objectives: Typically stated using behavioral terminology, attempting to precisely determine educational outcomes, or a desired performance which learners must exhibit before evaluating them as competent. The results of instruction rather than the process of instruction.
Educational Goals: A statement of educational intent usually in broad statements using general, abstract terms.
Instructional Objectives: Describe an intended outcome of instruction rather than an instructional process.
Performance: What the learner is able to do.
Conditions: Important circumstances under which the performance is expected to occur.
Criterion: The level or quality of performance that will be considered acceptable.

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Bid Shopping

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Bid shopping is considered an unethical practice used by contractors to gain advantage over their clients in the bidding process. Bid shopping can be harmful to the construction industry because it creates an unhealthy business environment, eliminates the benefits of the bid system, promotes lower standards of quality performance, delays project completion and reduces job site safety. Attempts have been made to stop bid shopping through contract law but these attempts have not been successful. Educating contractors of the effects of bid shopping is a means of helping to reduce the amount of bid shopping that occurs.

Key Words: Bid Shopping, Ethics, Estimating

Introduction

Graduates of construction programs will be responsible to discover and use processes that allow contractors to build cheaper, faster and more efficient projects. To accomplish this, students must be taught methods that accomplish this goal and informed about methods that do not accomplish this goal. One method that prevents the goal of building cheaper, faster and more efficient projects is bid shopping. Bid shopping is an unethical practice that hinders progress in construction and hurts the construction industry.

To better explain how bid shopping has a detrimental effect on the construction industry, this paper examines how bid shopping occurs in the bidding process, the difference between pre- and post-award bid shopping and the effects of each, and what has been done to try and eliminate the practice.

The Bidding Process

When a project is competitively bid, the owner hires an architect to create a set of plans and allow general contractors (contractor) to submit bids to build the project. In most states, statutory law requires that the prime contract for a governmental/public project is awarded to the lowest responsible bidder, whose bid meets those requirements set by the awarding authority. In the case of public projects, the awarding authority, or owner, is the public/governmental agency, and the projects are paid for through tax monies.

These laws further state that except under exceptional circumstance, once the prime contract has been awarded to the contractor, the awarding authority is prohibited from either re-soliciting bids for the project or renegotiating the bid price with the determined lowest bidder (Dufficy, 1989).

The purpose of these laws is to protect the awarded contractor and allow for the public projects to be performed at the lowest possible price or tax dollar. Private owners may also bid their projects using the competitive bid system or they may elect to negotiate the contract. Unlike the governmental/public agency owners, the private owners are not bound by law to award the project to the lowest responsible bidder.

Most building projects cover a large and broad scope of work, making it impractical for the contractor to perform most of the work itself. To complete the project on time and be the lowest responsible bidder on the bid, the contractor needs to solicit subcontract bids from subcontractors. Subcontractors submit their bids to the contractor to be incorporated into the contractor's bid. Once the prime contract has been awarded, the subcontractors become bound to the contractor in the same way the contractor becomes bound to the owner. This applies to public/governmental bids as well as private owner bids. That is, subcontractors are legally obligated to perform the work for the price specified on the bid. However, current law does not prohibit the contractor from re-soliciting or renegotiating the bid price after the prime contract has been awarded.

There are many different kinds of subcontractors in the construction industry, and competition among these groups is often strong. This competition allows the contractor to have the work performed at the lowest possible price. In theory, this sort of competition is healthy for the industry because it keeps the cost of construction down. This enables the contractor to receive a fair price for the subcontracted work, and the saved money is then passed on to the owner of the project. In reality, however, competition can lead the contractor to take advantage of subcontractors through the use of excessive bargaining pressure in the form of bid shopping.

Bid Shopping

Bid shopping is an unethical practice in which a contractor discloses the bid price of one subcontractor to another in an attempt to obtain a lower bid price. Included in bid shopping is "bid peddling," in which subcontractors themselves offer to undercut the known bid of another subcontractor. Bid shopping can occur both before and after the project owner awards the prime contract to the contractor.

Pre-Award Bid Shopping

Many people consider pre-award bid shopping, or bid shopping that occurs prior to the awarding of the prime contract, as an acceptable expression of free competition. "It (pre-award bid shopping) ultimately benefits the (owner) by arriving at the lowest possible bid for, and consequently the cost of, the project" (Dufficy, 1989).

Effects of Pre-Award Bid Shopping

Although this sort of competition may seem beneficial in terms of lower costs and market dynamics, the resulting savings do not come without a price. Subcontractors devote time and money to the preparation of their bids. To try and prevent contractors from shopping their bids, subcontractors submit their bids to the contractor just prior to the time that the contractor is required to submit their bid to the owner. The reasoning is that the contractor won't have time to shop their bids to other subcontractors. This practice is often referred to as "just in time bid submittal."

While this practice, used by subcontractors as a defense against bid shopping, does keep the contractor from bid shopping, it can also act as a double-edged sword. The problem is, if the subcontractors turn in their bids just prior to the deadline of the contractors bid turn, the contractor is unable to check for any discrepancies or errors. These discrepancies and errors, of course, lead to increased costs, disputes over the scope of work, and the general inefficient prosecution of work (Foster, 1997).

