Željko TORBICA*

PURDUE UNIVERSITY'S UNIQUE MODEL OF CONSTRUCTION MANAGEMENT EDUCATION — LESSONS LEARNED

Abstract: Construction Management program at Purdue University has introduced a unique educational model for its undergraduate degree. The curriculum transformation process has been an extremely complex endeavor with a set of unique challenges for which there was no reference in the existing literature. The article briefly describes Purdue's educational approach and provides a summary of some of the major challenges that have been encountered. The main goal is to encourage the discussion and exchange of ideas aimed at advancing the quality of undergraduate education regardless of the field of study. Although it is recognized that the complexity of the Purdue model may be too complicated to be adopted in its entirety (as a „whole"), it is believed that there are many aspects of the model that other institutions can study and potentially benefit from.

Key words: *construction management, undergraduate education, integrated curriculum*

1. INTRODUCTION

Purdue University's reputation as a premier institution in engineering, science, and technology, is well established both nationally and internationally. In a complimentary fashion, the School of Construction Management Technology (SCMT) has been building the reputation as a premier institution for the advancement and dissemination of knowledge in the field of construction management. The School is one of six academic units in the Purdue Polytechnic Institute (PPI) which is one of the 10 academic colleges of Purdue University. The School is offering a full spectrum of degrees including baccalaureate (BS), masters (MS) and doctorate (Ph. D.) degrees. The subject of this paper is the ongoing transformation of the undergraduate

* Željko Torbica, School of Construction Management Technology, Purdue University, USA

construction management program. An overview of Purdue's unique educational approach is provided, with a summary of some of the challenges encountered, results accomplished and lessons learned. The goal is to encourage the discussion and exchange of ideas aimed at advancing the quality of undergraduate education regardless of the field of study.

A Bachelor of Science (BS) degree at Purdue University was officially introduced in 1967. An important milestone in the program's evolution was obtaining the accreditation from the American Council for Construction Education (ACCE) in 1979. The program was one of the first two programs in the country that were accredited by the ACCE. The School has demonstrated its systematic and sustained efforts of providing a quality education through an application-based classroom, laboratory, and immersive learning experiences aimed at enabling students to become problem solvers and critical thinkers. Purdue construction management graduates are the most sought-after entry-level construction management professionals in the country as they have consistently demonstrated their readiness for work in any sector of the construction industry, for any size of company, nationally and internationally. Purdue CM career fairs are the largest construction management fairs in the country typically attended by about 200 companies.

2. PURDUE CM UNDERGRADUATE CURRICULUM TRANSFORMATION

Purdue Polytechnic Institute (PPI) has gained a national reputation for its teaching philosophy that was reformed around *10 Elements of Transformation* in response to a changing economy and a changing student base. The 10 Elements include: (1) Theory-Based Applied Learning; (2) Team Project-Based Learning; (3) Modernized Teaching Methods; (4) Integrated Learning-In-Context Curriculum; (5) Integrated Humanities Studies; (6) Competency Credentialing; (7) Senior Capstone Projects; (8) Internships; (9) Global/Cultural Immersions; and (10) Faculty-to-Student Mentorship. The curriculum transformation undertaken by the School of Construction Management Technology (SCMT) is in direct response and alignment with the 10 Elements of Transformation, but the extent of the transformation has been significantly broader and more complex. In fact, the construction management curriculum transformation has been one of the most complex and unique initiatives in a long history of Purdue University; we are not aware of any other academic program that has attempted to implement the integration of this magnitude encompassing the entire four-year curriculum. Since there is no roadmap to follow, the SCMT faculty have had to

demonstrate a great deal of creativity and ingenuity in implementing this transformation.

The impetus for the transformation was the fall 2015 School's retreat meeting in which the faculty were asked „*If you could start over from scratch, what would you do*?" The faculty took the challenge and set a goal to transform curriculum into an innovative learning environment that creates a „*seamless transition from college to industry*". After 2 years of preparation the new curriculum was launched in the Fall 2017 semester and subsequently the first cohort of students following the new curriculum graduated in December 2020, one semester ahead of schedule.

