

Identifying the Static and Dynamic Nature of Course Content: Focus on Construction

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Abstract

There is a variety of academic programs in the United States that produce students ready to be employed in the construction industry. These programs are generally accredited by ABET or ACCE. ABET accredited programs are reviewed by a variety of commissions, such as the Engineering Accreditation Commission, the Engineering Technology Accreditation Commission, and the Applied and Natural Science Accreditation Commission, and have descriptions such as “Construction Management”, “Construction Engineering”, “Construction Engineering Technology”, etc. ACCE accredited programs are more streamlined, and their descriptions are in general “Construction Management”.

In any case, these programs have curricula that are similar in various ways, and this research aims to identify these similarities. Research presented in this paper shows results from a survey of faculty from these programs that aimed to identify: 1) courses/topics with content that does not dramatically change over time and does not need to be constantly updated, 2) courses/topics that need constant updating and for what reasons, 3) courses/topics that are novel and represent material that is in the forefront of construction engineering/management technology, and 4) topics that will be appearing in curricula in the near future.

The results of this investigation will help construction programs plan their future curricula and help program administrators ensure an even faculty workload distribution.

Key words: Construction, Course Preparation, Education

Background

Faculty should strive to improve their courses. It is an obligation to students and to the teaching profession in general for faculty to provide a classroom environment that is engaging, and with course material that challenges and informs students of new techniques, knowledge, and the critical reasoning skills necessary for the modern professional environment. Some examples where faculty document this course modernization include the efforts to further engage students in engineering economy [1], to introduce new methodologies relating to computer vision [2], or to address content obsolescence in a computer science course [3]. In any case, these changes generally involve and require substantial effort by faculty, many of them might feel uncertain if these changes can be successful after their implementation.

In this paper, the authors investigate course content upgrades in the construction management/engineering education in US universities, and identify whether courses are “static” or “dynamic”. The authors define “static” courses as courses where the course content does not change over time. This does not suggest that faculty do not update examples or class projects from year to year, nor that faculty do not try to improve their method of course delivery with innovative teaching methodologies. Rather, “static” relates to course topics and themes that remain the same over time. This “static” nature can be due to the lack of innovation or new

industry improvements. “Dynamic” courses on the other hand, are courses where the content requires frequent updates due to a variety of reasons such as changes in technology within the construction industry, and maturation of the course topic area.

The objectives of this investigation were to:

- Identify courses/topics with content that does not dramatically change over time and do not need to be constantly updated, with reasons as to why that would be the case.
- Identify courses/topics that need constant updating and for what reasons.
- Identify courses/topics that are taught in construction programs that are novel and represent material that is in the forefront of construction engineering/management technology, and
- Identify and provide input on possible topics that will be appearing in curricula in the near future.

Methodology

For this investigation, the authors developed a survey which was distributed in the fall of 2022 to the U.S. population of faculty in ABET-[4] and ACCE-[5] accredited programs related to construction. Specifically, from the ABET accreditation agency, 92 programs were selected that satisfied the following criteria:

- Civil Engineering Technology (n=20)
- Construction Engineering (n=23)
- Construction Engineering Technology (n=24)
- Construction Management (n=25)

From the ACCE accreditation board all 75 baccalaureate degree programs were selected from the list available on the ACCE website. Because of some overlap in accreditation board and criteria assessed, the final number of unique programs was 132. Using online searches through departmental websites, individual faculty were selected from all of the identified universities. In total, 1,106 faculty were selected for the survey. Approval for distribution of the survey passed Bucknell University’s IRB requirements (Approval Number 2223-067). The departments/schools were further identified and categorized according to the 2018 Carnegie Classification of Institutions [6] they belong to as follows:

- R1: Doctoral Universities - Very high research activity,
- R2: Doctoral Universities - High research activity,
- D/PU: Doctoral/Professional Universities,
- M1: Master's Colleges and Universities - Larger programs,
- M2: Master's Colleges and Universities - Medium programs,
- M3: Master's Colleges and Universities - Smaller programs, and
- Baccalaureate Colleges: Arts & Science Focus or Engineering Focus.