Post-Award Bid Shopping

Despite all of the problems associated with pre-submission negotiations, it is post-award bid shopping that is considered the most harmful to the construction industry. In post-award bid shopping, the contractor seeks to obtain a lower price from a second subcontractor, after having already been awarded the prime contract through the original subcontractor's bid. Post-award bid shopping serves only to benefit the contractor, as monies from these savings are used to increase the profit margin rather than being passed on to the public authority or owner.

The steps to bid shopping are simple. First, the contractor solicits bids from various subcontractors for the scopes of work on the project. It should be mentioned that soliciting these bids and/or listing them in its own prime contract bid does not bind the contractor to these subcontractors in any way.

Second, the contractor returns to the subcontractors and attempts to further chisel down their bid prices by using the incorporated subcontractor's bid as a negotiating tool. This happens after the awarding of the prime contract, but before the contractor enters into a subcontract agreement. To do this, the general gives the subcontractors permission to use any means possible to achieve the lower price, including suggesting design modifications under the guise of "value engineering" (Mechanical Contractors Assn., 2001).

Lastly, the contractor repeats the above steps, using the lowest received bid each time as the benchmark until the lowest possible price is obtained. Each subcontractor is forced to either reduce his or her costs and/or profit margin, or forfeit being awarded the contract. Those that can afford to do so will drop out, while those who need the work are forced to remain. This process continues until "all but one subcontractor drops out of the bidding or there appears to be no further reduction attainable" (Mechanical Contractors Assn., 2001).

Effects of Post-Award Bid Shopping

The post-award bid shopping effects on the industry are discussed below. Although there are many detrimental effects associated with bid shopping, this paper focuses on the following five.

Creates an adverse business environment. Bid shopping affects the industry by creating an unhealthy business environment. In order for a project to be built on time and within the budget, the owner, architect, contractor and subcontractor need to be able to work together as a team. This teamwork is necessary to allow for timely problem solving and efficient performance of the work. Bid shopping destroys team spirit and cooperation by creating a spirit of distrust and self-interest among project team members. "Subcontractors who have been shopped to the point where they don't know whether the job will be profitable aren't likely to exhibit a spirit of trust with the other "team" members. Bid shopping is more likely to produce a situation where everyone is their own team and the game is survival" (Mechanical Contractors Assn., 2001).

In bid shopping, everyone looks out for themselves rather than the good of others and the project. The contractor, insensitive to a subcontractor's financial position, seeks to increase the profit margin at the subcontractor's expense. The subcontractor, in an effort to stay in business, seeks to do whatever it takes to finish the project as cheaply as possible. The owner expects the contractor to have all of the work performed on time and according to the specifications despite whatever problems the contractor may have with the subcontractor. All of this self-interest makes it difficult to work together as a team.

The problem is further amplified because bid shopping creates a spirit of distrust between contracting parties. The subcontractor, assuming that the contractor could care less whether they stay in business or not, presumes that the contractor devalues their opinion and seeks further ways in which to take advantage of them. The contractor, knowing that he is held responsible for the finished product, presumes (with reason) that the subcontractor will attempt to cut as many corners as possible in order to save costs. All of this distrust further destroys team spirit and creates an adverse work environment.

Defeats the purpose of the competitive bid system. Bid shopping affects the industry by eliminating the benefits that are supposed to flow from the competitive bidding system. Projects are awarded through a competitive bid system because it is supposed to allow for quality work to be performed at the lowest price. A competitive bidding system works best when a large number of bids are submitted with differing prices over the same scopes of work. When this occurs, the award can be given to the lowest priced bid, and the project can be built for the lowest cost. Bid shopping frustrates the competitive bid system because it reduces the number of submitted bids and raises their prices overall.

If a contractor is known to have a history of bid shopping, the subcontractor may decide to submit a bid to all the contractors bidding the project, except for the "bid shopping contractor," or they may not bid on the project entirely. Another option for subcontractors is to simply inflate their initial bids in an effort to secure bargaining room against future attempts at chiseling them down (Dufficy, 1989). Either way, the system is frustrated because fewer people compete, the price of construction is artificially high, and any savings that are attained through bid shopping are not passed on the owner.

Promotes lower work quality. Bid shopping affects the industry by promoting lower standards of work performance. Post-award bid shopping "endangers the quality of … construction projects inasmuch as subcontractors who perform under unconscionable subcontracts allowing for negligible margins of profit are tempted to provide inferior services and materials in order to cut costs" (Dufficy, 1989). What this means is that in an effort to make up for lost profits, cash-strapped subcontractors may be tempted to cut corners by using improper materials or employing improper installation procedures.

Quality can be further compromised through the subcontractor's hiring practices. In an effort to cut costs even more, the subcontractor may choose to employ underpaid or under trained labor over skilled professionals. These workers often lack the training and experience to perform the same quality of work as their better-paid counterparts. The problem is only worsened when a communication problem exists due to a lack of language skills, which is also common with under trained workers. Cost control could also force the subcontractor to reduce manpower allotment to the bare minimum. Either way, the project quality is compromised because the workers are unable to produce the same quality of work within the same time restraints that could have been achieved had the hiring practices of the subcontractor remained the same.

