

**2006-1862: PROJECT MANAGEMENT TRAINING AND CERTIFICATION FOR A  
PUBLIC SECTOR ENGINEERING ORGANIZATION**

**John Kuprenas, University of Southern California**

**Elhami Nasr, California State University-Long Beach**

## **Project Management Training and Certification for a Public Sector Engineering Organization**

As engineers progress through their careers, many engineers perform less traditional technical engineering and spend more time acting as engineering project managers who perform little or no traditional engineering work. Engineers functioning in both roles, however, are essential to successful project delivery. Recognizing this fact, many public sector organizations offer opportunities for continuing education courses to practicing professionals to expand their management skills and assist in their development as project managers. This work presents the results of one agency's efforts in this regard.

This work documents the project management training and the post project management training examination/certification process used by the City of Los Angeles, Bureau of Engineering, a very large Southern California public sector engineering agency. This paper will assess the effectiveness of the group's entire training program and the effectiveness of specific training modules and instructors. Conclusions summarize the lessons learned through the training and examination processes and detail recommended areas to expand this research.

### **Background on the Bureau of Engineering**

The City of Los Angeles' Department of Public Works creates and maintains the physical framework and underpinnings of one of the most geographically, economically, and ethnically diverse cities in the world. Consisting of seven separate Bureaus, the Department of Public Works is responsible for construction, renovation, and the operation of City Facilities and infrastructures. One Bureau, the Bureau of Engineering, has over 800 employees and is responsible for the planning, design, and construction management of capital improvement projects for the city including stormwater, sewer systems, street and other infrastructures.

Although the quality of the Bureau of Engineering's designs has always been good (based on life cycle performance), some projects and programs have experienced significant delays and cost overruns in the design and construction phases. With several large bond funded construction programs in the planning stages, the Bureau of Engineering executive staff and the Board of Public Works mandated a shift to improve project delivery in order to restore public and City government confidence in the Bureau's ability to manage these future programs. Essential to the success of the Bureau's transition to Project Management is training in fundamental skills required for deliver a project<sup>1</sup>.

### **Training Program**

The Bureau's project management training program is a 15 week course that meets weekly. The program is broad in that it covers all elements of project management, but it also is geared toward the procedures that the Bureau uses in managing projects within the City of Los Angeles. Table 1 summarizes the training program. As shown in the figure, there are 11 subjects covered over 14 weeks with the 15<sup>th</sup> session set aside for review and discussion of the certification test. Each session lasts from 4 to 6 hours. Most subjects are covered in one class meeting session, but two subjects were given more than one session. The complex subject of time management / scheduling was given two sessions, and a subject judged to be of great importance to the Bureau, presentation skills for engineers, was given three sessions. The table also shows the mix of

instructors used in the training. Most training was done by Bureau senior staff, but the program also utilized University Professors and specialty consultant trainers. The training that had the most focus on Bureau project management procedures was taught by in-house instructors who were senior experts on the subject. Subjects that were more generic and/or specialized were taught by outside instructors. As shown in the table, the core objective of the training was to enhance the skill of engineers so as to allow promotion into management positions responsible for the entire project delivery process. These core training areas were comparable to other agency core training areas<sup>2</sup>.

