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Leveraging Faculty Externship to Develop New Concentrations and Specializations in Construction Management Curricula

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Abstract

This "Work in Progress" paper provides insight into a viable strategy for enhancing Construction Management (CM) curricula through the integration of concentration(s) and specialization(s) within program degree paths via formalized engagement of a faculty member industry residency. Ultimately, a faculty member's industry residency aims to gain familiarity and hands-on experience utilizing cutting-edge industry trends and best practices. It requires embedding a full-time faculty member within an industry environment during a typical summer academic semester, reducing available faculty resources for the related degree program. As a result, this faculty development initiative is often more difficult for academic units to support due to real and perceived budgetary and schedule sustainment constraints. Despite challenges, the case study will highlight that considerations other than upfront cost should be more heavily weighted. A more visible return on investment is realized through the purposeful development of educational objectives for the faculty development experience (in this research case, an industry residency) and alignment and documentation of those objectives against the greater vision of enhanced curriculum development plans. Systematic documentation of the industry residency experience and alignment with curricular program requirements, student learning outcomes (SLOs), and accreditation requirements create an opportunity for sequential course development in both undergraduate and graduate curricula. Simultaneously, this makes the foundation for a concentration or an area of specialization (respectively) within the degree path(s). The paper aims to propose a framework that offers the ability to create an agile curriculum that can respond to industry needs and generate student recruitment and retention. In addition, the paper analyzes the perspectives of industry participants on promoting opportunities for educators to upgrade their skill set and knowledge base with advancements in the construction industry.

Keywords: Construction curriculum, Faculty Development, VDC concentration, curriculum development strategies

Introduction

Construction management education details the process of horizontal and vertical infrastructure, including private and public construction projects. Students in this curriculum within most universities train on foundations and advanced concepts of construction means and methods, construction estimation, project planning and scheduling, and overall construction project management principles through core courses. With the evolution of technology, from papers to digital drawings, from hand tools to digital tools, and from tape measure to laser scans, the industry has constantly been evolving towards an increase in construction productivity and efficiency via the adoption of newer technologies. This always allows educators to utilize specific software tools in classroom education to prepare the future workforce for the construction industry. In addition, many researchers and textbook authors published several materials on topics and content whenever there was a new trend in the industry. In the last decade, the construction industry changed how stakeholders communicate using advanced technological innovations and virtual design and construction (VDC) tools. This includes new

software, cloud-sharing platforms, document management tools, advanced equipment such as VR/AR, laser scans, drones, and construction robotics.

While technology and recent innovations are available for educators as a faculty version to utilize in the classroom, only recent tech-savvy graduates understand these technological innovations. A department/program should not hire only recent graduates with solid technological knowledge. In addition, the current faculty members do not typically or regularly undergo rigorous training in utilizing advanced technologies in the classroom because of their existing teaching, research, and service workloads. Usually, it is challenging to get trained in construction projects because of conflicting agendas between academia and the industry.

As a result of this challenge, the existing students do not gain knowledge on the foundations of advanced technological innovations and find it challenging to handle innovations right after graduation. This increases the training and cost time for the companies who hire them and cannot utilize them immediately in the projects. While this is not the same in all universities, the authors are identifying the potential to implement advanced technological education in the construction management curriculum in one of the universities in the New England region of the United States. This paper aims to showcase how a faculty externship can be utilized to develop a new VDC concentration and specialization in a CM program where BIM and VDC are not currently a heavy part of the curriculum.

Motivation

The construction management program in most institutions in the United States is accredited by the American Council of Construction Education (ACCE). ACCE establishes 20 student learning outcomes (SLOs) for undergraduate construction management programs and 10 SLOs for the master's program. At the undergraduate level, there is only one specific SLO pertaining to technology advancements in construction projects: SLO 10, which details applying electronic-based technology to construction projects. Similarly, at the master's level, SLO 8 details applying advanced construction management practices for utilizing the latest technologies and tools for managing construction projects.

Recent trends in the construction industry

The role of advanced technologies that include digital twins, artificial intelligence, cloud-based document management, and tracking using XR components are often utilized in complex construction projects on large and small scales. One of the primary reasons for utilizing these technologies and innovations is Virtual, Design, and Construction (VDC) tools and techniques available to skilled laborers and employees who can handle and utilize these tools to speed up the process of construction projects and improve cost, productivity, and overall marketing strategies of new construction. Researchers have identified various successful strategies, metrics, and scorecards to evaluate the role of VDC in a project's success and how it changed how construction projects and stakeholders communicate [1]–[4].