Delays project completion. Bid shopping can delay the project completion. One of the ways in which this can happen is a through lack of planning. "A bid that has been shopped … is often awarded to an unqualified subcontractor who entered into the process late in the bid phase and has not adequately planned for the job" (Mechanical Contractors Assn., 2001). Often times a contractor awards a subcontract bid to a subcontractor who has hardly seen the construction documents, but assumes that he could perform the work for less than his competitor. This is especially true with smaller subcontractors who have very little overhead and are desperate for work. If the subcontractor has not planned and prepared properly for the job, chances are they will not be able to complete it on time. This may also lead to in increased cost for general requirements because of the extended project schedule.

Another reason for improper planning on the part of the subcontractor is due to just in time subcontract bid submittals. As mentioned earlier, this is a means used by the subcontractor to thwart pre-award bid shopping by the contractor. Because the bids are received just prior to becoming legally binding, the contractor is unable to obtain clarifications from subcontractors. The clarifications that the contractor may want to obtain from the subcontractors may include scope of work clarifications, the subcontractor's manpower availability, or the work backlog of the subcontractor.

Other delays attributed to bid shopping come from reduced manpower, end of project rework and poor employee morale. Bid shopping forces a subcontractor to reduce the costs in an effort to break even or make up for lost profits. One way in which a subcontractor can do this is by reducing the crew size. Obviously, by reducing the size of the crew, the odds of finishing the project on time are less likely than they would have been if the original crew size been kept. The subcontractor may seek to further cut costs through corner cutting. When quality specifications have not been properly met, the result may be increased delays due to end of project rework.

If money continues to be tight, the subcontractor may even find himself unable to pay his employees in a timely manner. Pay delays, forced overtime and an adverse business environment all help to create unhappy employees who become less motivated to finish the work on time.

The Human Toll. Lastly, bid shopping has a detrimental effect on the lives of the people involved in the construction industry by exposing them to additional risk. Bid shopping exposes our subcontractors to additional financial risks by forcing them to take a loss of profit in order to get the job. "When confronted with bid shopping, a subcontractor whose bid was used to win the prime contract must either acquiesce in post-award negotiations and reduce its margin of profit on the subcontract or not be awarded the contract. Either decision has lead to the lost profits and the economic ruin of many subcontractor businesses" (Dufficy, 1989).

Worst of all, bid shopping exposes our workers to additional safety risks by tempting the subcontractor to either push insufficiently sized crews to complete the work on schedule or cut costs on safety equipment. This could contribute to the already high industry risk by causing an accident on the job site that could result in the injury or death of a worker. Both of these risks, financial and safety, are unreasonable to require from subcontractors, and are the very cause of the elimination of the practice of bid shopping. It must be understood that these are people and not just businesses that are being affected by bid shopping.

Why Bid Shopping Exists

To prevent bid shopping, one must understand why it occurs. Bid shopping exists due to the inability of the subcontractor to tie the contractor to their bid. As mentioned earlier, the owner protects the contractor against post-award negotiations tactics under statutory law. Unlike the contractor, however, no such protection exists for the subcontractor. Under common law, the contractor is not obligated to enter into a contractual agreement with a subcontractor, even though the subcontractor's bid was used in the preparation of the (contractors) bid (Foster, 1997).

Although no contractual relationship actually exists that can bind the contractor to the subcontractor, the subcontractor, on the other hand, may find themselves bound to the contractor by way of its submitted bid. "Courts generally allow the contractors to hold subcontractors to their bids, even though a subcontractor has made an honest mistake in preparing its bid and no formal subcontract was ever created" (Stockenberg, 2001). As a result, the contractor is guaranteed a price on the scope of work and, having avoided entering into a formal subcontract, " is free to engage in further negotiations with these as well as other subcontractors in order to secure a still lower bid" (Dufficy, 1989).

Attempts to Curb Bid Shopping

In an effort to tie the contractor to the bid, and therefore control post-award bid shopping, some states have created statutes requiring that the contractor supply a list of subcontractors that are intended to work on the project. Oregon recently passed such legislature in 1999, insisting that the names all first-tier subcontractors furnishing labor or materials, be submitted within four working hours of the bid submittal deadline (ENR, 1999). The hope is that, by requiring that these subcontractors be listed on the contractors bid received by the owner, the owner can hold the contractor to use the subcontractors listed on their bids.

Unfortunately such legislation doesn't always hold. In the California case of *Klose v. Sequoia Union High School District*, the court held that such statutes "did nothing to obligate the contractor to the subcontractor" (Foster, 1997). Due to the system of precedence, or the tendency of the courts to follow after proceeding rulings in our legal system, supreme courts in Idaho and Minnesota also reached similar decisions.

Other attempts to curb bid shopping practices include efforts to change the traditional concept of offer and acceptance principles through the Uniform Commercial Code. According to the code, the contractor's use of a subcontractor's bid in the preparation of the its own bid, constitutes an acceptance of that offer once the contractor has been awarded the prime contract. Unfortunately, these attempts, like the many other national attempts to prevent bid shopping, have proved largely ineffective (Dufficy, 1989).

