Exposing Students to Innovative Construction Technologies in the Undergraduate Civil Engineering Technology Curriculum

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Abstract
Incorporating new and innovative construction technologies into the undergraduate curriculum is often difficult due to time constraints. Field trips, seminar speakers, and multimedia provide opportunities to expose students to new and emerging technologies outside of the traditional lecture format. Each of these can be highly visual to facilitate student interest and learning, but all have advantages and disadvantages that affect their use. One field trip and one seminar speaker, in cooperation with the Pittsburgh District, U.S. Army Corps of Engineers, provided this opportunity for Civil Engineering Technology students at the University of Pittsburgh at Johnstown. In another case a video was used. Student response on the effectiveness of these different learning experiences was also obtained.

Introduction

New technologies are continuously being developed and implemented in civil and construction engineering practice. Incorporating these new technologies into Civil Engineering Technology (CET) curriculum is difficult due to limited time available in class and the wealth of basic concepts that must be covered. Although it is impossible to incorporate all technological advances into the undergraduate curriculum, exposing students to some of these technologies is desirable. In addition to the new technologies themselves, discussing how and why new technologies are developed and implemented benefits students in their education as well as their careers. Not only do they become aware of a specific recent development in their field, they also can develop an understanding of how existing technology leads to new developments in a particular field. This provides the foundation for life long learning opportunities as many new technologies will likely be introduced and implemented in practice during their careers.

Several ways to incorporate new technologies into the curriculum include field trips to innovative project sites, presentations by guest speakers from industry, videos of innovative projects, selected readings on recent innovations, and lectures by course instructors regarding innovations in practice. Each has advantages and disadvantages. This paper considers the use of field trips, guest lectures and videos as a way to present innovations to undergraduate CET students in a junior level Soils Engineering course.

Field Trips

Field trips provide students an opportunity to see the actual application of recent technological developments in construction and civil engineering technology. Students greatly enjoy the break from classroom lectures and are left with lasting visual images. Field trips require a certain degree of instructor coordination and may be subject to student schedule conflicts. Depending on the project's location, transportation and travel time may make trips to the most interesting sites difficult.

A single field trip to a site usually presents a project at one instant in time. It may be difficult for students to appreciate and understand the entire project based on what is visible on a given day. Project overviews by construction personnel at the site or by the instructor prior to the site visit can help students visualize the entire project. Large projects with considerable press coverage may provide opportunities for students to become familiar with the project in advance.

Field trips also provide opportunities for interaction. Students are able to ask questions of site representatives regarding the project and the profession. Opportunities for developing contacts for potential summer and permanent employment also occur.

Braddock Dam Field Trip

A field trip to the construction site of the new Braddock Dam navigation structure near Pittsburgh, exposed students to the first use of in-the-wet construction by the U.S. Army Corps of Engineers. The new dam is the largest float-in navigation structure built in the United States[1]. Constructed on land in a casting basin as two large football-field sized segments, the completed dam sections are floated out into the river, towed 27 miles upstream to a mooring site near the new dam location where final preparations are made[1]. Simultaneously, construction of the dam foundation is occurring from barges in the river; thus decreasing the total time needed for dam construction, as well as the cost. The prepared dam segments will then be towed to the dam site and sunk onto the prepared foundation. Once the segments are in place, completion of the dam structure will occur from the river above. [1]

The field trip allowed students to see the considerable scale of this $107 million[1] project, the testing of prototype dam sections possible only on large projects such as this, and the cooperation between the Corps and the contractor. The field trip also allowed student interaction with representatives of the design and construction management team. Students inquired about summer employment opportunities with the Corps and application information was provided as a result.

One limitation of this field trip was observing the construction at one instant in the construction schedule, rather than observing the entire construction from start to finish. Because the casting basin, temporary mooring area and dam site on the river are at three different locations, students were only able to see the temporary mooring area during the visit. The Corps, however, had a short professionally produced video available that was viewed before heading out to the construction site. The video gave an interesting overview of the entire project, improving student understanding about the project. Representatives of the Corps also discussed how the decision to use “in-the-wet” construction was made over more traditional procedures and also discussed project management issues with the students.