Introducing Building Information Modeling (BIM) education is not new to the construction management curriculum. Many faculty experts and industry practitioners excel in teaching BIM to students and helping them understand the core concepts of BIM [5]–[7]. However, VDC

introduces BIM tools to track and manage projects but also includes other computing tools such as Extended Reality (XR), digital twins, and holographic and immersive visualizations, considered advanced computing methods and not BIM. These computing tools are changing how VDC guides the stakeholders, communication protocols amongst parties, collaboration and management techniques for projects and teams at different locations, etc. This was explicitly useful during the COVID-19 pandemic since most of the employees in traditional construction firms were asked to work remotely to avoid any health deterioration [8].

Faculty Externships

Numerous research and case studies utilize faculty externships in different industries [9]–[15]. Precisely, [10], [14] detail the construction internship for the faculty members in the construction management program. In 2011, Associated General Contractors developed a faculty residency program for junior faculty members to externship during the summer AGC research program [14]. Most universities develop strategies for faculty development through industry partnerships on research and hands-on learning [9], [10], [12], [16]–[20]. With research, [17] develops a framework to support early career award faculty funded by National Science Foundation (NSF). In addition, it is essential to identify the faculty mentoring practices that can increase the productivity of the faculty [21].

The construction management curriculum averages 130-135 credits at the undergraduate level and 30-33 credits at the graduate level. Due to the requirements of typical accreditation, it is usually challenging for the CM program to establish new courses specifically with only one or two SLOs specific to technology. At the same time, there is more liberty to create multiple electives in the graduate programs. However, due to the total competitive credits, it is challenging to add more technology-based courses unless opened to all related disciplines at the institute. Moreover, construction education focuses more on the core concepts of construction project management, which consumes more contact hours with the students. In addition, it is challenging for academia to upgrade their technological base constantly with the upgrade in the construction industry. For example, the construction industry has been utilizing old laser scanning technology more recently than before. This does not reflect right away in the curriculum because of how laser scans are employed in the industry and how they changed from being used as building layouts to developing point clouds of existing buildings. This motivated this paper to build a dedicated concentration on introducing BIM, developing foundational and advanced courses on VDC, and implementing the knowledge base in the capstone course.

Objectives

This paper aims to identify the potential for the faculty to perform externships during summer semesters to develop concentrations that are essential skills for the future construction industry workforce. In this paper, the authors identified the proposed curriculum framework through industry partnership and faculty externship opportunities for a full-time faculty during summer. This new-knowledge training for the faculty members from AGC helped them to learn, create and develop new electives and teach them through "live knowledge-transfer" pedagogy.

Development Process

The process includes identifying the potential for the faculty members to perform externships during summer, creating constructive goals for the faculty member, developing a live knowledge transfer course in the same summer, aligning with strategic pillars of construction education, and developing a new concentration for future workforce development. In this case, the faculty performed a VDC Externship at a Boston/New England contracting firm. Figure 1 details the development process of this paper. The faculty developed the skillset on VDC by learning, observing, and participating at the Assistant Project manager level for a 10-week externship with a contracting firm. Specifically, the faculty worked with the VDC department in the following areas:

1. Project Planning
2. MEP Coordination
3. Site Logistics
4. Laser Scanning
5. Drone Flights
6. 4D scheduling
7. Tools include Open Space and Matterport
8. Site Layout

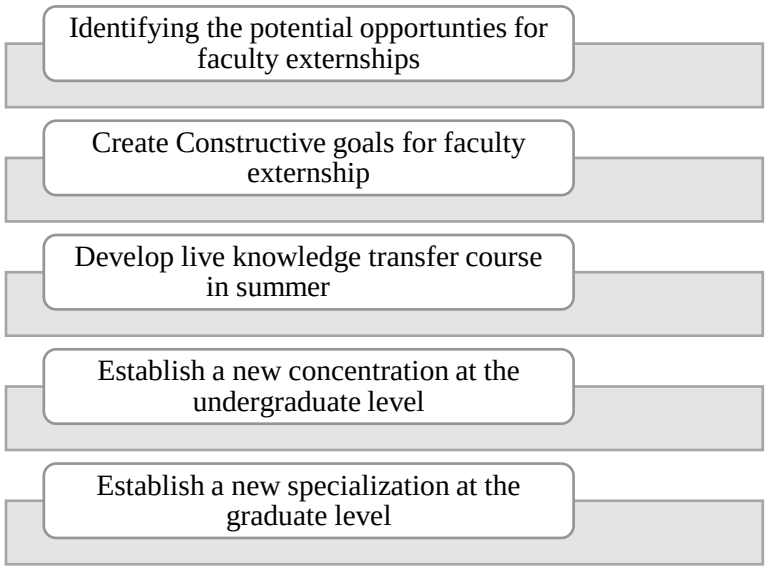

Figure 1 Development Process

1. Identifying the potential opportunities for externships

The construction firms provide opportunities for the faculty members to work as full-time employees during their off-semesters to get some new-knowledge training. However, not all faculty members can perform this due to many factors, including site or office location challenges, immigration requirements, personal reasons, etc. Many industry experts in the construction field can be invited as guest lecturers or speakers to the classes. However, this approach might fulfill the knowledge upgrade on a specific topic or course and will be less effective for the program and the curriculum. Also, the logistics of scheduling guest lecturers from the industry have always been challenging because of time conflicts. The AGC of America

developed a faculty residency program where junior faculty members can perform externships up to two times for 10-12 weeks during their academic career. AGC also specifies that this will be a three-party initiative where the faculty's department/university, the sponsoring construction firm, and AGC will split the cost of this externship equally, and the cost must not exceed a total of $30000. The faculty will work with the construction department and the contracting firm to design a plan and apply for this faculty residency program.

2. Create constructive goals for the faculty externships

The faculty members of the construction program define the area of interest and then find potential employees. Once the faculty goes through the interview process, the faculty will be asked to develop a set of goals that can benefit both the faculty members and students of the program. In this research, the faculty selected VDC as the area of interest and found a potential employer interested in hiring the faculty as the industry resident. Once finalized, the faculty member developed the following objectives after coordinating with the contracting firm for this VDC externship:

1. Understand the need for MEP coordination that helps in clash detection
2. Learn how site logistics can be developed using VDC tools
3. Utilize laser scans and drones on the construction site for various construction processes and develop new point clouds for existing buildings.
4. Use immersive tools and understand to develop 4D scheduling, 5D Estimating and 6D facility management and 7D Sustainability information.

3. Develop a live knowledge transfer course

The faculty did the externship for 30-35 hours during the summer for ten weeks and worked with the VDC department of the contracting firm. The faculty resident/extern started with the basics of VDC and was initially involved in understanding and researching VDC tools. The faculty was given a sample project to understand how to develop site logistics using VDC tools such as Autodesk Revit, Enscape, and Sketchup. In addition, the faculty extern performed site visits to learn to scan buildings using laser scanning equipment and how to deploy those scans and point clouds into Autodesk Revit software. After learning the basics of how these technologies are utilized, the faculty had an opportunity to practice with a sample project and discuss any concerns with the VDC director and the team. The faculty also worked with the estimating, scheduling, and project management department to research and learn how VDC tools improve their productivity. Thus, the faculty extern could meet all the goals within the timeframe and document all the knowledge acquired during the externship.

The faculty who performed this externship also taught an evening course on "Engaging Technology in Construction Projects," The faculty utilized the new-knowledge training from the contracting firm for ten weeks to teach the students and transfer live knowledge on VDC. This also helped the faculty to develop a solid foundational knowledge of VDC. In addition, the faculty went through the CM-BIM certification courses through AGC to upgrade the knowledge base on BIM concepts and theories.

Undergraduate VDC Concentration

The Virtual, Design, and Construction (VDC) concentration for the construction management program is proposed in response to the modern construction industry's increasing demand for technology-related expertise to manage construction projects. Construction companies are moving towards managing projects through immersive technologies, Artificial Intelligence, and digital twin technologies. Specifically, after COVID, these technologies helped the industry to handle projects from different locations. Hence, the new concentration aims to provide a track for the students of CM to learn and utilize these technologies in the classroom and environment and implement their skills during their co-ops and full-time opportunities. The VDC concentration will include 15 credits of courses, including 2 CM required courses, 2 CM electives, and 1 Capstone project course.

The new concentration will include 15 credits of coursework. The first course will be the introductory course, CONM 1500: Introduction to BIM, which details the basics of Building information modeling. The second course will be a required construction course on plan reading and specifications. Both course 1 and course 2 are required existing courses in the CM curriculum at the university the authors teach. The third course is the summer elective on VDC foundations. The fourth course will be the senior spring elective on advanced VDC and BIM visualization. The final course will be the senior capstone project, where students will complete a capstone project and present it at the end of the semester. In addition, this program will prepare students for the evolving built environment industry in differentiated ways from current programs across campus and regional competitors.

Course Descriptions are as follows:

Course 1: Introduction to BIM

This introductory Building Information Modeling (BIM) course focuses on basic BIM concepts and discusses the impacts of BIM in the construction industry. The course utilizes Autodesk Revit as the BIM platform for learning critical aspects of designing and documentation of building elements. The fundamentals of BIM training are provided to the students through labs and lectures to advance students' skills in the Virtual, Design, and Construction (VDC) aspects of construction. The course also introduces Enscape, rendering software to utilize and learn high-quality rendering processes. The software tool used in this course requires a Windows Operating System.

Course 2: Plans and Specifications

This course teaches students how to read and interpret information on civil, architectural, and structural prints and information found in construction specifications.

Course 3: VDC Foundations

This course aims to provide knowledge on managing construction projects in this digitalized environment through technologies, models, and software in all phases of construction sites. The course also emphasizes introducing advanced construction methods and technologies to prepare

students as a technology-skilled workforce for the construction industry in the mere future. The course is divided into three critical phases of construction, 1) the pre-construction phase, 2) the construction phase, and 3) the post-construction phase. Students will learn through each module and be assessed through quizzes, reading assignments, projects, and presentations. We also plan site visits to understand the Return on Investment (ROI) on these technologies, including hardware and software products.

Course 4: Advanced VDC and BIM Visualizations

Technology is transforming the modern landscape of the construction industry. Issues related to productivity on (and off) job sites, safety and complex site logistics, coordination of multiple trade design and installation, project management processes, and turnover requirements are explored through the engagement of software, hardware, and advanced technology workflows. This course emphasizes a deeper understanding of BIM and develops students' knowledge of collaborative tools, construction technologies such as automation and robotics, and the utilization of immersive technologies such as Virtual and Augmented Reality tools and software. Students are exposed to the basics of programming to enforce the benefits of programming in the construction industry.

Graduate VDC Specialization

The proposed VDC Specialization for the Masters in CM students will include four courses. Students doing a full-time master's in construction management (2-year degree) will enroll in one course in VDC specialization every semester and graduate with a Master of Science in CM specializing in VDC.

The first course in this specialization will be the essential introduction to Information technology in the construction industry. This course will provide a strong foundation for students who do not have a background in the IT of the construction industry. The second and third courses will be Course 3: VDC Foundations and Course 4: Advanced VDC and BIM Visualizations, cross-listed as undergraduate and graduate electives. As assessment criteria, students at the graduate level will be completing more complex academic projects and presentations compared to the students at the undergraduate level. In addition, both the cross-listed courses will be an in-person class for the undergraduates and a hybrid modality for the graduate students.

The course description for Course 1 is as follows.

Course 1: IT in the Construction Industry

The course provides information technology applications in construction, computer applications, to emerging web-based and mobile technologies. It also includes design, development, data capturing, data analysis, and data visualization using the software.

Conclusion and Discussion

This research presents a novel alignment of faculty externships with simultaneous course and curriculum development. The outline highlights how a faculty member within an accredited construction management program engaged in a summer semester industry externship position

within a Virtual Design and Construction firm to transfer the professional development process into curricular advancements immediately. The experience provided the faculty member with base knowledge in cutting-edge use of technology within the construction industry over three months, translating into the potential for a series of courses at both the undergraduate and graduate levels for concentrations and specializations. Typical course development fees for a unique topic or elective course run stipends between $1200-2000 per credit hour (outside of standard faculty teaching load). As such, this research highlights an investment process in which the school allocates $10k for professional development (via three-way split) and, in return, receives approximately $24k in the course development as standalone specialization or concentration (double if cross-listed coursework) and simultaneous professional development for the faculty member engaged in the process.

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