Finally, in its latest efforts to eliminate the consequences brought about by bid shopping, the American Subcontractors Association submitted to congress to enact The Construction Quality Assurance Act of 2001. This bill was reintroduced to Congress on March 19, 2003 (Mendes, 2003). This bill, once it is passed, will give contracting officers the right to investigate bid shopping allegations on all federal contracts over one million dollars. Under this new act, penalties for bid shopping could include contract cancellation, fine covering the differences between bid prices and debarment (Angelo, 2001). Whether the act will have any effect remains yet to be seen.

Why Legislation Have Failed

The three main reasons why legislative attempts to stop bid shopping have failed are the following:

> First, when subcontractors submit their bids just in time, the contractor does not have enough time to thoroughly analyze each bid before submitting their bid to the owner. As a result, the contractor may find that a subcontractor's bid that was already submitted has either an incomplete scope or was overlapped by another bid that was also submitted. As a result, the contractor may need to change the subcontractor to one who's scope of work is more complete or fits in better with the other subcontractor bids. Given the above conditions, the disallowance of changing subcontractors after the bid would greatly hamper the contractor's ability to manage the project.
>
> Second, the contractor should have the right to select whomever they want to use for a project. There may be other considerations such as past performance on a project that may influence the contractor's selection of subcontractors.
>
> Third, a contractor may need to change to a different subcontractor after the bid due to manpower availability. The subcontractor may not have the manpower to meet the schedule that the contractor wants to use. While the contractor could legally force the subcontractor to perform on the project, the contractor may elect to use a different subcontractor that has the manpower available to work on the project.

At bid time, the contractor may have received only one or two bids and felt that the subcontractor bids were too high, therefore, plugging in their own numbers. The contractor then attempts to find a subcontractor that will perform the work at the plugged-in price. If the contractor cannot find a subcontractor to meet their price, then the contractor's profit is reduced.

Suggestions for Reducing Bid Shopping

The first step towards the elimination of bid shopping is to educate the contractors and subcontractors about the effects of bid shopping as described in this paper. Then hopefully the contractors and subcontractors will refrain from engaging in bid shopping practices. This may seem idealistic, but it is a step in the right direction.

A more realistic solution to help curb bid shopping would be to incorporate standard bid forms for each project. This would greatly reduce the risk to the contractor on bid day, by helping reduce the potential for missed scopes of work or double coverage. The standardized bid form would reduce the need for a contractor to change subcontractors after the bid opening.

Subcontractors allow themselves to be bid shopped. If subcontractors would not reduce their price when pressured by the contractors, the bid-shopping contractors would go out of business.

Conclusion

In this paper, bid shopping and its negative effects on the construction industry have been closely examined. Legislation has been enacted in an effort to eliminate these harmful consequences, but has been overturned in the courts thus far. The only way to effectively control bid shopping is by controlling ourselves and influencing those around us to do the same. Hopefully this paper will help educate contractors on the negative affects of bid shopping and will help influence them to avoid the practice of bid shopping. If bid shopping could be eliminated in our companies and our industry, everyone will benefit.

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Cooperative Education in the Associated Schools of Construction

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The purpose of this paper is to present the extent of cooperative education within construction management programs in the Associated Schools of Construction (ASC). The extent of cooperative education was determined through a survey of all ASC construction management programs. This paper presents a brief history of cooperative education, research methods, cooperative education survey findings, and a tabulation of survey results. It was determined that the majority (91%) of ASC colleges and universities within the Associated Schools of Construction have some type of cooperative education program.

Key Words: Cooperative Education, COOP, Internship, Work Study

History of Cooperative Education

Formal cooperative education was innovated at the University of Cincinnati in 1906 by Professor Herman Schneider (Collins, 1986). He envisioned the kind of collegiate institution that would offer a combined theoretical and practical education. After the University of Cincinnati started a cooperative education program in 1906 the number of college cooperative education programs throughout the United States has increased tremendously. According to Henry (1954) the following colleges, in order, started cooperative education programs between 1906 and 1921: Northeastern University, University of Detroit, Georgia Institute of Technology, University of Akron, Drexel University, Massachusetts Institute of Technology, and Antioch College.

Between 1921 and 1943 at least one college per year started a cooperative education program. College implementation of cooperative education programs increased after 1943. Two or three colleges started cooperative education programs each year between 1943 and 1963. The pace of cooperative education implementation accelerated after 1963 through the efforts of the National Commission for Cooperative Education. The number of cooperative students in 1960, 1970, 1980, and 1990 were approximately 50,000, 100,000, 180,000, and greater than 200,000 respectively. Government financial support has been one factor in the recent growth of the cooperative education movement.

Introduction

Many construction education and industry leaders realize the value of cooperative education. The industry can screen prospective employees from a pool of cooperative education students and collaborate with education faculty to influence the undergraduate programs to further meet their needs in a future employee. Faculty members can better explain concepts in the classroom to students, who have experience in the construction industry. Understanding the degree to which the university and industry benefit in mutually meeting each other’s objectives through a cooperative education program was one purpose of this research project. The main purpose of this research project was to determine the extent of cooperative education within colleges and universities in the Associated Schools of Construction (ASC).