Prior to the field trip, the Corps had provided several papers, press releases, and web site information about the project[1,2,3]. This information was distributed to students to help them become familiar with the project. In addition, after the site visit, students were able to track progress on the project on a web site. Web cameras provided a view of the floating of the dam section into position and its sinking onto the prepared foundation.

Student Response Regarding the Field Trip

The field trip site was approximately 1-1/2 hours from campus. The field trip was scheduled on 18 October 2001 to correspond with an evening ASCE Geotechnical Group dinner meeting and lecture in Pittsburgh. The time commitment to attend was therefore approximately 10 hours for round trip travel, the field trip, and the ASCE meeting. There was no charge for the field trip or the dinner meeting, and a university van was used for transportation. Because of the time commitment involved, attendance was optional for the 25 students in the Soils Engineering course and was open to other CET students. A total of 14 students attended the field trip. Of these, 10 were juniors in the Soils Engineering course. Several students drove themselves and did not attend the ASCE meeting afterwards. Nine of the 14 students attended both the field trip and the ASCE meeting.

A total of 21 students in the Soils Engineering course completed a questionnaire on 3 and 4 December 2001 about the field trip. A copy of the questionnaire is included in the appendix. Ten students, or 48% attended the field trip. The reasons why the other students chose not to attend the field trip was due either to the time commitment involved or conflicts with their schedule, as shown in Table 1.

Table 1. Student reasons for not attending field trip

Reason for Not Attending	Percent
Amount of Time Required	54.5
Not Required by Instructor	0
Not Interested in Project	0
Night Class or Work Schedule	45.5

Those that attended the field trip were asked to rate various aspects of the experience on a scale of 1 to 5 with 5 being highest and 1 lowest. The evaluation topics and average responses are presented in Table 2.

All 21 students were asked to indicate whether handouts and class discussions improved their learning regarding the project. Seventy-six percent (76%) of the students indicated that the handouts and class discussion helped, while 24% indicated that did not learn anything. All of the students that answered no had not attended the field trip, and had probably not read the handouts since there were not related assignments.

Table 2. Average student response regarding field trip

Evaluation Topic or Question	Average Student Response
Overall Quality of Field Trip (1 poor – 5 excellent)	4.3
Overall Quality of Presentation by Site Officials (1 poor – 5 excellent)	4.5
Quality of What You Saw During Site Visit (1 poor – 5 excellent)	3.8
Relationship Between Project and Course Material (1 poor – 5 excellent)	3.9

Table 2. Average student response regarding field trip

Evaluation Topic or Question	Average Student Response
How Interesting Did You Find the Project? (1 very little – 5 very interesting)	4.7
Your Ability to Follow the Technical Aspects of the Project (1 hard to follow – 5 easy to follow)	4.0
Relative Amount of Knowledge Gained by Visiting the Site (1 learned nothing – 5 learned a lot)	3.7

All 10 students who attended the field trip were able to recall something innovative about the project. Of those that did not attend, 73% were able to recall something about the project, as well, due to the class discussions and handouts.

Guest Speakers

Bringing guest speakers into the classroom provides another way to expose students to new and emerging technologies. Local professionals from industry, especially alumni, are an excellent source for obtaining guest speakers. A difficulty may occur in scheduling and campus location. Another difficulty may occur if the topic is too complex for student understanding. In addition, poor presentation skills and/or audio-visuals my hamper student interest. Instructors coordinating with guest speakers should clearly identify the academic level of the audience to the speaker. In addition, classroom discussions about the project by the instructor before the presentation may improve student interest in the presentation.

Presentations by guest speakers can provide a complete overview of a given project or they can concentrate on a particular technical aspect. Students can benefit from the interaction experience with the guest lecturer by asking questions and participating in discussions. These experiences also provide students a local contact for summer and permanent employment opportunities. If the presentation is to a large group of students, the interaction benefits will likely be reduced.