The survey questions were separated into several groups. The first section asked questions about the individual faculty teaching experience. The researchers asked about the number of courses

they teach per year, and then they were asked to identify the course topics they have experience teaching, along with the course level (first year, sophomore, junior, or senior). The researchers conducted an initial search of courses/topics to include in this section and provided space for the faculty to include up to four additional courses not included in that original list. The initial list of course/topics was the following:

1) Introduction to construction, 2) Statics, 3) Construction materials/Mechanics of Materials, 4) Construction Safety/Safety Engineering, 5) Construction Estimating, 6) Construction Scheduling, 7) Mechanical Systems, 8) Electrical Systems, 9) Engineering Graphics, 10) Virtual Design/Construction, 11) Engineering Economics, 12) Contracts and Specs/Legal Aspects, 13) Project Management, 14) Construction Means and Methods, 15) Heavy Civil Construction, 16) Temporary Structures/Construction, 17) Surveying, 18) Geotechnical Engineering/Soil Mechanics, 19) Structural Engineering/Design, 20) Concrete Design, 21) Steel Design, and 22) Senior Design/Capstone.

After identifying the courses for which they have experience teaching, the faculty were asked to identify the frequency with which they update the course content for these courses. The question was specific for them to identify the frequency with which content was updated, and not the method with which the content was delivered in class. Since the definition for frequency is subjective, faculty participating in the survey were provided with the following options:

- After the first time I taught the course, the majority of the content remained the same without changes
- After the first time I taught the course/topic, I revise a majority of the content again after every 4 or 5 times I teach the course/topic
- After the first time I taught the course/topic, I revise a majority of the content again after every 2 or 3 times I teach the course/topic
- I revise the majority of the content for this course/topic EVERY time I teach it

If they selected that they do not update the course, they were then asked the following questions:

- Why do you think the content for the courses/topics you indicated, do NOT require frequent update?
- Are there difficulties in finding content to incorporate in these courses/topics? Please describe:

If they selected that they update the course content, they were then asked the following questions:

- Why do you think the content for the courses/topics you indicated requires frequent update?
- Are there difficulties in finding content to incorporate in these courses/topics? Please describe:

In the next set of questions, the participants were asked about their own departments. The following questions were used using the following scale: None, 1-19%, 20-39%, 40-59%, 60-79%, 90-99%, and All.

- The percentage of courses in my department/academic unit that do NOT need content updating
- The percentage of courses in my department/academic unit that need content updating
- What percentage of undergraduate courses in your department/academic unit do you think are at the forefront of the construction industry?

The survey continued with two general questions regarding course novelty and possible courses that they expect would appear in the near future. These questions were:

- Please identify courses/topics that are taught in your program/academic unit which you think are at the forefront of the construction industry? (Please list both Graduate and Undergraduate courses/topics.)
- What possible courses/topics do you believe will be appearing in the near future in construction engineering/management/technology curricula?

The last section of the survey asked demographic questions, and that section was optional to the participants. The survey was distributed via Qualtrics and a reminder to complete the survey was sent out 2 weeks later. A total of 164 valid responses were received, representing a response rate of 14.8%. Responses were obtained from 76 unique universities, representing 57.6% of all the different programs in the sample.

Results

Participant Characteristics

There was significant geographic representation of the responses from 37 of the 50 states as shown in Figure 1. No responses were obtained from DC or the US territories. Regarding the university classification (as shown in Table 1), the majority of the responses were from R1 institutions (n=93). Of the 164 responses, 152 were obtained from individuals from public institutions, while 12 were from individuals working in private institutions.

