

## **Comparison of Student Performance to Professional Performance**

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### Abstract

Mock bid lettings allow construction-engineering students to compare their cost estimates with professional cost estimates under highly realistic conditions. Since the cost estimates are based on the construction process designs, the mock bid letting validates the construction process design developed by the students. This paper describes the mock bid letting that is jointly sponsored by Iowa State University, Iowa Department of Transportation and the Associated General Contractors of Iowa.

Several steps are involved in the mock bid letting process and the students work in groups of three or four. They obtain contract documents from the contracting authority and attend presentations on transportation construction cost estimating. Then each group is assigned to a professional cost estimator who acts as a mentor. The groups visit the job site with their mentors and then develop a prime contractor cost estimate. A substantial portion of the cost estimate is subcontractor and supplier quotes. Such quotes are provided to students directly from actual subcontractors and suppliers as if they were quoting professional contractors. The bids are submitted to the contracting agency at the same time and according to the same rules as the professional bids. If the student bids are responsive, they are read aloud after the professional bids.

The paper briefly describes how mock bid lettings are conducted and provides a rubric for evaluating student work. Student bids and professional bids are compared and reasons for differences are explained. A list of lessons learned and recommendations for future bid lettings are also provided.

### I. Introduction

Educators and students desire the opportunity to compare student and professional performance. Such opportunities allow educators to assess student preparation for professional tasks while students glimpse ahead at their future jobs. The best opportunities are ones that require students to demonstrate a wide variety of technical,

organizational, and social skills in order to complete a significant project. Mock bid lettings provide such an opportunity for future construction professionals.

Iowa State University's Construction Engineering Curriculum has conducted three mock bid lettings in cooperation with the Iowa Department of Transportation and the Associated General Contractors of Iowa. Students work in groups of three or four. Iowa DOT provides contract documents for actual transportation construction projects and Iowa State University provides classroom instruction on cost estimating. Then, with the help of industry mentors, students design the construction process and estimate prime contractor costs. Shortly before the bids are due, actual subcontractors and suppliers provide quotations at the same time and in the same way that they provide quotations to industry professionals. Students bids are submitted to the Iowa DOT at the same time and under the same rules as professional bids. Then the student bids are read aloud and tabulated along with the professional bids. The only difference between the student experience and the professional experience is that the students do not have to build the project if they are low bidders!

## II. Transportation Bid Lettings

Most state transportation authorities conduct bid lettings on a monthly basis. All state transportation construction work is offered for bid at these times. This allows the industry to focus its efforts on bidding at these times. Usually, prospective contractors, subcontractors and suppliers gather at designated hotels for the bid lettings so they can exchange subcontractor and supplier quotations, personally answer questions and give clarifications. In Iowa, bid lettings include between 25 and 200 projects each with total value ranging from \$8,000,000 to \$130,000,000.

In Iowa, the bids are due at 9:00 AM on the day of the bid letting. There is an understanding that supplier quotes will be delivered by 10:00 PM and that subcontractor quotes will be delivered by midnight during the previous evening. Since a substantial portion of many projects is subcontractor and supplier costs, it is obvious that prime contractors will have to complete their bid in the early morning hours. Students share the challenge with contractors of making important calculations and decisions in the middle of the night when they are tired.

Participants in the mock bid letting receive one credit as a special project class. This can be applied to their degree as an engineering topic elective. It is the intention of Iowa State University to offer this experience each year. Students may continue to use the experience for credit as long as they have a different experience each time. For example, the first year a student may serve as an assistant to estimate a bridge construction project and then serve as a leader to estimate a paving project in the second year.

## III. Objectives

The objectives for the mock bid letting are that the students will:

1. Understand the entire bidding procedure
2. Appreciate the attention to detail required to submit a responsive bid
3. Work effectively in groups
4. Interact effectively with contracting agency personnel, suppliers, subcontractors and competing contractors.
5. Discreetly handle confidential information
6. Conduct a thorough site visit.
7. Interpret contract documents including standard plans and general specifications
8. Visualize and communicate the construction process required to complete the project.
9. Estimate the prime contractor's portion of the cost of the project and provide documentation.
10. Accept and interpret subcontractor quote and supply quotes.
11. Ask for and understand clarifications where necessary.
12. Incorporate subcontractor and supplier quotes observing all applicable goals regarding minority and disadvantaged business participation.
13. Submit the bid according to the rules of the contracting agency.
14. Execute a contract according to rules of the contracting agency.