Johnstown Local Flood Control Project Rock Anchor Installation

Students were exposed to rock anchor installation on a recently completed local project through a guest speaker from the U.S. Army Corps of Engineers. The Johnstown, PA Local Flood Control Rehabilitation Project involved the installation of passive rock anchors for retaining wall stability along 9 miles of river channel.[4] The Microsoft PowerPoint presentation was highly visual including text, tables, figures, graphs, and construction photographs. The speaker emphasized the relationship between the geology, the rock anchor installation, and the structural components of the system. The same individual who led the Braddock Dam field trip made the presentation on the rock anchor project. The presentation provided a rather complete exposure to the entire project and allowed for limited student interaction with the presenter.

Student Response Regarding the Guest Lecture

The presentation[5] was made on 1 November 2001 in a required seminar to a large group of about 70 students in an auditorium setting. The students were CET undergraduates ranging from

sophomores to fifth year seniors. The presentation was prepared using Microsoft PowerPoint. The students were not given any additional information about the topic in class.

A total of 21 students in the Soils Engineering course completed a questionnaire on 3 and 4 December 2001 about the presentation. A copy of the questionnaire is included in the appendix. Seventeen students, or 81% attended the presentation. Those not attending the presentation were excused from seminar due to professional internships.

Those that attended the presentation were asked to rate various aspects of the experience on a scale of 1 to 5 with 5 being highest and 1 lowest. The evaluation topics and average responses are presented in Table 3.

The 17 students that attended the presentation were asked to indicate whether a class lecture would have improved their learning regarding the project. Eighty-eight percent (88%) of the students indicated that a lecture in class would have helped them understand what the speaker was talking about, while 12% indicated they did not think a lecture would have helped.

Of the 17 students that attended the presentation, only 7, or 41% recalled something innovative about the project. The majority of the students could not recall anything innovative about the project, even though they attended the presentation. Approximately 30% of the students responded that they found the presentation to be too technical and above their level of understanding.

Table 3. Average student response regarding guest lecture

Evaluation Topic or Question	Average Student Response
Overall Quality of Presentation (1 poor – 5 excellent)	4.1
Quality of Visual Materials (1 poor – 5 excellent)	3.8
Quality of Presenter (1 poor – 5 excellent)	4.0
Relationship Between Project and Course Material (1 poor – 5 excellent)	3.7
How Interesting Did You Find the Presentation? (1 very little – 5 very interesting)	3.5
Your Ability to Follow the Technical Aspects of the Presentation (1 hard to follow – 5 easy to follow)	3.3
Relative Amount of Knowledge Gained During the Presentation (1 learned nothing – 5 learned a lot)	3.4

According to Mines[6], students indicate they learn better from traditional lectures than from PowerPoint presentations. He found students were less attentive to the material presented and less interaction occurred between the students and presenter using PowerPoint. This appears to be true in the current study, as well.

In the presentation on the rock anchor project, some of the graphs and figures were complicated and confusing to the students. Other studies[7,8] indicated students dislike multimedia presentations that include figures that are too complex or present too much information with out adequate time and discussion to understand the material.

It has also been shown that students are often not truly interested in understanding the material being presented.[7] Student focus is not so much on learning about some technical aspect in a particular course, but rather their focus is on passing the course and doing whatever is necessary to get a grade they would be satisfied with.[7]

The rock anchor project presented by the guest speaker was given in a required weekly seminar for CET majors. Student attitude toward the seminar is generally not favorable. Thus, a presentation in this setting was probably not taken as a benefit of their education, but rather as a chore. The students from the Soils Engineering course present for the seminar were told about the presentation but were not given an assignment regarding the presentation. As a result, student attention may have been minimal and combined with the complexity of the topic, few students retained much from the presentation.

Videos

Videos of innovative projects provide another way to expose students to new and emerging technologies. Commercially available videos from sources such as PBS, the Discovery Channel, and professional educational and trade organizations can provide information on innovative construction projects and technologies. The costs to acquire certain videos may be prohibitive, while others are more reasonably priced. Some from trade organizations may be available to educational institutions free of charge. Another option for obtaining videos is through interlibrary loan services. In deciding to purchase a video, the cost and useful life of the video should both be considered. Expensive videos that may be outdated in several years are probably not a worthwhile investment.

