

Bringing the Construction Jobsite to the Classroom

Mikael J. Anderson, MS, PE, General Building Contractor
California State University, Sacramento
Sacramento, California

Students often learn by doing, which is the reason construction management courses coincide with frequent jobsite visits. As class sizes continue to grow across the nation in the construction management programs, the number of students visiting jobsites on a regular basis increases. The larger class sizes visiting construction jobsite creates an added risk in terms of safety. Additionally, the learning objective for these jobsite visits to enhance the subject matter from the classroom lectures is reduced. The inexperienced students often do not know what they are observing on jobsites, and the larger class sizes compound this problem. By recording video from ideal construction projects, the instructor can pause, rewind, and fast forward as needed in order that all the students may equally learn the relevant details of the operations. Students can review the videos at their convenience for further study and in preparation for tests.

Key Words: Field Visits, Operational Analysis, Estimating, Scheduling, Site Logistics, Equipment, Production Rates

Introduction

Visits to construction jobsite on a regular basis are an essential part to many undergraduate construction management courses. From a teaching standpoint, regularly aligning the proper construction projects with the relevant subject matter being taught in the relative course that particular week can create a challenge. The enrollment in our construction management program has increased in triplicate over the past 5 year period. This increased enrollment requires more lab sections in order to maintain the integrity of small class sizes for construction jobsite visits. These added lab courses require additional faculty resources, which cost the university more time and money. The weekly lab sessions must be offered at the same day and same time each week in order to avoid conflicts with the student's class schedules. The weather, vicinity of the project, and timing of the operation being observed create additional challenges to the teaching objective for the lab course.

The fundamental reason that construction jobsite visits are needed for related courses is that the students can begin to visualize the concepts being taught. Students must be able to understand the steps and processes of an operation in order to adequately estimate and schedule the materials, labor, and equipment. After 10 years of teaching college level undergraduate courses, I have noticed three types of students that typically enroll into construction management programs. The first types of students are those that come back to school after working in the construction trades for many years. Although these students' specific experiences are useful towards their success in the program, they still need to visit jobsites to expand their knowledge base with many other operations. The second types of students are those that intern part-time as project engineers in the construction industry while they work towards their undergraduate degree. These working students tend to appreciate the efforts put forth by the professor in selecting the appropriate jobsites, and they bring their own experiences to the classroom. The third types of students come to the universities directly from high school and do not have any construction experience. These inexperienced students are often overwhelmed by the magnitude

of the work on the construction site and tend to not know what details they are looking at in terms of the operation being observed.

The purpose of this paper is to share an innovative use of technology as accomplished with construction videos and time lapse still photography, which are specific to lecture topics begin discussed in the classroom for that particular week. When discussing labor-paced operations, a drywall or framing operation specific video can be shared. Equipment paced operations, such as steel erection, asphaltic concrete paving, or mass grading can also be taught from these video archives. The videos are interactive, allowing students to pause, rewind, and review in more depth on their own study time. Homework assignments can be developed through the videos by requiring students to develop production rates for an operation. These actual production rates can then be compared with the theoretical textbook production rates, such as equipment manuals or RS Means.

The new knowledge being presented is the method to which these are recorded specific to an actual jobsite operation. Traditionally professors have been able to purchase published construction videos, of which provide students with a “general” understanding of various construction operations. These standard store bought videos rarely provide the specific data that can be learned from an actual jobsite tour. Many construction management programs supplement the classroom lectures with construction jobsite tours to supplement the course being taught. As class sizes increase, the objective of these actual jobsite tours is often lost. Providing these job specific interactive videos allows all students in larger classes to equally learn the field visit objective in a controlled classroom environment.

The class sizes for the lab sessions are limited to fifteen students due to safety protocols on the construction jobsites. Students are required to provide formal lab reports after each jobsite visit. Upon review of these lab reports for the past 5 years, it becomes obvious that many of the students are missing the main topics of each jobsite visit. The students are now required to submit their hand-written field notes with their formal lab report in order to encourage the students to pay more attention during the jobsite tours. Construction sites are busy and loud with workers and equipment, thus making it difficult for fifteen students to each hear the details of the jobsite visits. The feedback in terms of lab reports substantiates the conclusion that the students are not learning the full objective of the lab sessions. The alternative would be to bring the construction site to the classroom, where specific operations can be discussed and analyzed in a controlled manner by the professor.

