

Incorporating the Use of Job Cameras in a Construction Planning and Scheduling Course

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One of the toughest hurdles to overcome in construction education is the varying levels of construction field experience among undergraduate students. While an internship is a common construction management requirement, it is often completed after classes in planning and scheduling. This poses a challenge for the modern construction educator concerning course design. If the instructor begins discussing activities that the inexperienced student has never seen, the student may fall behind classmates. This paper presents a unique methodology for overcoming this challenge. A semester-long term project required undergraduate planning and scheduling students to view several progress photos using current Job Camera technology. A survey was administered to three semesters of students exposed to the teaching methodology in order to assess the student's ability to identify and sequence activities before and after being exposed to the teaching methodology. Survey results indicated that 88% of the respondents reported an improvement in their ability to both identify and sequence activities.

Keywords: Construction Planning and Scheduling, Job Cameras, Progress Photographs

Introduction

Ever since the National Education Association established the Department of Visual Instruction in 1923, educators have been receiving support to incorporate audiovisual instruction media into their classrooms (NPBA, 2004). In the realm of construction education, this has led to great resources such as instructional videos on surveying, excavation, and building to name a few. Students with little or no practical experience are able to overcome this deficiency by studying the necessary procedures.

Just like instructional videos, Job Camera technology enables students to study the construction of entire projects one photograph at a time. Modern Job Camera technology relies on a remote camera placed at the jobsite that transmits high-resolution photographs through a cell tower to a central data center where they are archived and placed on a server (see Figure 1). Students are then able to access the photographs from any computer with an Internet connection. In order to maneuver through the multitude of archived photographs, the data center provides an interface.

The Oxblue Corporation is one organization that rents Job Cameras and provides a data center with an interface (see Figure 2). The interface enables the user to jump around to different photographs in the archive by clicking on different calendar days and selecting different times of the day. Another feature allows the user to zoom in to a portion of the photograph and hold that zoom while advancing the photographs. This allows the viewer to concentrate on the same area for multiple photographs. These advanced interface functions separate the use of Job Cameras from mere banks of photographs or time-lapse videos.

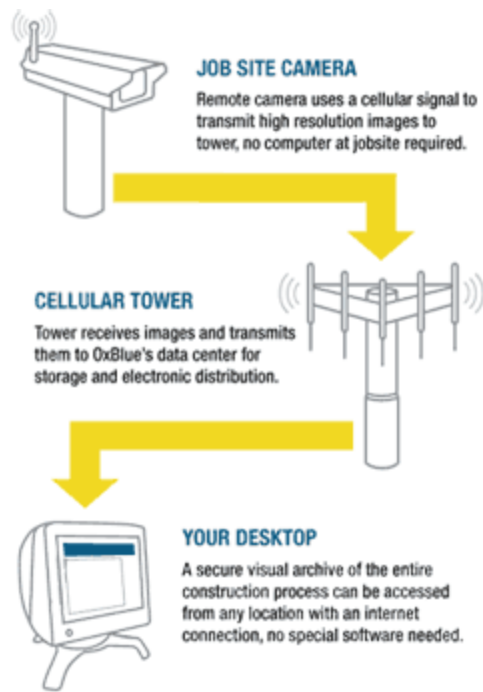


Figure 1: How Job Cameras Work (Oxblue Corporation, 2005)

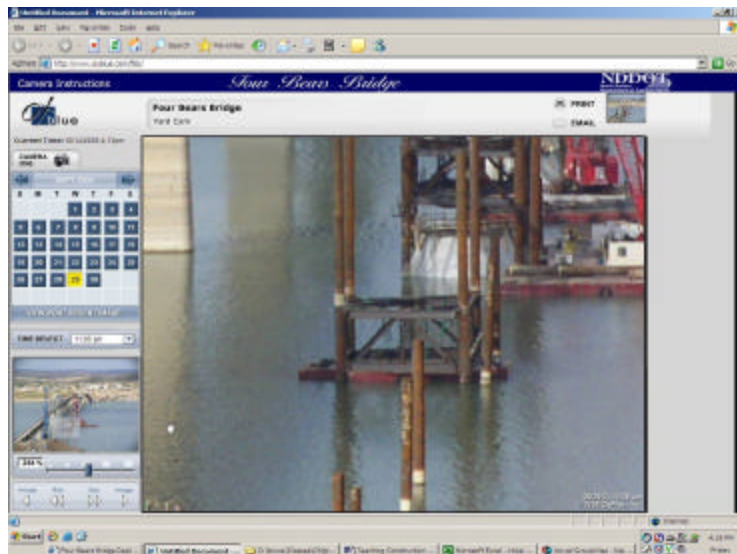


Figure 2: The Oxblue Corporation's Job Camera Interface (2005)

Since job experience is not a pre-requisite to the course, students may not have a frame of reference when discussing construction activities. To offset this problem, a unique teaching method was utilized in a construction planning and scheduling course. Job Camera technology was incorporated into the course to bring the students to a common ground of understanding concerning construction field operations.