During the fall of 1996, a survey questionnaire was sent to 88 schools that are ASC members. The purpose of the survey was to assess the extent of cooperative education as a recognized segment of the various curriculums. The need for such a survey existed from the fact that this information did not exist and that it would assist ASC programs to know what other universities were doing when making decisions about cooperative education in their curriculum. Of the 88 surveys mailed, 43 completed surveys were returned. In order to answer the basic question of whether a program had a cooperative education program or not, an e - mail follow - up questionnaire was sent to those who did not respond to the mailing. Eleven additional responses were received for a total of 54 responses of the 88 surveys sent out (61%).

One of the concerns in developing this questionnaire was the definition of cooperative education (coop). For this questionnaire, the word “coop” was any work experience that is recognized by the school as part of the expected education experience. We found that even with this definition there was some confusion over the term “coop." Some respondents were more accustomed to “internship” or “work study." Although there is an official distinction between these terms we have used them interchangeably.

Research Methods

The following process was used to develop and distribute the survey questionnaire to determine the status of cooperative education at ASC schools:

1. A brief telephone and e - mail inquiry was done with approximately ten ASC members to find out whether a need existed for such a survey, whether such a survey had previously been done and whether ASC would have an interest in the results. The response was positive on these points.

2. The questionnaire was developed by the Construction Management and Technology (CM&T) faculty in consultation with the College of Technology’s Cooperative Education Office.

3. The questionnaire was sent out and reviewed by about ten ASC members. Their concerns, corrections, and comments were considered and incorporated into the questionnaire where appropriate.

4. The questionnaires were distributed in October to the 88 ASC schools as shown in the membership directory of 1995 - 96. A self - addressed, stamped envelope for return to BGSU was included.

5. To facilitate questionnaire tracking, consecutive numbers were assigned to each questionnaire in the order they were received.

6. The questionnaire responses were reviewed and interpreted by the CM&T faculty. Most of the questionnaires were thoughtfully completed. In a few cases partial information had to be disregarded.

Major Findings

The major finding of this research project is that most Associated Schools of Construction (91%) have some type of coop program for their students. A majority (58%) of the programs required this formalized experience. Most programs have two work terms (either quarters or semesters) of coop earning three to four credit hours per work term. The student generally pays tuition for the credit hours earned, works about 400 to 500 hours per work term and earns between $7.50 to $10.00 per hour. Coops are generally done during the summer (74%). The coops are evaluated in numerous ways and the coop programs are administered with several combinations of university staff. Contractor demand for coop students generally exceeds the number of students available. The level of satisfaction among the participants, students, faculty and employers, is very high with an 8 out of 10 approval rating.

Tabulation of Results

The following is a tabulation and discussion of the 24 fill - in - the - blank questions and a summarization of general comments resulting from the narrative questions, 25 through 29. As in any survey, which includes opinion, this survey required some interpretation of the responses. Some of the returned questionnaires were not complete, therefore some of the tabulation of numbers does not add up to the total number of respondents. Eighty-eight questionnaires were sent out with a response of 54 (61% response rate). Forty-three responses were for completed questionnaires returned via mail. The other 11 were e - mail responses to the basic question of whether the construction management program had a cooperative education program and if it was required.

1. *What is the degree that your students receive?*

   Two of the programs were two - year associates, 40 were four - year bachelor degrees, and one school was a master’s degree. Some of the bachelor programs were combined with either an associate’s degree and/or a master’s degree. Five schools indicated that they had a master’s program. There may have been more masters’ programs but this questionnaire did not specifically ask for this information.

2. *Is your university on semesters or quarters?*

   Of those responding, 13 were on quarters and 30 were on semesters.

3. *What are to total hours required for a degree?*

   For those programs that are on semesters, the hours ranged from 124 up to 144 credit hours with the average being 130. For those programs that are on quarters, the hours ranged from 181 to 205 hours with the average being 195.

4. *Does your program have one of these formalized programs; work study, internship, and/or cooperative education? The other option was none.*

   Of the 54 schools responding to this question, 49 (91%) indicated that they had one or more of the formalized programs while 5 (9%) did not.

5. *If you have a recognized work - study program, then how many terms and academic credit hours are required?*

   From this question, we not only received the requested information but also determined the number of schools requiring a work - study program and how many did not. Of the 45 schools responding to this question, 26 (58%) required the program and 19 (42%) did not. The number of required work terms varied from one to six with an average of 2.1. The credit hours for a single work term varied from 0 to 12 with an average of 3.8. Three credit hours per term was the most common number of credit hours. This indicates that 2 terms of 3 to 4 credit hours per term is typical for those programs that require the work - study experience.

6. *How many work terms and coop credit hours does the program permit as electives?*

   The responses to this question were rather inconclusive and in some cases made little sense. We decided not to present any findings on this other than determining which programs required work - study and which did not. These findings have been tabulated in narrative for question #5.

7. *If coop is an elective, what percentage of your graduates goes through the coop experience?*

   Seven schools responded to this question. The percentage of graduates going through the elective coop experience varied from 1% to 80%. The average was 32%.

8. *What is the average total amount of credit hours of cooperative education for a degree?*

   The responses to this question were rather non - responsive. As indicated in #5 above, the typical program has 2 terms of 3 to 4 credit hours per term for those programs that required the work - study experience.

9. *How many employment hours and employment weeks are required in a single work experience?*

The schools primarily answered in total number of hours. The total hours varied from 70 (next lowest was 240 hours) to 640 hours with the average being 411 work hours. The employment weeks were as low as 8 and as high as 16 with the average being 10 weeks.