Getting Started

Expensive high tech equipment is not necessary to produce quality construction videos. A person can accomplish their goals for the videos by using ordinary handheld digital video and digital still cameras. There is a learning curve when using the editing software for the videos, depending on the level of the end user. The most important element is that the video is recorded in a raw, digital format. The DVD video camera compresses the videos upon initial recording, which lowers the quality of the raw video. The least expensive method to record in an uncompressed, true digital format is with the mini-DV media tapes. The mini-DV tapes do not sacrifice video quality, so that the best image is received upon editing the construction video.

The video editing should take place on a desktop computer equipped with an aggressive video card, large hard drive, and a DVD burner. Sixty minutes of raw video can take up to 15 GB of space on a hard drive, thus quickly filling up a standard 200 GB hard drive fairly quickly. The following table lists the minimal equipment needed to get started on recording and editing construction videos:

Video Equipment

Item	Description	Approximate Cost
1	Digital Video Camera (mini-DV), high definition, widescreen, 1080i format	\$1300
2	Digital Still Camera	\$300
3	Video Editing Software	\$125
4	Tripod, Mini-DV tapes and blank DVD's	\$100

Method

There are several methods for bringing the construction jobsite to the classroom. Educational construction videos can be purchased through many available resources. These videos can be shown in the classroom and paused at the professor's discretion for further discussion of the specific operation. Project managers from local jobsites could come to the university as guest lecturers and discuss their current construction projects with the students. The professor can video tape specific construction operations, in effect building a video library for the students to review at their own convenience. Due to costs and logistics, the best strategy was to make videos in-house from local construction jobsites.

Inspired by the increased use of technology by students during group presentations, it was decided to use several sources for collecting information from construction jobsites. The primary method was video taping the operations. Secondary techniques involve the use of time lapse photography. Traditionally, still photos remain a common method for recording details of the project. Interviewing the project manager and project superintendent is a top priority in order to understand the details of the project, such as the estimate, schedule, site logistics, coordination of the work, and project drawings and specifications.

Time Lapse Video

Time lapse photography provides an effective way of portraying an entire operation in fast forward mode. Many digital video cameras have the capability of capturing still photos at regular intervals. Most digital still cameras come with built-in timers which can also be used to take photos at regular intervals. The camera must be mounted on a tripod in a location on the jobsite that will allow the entire construction operation to be captured from start to finish. Typically the timer is set to record still photos every 5-minutes from a fixed viewpoint, although any reasonable interval that captures the relevant detail of the operation will suffice. The still photos are downloaded in chronological order into a standard video editing program. The editing program assigns a time element to each photo which allows the still photos to be transformed into a time-lapse video. This method allows the students to properly evaluate a multi-day operation over the course of less than 10-minutes. The students can easily develop crew balance charts used in their analysis of the operation.

The first example of the use of a time lapse video was from a student volunteer project at the university. The project was preplanned and implemented by the construction management student body. The faculty provided project oversight and assisted with labor on the project as directed by the student project manager. The video camera was placed at the best vantage point to capture the sidewalk excavation, setting formwork and reinforcing steel, and concrete placement and finish. Still images were taken at 1-minute intervals and made into a video. The following images were taken from the video during the concrete pour to illustrate this time lapse video technique. The full version of the video was 5-minutes in length for a 2-day operation.



Figure 1: Time Lapse Video – Concrete Sidewalk Placement



Figure 2: Time Lapse Video – Concrete Sidewalk Placement



Figure 3: Time Lapse Video – Concrete Sidewalk Placement



Figure 4: Time Lapse Video – Concrete Sidewalk Placement

The second example of the use of a time lapse video was taken from a California State Highway Emergency Bridge Repair project. The bridge was incapacitated during the explosion of a gasoline tanker truck. The damaged portion of the bridge served as a major traffic route for a large metropolitan area. The emergency work was completed in 24-hour shifts over a 2 week time period. The portion of the work on the time lapse video shows erection of the falsework for the bridge deck through the concrete placement. (Caltrans, 2007 – I880 Bridge Repair)

