Auburn University Samford Hall Tower Logo in orange and blue

# ASSESSMENT REPORT

# Executive Certificate in Construction Management

This is a distance education certificate program in the McWhorter School of Building Science. This is the first of three certificate programs in the School, and it was started in 2013. A typical cohort of students in this program is between 15 and 25 students. The program starts in fall semester each year and ends in the spring semester of the following year. All students in the program are full time employees in construction or a related sector. Students take two courses each semester. The certificate program has a ‘residency’ requirement where students are on campus for one week to attend classes. A third of the course content is delivered while students are in residency. For the remainder of the semester, students attend weekly online classes, for one-hour per course via a web-based meeting software (Web-Ex). Students also study asynchronous online course material (such as videos and presentations) via CANVAS, which is created by faculty. The online classes account for another third of the course content and the asynchronous material accounts for the remainder of the course content.

This program was started as part of the ongoing collaboration between the United States Army Corps of Engineers (USACE) and the McWhorter School since 2009. A majority (more than 90%) of the students in the program are employees of USACE and other agencies within the Department of Defense. The contents of the course have been developed in consultation with the USACE. Typical students attending the program from USACE have either an engineering or a business background. The program also helps USACE employees by allowing the contracting employees from the business side see things from the engineer’s perspective and vice-versa. For almost all students in this certificate program, this is the first formal coursework in the discipline of construction management.

## Student Learning Outcomes

### Specificity of Outcomes

1. SLO 1: To analyze construction documents and perform quantity takeoff.
2. SLO 2: Students will be able to analyze the impacts of construction planning, sequencing, and scheduling based on the range of implications related to contractor choices and constraints, managerial decision-making, and project cash flow.
3. SLO 3: Students will understand the legal implications of contract, common and regulatory law to manage a construction project.
4. SLO 4: Students will be able to create construction execution plans for heavy civil projects.

### Comprehensive Outcomes

This certificate program is an introduction to the discipline of construction management for those individuals who have a degree in a construction related discipline such as architecture or civil engineering or for those who are already employed in the construction industry. The faculty agreed that the proposed SLO’s accurately reflect the expected outcomes for the certificate. Each individual SLO is further described for comprehensiveness below.

1. SLO 1: There are two main disciplines involved when producing a construction estimate; first quantity take-off, and second pricing. While pricing can be somewhat subjective and based on market conditions, quantity take-off tends to be more objective. To perform accurate quantity take-offs the estimator not only needs a basic understanding of math and geometry, they also need to have advanced visualization and plan reading skills. Coupled with those skills and estimator needs to be familiar with construction means and methods. Quantity take-off is the first skill to be developed and honed by a novice estimator.
2. SLO 2: Construction sequencing strategies have a significant impact on the building process, which impact labor, equipment, logistics, jobsite overhead, cost of capital, and a variety of other industry considerations.
3. SLO 3: A successful construction project requires appropriate construction documents that are often embodied in the project manual. Some of the most important documents are the contracts among the different parties that will dictate responsibilities and actions as the project moves forward. Properly identifying risks and fairly allocating these through a proper set of contracts are tasks that construction executives are faced with on a daily basis.
4. SLO 4: A construction execution plan includes the development of construction cost estimates, construction schedules and addressing project specific logistical issues. These issues constitute the core foundation of responsibilities for a construction professional in the heavy civil construction industry. The heavy-civil course is an elective course for the certificate in construction management. However, this course was the only offered elective and was taken by all students in the program. It is anticipated that the course was also taught in Spring 2017 semester and is anticipated to be taught again in Spring 2018.

### Communicating Student Learning Outcomes

The student learning outcomes were communicated to the faculty at a graduate faculty meeting. The assessment submissions were also shared with faculty. The student learning outcomes will be posted on the school’s website.