10. *What percentages of the coops are taken during summer versus other times?*

Seventy - four percent are taken during the summer. Three programs have exclusively a summer program coops exclusively in fall and spring with none in the Summer.

11. *What is the average pay for a coop employment?*

# of responses
8.4 No pay, done for experience
9 Less than $7.50
10 $7.50 to $10.00/hr
11 $10.00 to 12.50/hr
12 More than $12.50/hr

12. *How much do students pay the university for each coop work experience?*

The most common response was that the student paid the usual tuition for the credit hours taken. The average was $258 per experience. This ranged from $0 to $832. If the five schools that do not charge for coops are deleted from the tabulation, the average for those schools that do charge is $330 per experience.

13. *Coop systems are administrated by various units or a combination of units within the university structure. What percentage of your coops are administered under the direction of the following units: university, department, college, and/or program.*

# of responses
8 By University Only
5 By College Only
8 By Department Only
6 By Program Only
5 By Combination of University and Department
1 By Combination of Department and Program

14. *How many equivalent full time staff administers the coop program (remember this is only for construction and you might have to prorate the entire staff between programs)?*

The average of the 29 responses was .43 with the range going from 0 to 1.

15. *In the past year, how many coop students participated in the coop program and how many total students were eligible?*

    Once again the responses were incomplete and inconclusive. No general summary could be made from the information.

16. *What percentages of the coop assignments are found by the student though their own efforts or contacts (in lieu of the paid university staff or contractors contacting the university)?*

    # of responses
    9 less than 10%
    6 11% to 25%
    5 25% to 50%
    10 more than 50%

17. *Contractor demand far exceeds the students that are available.*

    The response was a Likert scale of 0-to-10 with 0 indicating strongly disagree and 10 indicating strongly agree. The average response was 6.7 indicating a general agreement.

18. *Some coop programs formulate an ongoing agreement between the coop employer and the university. In these agreements, the employer is obligated to provide employment positions for coop students and the university is obligated to provide students for these positions. What percentages of coop employers meet this arrangement?*

    Twenty schools indicated that 0% of the employer were obligated to hire students. Six schools indicated that they had such an arrangement. The average of these schools was 45% with a range from 4 to 100%. The response of 100% indicates that, at least, one school has an arrangement by which the coop employer and student employee is very much controlled by the school's program.

19. *Coop jobsite visits of the student are done by:*

    # of responses
    11 Construction Faculty Only
    0 Coop Staff Only
    15 No one
    4 A Combination of Faculty and Staff

20. *How are students evaluated?*

    # of responses
    4 Only by Evaluation Form done by Employer
    0 Only by Coop Jobsite Visit
    1 Only by Written Report by Student

9 Evaluation Form by Employer and Written Report done by Student
2 Coop Jobsite Visit and Written Report done by Student
12 Combination of all three methods

21. *How many type written pages are in the average student report?*

# of responses
10 1 to 5 pages
13 6 to 10 pages
5 11 to 20 pages
1 21 or more
3 N/A

22. *Are the students required to keep a journal or diary?*

# of responses
14 Always
6 Sometimes
9 Never
1 Yes, a brief one

23. *Do you believe that cooperative education helps graduates find employment?*

# of responses
22 Always
10 Sometimes
1 No effect

24. *Receive higher starting salaries?*

# of responses
11 Always
18 Sometimes
2 No effect

This has been examined closer by (Wessels and Pumphrey, 1996), who found that there was really only the benefit of increased wages for females and those that have the least experience. Experienced workers' wages are less affected by cooperative education. Also asked in this question was the percent hired into a permanent position from their coop employment. There were five responses and they were 100%, 90%, 50%, 33% and 10%.

25. *On a scale from 1 to 10 (with 10 indicating satisfied) what is your perception of the level of satisfaction with the coop program of each of these groups at your institution?*

8.4 Students
8 Faculty

8.5 Employer

The satisfaction level that the respondent reported was actually lower than other studies. While the faculty who answered this questionnaire perceived that there was an 8.4 level of satisfaction with students, studies on disciplines other than construction have shown that 95% of the students would recommend cooperative education to other students (Dubick, 1996). In addition to the above fill - in the - blank questions the following narrative questions were asked. The responses have been summarized in the next section of general findings of narrative. The complete reporting of these narratives are shown in Appendix A.

26. *Please elaborate on any information to demonstrate that a formal internship or coop experience is an important aspect of a construction education.*

A major portion of these responses discussed the value of improved classroom participation of the students after the coop experience. Others endorsed the value of exposing the students to "real life" construction experiences and the opportunity for the employer and student to assess the possibilities of permanent employment without the pressure of making a long-term commitment. A couple of schools responded that they had little support from the construction industry. This is contrary to the favorable response found in question #17. One school suggested that ASC fund a coop education-training program for the member schools.

27. *Do you feel that a formal internship or coop experience is unnecessary because most students work construction without it being a university requirement?*

More than three - quarters of the respondents indicated that they felt that a formal internship or coop experience was necessary. One school brought up that students hate to pay the tuition for construction work that they probably would have done anyway. Another indicated a concern that coops force students to take work that may not be convenient to the demands of their personal life.