The „old" curriculum was organized in a traditional way with the Construction Management Body of Knowledge (CM BOK) being „compartmentalized" in a number of individual courses, typically, 3-credit-hour courses, each covering a single subject area, and taught in particular year/semester in isolation of other courses. The new curriculum, on the other hand, attempts to „de-compartmentalize" the CM knowledge, by combining material from several single-discipline courses into new „integrated" multi-discipline courses („horizontal" integration). The material from any „old" single-discipline course in now being spread over a number of courses and is covered in multiple semesters („vertical" integration). Figure 1 graphicly depicts that process.

As an example, the subject area of „Estimating", which, in the „old" curriculum was covered in a single 3-CH Estimating course in the third (Junior) year, is now taught in (at least) 5 courses throughout the entire four-year curriculum; in CM 100 (1st year), in CM 200 (2nd year), in CM 300 (3rd year), and in CM 400 and CM 450 (4th year) (see Figure 2).

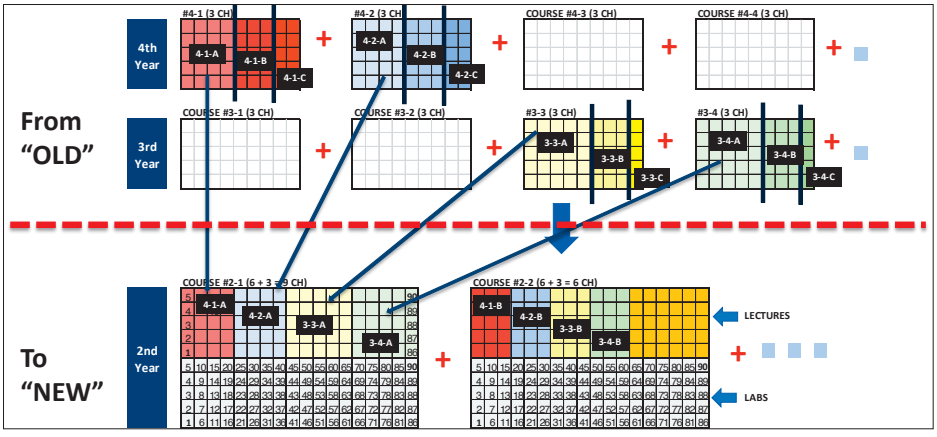

Figure 1: CM knowledge „de-compartmentalization"

Figure 2: Courses that include „Estimating“ subject area

One of the results of this transformation is that the single-discipline 3-CH courses are „replaced“ by bigger, 6-CH and 9-CH, multi-disciplinary courses, such as CM 200: Intermediate Pre-Construction Management. As it can be seen from Figure 3, this 9-CH course is covering material from (at least) 15 different subject areas, and is taught by a team of 10 + instructors.

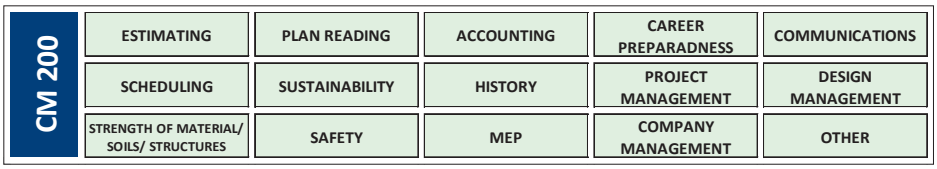

Figure 3: Subject areas covered in CM 200

3. „NEW“ LEARNING ENVIRONMENT

The contents of the old and new curriculum are practically identical; we believe the program content realistically represents the contemporary Construction Management Body of Knowledge (CM BOK). What has changed is the „manner“ in which the content is taught and learned. Heavy emphasis is placed on Active Learning (anything course-related that students in a class session are called on to do other than simply watching and listening to a lecture and taking notes[1]), **P**roject-**B**ased **L**earning (PBL) (a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge); utilization of documents and project files from actual projects („case studies“); and utilization of co- and team-teaching.