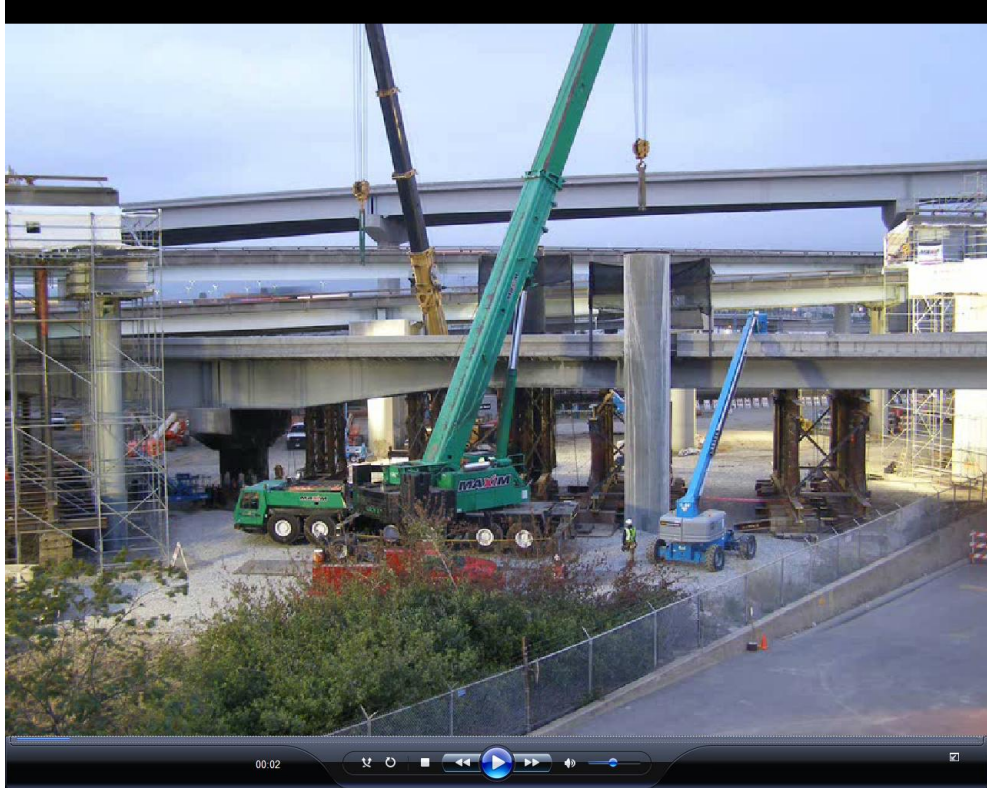


Figure 5: Time Lapse Video – Emergency Highway Bridge Repair (Columns)