*Table 1. Summary of the Bureau of Engineering Training Program*

Module (1)	Subject (2)	Number of Sessions (3)	Instructor (4)	Topics Covered (5)
1	Introduction to Project Management	1	Bureau Senior Staff	<ul style="list-style-type: none"> <li>▪ Definitions</li> <li>▪ Responsibilities</li> <li>▪ Organizations</li> </ul>
2	Project Planning	1	Bureau Senior Staff	<ul style="list-style-type: none"> <li>▪ MOUs</li> <li>▪ Scoping</li> <li>▪ Budgets</li> </ul>
3	Project Design / Bid & Award Process	1	Bureau Senior Staff	<ul style="list-style-type: none"> <li>▪ Estimates</li> <li>▪ Timelines</li> <li>▪ Bottlenecks</li> </ul>
4	Managing Consultants	1	Bureau Senior Staff	<ul style="list-style-type: none"> <li>▪ RFPs / RQFs</li> <li>▪ Contracts</li> </ul>
5	Construction Management / Project Closeout	1	Bureau Senior Staff	<ul style="list-style-type: none"> <li>▪ Record keeping</li> <li>▪ Inspection</li> <li>▪ Change Orders</li> </ul>
6	Managing Time I & II	2	University Professor	<ul style="list-style-type: none"> <li>▪ Logic</li> <li>▪ Barcharts</li> <li>▪ CPM</li> </ul>
7	Managing Money	1	Bureau Senior Staff	<ul style="list-style-type: none"> <li>▪ Const. Costs</li> <li>▪ Const. Estimates</li> <li>▪ Soft Costs</li> </ul>
8	Presentation Skills	3	Professional Trainer	<ul style="list-style-type: none"> <li>▪ Communications</li> <li>▪ Audiences</li> <li>▪ Presentations</li> </ul>
9	Human Aspects of Project Management	1	University Professor	<ul style="list-style-type: none"> <li>▪ Performance</li> <li>▪ Leadership</li> <li>▪ Influence</li> </ul>
10	Total Quality Management	1	Professional Trainer	<ul style="list-style-type: none"> <li>▪ Deming</li> <li>▪ Tools</li> <li>▪ Teams</li> </ul>
11	Negotiation	1	Bureau Senior Staff	<ul style="list-style-type: none"> <li>▪ Authority Levels</li> <li>▪ Trade-offs</li> <li>▪ Benefit / Cost</li> </ul>

## Certification Examination

About one month after completion of the training, all students that were trained were required to take a comprehensive examination covering the subject matter of the training. The examination acted as a certification examination for Bureau of Engineering Staff who wished to transfer to newly created Project Manager Classification positions. The exam is broken into 11 sections. The breakdown of each examination section by subject, type of question, and maximum points is shown in Table 2. The table shows that the most points were available on the Managing Time and Managing Money subjects. These two topics account for 70 of the possible 190 examination points. All of the other exam sections range in value from 10 to 20 points. The exam was originally intended to be 200 points, but the 10 points of questions regarding Total Quality Management were removed from the test since the questions supplied by the professional trainer were too specific to the training rather than project management.

Each short answer exam section had between two and six questions; hence, each individual exam short answer question was worth two to five points. The two calculation sections of the exam each had only one question; hence these multiple page, complex questions in these two exam sections were valued at 35 points.

*Table 2. Certification Examination Information*

Exam Section (1)	Topics (2)	Type of Questions (3)	Number of Questions (4)	Max. Points (5)
1	Introduction to Project Management	Short Answer	5	20
2	Project Planning	Short Answer	4	15
3	Project Design/Bid & Award Process	Short Answer	5	10
4	Managing Consultants	Short Answer	4	10
5	Construction Management / Project Closeout	Short Answer	6	15
6	Presentation Skills	Short Answer	3	10
7	Human Aspects of Project Management	Short Answer	4	15
8	Negotiation	Short Answer	2	10
9	Negotiation/Time/Money	Short Essay	3	15
10	Managing Time I & II	Calculation	1	35
11	Managing Money	Calculation	1	35

In tone, the exam was geared toward practicing professionals with the idea to test understanding of broad concepts rather than a memorization of training specific items. About one half of the questions were specific to managing projects in the City of Los Angeles and for the Bureau of Engineering. The remaining one half of the questions were written to test core knowledge applicable to general public sector projects.

The examination was “open book” and “open notes”. Talking and sharing of resources was not allowed. Calculators were allowed; personal computers were not allowed. The exam was timed with four hours to complete all sections. In most cases, however, time was not an issue. The maximum possible overall score was 200 points (with 10 free points as described above). Candidates needed to earn a cumulative score on all sections of 75% to pass. Students who did not achieve a total score of 75% were given the opportunity to retake the specific exam sections in which they scored less than 75%. The retake score data is not included in the analysis of this paper.