28. *What are the biggest barriers to the administration of a coop program?*

By far the most common barrier was time and money. Other problems that were highlighted were the lack of quality placements, lack of support by the university and the difficulty of restructuring the curriculum to accommodate coops. Two respondents indicated that there were no barriers to coop.

29. *What unique characteristics have you found beneficial in a coop program?*

Many of the responses were reiterations of points previously mentioned. A couple of new points were made. The opportunity exists for networking between the university and the construction company. There is the obvious value of student networking but it also exists for the university. In addition, one school brought up the fact that coops provide financial support that can be used for summer support for the faculty.

30. *What other information about cooperative education would you like to share that might be helpful in this survey?*

    Several schools had various comments but one that was noteworthy was that one of the schools has a special three credit hour class in which students are found positions and are taught interviewing and resume writing skills.

Discussion of Results

Most schools (91%) have some form of coop program. Of these, 58% are required programs while 42% are electives. For those which are elective, a significant portion (32%) elected a coop program. The range for electing coop varied from only 1% to 80%. A typical coop included 2 terms of 3 credit hours each. Some did not give credit while others gave 12 hours credit for a single work experience. The duration of the employment was around 400 hours per work experience (range from 70 to 600). The rate of pay for the coops is certainly above minimum wage with most getting between $7.50 and $10.00 per hour. About three - fourths of the coops are taken in the summer. A few schools indicated that coops alternated semester to semester with class work. The students typically pay tuition rate for the hours taken in coop.

Although there is always some university structure by which the coop is administered, many of the students find their own coops. The administration structure within the university for coop doesn't have a typical format and is administered by every unit and/or combination of units. Though some programs mentioned that industry support is not available, most said that finding jobs is not a problem and they are available. However, few contractors are obligated to hire coop students regardless of the job situation.

Review and evaluation of the student during the coop varies dramatically. About half of programs don't provide a jobsite visit by a member of the university. In the situation where there are jobsite visits, the visiting individual may be either coop staff or construction faculty. There were no predominant means by which evaluations were done. Evaluation forms by employer, student reports and jobsite visits all made up the possibilities. The BGSU student performance evaluation profile (completed by the employer) is shown in Appendix B. In most cases, some type of written report was required with 6 to 10 pages being the most common length. In most cases, the student was required to keep a journal or diary of their activities. Most schools were confident that coops helped the student, not only find permanent employment, but also at a higher starting salary.

Finally, it is the perception that all the participants, i.e. students, faculty and employers were pleased with the coop programs. It should be pointed out that a few schools were not impressed with coop programs and gave them low marks.

Summary

Hopefully, this paper provides a perspective of how coops are incorporated into the curriculum of most of the ASC schools. From this perspective the reader can address the strengths and weaknesses of their individual programs. Although this paper has not been an instruction manual on how to set up a coop program, it should give the reader an understanding on the magnitude of many aspects of a cooperative education in the Associated Schools of Construction.

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Appendix A

Responses to questions 25 to 29

(The number prior to the comment is simply the number assigned to the questionnaire at the time it was received. This helps in tracking the responses.)

25) Please elaborate on any information to demonstrate that a formal internship or coop experience is an important aspect of a construction education.

1 - Quite valuable
3 - Students find what real life is all about first hand. Employers offer higher salaries to graduates with "real" experiences. That is what "industrial technology program" is all about: hands - on.
5 - Give sound experience to the education being received. Most demonstrate improved classroom performance as a result of the experience.
8 - Employers for the most part place great emphasis on construction experience. The coop program does an excellent job in providing opportunities foe experience.
11 - Employers can hire without a permanent job commitment. Great experience for the students.
12 - Students come back more motivated.
16 - More and more firms are using coop as a pre - employment screening process.
21 - Only way to truly expose students to industry demands.
22 - Important that it takes place between junior and senior year. Changes quality of the performance in Capstone course required at the end of the senior year.
24 - This is the way to have student really learn and apply and relearn such that true mastery occurs of the subject.
25 - Each company has a formal agreement with the university and my program.
27 - You should ask students. It's one of the greatest experience in their careers.
29 - I believe it is very important. Implementing it is a major problem. Contractor response is very poor to non - existent.
30 - We are an evening and weekend program primarily. We do have one or two courses during the day. Our students are working by the time they are juniors.
31 - Industry advisory committee meets twice/year. Employers are willing to spend minimum possible for on - job training.
32 - We are firm believers in formal required internships before graduation.
33 - Provides direction to student. Helps motivate students when returning to classroom.
34 - We have no coop program. Credit is allowed for internship by student petition. It is not required.
37 - Great. Brings student to the realization that classroom activities are relevant.
39 - You summarized this well in your abstract. Coop fills the void that the very ineffective standard hiring practice leaves.
41 - When the experiences provide responsibility, the student matures in his discipline.
42 - Absolutely necessary. We would like ASC to fund training for member schools. We'd like to do it.

26) Do you feel that a formal internship or coop experience is unnecessary because most students work construction without it being a university requirement?