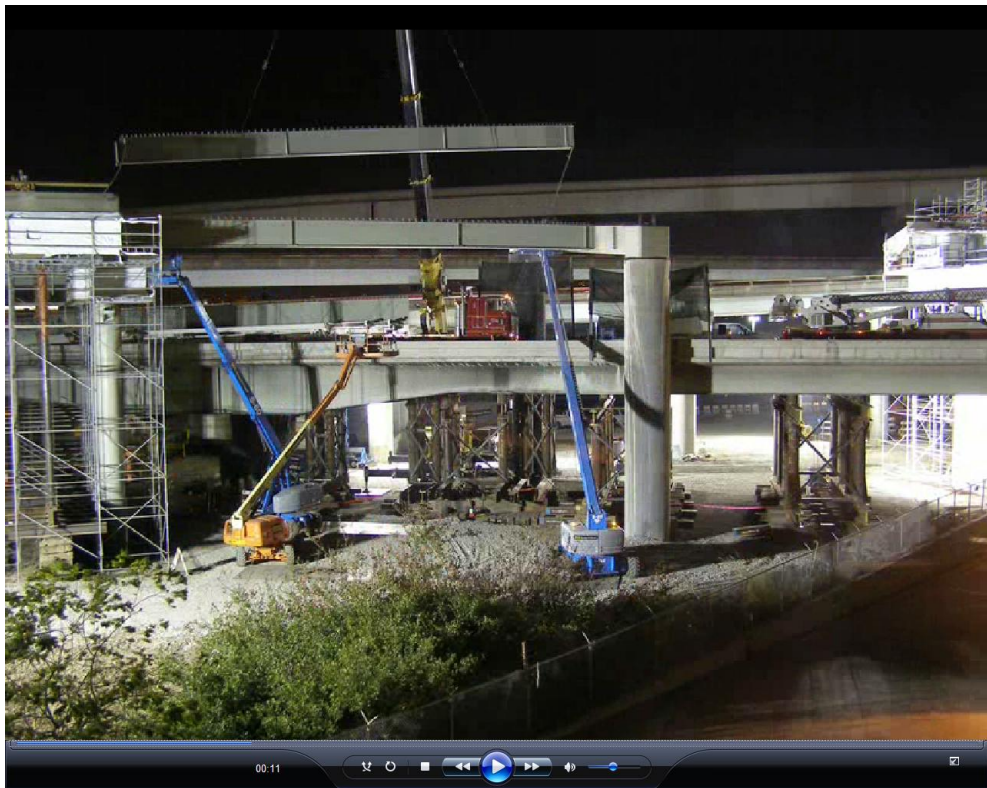


Figure 6: Time Lapse Video – Emergency Highway Bridge Repair (Steel Girders)

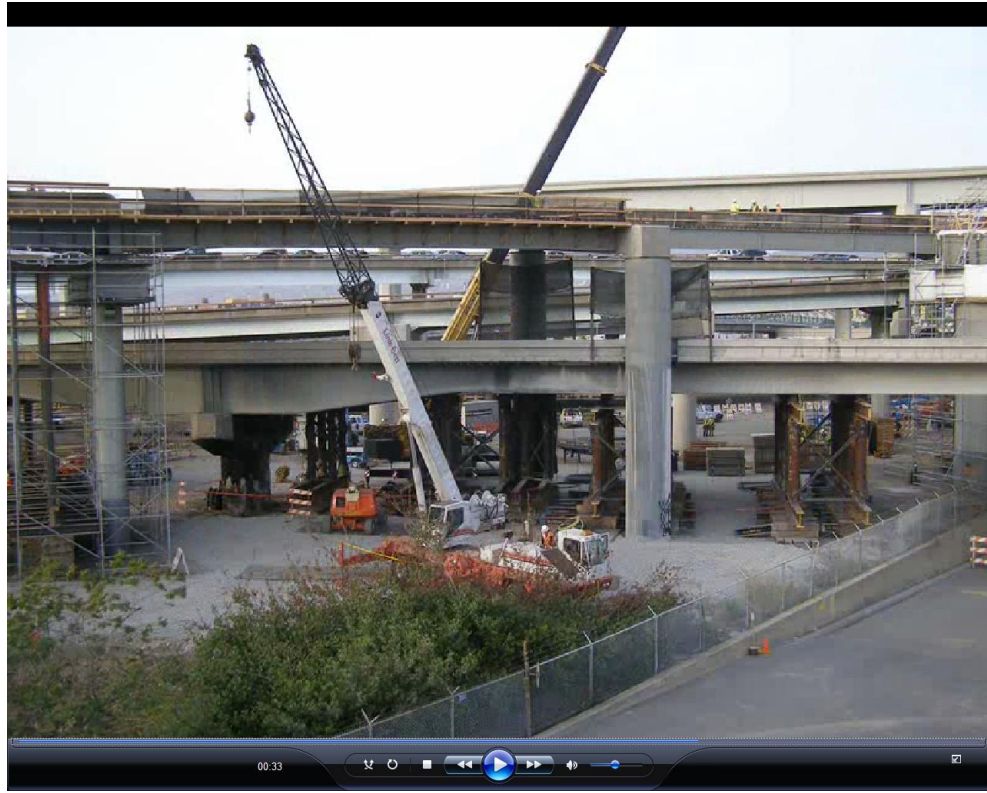


Figure 7: Time Lapse Video – Emergency Highway Bridge Repair (Falsework)



Figure 8: Time Lapse Video – Emergency Highway Bridge Repair (Place Concrete)

Video Footage

Recording raw data from the construction jobsite requires a higher level of preplanning as compared to time lapse videos. Assigning an inexperienced student to record construction operations often creates more work when it comes time to edit and splice the video into a legible format for the classroom setting. Once the objective of the jobsite visit is determined, then the planning of the work can begin.