The remainder of this paper presents how the instructor incorporated the Job Camera teaching methodology into an undergraduate planning and scheduling course through a semester-long term project, discusses how the instructor has tried to assess the effectiveness of the methodology through a short survey, examines the results of the survey, and poses future directions.

Job Camera Teaching Methodology

Background of Term Project

The term project in the planning and scheduling course shifted in recent years from a two-week project at the end of the semester to a semester-long project that incorporated and applied class material as it was learned. The primary text used for the course was *Construction Project Planning and Scheduling* by Charles Patrick (2004). The term project followed Patrick's basic steps in creating a network model including: defining activities, putting activities in order, diagramming the activities in network format, determining activity durations, and calculating the schedule. The term project followed the remainder of the course that included transitioning from activity on arrow to precedence networking, creating a cost distribution graph, and scheduling the project using three computer programs. The goal of the term project was to tie the text, class discussion, and real world example together for an optimum learning experience.

Term Project Assignments

The eight term project assignments outlined below were used for three semesters on three different projects: a Wisconsin clinic (Fall 2004), a Texas clinic (Spring 2005), and a North Dakota bridge (Fall 2005). These term project assignments were given in addition to the typical homework problems such as drawing networks and working through calculations. A table listing the term project assignments and their point values was provided in each syllabus (see Appendix A).

Term Project Assignment Number One: Define the Activities

The first term project assignment required the students to visit the provided project website, view the available pictures, and identify fifty construction activities. Students spent an average of 4 hours reviewing the pictures to arrive at the fifty activities. Students then entered the activities into an Excel spreadsheet.

Students were encouraged to search the Internet for other project pictures and information. These sites were very helpful because they explained the impact on the community and provided secondary project information such as the actual milestone schedule and budget information. The Four Bears Bridge website, for instance, provided by the North Dakota Department of Transportation and Oxblue Corporation, included historical photographs of the previous two bridges. These photographs provided the student with a feel for construction methods and their improvement over the years. Figure 3 below shows the sheet piling that had to be installed

before concrete could be poured in pier 2 of the previous bridge in 1955. Figure 4 shows the constructor's modern day approach where a concrete cofferdam was formed and poured on a barge at the shore before it was transported to its final location.

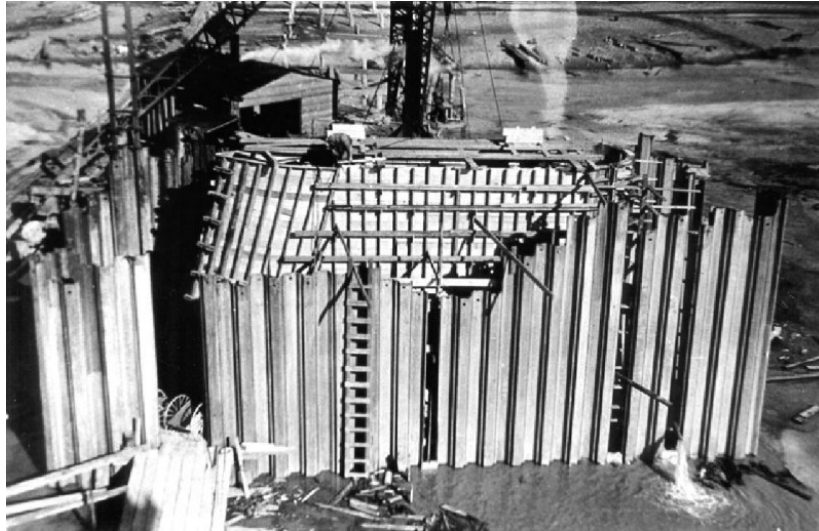


Figure 3: Pier 2 of the second Four Bears Bridge in 1955 (NDDOT, 2005)



Figure 4: Pier 3 of the third Four Bears Bridge in 2004 (NDDOT, 2005)

This first assignment worked well because students were forced to narrow vast quantities of information gathered from the pictures into activities of two or three words, following the verb plus subject format instead of entire sentences. Students also had to decide their level of detail and be consistent throughout the fifty activities. Upon collecting and discussing the first list of fifty activities with the students, the instructor then provided a common list of activities to each

student. This list contained as many of the students' original activities as possible so they would take ownership of the list. The left column of Appendix B shows 24 of the 50 activities the students created after viewing photographs of the Four Bears Bridge project.