#### IV. Tasks

The mock bid letting is organized into the following tasks:

*Task One – Attend Highway and Heavy Cost Estimating Presentations.* Approximately four one-hour presentations are given on Highway and Heavy Cost Estimating. Students attend these presentations and complete example problem assignments.

*Task Two – Obtain Contract Documents.* Students are given the contract documents at the same time they become available to contractors. The contracting agency sends addenda to the instructor for distribution to student groups.

*Task Three – Mentor assignments.* Each student group will be assigned to a professional construction estimator that will act as a mentor. Student groups may discuss the generalities of the estimate and ask advice regarding prospective subcontractors and suppliers. It is not intended that the mentor will advise the students on the estimate details.

*Task Four – Site Visit.* Students will conduct and document a site visit. In most cases, students will meet their mentor at the site.

*Task Five – Construction Process Design and Prime Contractor Estimate.* Students will devise and document a construction process design and prime contractor estimate according to the previously presented procedures. When students have finished their design, they may ask their mentors to review the estimate in general, not in detail.

*Task Seven – Accept Subcontractor Quotes.* Student groups will work in rooms at the bid letting hotel. Subcontractors and suppliers will volunteer to provide the same quotes to student groups as they do for the contractors. Supply quotes will be submitted by 10 PM

and subcontractor quotes will be supplied by midnight. Students will hold quotes in confidence and respond to questions regarding time and place of delivery, number of mobilizations required, and schedule of work. They will ask subcontractors and suppliers for reasonable clarifications.

*Task Eight – Compile Bid.* Students will incorporate subcontractor and supplier quotes into their bid in accordance with minority and disadvantaged business entrepreneur goals.

*Task Nine – Submit Bid.* Students will submit their bids in accordance to contracting agency rules, including the bid bond and accompanying documentation. The professional bids and the mock bids differ in color to avoid confusion while the bids are being read.

*Task Ten – Bid Reading.* The contracting agency will read student bids after all the contractor bids have been read. Unresponsive student bids will not be read.

*Task Eleven – Contract Execution.* All student groups will execute a mock contract.

*Task Twelve – Documentation Review.* Students will submit their construction process design, cost estimate, subcontractor selection and bid to their instructor for review and grading. The assignments will be graded according to the rubric in Table 1.

## V. Experience with mock bid lettings

Iowa State University has conducted three mock bid lettings. The first was in March 1998, the second was in October 1998 and the third was in October 1999. This section briefly describes each experience.

### A. March 1998

The first mock bid letting had 15 student participants that worked in three groups of four people and one group of three people. The students were recruited from sophomore, junior and senior classes. The seniors became group leaders and the juniors and sophomores assisted at levels that were appropriate to their knowledge of cost estimating. The students bid on three projects:

- BO 26—Reinforce Concrete Box Culvert. Low contractor bid: \$108,355.35
- BO 28—Precast Beam Bridge. Low contractor bid: \$982,208.52
- BO 104—Flat Slab Bridge. Low contractor bid: \$323,973.73

BO stands for *bid order*, a designator assigned by Iowa DOT. These projects were selected because they did not require an overwhelming amount of estimating work, yet they were sufficiently complicated to required substantial participation by subcontractors and suppliers. Because the students needed subcontractor and supplier quotations, interaction between students and industry people was assured.