## Curriculum Map

1. The curriculum map below demonstrates where the various SLO’s are covered and assessed in the curriculum.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Course Title | SLO 1 | SLO 2 | SLO 3 | SLO 4 |
| Construction Cost Estimating | I, R, M, A |  |  |  |
| Construction Scheduling |  | I, R, M, A |  |  |
| Construction Law and Risk Management |  |  | I, R, M, A |  |
| Heavy Civil Construction |  |  |  | I, R, M, A |
| I = Introduce, R = Reinforce, M = Master, A = Assess |  |  |  |  |

## Measurement

### Outcome-Measure Alignment

Each of the learning outcomes are related to a skillset for a construction professional. The faculty felt the best way to measure the skillset in an academic setting is to use direct measures such as quizzes, assignments and projects to evaluate student achievement.

### Direct Measures

1. *SLO 1: This learning outcome was measured primarily from the students’ performance on a series of questions spread over two quizzes and by the students ‘performance on two graded assignments.*
   1. For the quizzes, students were provided a set of plans for a project they were not familiar with and were required to complete their quantity takeoff in a timed and controlled environment. During the graded assignments, students were required to perform quantity take-off for a project, which they had been working with the entire semester and were required to submit their deliverable by the specific date
2. *SLO 2: Students will be able to analyze the impacts of construction planning, sequencing, and scheduling based on the range of implications related to contractor choices and constraints, managerial decision-making, and project cash flow.*

This outcome was directly measured based on course quizzes and on an individual comprehensive project schedule assessment. The SLO was broken into the following sub-outcomes:

1. Construction Sequencing: Students will demonstrate their understanding of construction sequencing, means, and methods, including inherent factors and contractor choices in the process. This outcome was measured through three quizzes, based on class discussions as well as asynchronous material provided.
2. Schedule Analysis: Students will demonstrate their ability to review a construction project scope and a proposed project schedule, and then provide an in-depth analysis of the sequence and logistics. The analysis will include major sequencing strategies with which they agree or disagree, and why.
3. *SLO3: This outcome was directly measured by specific questions in quizzes and assignments. The SLO was broken up into the following three categories:*
4. Understand the US legal system: Students will demonstrate their understanding of the US legal system and the interaction of the state and federal courts. This outcome was measured by a series of questions on Quiz 1 and by the student’s individual work on Assignment #1 – Case Analysis.
5. Create a cash flow statement: The number one reason for the failure of a construction company is poor cash management / cash flow. Students will demonstrate their ability to create a construction cash flow statement. This outcome was measured by a series of questions on Quiz 2 and by the student’s individual work on Assignment #2 – Develop a Cash Flow Statement.
6. Understand the risks associated with construction projects and how contractors assume, share or mitigate the risk through contracts: Students will demonstrate an ability to identify and mitigate construction risks. This outcome was measured by a series of questions on Quiz 3 and with Assignment #3 – Letter Writing, Assignment #4 – Case Analysis and Assignment #5 – Letter Writing.
7. *SLO 4: This outcome was directly measured by specific questions in quizzes, assignments and projects. The SLO was broken up into the following sub-outcomes:*
8. Indirect Costs in Heavy Civil Construction Estimates: Students will demonstrate their understanding of including indirect costs in the unit prices of a heavy civil cost estimate. This outcome was measured by grading the cost estimate of the class project. Students worked in teams to create a construction execution plan for the interstate I-44 bridge replacement project in Missouri. Each team consisted of 4 or 5 students and the project had intermediate deadlines throughout the semester. The projects were graded using a rubric described in the results section.
9. Create Construction Schedules: Students will demonstrate their ability to create construction schedule for heavy civil construction projects. This outcome was also measured using the submissions for the team project. The rubric used to assess this sub-outcome is described in the results section.
10. Environmental Considerations: Students will demonstrate an ability to identify and mitigate environmental impacts of heavy civil construction projects. This outcome was measured in a series of four questions in quiz 3 of the course. A rubric was not used to grade student responses. The questions and student grades is presented in the results.

### Data Collection

The data collected for the generation of the report varied for each individual SLO. For all SLO’s reported in this assessment, the data was collected directly from student grades on quizzes, projects and assignments.

## Results

### Reporting Results

#### SLO 1: To analyze construction documents and perform quantity takeoff.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Quiz 2**   |  |  |  | | --- | --- | --- | | **Question** | **Description** | **Class Average** | | **1** | Reference sheet 15 (aka S-1) (Base Bid Foundation / Slab Plan) and details on sheet 17 (aka S-3), estimate only the perimeter continuous footing concrete (Do not include interior footings). Assume the footing elevation does not change, do not account for steps in the foundation. Please provide the quantity and price | **77%** | | **2** | Reference sheet 15 (aka S-1) (Base Bid Foundation / Slab Plan) and details on sheet 17 (aka S-3) estimate the building slab assume 4" thickness. Please provide the quantity and price | **95%** |   **Quiz 3**   |  |  |  | | --- | --- | --- | | **Question** | **Description** | **Class Average** | | **1** | Estimate the 8” back-up block wall (do not included interior partitions) around the exterior of the building. Assume wall height of 10”-8” around the entire perimeter.  Use elevation drawings to back out windows, doors, louvers, etc. | **81%** |   **Graded Assignments**   |  |  | | --- | --- | | **Assignment** | **Class Average** | | Concrete Takeoff | **94.3%** | | Masonry & Steel Takeoff | **89.65%** | |

#### SLO2:

1. Construction Sequencing: Students were taught about construction processes and sequencing including sitework, foundations, steel and concrete structures, mechanical/electrical/plumbing systems, building skins and veneers, and interior finishes. This is one of the first courses offered in the curriculum/certificate program, and in many ways is a foundation effort given that many of the students enrolled come from a business/non-technical background. Students were assessed on their knowledge of these considerations in 3 quizzes, compartmentalized by topic group. The class average for each quiz is presented in the table below. A rubric was not used to grade the quizzes.

|  |  |  |
| --- | --- | --- |
| **Assessment** **#** | **Assessment Sequencing Topic** | **Class Average** |
| 1 | Sitework, Foundations, and Basic Schedule Logic | 88.33 |
| 2 | Sequence of Building Structures | 86.30 |
| 3 | Sequence of Building Systems, Skins, and Interiors | 82.17 |

1. Schedule Analysis: Students were provided a set of construction documents for a 96,000 SF institutional building, as well as a proposed schedule for the project. The schedule was generated in Primavera software, and included over 100 activities. Students then reviewed the scope and proposed schedule, and provided an analysis of the proposed sequence including major strategies/issues with which they agreed or disagreed. The assignment format was a narrative in prose, with a maximum of 500 words. Submissions were evaluated by the instructor based on whether student assessment included relevant major items that would likely be considered in industry. As this could contain some subjectivity, the instructor’s assessment gave latitude in the items addressed by students, as long as they were relevant, significant, and aligned with course discussion. Class average is shown below:

|  |  |
| --- | --- |
| **Assessment** | **Class Average** |
| AU Forestry Facility – Schedule Assessment | 92.78 |

#### SLO 3: Students will understand the legal implications of contract, common and regulatory law to manage a construction project.

Understand the US legal system: Quiz 1 tested the students’ comprehension of the US legal system. A series of 35 questions were used to measure how well they understood the materials presented and readings about the organization of the US legal system. In addition, the students read and analyzed a construction related case that dealt with the parties trying to litigate in both the state courts and federal courts.

Grade Distribution (10-point grading scale used throughout) – Quiz 1:

A – 12 students

B – 9 students

C – 2 students

D – 1 student

F – 0 students

Assignment #1 – Case Analysis:

A – 21 students

B – 3 students

C, D, F – 0 students

Narrative: Two of the three students scoring below the 80% mark indicated that the time constraint on Quiz 1 was the cause of their performance being lower than they expected.

Create a cash flow statement: Students were provided year-end financial statements for a commercial construction company doing approximately $50 million in annual revenue. From these financial statements, the students were required to create a monthly cash flow statement for the company. Quiz 2 tested the students’ comprehension of this material. A series of 40 questions were used to measure how well they understood the material presented.

Grade Distribution – Quiz 2:

A – 6 students

B – 4 students

C – 6 students

D – 5 students

F – 3 students

Assignment #2 – Cash Flow Statement:

A – 16 students

B – 2 students

C – 4 students

D – 0 student

F – 2 students

Narrative: The students agreed that this section was the toughest part of the class. Creating a monthly cash flow statement is a detailed Excel problem. Some of the students acknowledged that did not have a very good background in Excel.

Understand the risks associated with construction projects and how contractors assume, share or mitigate the risk through contracts: The instruction provided and readings focused on three subject areas of major importance and two areas of lesser importance. The former area covered contracts, insurance and surety bonds. The latter focused on workplace law and environmental law. Quiz 3 tested the students’ comprehension of this material. A series of 36 questions were used to measure how well they understood the materials presented and required readings. In addition, the students read and analyzed a construction related case that dealt with an owner terminating a contractor and wrote two letters on issues related to this case.

Grade Distribution – Quiz 3:

A – 19 students

B – 4 students

C – 0 students

D – 0 students

F – 1 student

Assignment #3 – Letter Writing

A – 10 students

B – 8 students

C – 4 students

D – 0 student

F – 2 students

Assignment #4 – Case Analysis

A – 13 students

B – 7 students

C – 2 students

D – 1 student

F – 1 student

Assignment #5 – Letter Writing

A – 15 students

B – 4 students

C – 4 students

D – 0 student

F – 1 student

Narrative: One student, for reasons never revealed, dropped out of the program before Quiz 2. Therefore, one of the Fs reported on Quiz 2 and 3 and on Assignments 2 – 5 belong to this student.

#### SLO 4: Students will be able to create construction execution plans for heavy civil projects.

Indirect Costs in Heavy Civil Construction Estimates: Students were required to develop a construction budget for the I-44 bridge replacement project. As part of the submission, students were required to show a detailed project estimate and a verbal narrative addressing their approach to indirect costs. The project estimates were graded for accuracy and the narratives were graded for their approach for incorporating indirect costs in their estimates.

Project Estimate:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | The project estimate deviates more than… | | | | |
|  | > 10% | 10% | 5% | 2% | 0% |
| Group 1 |  | X |  |  |  |
| Group 2 |  |  |  | X |  |
| Group 3 |  |  |  | X |  |
| Group 4 | X |  |  |  |  |
| Group 5 | X |  |  |  |  |

Project Narrative:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Narrative accurately and fully describes how indirect costs are included in the estimate |  | X | X |  |  |
| Narrative fully describes how indirect costs are included in the estimate, but includes errors in assumptions | X |  |  | X | X |
| Narrative does not address some aspects of how indirect costs are included in the estimate and has some errors |  |  |  |  |  |
| Narrative misses several aspects of items that constitute indirect costs and is inaccurate in its assumptions regarding including items in the estimate |  |  |  |  |  |
| Narrative does not address how indirect costs are included in the estimate and is not accurate |  |  |  |  |  |

Create Construction Schedule: Students were required to create a construction schedule for the I-44 bridge replacement project. The schedules submitted by students were graded using a rubric, on a Likert scale.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| The schedule includes all activities required to complete the project | 4 | 5 | 5 | 4 | 4 |
| The logical sequence of activities accurately depicts a reasonable schedule for a bridge replacement project | 4 | 4 | 5 | 5 | 4 |
| The duration of activities is reasonable to complete the tasks in the allotted amount of time | 4 | 5 | 4 | 5 | 5 |
| The scheduling software used to create the schedule was fully leveraged to show the schedule in a readable format | 3 | 5 | 5 | 4 | 3 |
| The critical activities in the schedule reflect a logical sequence of activities, in the order of importance to the overall schedule | 4 | 5 | 5 | 4 | 4 |
| 5 = Excellent; 4 = Good; 3 = Average; 2 = Below Average; 1 = Poor; | | | | | |