### Analysis

Data set for exam analysis consists of 70 examination scores from 2001 to 2003 based on 4 training sessions. Figure 1 shows the examination score breakdown by section with total score for all 70 students that took the exam. The figure shows a high score of nearly 90% for the exam section on project planning. Exam scores on sections related to design / bid and award and construction management also scored high (above 80%). The lowest scoring section of the exam was near 50% for the exam section on human aspects of project management. Also scoring low at just above 60% was the examination section on managing consultants. The average total score for all sections is shown to be about 73%.

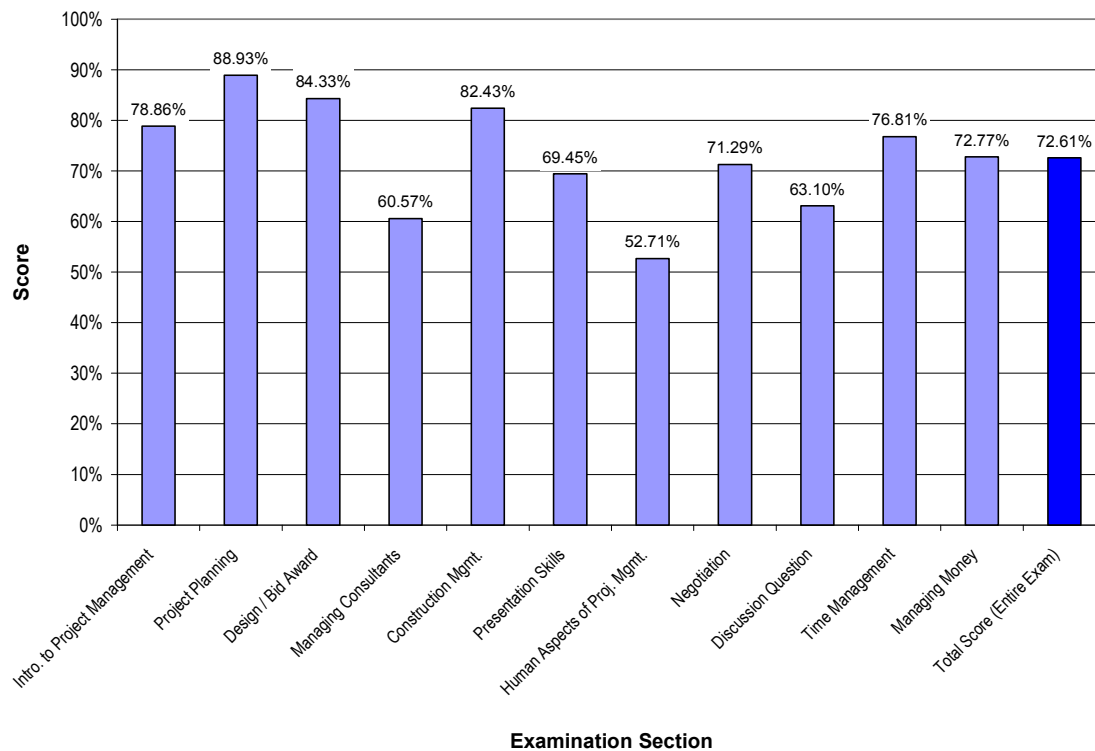


Figure 1. Average Examination Score by Examination Section

The first analysis compares examination scores based the organization or department within the City for which the student worked (70 data points). Table 3 shows this summary and shows that the organization based average overall exam scores ranged from 79.38% to 59.10%. The highest average total exam score was for the organization called “Others” (a subgroup that consisted of City staff from outside the Department of Public Works, i.e. Police, Library, and City Administrative Office students). The highest average exam section score was 95.83% for the Negotiation section, again from the organization “Others”, and the lowest were 23.00% by the Contract Administration organization for the Negotiation/Time/Money section and 25.83% by the organization Department of Recreation and Parks for the Human Aspects of Project Management section. The Bureau of Engineering scored consistently well across all examination sections, but interestingly, the organization subgroup “Others”, Table 3 - column 7, scored the highest on seven of the eleven examination sections.