	Site Visit	Visited site and developed permanent documentation for later reference. Developed a checklist of problem areas, thoroughly inspected these areas, and took notes on conditions at the job site.	Visited and actively inspected the site. Permanent documentation is made and problem areas are noted.	Visited and casually observed the site conditions.	No site visit is conducted.
	Mentor interaction	Study plans very closely to develop questions for mentor before meeting. Contact mentor before letting and get to know personnel. Set up a meeting time well before letting.	Call mentor before letting to set up a meeting time. Reviewed plans and develop questions for mentor before meeting.	Wait until letting before first contact with mentor. Develop few questions for mentor.	Group does not meet with mentor.
	Completion of construction process design	Project built completely on paper before letting. Team members have met and reviewed the construction process.	Except for a few details, the construction process is completed prior to letting.	Part of the construction process design is completed prior to letting.	Construction process design is developed the night before the letting.
	Advertising for sub-quotes	Call every subcontractor and supplier a week before the letting to request subquotes. Earn trust and respect of subcontractors and suppliers through previous contact.	Call the most important subcontractors and suppliers the week before the letting.	Call subcontractors and suppliers the day of the letting to request quotes.	Make no contact with subcontractors or suppliers.
	Final Price	A very competitive bid that leaves very little money on the table.	A bid that is within the range of the other contractors' amounts.	A bid that is higher than the other contractors' amounts.	A very low or very high bid, an amount that is way out of range.
	Responsiveness of Bid	Acceptable		Not Acceptable	
		Accepted and read by owner.		Not read by owner	

On bid night, all four student groups worked in a large meeting room in the conference area of the hotel while the contractors occupied the regular hotel rooms in the upper stories. It was a challenge for subcontractors and suppliers to find the student room in order to deliver quotes because they normally deliver quotes only to hotel rooms. Very few subcontractor and supplier quotes were provided, and people who had prior relationships with the writer or one of the students supplied most of the quotes.

Because students were all in the same room, what should have been confidential conversations were overheard by competitors. Due to a booking error, students were forced to move at midnight—a time that they should have been focused on calculations. Despite these difficulties, three of the groups were able to bid on all three of the projects and a fourth group was able to bid on two projects. The student bids were generally within the range of the professional bids or slightly above (Figure 1). Later analysis indicated that students who submitted the bids that were above the contractor bid had overestimated labor costs. One bid was 2% below the low professional bid for the reinforced concrete box culvert. The assessment was that the students could estimate costs reasonably well in comparison to the contractors.