Term Project Assignment Number Two: Put the Activities in Order

Term project assignment number two required the students to provide 1-3 activities from the original fifty activities that immediately preceded each of the activities. The right column of Appendix B shows the activities that immediately precede the original activities. Like many scheduling and project management authors (e.g., Mubarak, 2005; Stevens, 1990), the instructor used activity and immediate predecessor activity (ACT/IPA) charts to teach logic. Given the list of activities already agreed upon, the student filled in the predecessors to each activity. This assignment required the students to return to the Job Camera photographs to determine the contractor's sequence of events.

Figures 5-7 show three screen shots of the Four Bears Bridge using the Oxblue Corporation's Job Camera interface (2005). Figure 5 below shows a pier location that is about to receive its cofferdam base. Figure 6 shows the same location a day later at the same time.

If the student just clicked through the photographs by day, he or she would see the cofferdam magically appear somewhere between these two days. However, because these photographs were taken every ten minutes on this project, the student was able to pull up 9:10 am on September 30 to see a boat pushing a barge and cofferdam base into the proper location (see Figure 7).

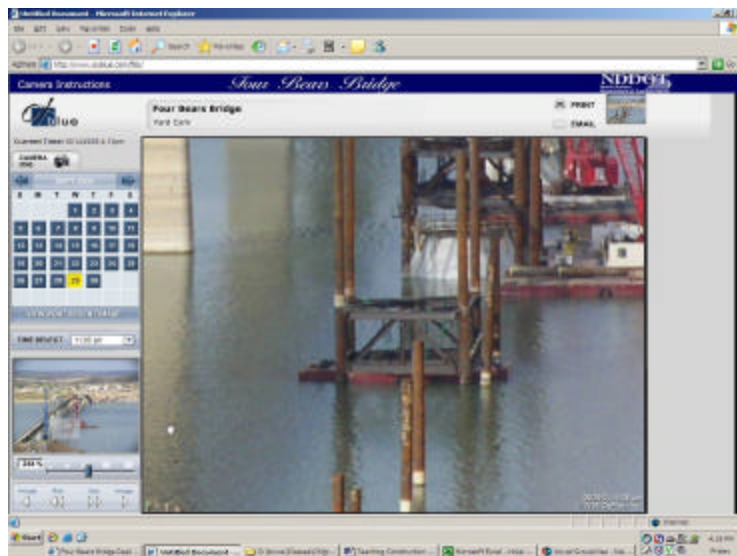


Figure 5: Four Bears Bridge photograph taken 9/29/04 at 11:06 am (Oxblue Corporation, 2005).

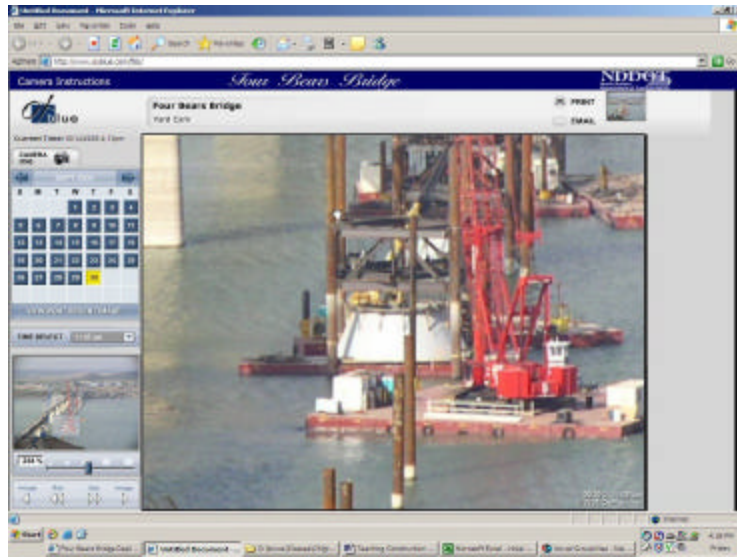


Figure 6: Four Bears Bridge photograph taken 9/30/04 at 11:05 am (Oxblue Corporation, 2005).