Table 1: Distribution of responses according to university classification

University Type	N	%
Doctoral Universities – Very High Research Activity, R1	93	56.7
Doctoral Universities – High Research Activity, R2	38	23.2
Doctoral/Professional Universities, D/PU	11	6.7
Master’s Colleges and Universities – Larger Programs, M1	16	9.7
Master’s Colleges and Universities – Medium Programs, M2	2	1.2
Master’s Colleges and Universities – Smaller Programs, M3	2	1.2
Baccalaureate Only	2	1.2
Total	164	100%

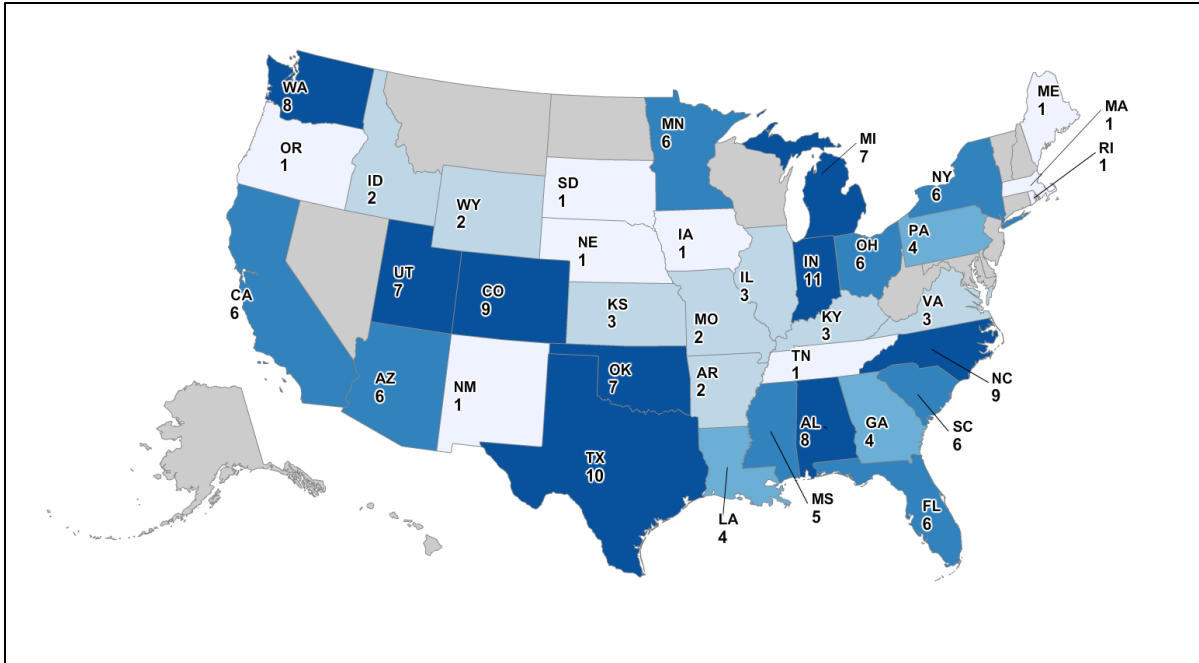


Figure 1: Geographic distribution of responses

Participant Experience

The participants who responded were asked to state their experience in teaching courses/topics that are usually present in a construction curriculum, as well as the student group to whom they have experience teaching that particular course/topic. This information is summarized in Table 2. Many participants indicated that they instruct the topics to multiple years (first to fourth), thus the sum does not match the participant number (n).

Participants had the option of adding additional courses/topics they teach, and several more were identified, such as: Plan reading, Industrial hygiene, Risk management, Asphalt design, Accounting, Leadership, Residential/Commercial construction, Roofing, Rigging, Equipment management, etc. In total more than 50 additional topics were identified. For brevity these courses were not included in the analysis presented in this publication.

Comparisons within department

Faculty were asked to identify the percentage of courses/topics in their department that do not need frequent content update. The results are shown in Table 3. Similarly, faculty were asked to indicate the percentage of courses in their department that require frequent update, and that information is shown in Table 4.