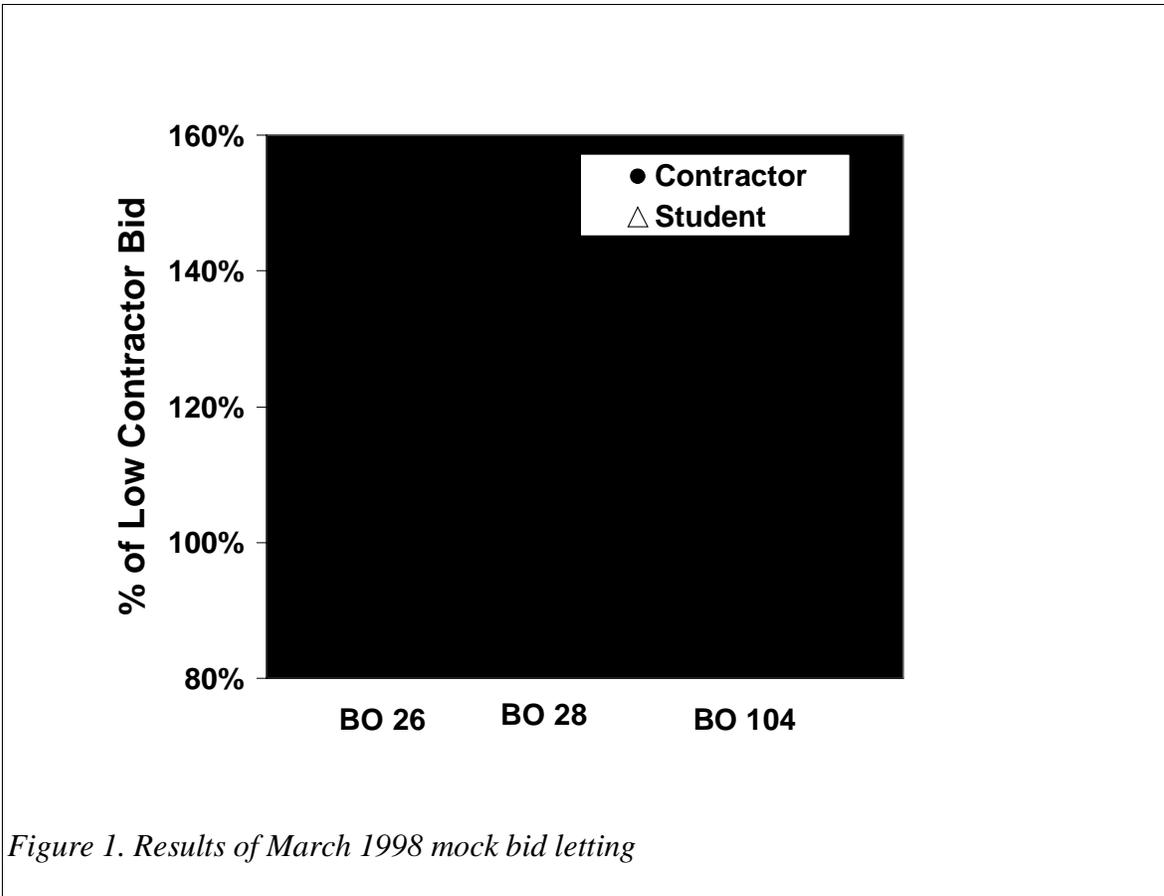


Figure 1. Results of March 1998 mock bid letting

As a result of the experience, the following improvements were planned for the next mock bid letting:

- Students would attend the previous bid letting so they would have a better understanding of what is involved and so they could meet with mentors, subcontractors and suppliers.
- Students would more aggressively solicit subcontractor and supplier quotes by calling likely candidates before the bid.
- Students were to be housed in hotel rooms and notices would be posted in the lobby area with the student room numbers. This would allow subcontractors and suppliers to find the student room more easily.
- Student estimate would be retained and shared with the next group of students, simulating the build up of experience in a company.
- The mock bid letting would be conducted in October rather than March. Traditionally, the March bid letting falls the day after Iowa State University's spring break, so it is difficult for students to interact with mentors to prepare bids. This is because most of the mentors do not conduct site visits until the week before the project is bid, which is the week that the students are on spring break. Also, traditionally March is a large bid letting and the professionals are busy with their own work and have little time to assist students. The February letting is too early in the semester for students to prepare and the April letting is too late because end of semester projects compete heavily for student time. The October letting falls in the middle of the fall semester. Students have sufficient time to prepare, yet the mock letting does not compete with the end of the semester rush. Traditionally, the October letting is a small letting, so contractors have extra time to interact with students.

#### *B. October 1998*

The next mock bid letting was conducted in October 1998. Nine students participated on three teams. The students bid on four projects:

- BO 007—*Precast Concrete Bridge over a River*. Low contractor bid \$475,035.81
- BO 103—*Grade and Pave 4.8 km (3 Mi) of Suburban Arterial Road*. Low contractor bid \$1,060,934.38
- BO 105—*Grade and Pave 2.4 km (1.5 Mi) of Urban Arterial Road*. Low contractor bid \$1,237,959.27

The grading and paving projects were selected so that the students who were repeating the experience could obtain credit by estimating something other than bridges. This mock bid letting was considerably more challenging for the students (Figure 2). Both grade and pave projects required contractors to maintain traffic during construction, which adds considerable complication and cost.