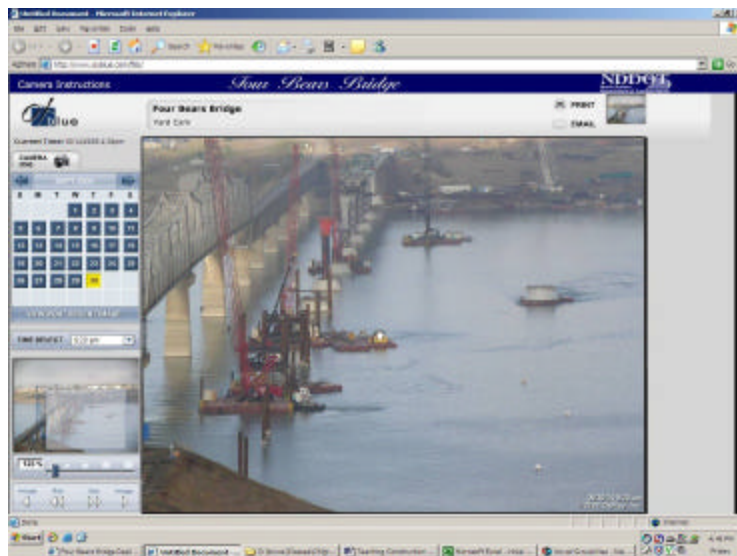


Figure 7: Four Bears Bridge photograph taken 9/30/04 at 9:10 am (Oxblue Corporation, 2005).

Term Project Assignment Number Three: Diagram the Activities

As the classroom instruction shifts from logic statements to Activity-On-Arrow (AOA) diagrams, students were asked to complete an AOA diagram for the term project. While calculations were not required, the student was asked to leave room within the diagram for the calculations at the end of each activity. After sketching many relationships on scrap paper, students transferred the diagram to 17"x22" graph paper.

Term Project Assignment Number Four: Determine Activity Durations

Term project assignment number four required students to provide durations for activities. This assignment helped students comprehend such concepts as lead, lag, and concurrent activities. Another benefit was that it allowed the instructor time to review and grade the logic in the AOA diagrams. Once the students turned in the durations, the instructor returned a list of common durations for each activity and the graded AOA diagrams.

Term Project Assignment Number Five: Calculate the Schedule

Once the students received the graded AOA diagram, they were able to make logic corrections. Working with a common list of durations, the students then had to perform a forward and backward pass on their corrected AOA diagram. This included the calculations for total float and free float. Students also had to highlight the critical path and return the network back to the instructor.

Term Project Assignment Number Six: Repeat Assignments 3 and 5 Using the AON Method

The classes transitioned to the Activity-On-Node (AON) technique using term project number six. It required students to apply the knowledge by re-drawing their AOA diagrams using the AON technique. Again, the students used 17"x22" graph paper and provided calculations.

Term Project Assignment Number Seven: Computer Applications

Assignment number seven required the students to input the activities, durations, and relationships into MS Project, Primavera SureTrak, and Primavera Project Planner. Students were required to print the Gantt chart for each program and provide a comparison paper on the advantages and disadvantages of each program. They also had to explain any differences between their hand calculations and those on the computer.

Term Project Assignment Number Eight: Create Project Notebook

The last term project assignment was to organize all of their material into a term project notebook. Students were required to reflect back on the experience and explain what they had learned in a one-page typewritten cover page.

Student Evaluations of Job Camera Teaching Methodology

In order to determine the effectiveness of the teaching methodology, the instructor created a six-question survey. Because so many of the students were still in the program, the instructor decided to administer the survey in the classroom and over the phone. Once the survey acquired approval from the instructor's Institutional Review Board, the instructor attempted to contact all 43 of the affected students.

One possible area of concern questions the validity of the phone survey because of perceived bias specifically due to the instructor verbally providing the survey to students. In hindsight, the instructor should have administered a blind electronic or paper survey to the students to limit such bias.

The instructor achieved a 79% return rate by collecting surveys from 34 out of 43 respondents. As one can see in Appendix C, the survey asked the student which project they had been exposed to (question 1) and the student's practical construction experience (question 2). The survey then asked the student to rate their ability to identify activities necessary to construct their project before taking the course (question 3) and after taking the course (question 4). The remaining two questions asked the student to rate their ability to sequence those activities before taking the course (question 5) and after taking the course (question 6). The students were then given a space to provide additional comments.