1 - No - It should be required
2 - The experience is what's important.
3 - Coop Experience MUST be a requirement of all construction programs regardless.
5 - Not unnecessary; Just not required. Good student's understand the value and take advantage while others do not.
8 - No. We require all of our construction students to in a construction related job for at least 12 weeks. The formal coop program meets and greatly exceeds this minimum requirement. Participants are highly sought by construction firms.
11 - Disagree.
12 - No

15 - No, very necessary for our students. 50% of our majors have no construction work experience.
16 - Yes. Most students see the value and participate voluntarily.
21 - Partly agree. Depends on the individual.
22 - No. The organized process, follow - up reports and contact with industry are very important parts that mature students.
24 - No. Structured internships are the best way a achieve educational and professional objectives.
25 - No. They need the final application of all their experience and it needs to be structured over a broad spectrum of knowledge base.
26 - No. It's often easier for students to have other jobs and work around their schedules than to construction job.
27 - Internship is a 14k Gold arrangement. All parties feel it enhances value of the student. It weeds out those who are not really going to stay in construction.
29 - I feel it is highly desirable. The problem is in the implementation.
30 - I believe a program should require some work experience before their senior year. 800 hours was adopted here because industry felt it would be the minimum needed, i.e. 2 summers. How the students get that experience is up to them.
31 - No. Faculty acts as job exchange for willing students to find internship employment. Such employment is highly recommended by the faculty.
32 - No. Lots of time previous experiences are (quality) questionnaire. Also, we found that it is beneficial for faculty supervisors to visit these construction companies for various reasons.
33 - No.
36 - Yes. Our internship requires that the employer give the student management experience. Most construction work by students outside college is typically labor experience.
37 - No. A different prospective that it generates.
38 - Hate the collection of the fees by the university.
39 - Absolutely not! Coop is the single most important component of our program.
41 - We believe in the formal experience but may reduce to 3 hours/work experience. Still would make money under present system.
42 - No.
44 - This is not the point. Employers of graduates <u>know</u> our graduates have already been through the wringer. It's not left to choice or chance.

27) What are the biggest barriers to the administration of a coop program?

1 - Faculty not having time or financial support to visit coop sites.
3 - Experienced personnel, needs a full - time faculty, and resources.
8 - Reluctance of students to commit to the extra time required for coop and distance involved in visiting students while they are working.
11 - Finding appropriate quality placements
12 - Non - English speaking permanent residents.
15 - Money and Time
16 - Resources
22 - Lack of adequate developmental support from the engineering dominated college.
24 - Time required and lack of resources.
25 - Hard work and time.
26 - It's volunteer work which is not rewarded by the university.
27 - Commitment of a faculty member to operate it. But answering this would require a journal article of 20 pages.
29 - None - administratively.
30 - Time!
31 - None.
32 - Everything seems to work well at our program.
33 - Time. We are in the rural setting. Other demands on faculty.
35 - Budget and time for internship coordinator to travel to internship sites. A lot of paper work and preplanning.
37 - College arrangement of our institutes; should be administered by the program.

38 - that is my off quarter.
39 - Lack of commitment by our president.
41 - Need larger staff.
42 - Work commitment, cost, inability to restructure curriculum.
44 - Establishing enough reliable repeating coop sites. Construction runs hot and cold in the northeast. When it's cold, it's tough to place everyone.

28) What unique characteristics have you found beneficial in a coop program?

1 - Students appreciate the need to learn classroom material to be able to perform on the job site
3 - Provides graduates a unique real experience, links class - rooms to real life, and gets faculty to seek "real" experience.
8 - Having the central coop office assist students in finding coop jobs,. And the significant change in attitude and confidence exhibited by students after one or two coop terms.
11 - Having students seek their own placement.
12 - Interview process, Networking.
21 - Real Life.
24 - Employers get closer to the university.
26 - It brings the relevance to the student's classes.
29 - Ability to obtain "real world" experiences.
31 - Students familiarize themselves with real life situations. Tests reflect such situations. All curriculum tests reflect practical applications.
32 - Helps to get the "PR" out regarding our construction program and graduates.
33 - Learning contracts. Feedback systems.
35 - Future employment opportunities for student and "real world" experience.
37 - Professional quality of the activity.
38 - Students explaining program to potential employers.
41 - Summer pay for faculty. Several unique construction sites of interest. Some better interaction in teaching with experience.
42 - Structure, structure, structure. Substantial portion of the curriculum mandatory, alternating with classes.
44 - Diversity. We are not construction only. We are civil with design and facility jobs as well as construction.

29) What other information about cooperative education would you like to share that might be helpful in this survey?

3 - Graduates with coop experiences obtained higher entry - level salaries and were promoted much faster.
8 - Written requirements of other programs. We require a 5 to 10 page report on some aspect of the work experience, a daily dairy entry, and a summary report that goes on file in the central coop office.
11 - Students can sign u for a special 3 credit hour course in which they are found positions for them. They also are thought interviewing, resume writing skills.
12 - Ours is a required program. We have a formally established, large coop office. Student reports are discussed with the coop staff.
21 - Difficult to monitor, service and maintain.
31 - Personal endorsement in writing by faculty if student has B+ average.
33 - All win - students, university and employer.
39 - My program is the largest 2 - year civil program in the country and the college is the largest 2 - year college in coop in the country (seventh overall). I would be glad to chat about our experience. I look forward to reviewing the results of this study.
42 - Keep excellent statistics and survey reports.

Contributing Reviewers

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