Videos can provide a complete overview of a project. Depending on the intended audience, however, they may or may not provide much detail on technical aspects of the project. Unfortunately, television videos may treat the technical aspects of a project very superficially. They may however, make up for it by adding information on the social, political and human aspects of a project that are desirable relative to ABET requirements.[9] Videos allow convenient viewing and can even be assigned as an out of class exercise. They lack the ability for interaction that both the field trip and guest speaker provide. They can provide a complete overview of an entire project from start to finish, which is not usually provided by a field trip. Classroom discussions before during and after the video are definite advantages of this format. It is exceedingly easy to pause or rewind the video to discuss various images presented in the video and important aspects pertaining to course material.

Kansai International Airport Video

The innovative construction of the Kansai International Airport in Japan was presented to students through the use of video on 5 and 6 November 2001. Part of the Super Structures of the

World video series, [10] the Kansai International Airport video, produced by Unapix Home Entertainment, is available at reasonable cost.[10]

This airport is constructed on a man-made island in Osaka Bay. The video discussed not only the technical aspects of the project, but also the political and economic aspects.[11] The extensive planning and future development were also discussed. Constructing the island involved a huge earth moving operation and the placement of material in standing water within the confinement of a man-made seawall.[11] Placing the fill for the island presented two major concerns to the engineers. The weight of the soil fill would cause the underlying soil deposits to consolidate and soil fill placed in standing water tends to lose its strength during an earthquake.[11] To overcome these difficulties, the engineers used sand drains to speed up the consolidation of the underlying soil layers.[11] A very well-graded fill with many large cobbles and boulders was used to avoid strength loss associated with liquefaction of the fill material during an earthquake.[10] Differential settlement between the island and the terminal building required the use of computer monitoring of column movements and the use of hydraulic jacks to adjust columns periodically.[11] The project scope and use of a number of innovative technologies, made this a highly interesting project for the students. The video provided complete but rather general exposure to the entire project but lacked the interactive nature of the field trip or the presentation. The project was discussed in class prior to the video being presented. The video was also paused periodically to discuss images illustrating innovative technologies used on the project.

Student Response Regarding Video

A total of 21 students in the Soils Engineering course completed a questionnaire on 3 and 4 December 2001 about the video. A copy of the questionnaire is included in the appendix. Twenty students, or 95% viewed the video. The one student that missed the video was absent the day it was shown.

Those that viewed the video were asked to rate various aspects of the experience on a scale of 1 to 5 with 5 being highest and 1 lowest. The evaluation topics and average responses are presented in Table 4.

Table 4. Average student response regarding video

Evaluation Topic or Question	Average Student Response
Overall Quality of Video Presentation (1 poor – 5 excellent)	4.8
Relationship Between Project and Course Material (1 poor – 5 excellent)	4.5
How Interesting Did You Find the Video Presentation? (1 very little – 5 very interesting)	4.8
Your Ability to Follow the Technical Aspects of the Project (1 hard to follow – 5 easy to follow)	4.2
Relative Amount of Knowledge Gained by Watching the Video (1 learned nothing – 5 learned a lot)	4.2

The 20 students who viewed the video were asked to indicate whether discussion in class improved their learning regarding the project. One hundred percent (100%) of the students indicated that the discussions in class helped them understand the geotechnical aspects of the project shown in the video.

Compared to the field trip and guest speaker, the video corresponded most closely with topics covered in the course. In addition, it was easy to schedule the video at the appropriate time in the semester to correlate with the lecture. Field trips and guest lectures require more scheduling coordination and can not always be timed correctly for the topics covered in lecture.

Ninety percent (90%) of the 20 students who viewed the video were able to recall something innovative about the project. Several students commented that although the project was interesting, they found the video to be a bit too long and overly dramatic. Many students commented that they found the project very interesting and thought watching the video was a good experience.