We claim that the new, vertically and horizontally integrated curriculum, which is studied in an authentic, project-based, team-taught environment, provides students more opportunities to synthesize material earlier in their college career rather than waiting for a capstone course in their senior year. We also believe that the students retain more of their knowledge and education by scaffolding construction content throughout the four-year

[1] Felder, R., and Brent, R. Teaching and Learning STEM — A Practical Guide. Wiley, 2016.

program rather than condense all information into „stand-alone" 3-credit-hour courses.

4. CHALLENGES

Some of the most complex challenges of the transformation process are listed below.

Need for More Resources (including Faculty Lines)

Working on the transformation has taken a significant toll on faculty and staff. The first three years after the launch of the new curriculum were particularly demanding as the School was teaching-out the „old" curriculum, while developing and introducing new courses. In addition, introduction of co-teaching and team-teaching imposed some additional challenges, one of which was the determination of „actual" faculty teaching efforts („loads"). A new methodology for calculating actual efforts was developed in fall 2019 as a result of a comprehensive analysis that was conducted over the period of 4 months. One of the findings was that some faculty members

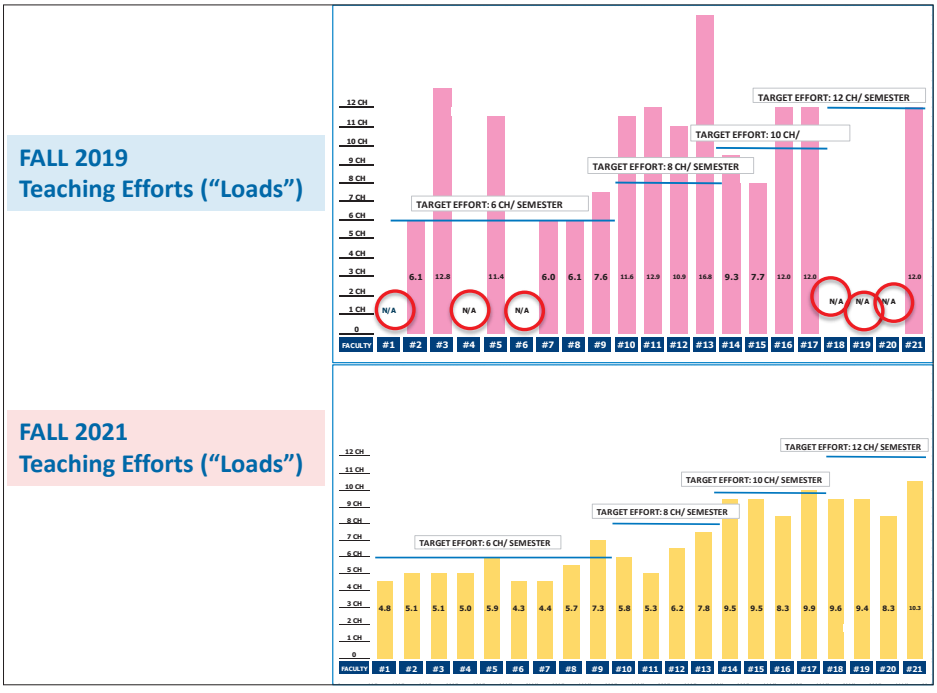

Figure 4: Comparison of teaching efforts („loads"): Fall 2019 and Fall 2021

had had consistently high teaching loads efforts („loads“). We were also able to make a strong case for additional faculty lines. More faculty members and the utilization of the new methodology have helped us improve the fairness of the process of sharing teaching responsibilities among faculty members (see Figure 4).