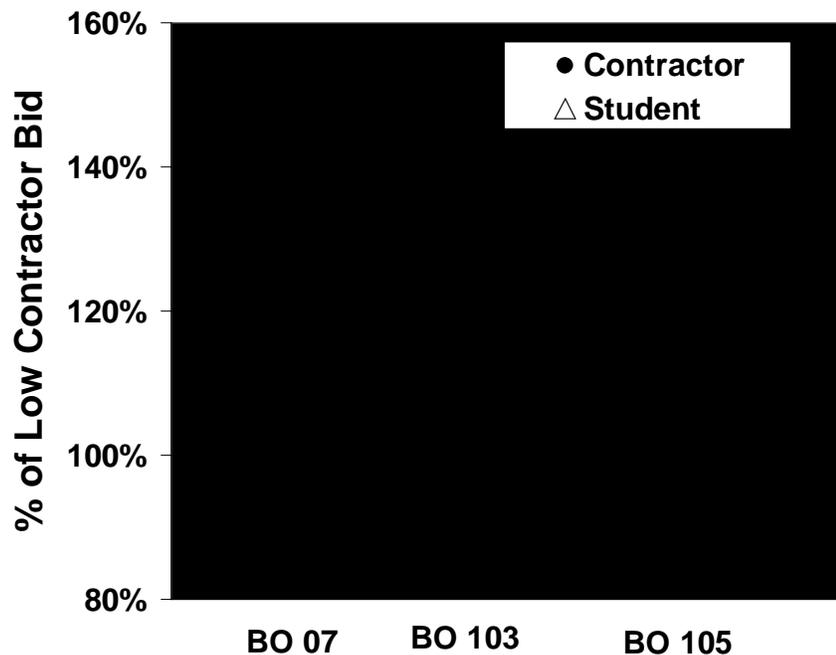


Figure 2. Results of October 1988 mock bid letting

Business practices are also complicated on grade and pave projects because the grading is performed by a grading contractor and the paving is performed by a paving contractor. One usually serves as the prime contractor while the other usually serves as the subcontractor. In general, both would prefer to serve as the prime contractor because the prime contractor retains more control of the project. In cases where either the grading costs more than the paving or vice versa, it is easy to decide that the prime contractor should be the organization that has the most cost in the project. However when the grading and paving are equal in cost, a war of nerves can develop between the grading and paving contractors. Each organization refuses to quote the other, because the other cannot turn in a prime contractor bid without the quote. In some cases certain grading contractors and certain paving contractors will set up alliances, so they do not have to find quotes. BO 103 was that kind of project.

The student group that was bidding on BO 103 intended to act as a prime contractor for paving and obtain quotes for grading. At midnight (nine hours before the bids were due) it became apparent no grading quotations would be forthcoming, so the students were left with a difficult choice – one that professionals occasionally face in the real world: Quickly estimate the cost for performing the earthwork and include it in their bid, or decide not to bid and waste the effort of developing their cost estimate for paving. The

risk of developing a quick estimate for earthwork is that it might be too low to cover the costs and the paving contractor would be responsible for making up the difference. Since the students didn't actually have that risk, they chose to develop a quick estimate, based on statewide average earthwork costs published by the Iowa DOT. Unfortunately, the grading was more difficult than average and the students turned in a bid that was 9.4% below the low contractor bid. Although the low contractor would prefer to bid only slightly lower than their competition, a 9.4% difference is not devastating for this type of work. Many contractors in similar circumstances leave this much "on the table" and still make a profit on the job.

The student bid for BO 105 was low by 14%. Later analysis indicated that they did not allow enough cost to cover the expense of maintaining access for adjacent property owners. One student group was 5% below the low contractor bidder for BO 007; this was considered an excellent bid. The Iowa DOT did not read the bid for the group that bid BO 005 because the bid was not responsive: the students had signed the bid in pencil, not in ink.

The students left the bid letting to the "congratulations" of the contractors for getting a lot of work cheap, plus stories about similar experiences from contractors. There were several stories about forgetting to sign documents. The last comment was always "Better to learn now than when you're doing for real!"

In reviewing the outcome of this mock bid-letting session, it was noted that more subcontractor bids were obtained and the atmosphere was more professional because the students were in hotel rooms. The students had taken on more difficult projects. Although they lacked the judgement necessary to account for all the costs of performing complicated jobs, they were able to design construction processes that address most of the major issues. It was resolved that future grade and pave jobs would be estimated by two student groups: one that would specialize in paving and one in grading. These groups would then swap quotes, ensuring coverage on all major items of work. The commitment was made to conduct the mock bid lettings on a yearly basis in October.

### *C. October 1999*

The most recent mock bid letting was conducted in October 1999. Twenty-three students participated in six teams. The students estimated on five projects:

- BO 014—*Pedestrian Tunnel*. Low contractor bid \$445,909.51
- BO 023—*Four Lane Bridge over Freeway*. Low contractor bid \$1,434,751.90
- BO 024—*Twin Bridges over Future Roadway*. Low contractor bid \$2,858,892.58
- BO 025—*Extend Reinforced Concrete Box Culvert*. Low contractor bid \$120,237.90
- BO 105—*Grade and Pave 2.4 km (1.5 Mi) of Rural Road*. Low contractor bid \$2,566,912.00
- BO 153—*Recycle and Resurface 17.6 km (11 Mi) of Rural Road*. Withdrawn

Ten bids were submitted and six were within the range of the contractor bids (Figure 3). One bid was higher than the contractor bids, one bid was considerably lower than the low bid, and one bid was 3% below the low contractor bid. One bid was not read because one of the bidding documents was not properly signed. As planned, for the grading and paving job, one of the groups quoted the others for the grading. Although another contractor provided a grading quote, the new policy provided an opportunity for a student group to learn how to estimate grading work.