*Table 3. Average Examination Scores by Student’s Home Workplace Organization*

Description (1)	Organization						
	Bureau of Engineering (2)	Contract Admin. (3)	General Services Division (4)	Recreation and Parks (5)	Bureau of Sanitation (6)	Others (7)	
Number of Students within the Organization	51	5	3	4	3	4	
Average Examination Score (all Sections)	75.78%	59.10%	62.11%	56.65%	63.84%	79.38%	
Score by Examination Section	Intro. to Project Management	78.53%	87.00%	80.00%	80.00%	75.00%	73.75%
	Project Planning	91.14%	74.33%	83.33%	80.00%	88.89%	92.08%
	Design / Bid Award	87.22%	57.67%	66.67%	78.33%	93.33%	93.33%
	Managing Consultants	66.44%	39.33%	31.67%	53.33%	30.56%	63.75%
	Construction Mgmt.	83.50%	76.00%	70.00%	83.33%	83.89%	84.17%
	Presentation Skills	71.05%	55.67%	40.00%	65.00%	76.67%	87.50%
	Human Aspects of Proj. Mgmt.	53.20%	36.00%	48.89%	25.83%	64.44%	88.33%
	Negotiation	74.48%	38.33%	60.00%	59.17%	66.67%	95.83%
	Negotiation/Time/Money	66.37%	23.00%	63.33%	63.33%	48.33%	82.08%
	Time Management	82.32%	65.07%	80.83%	41.61%	40.48%	80.71%
	Managing Money	77.07%	75.81%	40.00%	45.36%	78.25%	62.02%

The second analysis compares examination scores based on the student's work classification within the Bureau of Engineering. Hence, this is an analysis of only the exam scores for students whose home organization was the Bureau of Engineering (51 data points). Table 4 shows this summary for the five work classifications within the Bureau and shows that the average overall exam scores for this breakdown ranged from 79.49% to 61.79% based on work classification. The highest average total exam score was for the Bureau's Civil Engineer classification at 79.49% and the lowest was for the Architectural design work classification at 61.79%. The highest average exam section score was 100% for Construction Management from the classification Sanitary Engineering, and the lowest was 39.60% by the classification Architectural Design.

*Table 4. Average Examination Scores by Student's Work Classification within the Bureau of Engineering*

Description  (1)		Bureau of Engineering Work Classification				
		Architectural Design (2)	Electrical Engineering (3)	Sanitary Engineering (4)	Structural Engineering (5)	Civil Engineering (6)
Number of Students within the Bureau's Work Classification		6	4	6	7	28
Average Examination Score (all Sections)		61.79%	72.15%	76.53%	74.40%	79.49%
Score by Examination Section	Intro. to Project Management	74.17%	75.00%	83.33%	80.71%	78.39%
	Project Planning	82.50%	93.75%	98.61%	95.95%	89.82%
	Design / Bid Award	79.44%	76.67%	87.78%	85.95%	90.60%
	Managing Consultants	65.28%	56.25%	58.33%	78.33%	66.90%
	Construction Mgmt.	85.56%	100.00%	62.22%	86.67%	84.46%
	Presentation Skills	59.44%	62.50%	59.17%	63.57%	79.17%
	Human Aspects of Proj. Mgmt.	42.22%	55.00%	47.78%	44.76%	58.57%
	Negotiation	49.44%	79.17%	66.67%	85.24%	78.15%
	Negotiation/Time/Money	62.78%	62.50%	68.61%	59.29%	68.99%
	Time Management	64.46%	78.39%	88.04%	81.73%	85.63%
	Managing Money	39.60%	69.76%	86.90%	71.50%	85.43%

Overall, all work classifications within the Bureau did well, with the exception of the Architectural Design classification, Table 4 - column 2, who on average scored the lowest on six of the eleven examination sections.

The third analysis compares examination scores based on student's level of experience within the Bureau of Engineering. Table 5 shows an analysis based on work classifications of the scores for students whose home organization was the Bureau of Engineering (51 data points).