Results of Student Evaluations

Table 1 indicates that 19 out of 34 respondents (55.9%) had more than 1 year of general construction experience before taking CMgt 3355 Construction Scheduling. Of these 19 students, 50% felt like they could identify 1-50% of the activities before studying the Job Camera photographs.

Table 1
Experience by Identification Confidence Level BEFORE Studying Job Camera Photographs

			Percent of Activities Student Felt Confident in Identifying BEFORE Photographs				Total
			none	1-50%	51-75%	>75%	
General Construction Experience (1 sum = 3 months)	No Experience	Count Column %	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
	1 week to 3 months	Count Column %	0 0.0%	5 25.0%	1 8.3%	0 0.0%	6 17.6%
	3 months to 1 year	Count Column %	0 0.0%	5 25.0%	4 33.3%	0 0.0%	9 26.5%
	more than 1 year	Count Column %	0 0.0%	10 50.0%	7 58.3%	2 100.0%	19 55.9%
Total		Count Column %	0 100.0%	20 100.0%	12 100.0%	2 100.0%	34 100.0%

Table 2 indicates that 20 of the 34 respondents (59%) responded that they could identify 75% or more of the necessary activities to construct their project after studying the Job Camera photographs.

Table 2
Experience by Identification Confidence Level AFTER Studying Job Camera Photographs

			Percent of Activities Student Felt Confident in Identifying AFTER Photographs				Total
			none	1-50%	51-75%	>75%	
General	No Experience	Count Column %	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
Construction Experience (1 sum = 3 months)	1 week to 3 months	Count Column %	0 0.0%	1 100.0%	4 30.8%	1 5.0%	6 17.6%
	3 months to 1 year	Count Column %	0 0.0%	0 0.0%	4 30.8%	5 25.0%	9 26.5%
	more than 1 year	Count Column %	0 0.0%	0 0.0%	5 38.5%	14 70.0%	19 55.9%
	Total	Count Column %	0 100.0%	1 100.0%	13 100.0%	20 100.0%	34 100.0%

When the author analyzed experience by sequencing confidence level before and after studying the Job Camera photographs, he found that the tables were identical to the previous two. In other words, the respondents provided the same responses for questions 5 and 6 as they did for 3 and 4.

Several of the respondents, 20 out of 34 (59%), provided additional feedback in the comment section of the survey. Most of the comments were suggestions such as providing pictures that encompass the entire project from at least two vantage points inside and outside of the structure from the ground up.

Conclusions

Student experiences in construction management programs range from zero experience to completed internships. This presents a challenge to the modern construction educator.

This paper demonstrated a unique teaching methodology of incorporating Job Camera technology into an undergraduate planning and scheduling course that aided the students in understanding activity identification and logic. Survey results indicated that 88% of the respondents reported an improvement in their ability to both identify and sequence activities after studying Job Camera photographs.

Discussion and Recommendations

The author sees great potential in this area of study. For instance, the instructor could examine whether there was a significant difference between the mean test scores of a control group of students that were not exposed to the technique versus an experimental group that was exposed. He could also examine the difference between scores based on the type of project.

In recent semesters, the instructor has made several improvements to the term project. For example, the Fall 2006 students had access to the plans and specifications for a local Walgreens store as well as Job Camera photographs of several different stores being built throughout the United States. In addition, the contractor that built the local store provided the actual schedule. Thus, the students were able to compare their computer-generated schedules to the actual one used on the project.

Another improvement the instructor has made is to require the students to view several projects and discuss common methods as options rather than focusing on how the contractor in the Job Camera photographs constructed the project. It is hoped that this method will emphasize the many possible logic scenarios available to project planners.

In addition to providing a term project for a planning and scheduling course, the author sees potential applications in other construction related courses such as estimating, project administration, and project control. Estimators could perform a material takeoff, assign a crew, and estimate output per day. They could then use the Job Camera photographs to see how long it actually took. In addition, because Job Camera photographs provide the date of the photograph, the information may be used to complete Construction Daily Reports and update schedules.