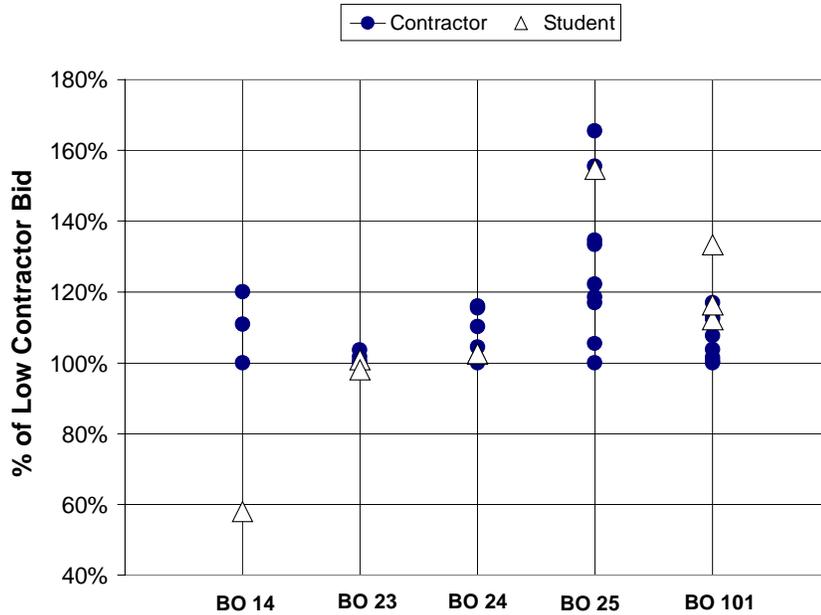


Figure 3. Results of October 1999 mock bid letting

In general, the student bids were within the range of the professional bids, even for BO 105, the grade and pave job. The students probably benefited from the experience of their predecessors. In addition, these projects primarily involved new construction, which is easier to bid for people with limited experience.

Occasionally the contracting authority withdraws projects before they are bid. This is done for a variety of reasons including errors discovered in the plans, failure to acquire right of way, or changes of concept for the project. For this reason, each group is required to estimate at least two projects. If one project is withdrawn, the students can still have the experience of obtaining subcontractor and supplier quotes for their other project. They can complete the prime-contractor portion of the withdrawn job estimate and turn it in for a grade. The wisdom of this policy was confirmed when BO 153 was withdrawn a week before the letting.

## VI. Reasons for success

The mock bid letting is popular among both students and construction professionals because it adds realism to the academic environment. Academics have recognized the need to include management, team skills and communication into engineering curriculums<sup>1,2</sup>. Others have developed assignments that simulate real world situations including decision making, teamwork and communication<sup>3,4</sup>. Several capstone classes have been developed that simulate real world experience; it is suggested that the results of such experience should be used for<sup>5</sup> outcomes assessments because their realism is sufficiently credible<sup>6</sup>. The mock bid letting takes this realism a step further by placing students in the work place with industry professionals and comparing their work directly.

Students learn best when they understand that an assignment is relevant, when they enjoy the assignment and when they have an appropriate level of concern for failure<sup>7</sup>. The relevance of the mock bid letting is obvious to construction engineers. The students also greatly enjoyed the opportunity to participate in such a unique experience. There was also a concern for failure because their bids would be read aloud in front of the industry professionals and their peers. Since the students work in groups, they rehearse their learning and increase their processing time, which also benefits learning<sup>7</sup>.

One of the most important reasons for success is the cooperation provided by the construction industry and the Iowa DOT. Iowa DOT increases its administrative load by participating. The contractors, subcontractors and suppliers share their time during an activity that is critical to the success of their business. However, the professionals participate with obvious enjoyment that a new generation is learning about a unique and exciting work assignment.

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