Case Study: As an example, a highway paving operation is being analyzed. The objective has been defined as determining production rates and costs for the entire paving operation. The contractor must “buy,” “haul,” and “place” the asphalt material for this operation. Experience states that the following sub-operations must be recorded to raw video:

Paving Sub-Operations

Item	Description	Comments
1	Asphalt plant production rates (material supplier)	Other paving projects in area affect plant production
2	Trucking company cycle times (bottom dumps)	Load → Haul → Dump → Return
3	Paving crew production rates	Paver speed, lift thickness, number of passes, and width
4	Non-linear paving work	Driveways, transitions, and intersections
5	Compaction roller production rates	Number of passes required to meet project specifications

Although each of these operations can easily be video taped, the details of the project must be discussed with the contractor in order to obtain accurate production rates. A site map or general plan of the project will detail the limits of the work. The project specifications and drawings will provide paving section details and compaction requirements for the asphalt. The labor and

equipment must also be noted for the operation to produce an accurate cost analysis. The specifics of the paving operation were noted at the jobsite and recorded as shown below for further study:

Paving Production Rates

Item	Description	Production Rates
1	Trucking – 11 double bottom dumps	24 tons AC / truck, 9 loads / truck / day
2	Asphalt Plant – 600 tons/hour capacity	Contractor requires 2400 tons/day
3	Paver – widths from 10'0" to 30'0"	Speeds up to 8 mph, actual = 70 to 150 feet/min
4	Compaction – 3 rollers full-time	Breakdown roller, Pnuematic roller, and Finish roller

Equipment Spread

Equipment	Model/Type	Quantity
Paver	TEREX CR-552RX	1
Roller	Ingersoll Rand DD-110	2
Roller	CAT PS-360B	1
Tack Coat	Tanker Truck with spreader bar	1
Semi-truck	Double Bottom Dumps	11
Skip Loader	CASE 416D	1
Pick-up Truck	Ford F150	2

Labor Crew

Equipment	Quantity
Foreman	1
Superintendent	1
Paving Operator	1
Roller Operator	3
Loader Operator	1
Asphalt Rakers	2
Laborers	1

Video Editing: The editing program used for this example was Pinnacle Studio Plus, Version 11. The video editing programs are organized in a timeline format. The top header shows the real time for the video. The first row below the timeline header represents the video clips and still photos. The second row represents the sound to the video. The third row is where a person can add text overlays to the video. The fourth row allows a user to add background sound, such as self-narration to coincide with the video in a learning atmosphere. The last row is where background music can be added to the video.