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Appendix A

Term Project Assignments (included in syllabus)

Component	Specifics	Due Date	Points
#1 Define the Activities	Review the Job Camera photographs to arrive at 50 activities.	8/31	5
#2 Put the Activities in Order	Create an ACT/IPA chart listing the activities and their immediate predecessors based on given logic.	9/7	10
#3 Diagram the Activities	Draw an activity on arrow (AOA) diagram in pencil on 17" x 22" graph paper following proper conventions. The diagram shall have a title block and shall be folded into fourths so that it will be 8.5" x 11".	9/21	15
#4 Determine Activity Durations	Update the ACT/IPA chart with a column for durations.	9/28	15
#5 Calculate the Schedule Using the AOA Method	Create a new AOA diagram with corrections. Complete a forward and backward pass and note total float and free float. Again, use 17" x 22" paper folded into fourths.	10/5	15
#6 Repeat Assignments 3 and 5 Using the AON Method	Draw the schedule using the precedence diagramming method. Complete a forward and backward pass and note total float and free float. Use 17" x 22" graph paper folded into fourths.	11/2	15
#7 Computer Applications	Print out the schedule in MS Project, Sure Trak, and P3 (Gantt). Provide a one page cover sheet comparing the three software packages.	12/7	20
#8 Project Folder	Organize the preceding items in a folder and insert it in the course notebook. Include a table of contents for the project folder.	12/14	5
		Total	100

Appendix B

Example of Term Project Assignment #1 Define Activities and #2 Sequence Activities Four Bears Bridge ACT/IPA Chart with 24 out of 50 Activities

ACT	IPA
Receive notice to proceed	-
Order Cranes	Receive notice to proceed
Order Steel	Receive notice to proceed
Order Barges	Receive notice to proceed
Clear Embankment	Receive notice to proceed
Cut access roads	Clear Embankment
Drive shore sheet piles	Clear Embankment
Deliver Cranes	Order Cranes
Deliver Steel	Order Steel
Deliver Barges	Order Barges
Survey casting building	Clear Embankment
Layout casting building	Survey casting building
F/R/P Footings/SOG	Layout casting building
Erect casting building	F/R/P Footings/SOG
Layout piles	Receive notice to proceed
Drive 2 piles	Layout piles, Deliver Crane, Deliver Steel
Set/Raise frame	Drive 2 piles
F/R/P Cofferdam Base	Deliver Barges
Transport Cofferdam Base	F/R/P Cofferdam Base
Set Cofferdam Base	Set/Raise frame, Transport Cofferdam Base
Drive 13 Diagonal Piles	Set Cofferdam Base
R/P Pier Base	Drive 13 Diagonal Piles
Disassemble frame	R/P Pier Base
R/F/P Pier Column	Disassemble frame

Appendix C

Job Camera Effectiveness Survey

The following short survey is an attempt to find out if viewing Job Camera photographs had an impact on your ability to identify and sequence activities. Please circle the best answer and provide any comments at the bottom of the sheet.

1. Which of the following semesters were you enrolled in CMgt 3355 Construction Scheduling?
 - A. Fall 2004 Term Project: Madison, WI Clinic (from steel on, pre-cast, EPDM roof, brick)
 - B. Spring 2005 Term Project: East Texas Clinic (ground up, steel, EIFS)
 - C. Fall 2005 Term Project: Four Bears Bridge (cofferdams, piers, bridge deck)

2. Which of the following best describes your level of general construction experience *before* taking CMgt 3355 Construction Scheduling? 1 summer = 3 months, so 4 summers = 1 year.
 - A. No experience
 - B. 1 week to 3 months
 - C. 3 months to 1 year
 - D. more than 1 year

3. Which of the following best describes your ability to identify activities required to complete this type of project *before* viewing the Job Camera photographs?
 - A. I would not have been able to identify any of the required activities.
 - B. I would have been able to identify 1-50% of the required activities.
 - C. I would have been able to identify 51-75% of the required activities.
 - D. I would have been able to identify 76% or more of the required activities.

4. Which of the following best describes your ability to identify activities required to complete this type of project *after* viewing the Job Camera photographs?
 - A. I would not have been able to identify any of the required activities.
 - B. I would have been able to identify 1-50% of the required activities.
 - C. I would have been able to identify 51-75% of the required activities.
 - D. I would have been able to identify 76% or more of the required activities.

5. Which of the following best describes your ability to put the activities in correct sequence for this type of project *before* viewing the Job Camera photographs?
 - A. I would not have been able to sequence any of the required activities.
 - B. I would have been able to sequence 1-50% of the required activities.
 - C. I would have been able to sequence 51-75% of the required activities.
 - D. I would have been able to sequence 76% or more of the required activities.

6. Which of the following best describes your ability to put the activities in correct sequence for this type of project *after* viewing the Job Camera photographs?
 - A. I would not have been able to sequence any of the required activities.
 - B. I would have been able to sequence 1-50% of the required activities.
 - C. I would have been able to sequence 51-75% of the required activities.
 - D. I would have been able to sequence 76% or more of the required activities.

Student Comments:
