

# An Innovative Approach to Teaching and Assessing Student Learning Outcomes Related to Construction Means and Methods

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This paper describes the innovative use of construction method statements to teach and evaluate student learning outcomes in a new advanced methods and material class in the McWhorter School of Building Science at Auburn University. In response to the introduction of the new ACCE Standards in 2014, the building science faculty conducted a major curriculum review. In relation to the area of construction means and methods, the aim was to incorporate material into the curriculum that would prepare students, upon graduation, to be able to “Analyze methods, materials, and equipment used to construct projects”. The result of the curriculum review identified the need to have a new senior level class entitled “Construction Project Analysis”. After considering several methodologies, the faculty decided to use construction method statements as the framework for enhancing student mastery of the student learning outcomes contained in the new course. The faculty chose to use construction method statements because method statements provide a framework to comprehensively evaluate students’ ability to analyze construction means and methods. The structure of a construction method statement is also flexible enough to allow the evaluation of other student learning outcomes such as quality assurance/control and controlling construction waste. The use of construction method statements is innovative because the practice of preparing method statements is a common practice in the United Kingdom but one that is not employed in the United States. This paper summarizes the use of construction method statements in teaching and assessing this advanced course for construction means and methods, quality assurance/control and controlling construction waste.

**Key Words: construction method statement, construction means and methods, construction quality, construction education**

## Introduction

The American Council for Construction Education (ACCE) currently accredits 75 construction programs in the United States (ACCE, 2018). In July 2014, the ACCE approved its current Standards and Criteria for Accreditation of Construction Education Bachelor Degree Programs. These standards incorporated a major cultural shift away from a prescriptive set of standards based on minimum hour requirements of subject matter and coverage of topical content and toward the demonstration of achievement of student learning outcomes. The requirements related to construction means and methods is one good example of how this accreditation change has caused construction programs to rethink how they teach and assess student learning.

Prior to introduction of the new ACCE Standards and Criteria, programs had to demonstrate they had taught at least six semester credit hours (90 instructional hours) of construction methods and materials, and covered specific topical content as part of that 90 hours of instruction. The topical content included composition and properties; terminology and units of measure; standard designations, sizes and graduations; conformance references and testing techniques; products, systems and interface issues; equipment applications and utilization; comparative cost analysis; assembly techniques; equipment selection; and building codes and standards (ACCE, 2014). As part of the last accreditation cycle, the building science program at Auburn University identified 178 hours of instruction related to construction

methods and materials. The majority of this material was taught in a sophomore survey class entitled “Construction Method & Materials” and two classes on mechanical and electrical systems.

In response to the introduction of the new ACCE Standards approved in July 2014, the building science program at Auburn University conducted a major curriculum review. In relation to the area of construction means and methods, the aim was to incorporate material into the curriculum that would prepare students, upon graduation, to be able to “Analyze methods, materials, and equipment used to construct projects”. The new standards would also require the program to demonstrate students had met this student learning outcome. The result of the curriculum review identified the need to have a new senior level class entitled “Construction Project Analysis”. In the course development process, it was evident that the learning outcome “Understand construction quality assurance and control” could also be assessed in this course.

The next problem addressed by the faculty was to formulate an effective strategy to assess the student learning outcomes of “Analyze methods, materials, and equipment used to construct projects” and “Understand construction quality assurance and control”. After considering several methodologies, the faculty decided to use construction method statements as the framework for enhancing student mastery of the student learning outcomes contained in the new course. The faculty chose to use construction method statements because this allows a comprehensive evaluation of students’ ability to analyze means and methods. The structure of a construction method statement is also flexible enough to allow the evaluation of other student learning outcomes such as quality assurance/control and managing construction waste.

The use of construction method statements for teaching and assessment is innovative because the practice of preparing method statements is not employed in the United States, but it is a more common practice in the United Kingdom. Requiring the students to prepare a method statement for a construction project requires them to analyze the project in depth to determine/identify: (1) means and methods, (2) major construction risks, (3) safety risks, (4) work sequence, and (5) resource requirements. This paper describes the use of construction method statements in teaching and assessing student learning in this advanced course for construction means and methods.

## **Defining a Construction Method Statement**

Method statements for construction (also known as construction method statements) are used in the United Kingdom to identify and control site-specific health and safety risks on a project. The United Kingdom’s Construction Design and Management (CDM) Regulations and its regulatory government agency, the Health and Safety Executive (HSE), do not require the use of method statements; however, their use is accepted as meeting the regulatory requirements set forth by these regulations for the overall management and safe execution of construction projects (Designing Buildings, 2018). This being the case, the use of method statements has expanded to include all aspects of construction project planning in addition to safety and risk mitigation.

According to the Building Construction Handbook (the authoritative reference for all construction students and professionals in the United Kingdom), “a method statement precedes preparation of a project programme and contains the detail necessary for construction of each element of a building. It is prepared from information contained in the contract documents. It also serves as a brief for site staff and operatives in sequencing activities, indicating resource requirements and determining the duration of each element of construction. It compliments construction programming by providing a detailed analysis of each activity.” (Chudley & Greeno, 2016). Method statements are not only used to formalize construction planning; they are also used to communicate the overall project execution plan to owners and other project stakeholders. A properly prepared method statement sets the stage for good communication and relationships between all project stakeholders from the onset of the project (March, 2009).

As stated above, regulatory agencies in the United Kingdom do not require the creation of method statements. Therefore, there is no prescribed format for these documents. Nevertheless, preparation of construction method statements have become common practice. While there is no prescribed format, method statements should not be excessively long or overly complex since they are used to aid conducting activities on site. As such, they should easily communicated to managers and workers at the site level (Cooke & Williams, 2009). An additional benefit of

a method statement is that it forces the contractor to review their means and methods for project execution. If an operation or element of the plan cannot withstand investigation, it should be revised or eliminated (March, 2009). A review of actual method statements revealed the following common elements:

- Project Description
- Assessment of Significant Construction Risks
- Protection of Existing Structures
- Safety Control Measures
- Work Sequence
- Preliminary Construction schedule
- Resource Requirements
- Quality Control and Quality Assurance Measures
- Equipment Utilization

The length and detail provided in individual construction method statements is dependent on the scope, complexity, and risks associated with each project. Including the elements listed above facilitates the analysis of means and methods prior to construction. Properly prepared, a method statement provides the basis for a construction company's safety plan, detailed cost estimate, detailed construction estimate, and provides a preliminary plan/schedule for executing the work. Although construction method statements are not commonly prepared by contractors in the United States, their flexible structure makes them an excellent vehicle for students to analyze construction means and methods from a set of construction documents prior to the start of construction from a different perspective by using a tool that is common practice in other countries.

### **Incorporating the Use of Method Statement into Course Content & Assessment**

The advanced construction means and methods class at Auburn University is entitled Construction Project Analysis. In addition to concentrating on means and methods, the course material includes lectures on quality assurance and control, construction waste management, and construction risk. Table 1 below contains the course objectives and the associated ACCE student learning outcomes (ACCE Doc. 103B, 2018):

Table 1

***Course objectives and student learning outcomes for Construction Project Analysis***

<b>Course Learning Objectives</b>		<b>Associated ACCE Student Learning Outcomes</b>	
<b>No.</b>	<b>Description</b>	<b>No.</b>	<b>Description</b>
1	Interpret the important & relevant construction issues in a geotechnical report	8	Analyze methods, materials, and equipment used to construct projects
2	Compare equipment used to construct buildings	8	Analyze methods, materials, and equipment used to construct projects
3	Break down a construction project into distinct phases	8	Analyze methods, materials, and equipment used to construct projects
4	Describe how construction companies reduce construction waste	18	Understand the basic principles of sustainable construction
5	Compare different materials & methods & equipment for various construction scenarios	8	Analyze methods, materials, and equipment used to construct projects
6	Identify quality requirements (quality standards) and the quality control/assurance items contained in a construction contract including codes and compliance inspections.	15	Understand construction quality assurance and control
7	Define and differentiate quality, quality control, quality assurance, total quality management, and quality improvement.	15	Understand construction quality assurance and control
8	Explain a quality control/assurance plan appropriate for a construction project	15	Understand construction quality assurance and control
9	Create a method statement for a construction project	8	Analyze methods, materials, and equipment used to construct projects
		15	Understand construction quality assurance and control
		18	Understand the basic principles of sustainable construction

As can be seen in Table 1, all of the student learning outcomes for the course are evaluated during the creation of the construction method statement for a project. More specifically, by composing and creating a plan for these student learning outcomes, students are evaluated based on an in-depth analysis of these items and their ability to apply them to an actual construction project.

One of the innovative portions of this course is the in-depth discussion on construction quality assurance and quality control. This area was not covered extensively in the previous curriculum prior to the inception of this course. Since one of the purposes of a construction method statement is to communicate the plan for executing a project to all stakeholders, including owners, the faculty made the determination that including a quality assurance and control plan as a requirement for the students' method statement would be appropriate. Making this a requirement had the added benefit of allowing a high-level assessment of this course objective and associated student learning outcome.

Since quality assurance and control are not standard across the industry, the faculty invited guest lecturers from several regional contractors to explain their quality management systems. In addition, the students were given a

lecture on the U.S. Army Corps of Engineers' quality assurance system and its three-phase quality control system. Taken together, these lectures presented the students with an excellent overview of quality management systems currently employed by the construction industry. The diversity of the presented material was designed to stimulate student thought as to how they will manage quality when they enter the workforce.

The course evaluation and assessment for Construction Project Analysis includes three quizzes and the creation of a construction method statement. Course objectives 1, 3, 5, and 6 are evaluated on Quiz 1; course objectives 2, 3, and 4 are evaluated on Quiz 2; and course objectives 6, 7, and 8 are evaluated on Quiz 3. Each quiz is worth 20% of the course grade for a total of 60%. The quizzes are designed to evaluate the students' comprehension of the material to ensure they are prepared to create a construction method statement. The method statement comprises the remaining 40% of the course grade.

In order to graduate from the undergraduate building science program at Auburn University, students are required to complete a thesis project. The thesis project is selected by each student. The cost for the project must be between \$1M and \$3M and have a floor area between 9,000 SF and 12,000 SF. For their selected thesis project, students are required to obtain a set of drawings and specifications. Using this information, they are required to prepare key preconstruction documents, a construction cost estimate, a detailed schedule, a safety plan, a cash flow diagram, a structural model, and other associated documents. The thesis project is completed the last semester prior to graduation.

Construction Project Analysis is a required course that is offered in the penultimate semester prior to graduation. When preparing the course materials for Construction Project Analysis, consideration was given to selecting a single construction project that all students would use to create a method statement. Upon further consideration, the instructor made the decision to require students to select the thesis project they would use the following semester and obtain the plans and specifications for the project. Doing so would allow students to analyze and prepare a construction method statement for their thesis project. The reasoning for this decision was that analyzing their thesis project would be a more realistic scenario and better prepare students to complete their thesis project as well as improving the final product. By creating a method statement for their thesis project, the students would be compelled to perform an in-depth analysis prior to starting work on their construction documents.

While preparing a method statement for a construction project is a new concept for our students, many of the individual elements comprising the method statement are taught in other courses in the curriculum. Therefore, preparation of the method statement not only introduces new material, but it reinforces the content and knowledge gained in several other courses. Table 2 below contains the outline of the method statement the students are required to create for their unique project, as well as the courses in the curriculum that prepare the students to prepare the individual elements of the method statement. As for the elements that are taught in Construction Project Analysis, the material is presented in a series of lectures and the students are then required to complete practical exercises to reinforce the lecture material. As for the overall preparation of the method statement, numerous examples of project method statements are provided to the students for their review to stimulate their thinking as to how to prepare their own method statement. Since there is no standard for a construction method statement, students are not given a prescriptive format. Rather, they are given the outline shown in Table 2, which contains the required information. It is left up to the students as to how to best present the required information. Students' construction method statements are graded using a rubric that follows the provided outline.

Table 2

***Method statement outline***

<b>Method Statement Outline</b>	<b>Preparatory Courses</b>
Project Overview <ul style="list-style-type: none"> <li>○ Project description and location</li> <li>○ Project stakeholders</li> </ul>	Preconstruction and Project Management
Risk Analysis <ul style="list-style-type: none"> <li>○ Identification of project risks</li> <li>○ Plan to eliminate or mitigate risks</li> </ul>	Construction Safety Construction Project Analysis
Means and Methods Analysis <ul style="list-style-type: none"> <li>○ Crane selection</li> <li>○ Major equipment selection</li> </ul>	Construction Means and Methods Construction Project Analysis
Preliminary Schedule <ul style="list-style-type: none"> <li>○ Phasing</li> <li>○ Work Sequence</li> </ul>	Scheduling and Field Operations
Preliminary Safety Plan <ul style="list-style-type: none"> <li>○ Identify at safety hazards</li> <li>○ Plan for mitigating hazards</li> </ul>	Construction Safety
Preliminary Quality Assurance/Control Plan <ul style="list-style-type: none"> <li>○ Create overall QA/QC system</li> <li>○ Detailed QA/QC plan for two specification sections</li> </ul>	Construction Project Analysis
Construction Waste Management Plan	Construction Project Analysis
Subcontracting Plan	Preconstruction and Project Management
Resource Requirements for Self-performed Work <ul style="list-style-type: none"> <li>○ Crew size</li> <li>○ Productivity</li> </ul>	Construction Estimating

**Preliminary Evaluation of the Course**

The Construction Project Analysis course was first offered in the fall semester of 2018. In addition to the normal student course evaluation, students completed a more detailed questionnaire that solicited their feedback concerning their perceived effectiveness of the course as well as their suggestions for improvements. Table 3 below contains a summary of student answers to this questionnaire. Following Table 3 is a brief analysis of the collected data.

Table 3

***Perceived student assessment of Construction Project Analysis course***

<b>Q1 List the 3 best aspects of this class. (Top 3 answers)</b>						
Overall course organization and content						64.1%
Earthwork means and methods/equipment selection						60.9%
Use of method statements to analyze thesis project and/or preparation for thesis						59.4%
<b>Q2 List 3 aspects of this class that need improvement. (Top 3 answers)</b>						
Need more method statement guidance						43.8%
Break method statement into segments instead of one submission at end of semester						31.3%
Overall course organization						28.2%
<b>Q3 Approximately how many hours did you spend working on the method statement assignment?</b>						
Mean: 29.51 hours						
<b>Q4 Do you think it would be better to submit the method statement in segments throughout the semester or submit it as one assignment at the end of the semester?</b>						
Submitted in segments						74.1%
One submission						22.4%
No opinion						3.5%
<b>Q5 Preparing a method statement has been helpful in preparing me to complete thesis next semester.</b>						
Strongly Disagree	Somewhat Disagree	Disagree	Neutral	Somewhat Agree	Strongly Agree	
3.4%	0.0%	0.0%	0.0%	20.3%	76.3%	

The following is a brief analysis of the collected data:

- *Question 1:* The percentages for the top three answers were high given the open-ended nature of the question. Even though there are numerous subjects covered in the course, a majority of the students liked the course content and organization. A majority also liked the time spent teaching earthwork means and methods and equipment selection. It is also clear from the responses that the students realize the value of the analysis required to prepare a method statement.
- *Question 2:* The number one response for this question reflected the desire of some students to have a more complete definition of the requirements for completing the construction method statement. As stated above, students were given an outline of the information that should be included in the method statements. However, the instructor resisted the temptation to make the instructions too prescriptive. To do so would have stifled student creativity. Some of the value of having the students prepare a method statement is that they are required to tailor the final product based on the unique attributes of their selected project.
- *Question 3:* The students each reported spending an average of almost 30 hours preparing their method statement. The fact that the assignment took this much time speaks to the rigor of the analysis they performed as well as the amount of effort it took to prepare the method statement document for submission.
- *Question 4:* The majority of the students believe that it would be better to submit the method statement in sections throughout the semester rather than one submission at the end of the semester. A deeper analysis of their comments indicated that they preferred completing the assignments in segments so they could receive early feedback to determine if they were meeting the intent of the assignment. Other student comments indicated that submitting the method statement in segments would force them to manage their time better and avoid a panicked rush at the end of the semester to complete the assignment.
- *Question 5:* The students overwhelmingly agreed that the preparation of a method statement was helpful in preparing them for their thesis. This result is to be expected given the nature of the assignment that allowed them to analyze their selected thesis project.

## Discussion

Although the data collected and summarized above is preliminary in nature, the answers to the questionnaire indicate that, from the students' perspective, the overall course and the use of construction method statements were effective teaching tools and prepared them to successfully complete their thesis project. As the course is offered in subsequent semesters, the faculty will continue to collect data in an effort to validate these early results. In the meantime, minor course content changes are being considered to improve the student learning experience. For instance, allowing students to prepare and submit one section of the construction method statement would set grading and quality standards for the remainder of the project. In addition to the course completion questionnaire, the faculty plan to have students complete a follow-up questionnaire after the completion of their thesis project to determine what knowledge gained in the Construction Project Analysis course was actually useful in the thesis process. The faculty will then analyze the collected data to make any needed revisions and improvements to the course material. In addition to soliciting data from the students' perspective, the faculty plans to collect and analyze quantitative data by comparing thesis grades both before and after the introduction of the Construction Project Analysis course into the curriculum. However, the collection and analysis of this data will take several semesters.

In summary, this paper documents the design of a new course in the building science program at Auburn University intended to teach and assess how students analyze and plan the execution of construction projects in the pre-construction phase. More specifically, it documents the innovative use of a construction method statement to both teach and evaluate course objectives and ACCE student learning outcomes. This approach prepares students to analyze and plan the approach they will use on their thesis project. The use of a method statement teaches the value of prior planning and should enrich the learning experience students gain from their thesis. The argument could be made that this approach has limited value for the students after graduation because construction contractors in the United States do not prepare or utilize method statements as part of their project planning and preparation. However, the faculty believes that requiring students to analyze projects from a different perspective using tools that are used in other countries is extremely valuable. The preparation of a method statement compels students to look at construction projects from a different perspective than the other courses in the curriculum. By doing so, it will improve their overall analytical skills and encourages them to think "out-of-the-box". When students join the work force, they will bring this additional analytical perspective to their employers. This creates a diversity of thought that, in the long term, will make them more effective construction professionals. Instead of applying the various elements of project planning piecemeal, they are compelled to analyze how the choices they make during preconstruction affect the overall planning process, and ultimately, project execution.

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