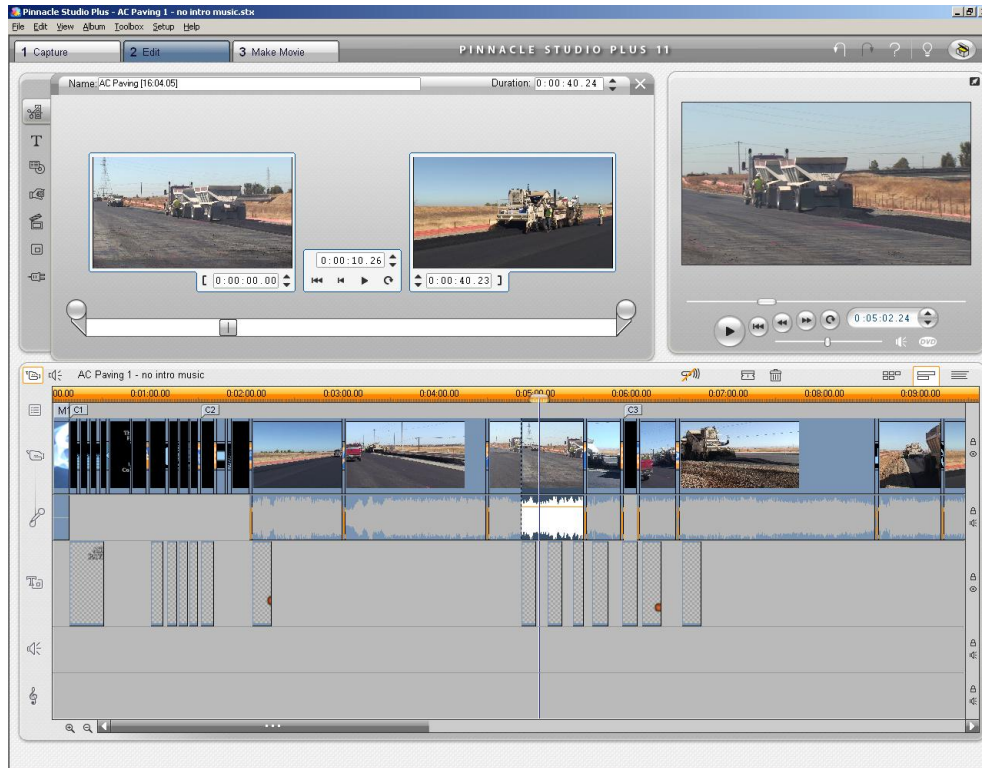


Figure 9: Video Editing Program – SAMPLE

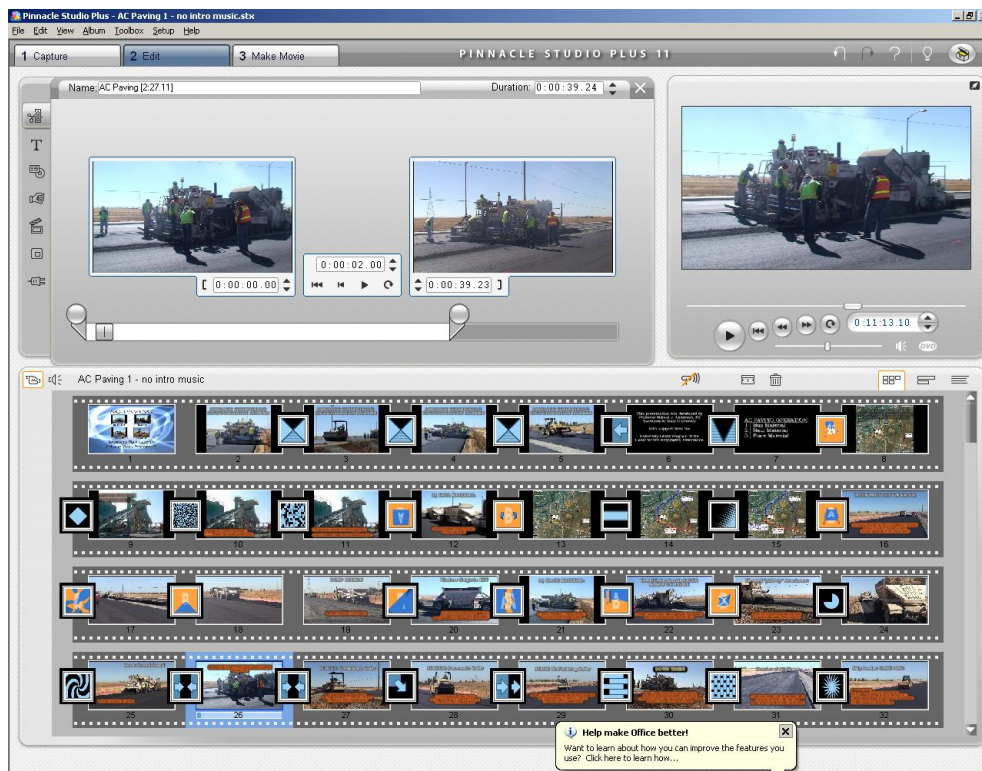


Figure 10: Video Editing Program – SAMPLE

Although there is a learning curve associated with the editing programs, it can become very easy to manipulate the video to produce a professional outcome. Menus can be added with scenes and transitions to give the video an overall Hollywood effect. The final stage involves burning the video onto standard DVD discs for distribution to the students. A few examples taken from the final version of the asphalt paving video are shown below:



Figure 11: Asphalt Paving Video – SAMPLE CLIPS



Figure 12: Asphalt Paving Video – SAMPLE CLIPS



Figure 13: Asphalt Paving Video – SAMPLE CLIPS



Figure 14: Asphalt Paving Video – SAMPLE CLIPS

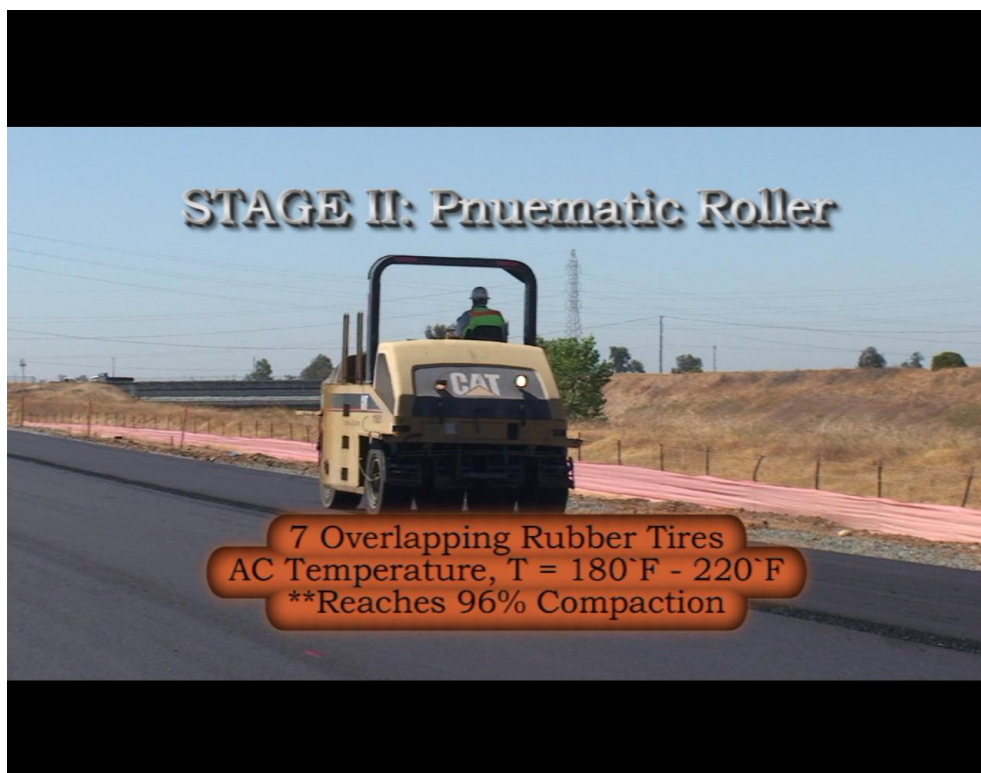


Figure 15: Asphalt Paving Video – SAMPLE CLIPS



Figure 16: Asphalt Paving Video – SAMPLE CLIPS

Results

Recording video for the various construction operations as they relate to the appropriate construction management courses will take many years. Several hours of raw video have been recorded during the past three months for heavy civil equipment operations. These video have transitioned into the editing phases and have been presented to students for comment. The students have provided positive feedback on the construction videos. The ability to replay, pause, rewind, and fast forward the videos have proven to be useful for the students as they review subject matter in preparation for homework assignments and tests. Most importantly, the students' time for the lab sessions is focused appropriately to the specific operation being discussed in the classroom. There are no wasted jobsite visits due to timing of the operation, location of the work, or weather delays. Some contractors do not want the video released to students for liability reasons. The videos can be checked out of a reference library or posted on the course website with the proper blockers to protect the copyright requests of all parties involved.

Discussion

Supplementing construction management lab courses with carefully scripted jobsite videos and time lapse photography has been shown to serve as a more focused method for students to learn the specific details to an operation. Lab sessions can remain larger in size, without compromising jobsite safety and content of the operations being analyzed. The rewards in terms of learning objective will outweigh the work required to prepare these intricate video libraries.

The time lapse videos require the least amount of effort to produce. Collecting the still photos is a matter of setting up a digital camera on a tripod. The still photos are then downloaded into a program that produces an instant video of the operation being analyzed. The full length videos require much more work in cutting and editing the video to match the subject topic being taught, including adding self-narration, still photos, and text descriptions. Both methods serve their purpose quite well in the college learning environment.

This paper is not being offered as research, but merely to share an innovative method using technology to manage larger groups of students for construction jobsite tours. The actual visits to the construction jobsites can be reduced, but need not be eliminated. There is still a lot to be said for students getting out to the jobsite to view the construction process firsthand.

References

California Department of Transportation (Caltrans – 2007). I-880 Emergency Bridge Repair Project. *Time Lapse Video excerpts*. San Francisco, CA.

Pinnacle Systems, Inc. Studio Plus Version 11. Video Editing Software. 2007.

Contractors shown in video clips: DeSilva Gates Construction. Granite Construction Company.