Environmental Considerations: Students were taught about issues related to environmental impacts of heavy civil construction projects. Earth moving is a significant aspect of heavy civil projects and the activities related that have strict environmental regulations. Students were tested on their knowledge of these environmental considerations in quiz 3. The four questions and the class average for each question are presented in the table below. A rubric was not used to grade the questions.

|  |  |  |
| --- | --- | --- |
| Question |  | Class Average |
| 1 | Give three reasons why SWPP plans are important for the construction industry. | 4.8 / 5 |
| 2 | Describe three key issues for effective sediment control on construction sites. | 4.9 / 5 |
| 3 | Discuss EPA suggestions for minimizing any potential negative impacts of cofferdams in waterways. | 4.4 / 5 |
| 4 | Discuss the staged approach for BMP installation on highway paving projects. | 4.6 / 5 |

1. Interpreting Results

#### SLO 1:

1. Based on the scores reported in the quizzes and graded assignments, the faculty agree that students have achieved the SLO.

#### SLO2:

1. Construction Sequencing: Assessment results across the three quizzes suggest that there is a reasonable level of understanding, although room for improvement. A closer look at individual scores suggests that a few students’ results may perhaps be skewing the average. This may indicate that overall the class is demonstrating a more solid understanding, but that improvements could be made to better prepare the entire group. Based on the executive delivery of the course, there could also be some consideration given the asynchronous material delivery and the on line nature of the assessments. The residency vehicle could be used to show samples of the material, and perhaps deliver a practice quiz.
2. Schedule Analysis: Assessment results for the prose analysis suggest that as a group, students developed reasonable skills in reviewing contract documents and then providing an analysis of a proposed project sequence/schedule. The word count constraint was intended to challenge the students to be selective in issues that they raised, although in some cases it resulted in the reflection of issues chronologically as opposed to by priority. Clarity to this could be provided, and the maximum word count could be reconsidered.

#### SLO 3:

1. Understand the US legal system: While this material is the most basic in the course, students typically do not do as well on it as the later material. This may be due to the breadth of the material or it may be that the later material is focused on construction and is therefore more interesting to the students. A better explanation as to why this material is important to the topic of construction law may be helpful for the students.
2. Create a cash flow statement: Students typically have a difficult time grasping this material at the outset. This may be due to lack of understanding of financial statements or a poor foundation in the use of spreadsheets. Two person teams for purposes of this assignment may be helpful to the students.
3. Understand the risks associated with construction projects and how contractors assume, share or mitigate the risk through contracts: Students are typically not very familiar with the various types of insurance encountered on a construction project nor how surety bonds actually work; but students find the material easy to grasp. No further action is deemed necessary in this area.

#### SLO 4:

1. Indirect Costs: The results for the construction cost estimation portion indicates that some groups made errors in calculating the estimate for the bridge replacement projects. Students need to be better taught about how to calculate the estimate totals for a heavy civil project. Students did a reasonable job in describing how indirect costs were calculated and included in the estimate. A narrative rubric should be given to students in the future to better guide their responses.
2. Construction Schedule: Student teams did a reasonable job creating construction schedules for the I-44 bridge replacement project. The averages across all categories was more than 4, except in the use of the scheduling software. Students may need a refresher on how to use construction-scheduling software. Some detailed instructions on how to print the scheduling to a PDF file would benefit students.
3. Environmental Considerations: The grades from Quiz 3 indicate that students had a high degree of knowledge and confidence in dealing with environmental considerations on a heavy civil project. No further action is deemed necessary in this area.

### Communicating Results

The results of this assessment are shared with graduate faculty in the McWhorter School of Building Science. A faculty meeting of the graduate faculty was held to discuss the results of the assessment.

## Use of Results

### Purposeful Reflection and Action Plan

The results of the assessment exercise did not indicate any glaring issues as they relate to student learning outcomes. Whereas, a few students did not perform well in the construction law class, it must be stated that two students had already decided that they would not be returning to complete the rest of the certificate programs (certificate 2 and 3). Faculty agreed to make minor changes in the course they teach. No large-scale changes are expected to be made at this time.