*Table 5. Average Examination Scores by Student's Level of Experience within the Bureau of Engineering*

Description  (1)	Level of Experience			
	Senior Level Positions (i.e. Senior Civil Engineer)  (2)	Management Level Positions (i.e. Civil Engineer)  (3)	Engineer Level Positions (i.e. Associate Civil Engineer)  (4)	
Number of Students within the Level of Experience	8	21	22	
Average Examination Score (Total for all Exam Sections)	81.17%	77.84%	71.86%	
Score by Examination Section	Intro. to Project Management	86.88%	80.48%	73.64%
	Project Planning	95.42%	89.52%	91.14%
	Design / Bid Award	90.63%	87.94%	85.30%
	Managing Consultants	70.83%	66.03%	65.23%
	Construction Mgmt.	91.67%	80.48%	83.41%
	Presentation Skills	78.13%	78.17%	61.67%
	Human Aspects of Proj. Mgmt.	60.00%	59.05%	45.15%
	Negotiation/Time/Money	80.83%	72.54%	74.02%
	Discussion Question	77.71%	73.41%	55.53%
	Time Management	85.85%	82.14%	81.20%
	Managing Money	78.57%	80.86%	72.90%



The table shows that the Bureau's average overall exam scores ranged from 81.17% to 71.86% based on experience level. The highest average total exam score was, as expected, for the Bureau's Senior Level staff, and the lowest was for the Associate Engineer Level of experience. The highest specific average exam section score was 95.42% for the exam section on Project Planning by the Senior Engineer Level subgroup, and the lowest was 45.15% by the Associate Engineer Level of experience for the Human Aspects of Project Management Section. Overall, all experience levels within the Bureau did well, but the Associate Engineer Level of experience, Table 5 - column 4, scored the lowest on eight of the eleven examination sections, and the Senior Level of experience, Table 5 - column 2, scored the highest on ten of the eleven examination sections.

## **Conclusions**

This work has documented the project management training and the post project management training examination/certification process used by the City of Los Angeles, Bureau of Engineering. This paper reviewed the contents, format, and instructors of the training and the post-training certification examination. Interpretation of the data results has provided limited conclusions as follows:

- Overall, the training program was successful. Coursework covered a broad range of topics with specific agency procedures also included in the training. Attendance at the classes was strong and more students wanted to take the courses than spots were available.
- Student scores on the certification exam were lower for course sections taught by non-Bureau instructors. Student scores on the certification exam were highest and lowest for the short answer exam questions (as opposed to short essay or calculation sections).
- The average score on the examination was over 70% for four of the five work Bureau work classifications, and all three levels of Bureau experience. Average scores for non-Bureau students were lower for four of the other five organizations trained.
- Work classification has substantial correlation to exam score with the Architectural Design classification scoring 10% to 18% lower than other classifications. The biggest experience based score differences, over 25%, were on the negotiation and the managing money exam sections.
- Level of experience has strong correlation to exam score with senior engineers scoring 10% higher than junior engineers, but even the junior engineers performed well (passing scores) on the exam. The biggest experience based score difference was on the short answer style questions, and the least experience based score difference was on the essay and calculation type questions.

Future research on this training can be expanded to several different directions. First, an analysis could be done to determine whether the format of the training materials or the results of the instructor / course evaluations have any correlation to the student performance on the certification exam. This would help to differentiate training effectiveness based on instructor

and course materials variables. Second, all of the analyses of exam performance by exam section could be expanded to include performance on specific exam questions. This would help to eliminate the potential influence of a poor exam question (a significant potential problem given the small number of questions in any particular section) Third, a refinement of the analysis of work classification to include specific functional tasks (i.e. performing management functions or not) would eliminate the influence of pre-existing student knowledge impacting training performance evaluations Most importantly, and highly recommended for the Bureau, would be an additional research project that would review long-term impacts of the training on organizational performance at multiple years from the training time period. Such a study could also be used to assess how follow-up training can be used to solidify positive impacts of this training program.

## References

- <sup>1.</sup> Kuprenas, John A., Madjidi, Farzin, and Alexander, A. Stephen (1999). "A Project Management Training Program". *Journal of Management in Engineering*, Vol. 15, No. 6, pp. 47-55
- <sup>2.</sup> Fisher, Deborah J., Schluter, Lynne, and Toleti, Pavan Kumar, (2005). "Project Management Education and Training Process for Career Development". *Journal of Construction Engineering and Management*, Vol. 131, No. 8, pp. 903-910.