Comparison of Student Responses

Although each method used to expose students to new and emerging technologies has its unique characteristics, it is useful to compare the student responses to several of the evaluation topics and questions. Table 5 presents the average response to the evaluation categories common to all three methods.

As can be seen in Table 5, students found the video to be the best overall in the categories compared. The field trip has the second highest ratings, while the guest speaker was lowest. Student interest in the field trip project was essentially as high as the project presented in the video. The inability of the students to see the true extent of the project during the field trip resulted in lower ratings regarding other aspects of the field trip.

Table 5. Comparison of average student responses

Evaluation Topic or Question	Average Student Response		
	Field Trip	Guest Speaker	Video
Overall Quality of Experience (1 poor – 5 excellent)	4.3	4.1	4.8
Relationship Between Project and Course Material (1 poor – 5 excellent)	3.9	3.7	4.5
How Interesting Did You Find the Project? (1 very little – 5 very interesting)	4.7	3.5	4.8
Your Ability to Follow the Technical Aspects of the Project (1 hard to follow – 5 easy to follow)	4.0	3.3	4.2
Relative Amount of Knowledge Gained (1 learned nothing – 5 learned a lot)	3.7	3.4	4.2

The lower student responses regarding the PowerPoint presentation by the guest speaker are likely due to a combination of circumstances. The project did not correspond very well with

material covered at the time in the Soils Engineering course. The project was therefore not discussed in class. The students found some of the presentation to be too complex and as the presentation went in that direction, they tended to tune out and lost interest. The presentation also was not highly interactive. Finally, the presentation was made a large auditorium in a required (but not very well liked) weekly seminar course. As a result, students tended not to connect the material presented to their Soils Engineering course.

It should be noted that this comparison is based on three specific projects and experiences. In different circumstances, a great speaker and a poor video may lead to completely different results. A field trip where students see more of a project or a wide variety of construction techniques may rate higher. Even in this case, students found the Braddock Dam project to be essentially as interesting as the Kansai Airport project. They noted however, that they expected to get closer to the actual construction and see more than they actually were able to see.

In the trials discussed here, no evaluation of student learning was conducted. One student did choose to write a term paper on the Braddock Dam project and another wrote about the Kansai International Airport project. However, other students were not quizzed or tested on the various projects. Similarly no written assignments were required. In hindsight, this may have discouraged student interest in the innovative and emerging technologies present in the three projects. To encourage student interest and understanding, an assignment or quiz should follow each experience to further evaluate the effectiveness of each method. Students will be motivated to learn and understand more if they will be responsible for it as part of their grade.

Recommendations

Incorporating innovative construction methods into the civil and construction engineering technology curriculum provides students exposure to new and emerging technologies. Discussing how current practice leads to new developments helps prepare students for the many innovations they may encounter in practice and that the profession will adopt during their careers. Using field trips, guest speakers, and videos are ways to provide students this needed exposure. Each has advantages and disadvantages. Based on experiences and student feedback, the following recommendations can be made:

Field Trips

- To get greater student participation, field trips should be scheduled locally so they are not too time consuming.
- Construction site field trips should show a variety of field applications and allow students to get as close to the construction as possible.
- Classroom discussions help improve student understanding of what the field trip illustrates
- Coordinate lecture topics with the field trip.

Guest Speakers

- Guest speakers should be aware of the academic level of students and prepare their presentation at the appropriate level. They should also try to be more interactive in their presentations.
- Students may be more receptive to small classroom presentations rather than large auditorium presentations.

- Classroom discussions of the topic before the presentation may improve student interest and understanding during the presentation.
- Coordinate lecture topics with the speaker's presentation.

Videos
- Use videos sparingly.
- If a video is too long, show only the important part in class, or assign students to view the video outside of class.
- Coordinate lecture topics with the video.
- Classroom discussion should complement the video.

A number of different methods are available to expose students to new and innovative construction technologies. Field trips, guest speakers and videos provide opportunities for incorporating construction innovations in the curriculum. Each method has its advantages and disadvantages. Using these different methods in combination with classroom discussion and assignments may help improve the learning experience for students.

Appendix

TO: CET 1131 Students

FROM: Professor Rose

SUBJECT: Questionnaire on Exposure to Innovative Construction Projects

DATE: December 3, 2001

I am in the process of writing a conference paper on the use of different ways to incorporate innovative construction methods into the CET curriculum. The attached questionnaire is needed to obtain feedback from you so I can assess the benefit of several different approaches

I appreciate your completing this questionnaire and will share my findings with you in seminar next semester.

Questionnaire

Project: Johnstown Flood Control Passive Rock Anchor Installation

1 Did you attend the presentation on this project in seminar on November 1, 2001?

Yes No

2 Please rate the following

Overall Quality of Presentation

1	2	3	4	5
Poor				Excellent

Quality of Visual Materials

1	2	3	4	5
Poor				Excellent

Quality of Presentation by Presenter

1	2	3	4	5
Poor				Excellent

Relationship Between Project Topic and Course Material

1	2	3	4	5
Poor				Excellent

How Interesting did you find the Presentation

1	2	3	4	5
Very Little				Very Interesting

Your Ability to Follow the Technical Aspects of the Presentation

1	2	3	4	5
Hard to Follow				Easy to Follow

Relative Amount of Knowledge you Gained During the Presentation

1	2	3	4	5
Learned Nothing				Learned a Lot

3 Do you think a lecture in class before or after the presentation would have improved your learning regarding this project? Yes No
Why or why not?
_____

4 If you can recall, mention one thing that was innovative about the rock anchors on this project
_____

5 Please provide any additional comments about the good or bad aspects of technical presentation such as this one in seminar.
_____
_____
_____
_____

Project: Kansai International Airport

6 Did you view the video on this project in soils lab? Yes No

7 Please rate the following

Overall Quality of Video Presentation

1	2	3	4	5
Poor				Excellent

Relationship Between Project Topic and Course Material

1	2	3	4	5
Poor				Excellent

How Interesting did you find the Project

1	2	3	4	5
Very Little				Very Interesting

Your Ability to Follow the Technical Aspects of the Project

1	2	3	4	5
Hard to Follow				Easy to Follow

Relative Amount of Knowledge you Gained by Watching the Video

1	2	3	4	5
Learned Nothing				Learned a Lot

8 Do you think the few items discussed in lab and class after watching the video improved your learning regarding this project? Yes No
Why or why not?
_____

_____

9 If you can recall, mention one thing that was innovative about the construction of this airport
_____

10 Please provide any additional comments about the good or bad aspects of video presentations such as this one in technical courses.
_____
_____
_____
_____
_____
_____

Project: Braddock Dam Construction

11 Did you attend the field trip to the Braddock Dam construction site on October 18, 2001?

Yes No

If NO, please indicate why not (check all that apply): _____ amount of time required;
_____ not REQUIRED by instructor; _____ not interested in project;
_____ Other (explain)_____

If NO, please skip Number 12, but complete Numbers 13 – 15.

12 Please rate the following

Overall Quality of Field Trip

1	2	3	4	5
Poor				Excellent

Overall Quality of Presentation by Site Personnel

1	2	3	4	5
Poor				Excellent

Quality of What You Saw During Site Visit

1	2	3	4	5
Poor				Excellent

Relationship Between Project Topic and Course Material

1	2	3	4	5
Poor				Excellent

How Interesting did you find the Project

1	2	3	4	5
Very Little				Very Interesting

Your Ability to Follow the Technical Aspects of the Project

1	2	3	4	5
Hard to Follow				Easy to Follow

Relative Amount of Knowledge you Gained by Visiting the Site

1	2	3	4	5
Learned Nothing				Learned a Lot

13 Do you think the handouts and aspects of the project discussed in class improved your learning regarding this project? Yes No
Why or why not?
_____

14 If you can recall, mention one thing that was innovative about the construction of this dam
_____

15 Please provide any additional comments about the good or bad aspects of field trips such as this one in technical courses.
_____
_____
_____
_____

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