Table 2: Faculty teaching experience according to student group

Course/Topic	n	First Year	Second Year	Third Year	Fourth Year
Introduction to Construction	79	63	19	11	6
Statics	33	8	19	13	4
Constr. Mat./Mech. of Mat.	64	21	44	15	8
Constr. Safety/Safety Engr.	36	4	8	21	13
Construction Estimating	83	3	25	58	26
Construction Scheduling	76	4	11	42	48
Mechanical Systems	37	3	14	23	7
Electrical Systems	30	4	12	16	6
Engineering Graphics	35	19	18	2	3
Virtual Design/Construction	47	12	15	16	22
Engineering Economics	38	1	5	22	13
Contr. & Specs, Constr. Law	55	5	20	27	18
Project Management	74	6	10	32	54
Constr. Means and Methods	61	9	38	27	14
Heavy Civil	36	3	3	16	22
Temporary Structures	28	1	4	12	16
Surveying	26	7	14	11	3
Geotech. Eng./Soil Mechanics	23	4	6	14	7
Structural Engineering/Design	25	1	2	15	11
Concrete Design	26	2	6	15	13
Steel Design	20	0	1	12	9
Capstone	50	0	0	1	50

Table 3: Percentage of courses in academic unit that do NOT require frequent content updates

<u>None of the courses</u>	<u>1-19% of the courses</u>	<u>20-39% of the courses</u>	<u>40-59% of the courses</u>	<u>60-79% of the courses</u>	<u>80-99% of the courses</u>	<u>All of the courses</u>
11	28	33	32	15	11	0
8.5%	21.5%	25.4%	24.6%	11.5%	8.5%	0%

Table 4: Percentage of courses in academic unit that require frequent content update

<u>None of the courses</u>	<u>1-19% of the courses</u>	<u>20-39% of the courses</u>	<u>40-59% of the courses</u>	<u>60-79% of the courses</u>	<u>80-99% of the courses</u>	<u>All of the courses</u>
1	17	16	35	36	17	9
0.7%	13.0%	12.2%	26.7%	27.4%	13%	6.9%

Course/Topic Specific

The qualitative data collected is quite extensive, and for brevity in this paper, the authors will present specific information on some of the courses/topics, specifically “*Introduction to Construction*”, “*Statics*”, “*Construction Estimating*”, and “*Construction Scheduling*”.

Course/Topic 1: Introduction to Construction

The topic of “Introduction to Construction” has been taught by 79 of the faculty (Table 2), to groups ranging from first year students to fourth year students. When faculty were asked how often they update the content of that course, 10 responded that they do not update the course content, while 24 said that they update the course content every 4 or 5 times, 28 every 2 or 3 times, and 11 said that they update the course content every time they teach the course as shown in Table 5.

Table 5: Frequency of updating “Introduction to Construction”

	No change	After 4 or 5 times	After 2 or 3 times	Every Time	No resp.	Total
# of faculty responding on frequency of updating course content for “Introduction to Construction”	10	24	28	11	6	79
# of faculty who provided comments on what they update in the course/topic		15	22	6		
# of faculty describing the changes as updates in homework, examples, projects, etc. (means & methods)		2	8	3		
% of faculty describing the changes as updates in homework, examples, projects, etc. (i.e. means & methods)		13.3%	36.3%	50.0%		

When asked why there is a need to update the course, many of the faculty indicated reasons such as:

- “*To stay current in the latest trends,*”
- “*To keep the course relevant*”
- “*Important to stay current with the industry*”, and
- “*... the class should be constantly updated to reflect the trends in market shifts, labor forces, software and tools, and many, many more changes.*”

But not all comments regarding these changes were related to topic content. Of the 24 individuals who stated that they update course content every 4 to 5 years, fifteen (15) provided some explanation to that extent. From these comments, two (2) of the fifteen (or 13.3%), described reasons that relate to updates in the delivery of the course (“Means and Methods”) and not course content. Similarly, from the 28 participants who stated they update content every 2 to 3 times, 22 provided some comments, 8 of which (36.3%) described the updates as changes to the “Means and Methods” of teaching the course, and not real topic content changes. From the eleven (11) participants who stated they update the course every time, six (6) provided comments on what they update, and half of these comments (3 or 50%) related to changes in the “Means and Methods” of teaching the course. This information is also summarized in Table 5. Examples of comments provided that relate to the delivery of the course, such as updated examples, projects, etc., are the following:

- *“Updated means and methods,”*
- *“To refine the way students learn, and to provide different homework,”*
- *“Visuals/links to the references,”*
- *“Update assignments / Refresh Instructor,”* and
- *“Trying to keep students engaged in the topics with hands-on class activities, videos, demonstrations, and projects.”*

When asked if there are any difficulties in finding material, the participants who indicated that they do not update the course said that the reasons are that this particular course in introductory and the material does not change very often. Some examples of the responses were:

- *“Fundamental process of construction management does not change,”*
- *“Generally, do not see a need to as I keep it very high level in the intro portions I teach and more discussion based with Q&A,”*
- *“Basic introduction topics,”* and
- *“The course is a standard for entrance into the program and other professors teach the same course, so it is important to maintain continuity.”*

Participants were also asked if they are having difficulties in finding new material content for the course, and the participants who did not update the course indicated in the majority that they did not have difficulty.

Participants who update the content for this course, indicated that they also do not have problems in finding material. One respondent indicated that there is very little cooperation in the department, and they are finding it difficult to find material for the course.

Course 2: Statics

“Statics” has been taught by 33 faculty (Table 2), to groups ranging from first year students to fourth year students. When faculty were asked how often they update the content of that course, nine responded that they do not update the course content, while eight said that they update the course content every 4 or 5 times it is taught, nine every 2 or 3 times, and three said that they update the course content every time they teach the course (Table 6). Comments regarding the

reasons for updating the course were referring to updating examples, and to minimize cheating. A similar analysis to the one shown for “Introduction to Construction” (presented in Table 5) is shown below, regarding the types of changes faculty make to the course. As observed, the majority of the comments that were provided indicate that the changes are not content changes, but changes to the method of delivery (“Means and Methods”) of the course.

Table 6: Frequency of updating “Statics”

	No change	After 4 or 5 times	After 2 or 3 times	Every Time	No response	Total
# of faculty responding on frequency of updating course content for “Statics”	9	8	9	3	4	33
# of faculty who provided comments on what they update in the course/topic		5	7	2		
# of faculty describing the changes as updates in homework, examples, projects, etc. (means & methods)		3	5	2		
% of faculty describing the changes as updates in homework, examples, projects, etc. (i.e. means & methods)		60%	71.4%	100%		

Course 3: Construction Estimating

Construction Estimating has been taught by 83 of the responding faculty, nine of which stated that they do not update the course content, while fifteen said that they update the course content every 4 or 5 times they teach it, 40 every 2 or 3 times, and ten said that they update the course content every time they teach the course. Eighteen of the respondents did not provide a response to this question as shown in Table 7. As in the previous courses presented, when participants were asked to provide the reasons for the need to update the course, a large percentage of participants also indicated reasons such as updating examples, projects, and to minimize cheating. A similar analysis to the one shown for “Introduction to Construction” (presented in Table 5) is shown below, regarding the types of changes faculty make to the course. As observed, many of the comments, especially from individuals who stated they update the course more frequently, were comments that relate to changes in the methods of course delivery (“Means and Methods”), and not the content of the course.

Table 7: Frequency of updating “Construction Estimating”

	No change	After 4 or 5 times	After 2 or 3 times	Every Time	No response	Total
# of faculty responding on frequency of updating course content for “Construction Estimating”	9	15	40	10	9	83
# of faculty who provided comments on what they update in the course/topic		14	29	8		
# of faculty describing the changes as updates in homework, examples, projects, etc. (means & methods)		5	20	6		
% of faculty describing the changes as updates in homework, examples, projects, etc. (i.e. means & methods)		35.7%	68.9%	62.5%		

Course 4: Construction Scheduling

Seventy-six of the participants indicated that they have experience in teaching “Construction Scheduling”, thirteen of which indicated that they do not update the course content, twelve indicated that they update the course every four or five times they teach the course, 32 indicated that they update the course every two or three times they teach the course, while 12 indicated that they update the course every time they teach it. Seven of the participants did not respond to this question as shown in Table 8. Once again many of the comments provided by the participants regarding the reasons for the updates, included comments regarding assignments, and examples, as well as to minimize cheating. A similar analysis to the one shown for “Introduction to construction” (presented in Table 5) is shown below, regarding the types of changes faculty make to the course. As observed again, many of the comments, relate to changes in the methods of course delivery (“Means and Methods”), and not the content of the course.

Table 8: Frequency of updating “Construction Scheduling”

	No change	After 4 or 5 times	After 2 or 3 times	Every Time	No response	Total
# of faculty responding on frequency of updating course content for “Construction Scheduling”	13	12	32	12	7	76
# of faculty who provided comments on what they update in the course/topic		8	24	7		
# of faculty describing the changes as updates in homework, examples, projects, etc. (means & methods)		4	12	3		
% of faculty describing the changes as updates in homework, examples, projects, etc. (i.e. means & methods)		50.0%	50%.0	42.9%		

Summary of course content changes

The remaining of the 18 courses/topics investigated in this paper, also exhibited similar characteristics regarding course content update. A large percentage of the participants who provided comments on the types of changes they implement provided information and improvements that relate to updates in examples, assignments, and projects, rather than course content.

A summary of the percentage of the comments that were “Means and Methods” changes and updates to the various courses from the faculty who stated they update the course every time after every 2-3 times and after every 4-5 times is shown in Table 9. As observed in many of the courses/topics, faculty rightfully update examples, projects, and try to improve their method of delivery, but they do not concentrate or address course/topic improvements. Highlighted in orange are the courses, with the highest percentage of comments that mentioned “Means and Methods” updates.

Some exceptions did arise, from faculty teaching courses/topics in fields that experience frequent technology changes, or a new (or newer) courses/topics in construction related curricula. Such courses/topics include Mechanical Systems, Electrical Systems, Virtual Reality and Construction, and Surveying. These courses are highlighted in green in Table 9.

Table 9: Percentage of responses that relate to changes and updates to course/topic means and methods

Course/Topics	Frequency of Course Updates		
	After 4 or 5 times taught	After 2 or 3 times taught	Every time course is taught
Concrete Design	16.6%	37.5%	100%
Construction Estimating	35.7%	68.9%	62.5%
Construction Materials / Mechanics of Materials	11.1%	23.8%	60%
Construction Means and Methods	0%	40%	40%
Construction Safety/ Safety Engineering	0%	45.5%	0%
Construction Scheduling	50.0%	50.0%	42.9%
Contracts and Specifications / Legal Aspects	46.2%	52.6%	50%
Electrical Systems	25%	10%	0%
Engineering Economics	16.6%	25%	100%
Engineering Graphics	80%	27.3%	50%
Geotechnical Engineering / Soil Mechanics	42.8%	50%	100%
Heavy Civil Construction	37.5%	54.5%	100%
Introduction to Construction	13.3%	36.3	50.0%
Mechanical Systems	11.1%	23.1%	0%
Project Management	47.1%	47.8%	25%
Senior Design / Capstone	83.3%	69.2%	76.9%
Statics	60%	71.4%	100%
Steel Design	20%	33.3%	100%
Structural Engineering/Design	16.7%	42.8%	100%
Surveying	33.3%	0%	0%
Temporary Structures/Construction	0%	37.5%	66.6%
Virtual Design and Construction	0%	0%	0%

Some of the comments that appeared in the responses relating to the reasons why courses with frequent technological updates that also require regular revision and update are listed below:

Surveying

- *Emerging technologies (instruments; modeling; etc.)*
- *New tooling and innovative ways of surveying have been developed*
- *Technologies are always changing in this area: LIDAR, photogrammetry, automated control systems to name a few.*

Virtual Design and Construction

- *New software updates, new technologies being released*
- *Rapidly changing field. What was new 5 years ago is abandoned by now*
- *This is a fast-evolving field - I like to balance the cutting edge of research with the current state of practice.*

Electrical Systems

- *Methods and systems change frequently in the industry nowadays. Updates of the sections of the course content are needed to reflect the industry trends.*
- *Same as mechanical, advances in equipment and use of clean energy, etc.*
- *There are always new systems being added to these systems. Not to mention the virtual design side being incorporated more and more.*

Mechanical Systems

- *Because of changing concepts in construction and the invention of new machinery*
- *This area is now technology driven.*
- *Equipment and efficiencies are constantly changing and improving.*

These comments suggest that these courses/topics are at the forefront of the construction industry, where technological changes and improvements occur more often and need to be reflected in the material and content taught in the classroom. It is not surprising that faculty spend effort and time to renew and keep the courses current for the quickly changing construction industry.

In many courses though, technological advances are not present, and any other changes that could be happening were not mentioned by faculty, suggesting the changes faculty make in these topics and courses are primarily for improvement of the means and methods of teaching, which is still important and necessary, and not on the actual content for the course.

Courses at the forefront of the construction industry and upcoming courses

Faculty were also asked to indicate the percentage of courses in their department/academic unit that are at the forefront of the construction industry, and the results are shown in Table 10. In addition, they were asked to indicate what courses taught in their program/academic unit are at the forefront of the construction industry and many indicated courses/topics that relate to new technology and practices such as: Virtual Design and Construction, Building information modeling, Robotics, Lidar Scanning, Drones, etc. A qualitative analysis of the responses is reserved for a future publication, but as a preview of the frequency of the key words and themes in the responses, a word cloud is shown in Figure 2.

Table 10: Percentage of courses in academic unit at the forefront of the construction industry

<u>No courses at the forefront</u>	<u>1-19% of courses at the forefront</u>	<u>20-39% of courses at the forefront</u>	<u>40-59% of courses at the forefront</u>	<u>60-79% of courses at the forefront</u>	<u>80-99% of courses at the forefront</u>	<u>All courses at the forefront</u>
3	20	30	27	22	22	8
2.2%	15.2%	22.7%	20.5%	16.7%	16.7%	6%

As expected, “construction” is the main word in the cloud, but the themes surrounding “construction” include terms such as “BIM” (Building Information modeling), “Virtual”, “VDC” (Virtual Design and construction), “technologies”, and “drones” which suggest that the faculty consider these courses that involve technology and software as courses at the forefront of the construction industry.

In addition to the above terms, words such as “estimating”, and “scheduling” appeared as well, which suggests that the faculty consider these courses at the forefront of the industry. Further investigation is needed to distinguish and understand what faculty consider as “forefront” for the industry, and what makes these topics (scheduling and estimating), to be considered as such.

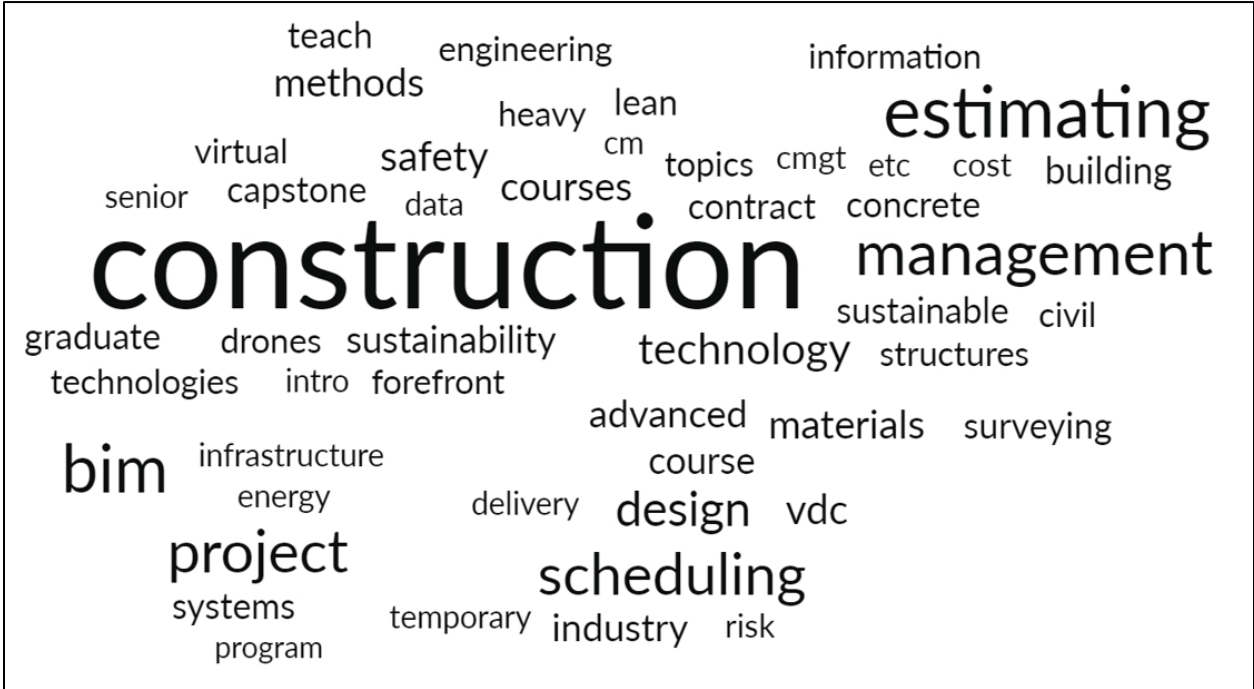


Figure 2: Word cloud of courses in the forefront of the construction industry

Other participants indicated courses/topics relating to new construction materials, such as mass timber, while others indicated courses that are more traditional in nature such as estimating, capstone, and project management.

Regarding courses that participants indicated would be appearing in the near future, many indicated courses/topics that once again relate to new technology (virtual reality, augmented reality, internet of things, drones, etc.). Others also indicated topics/courses such as supply chain, sustainability, and prefabrication among others. Once again, the participants provided wide-ranging responses to this question, and the researchers will be presenting a more in-depth analysis in a future publication. As a preview of that information, a word cloud of the responses is shown in Figure 3.

As expected, the word construction is the main word in the cloud, but in this case, it is surrounded by words that suggests more technology integration in the classroom, such as

In such courses, this frequent change in technology forces the introduction of new concepts into the courses, which suggests the courses are “dynamic” in nature.

The authors recommend that since the majority of the courses in construction curricula are very “static” in nature, departments should share the course content with newly hired faculty, and ask them to teach these “static” courses. Targeting “static” courses for newly hired faculty allows the faculty to concentrate on their method of delivery and not worry about finding adequate and updated content. Also, newly hired faculty will have an easier time relating to and teaching the course since they likely took a course with similar content in their academic preparation given that the content largely remains the same.

The authors aim to extend this investigation and attempt to correlate the findings of the faculty survey with what the construction industry considers as “static” and “dynamic” courses, and evaluate what industry professionals perceive as topics that need constant update, and what topics require the teaching of the fundamentals alone. The results can be used to evaluate the static/dynamic nature of an academic program as a whole.

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