Utilization of *Co*-teaching and *Team*-teaching

One of the distinguishing outcomes of the transformation is that each course is now being taught by a team of faculty members who are responsible for the instruction of materials in their areas of expertise. In addition to courses being team-taught, some individual lecture and lab sessions are also jointly taught („co-taught“) by multiple faculty members. Figure 4 depicts the difference between the two teaching arrangements, co-teaching and team-teaching. Two or more instructors conducting a joint session to the same group of students is considered co-teaching. If a group of students is split into smaller groups (teams or sub-groups), and each sub-group is taught

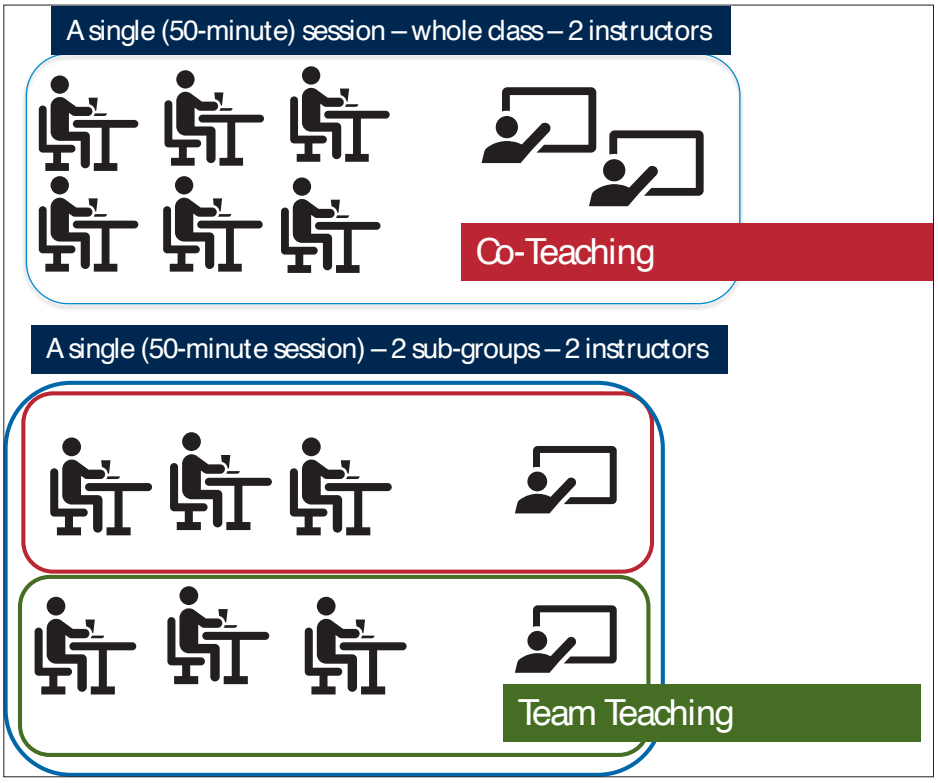

Figure 5: Co-teaching vs. Team-teaching

by a different single instructor, this arrangement is considered as team-teaching. We differentiate „co-teaching" from „team-teaching", in recognition that the „co-teaching" is typically a more complex teaching arrangement.

Identifying which sessions/ topics should be co-taught, what is the best way to conduct the joint sessions, which instructors should team up for a particular joint session/topic — these are some of the dilemmas that we are facing on a daily basis.

Management of Individual Courses

New courses have become much bigger and more complex to manage. A composition of a typical 9-CH course is shown in Figure 6.

There are 90 50-minute „lecture" sessions, and 90 50-minute „lab" sessions. As it was mentioned before, teams of instructors, in some cases with more than 10 of them, are involved in teaching a course, making the course coordination exceptionally complex. As a result, there is a need for frequent coordination meetings between team members, and also for each course it was necessary to assign one or two „Course Managers" who are responsible for the overall course coordination.

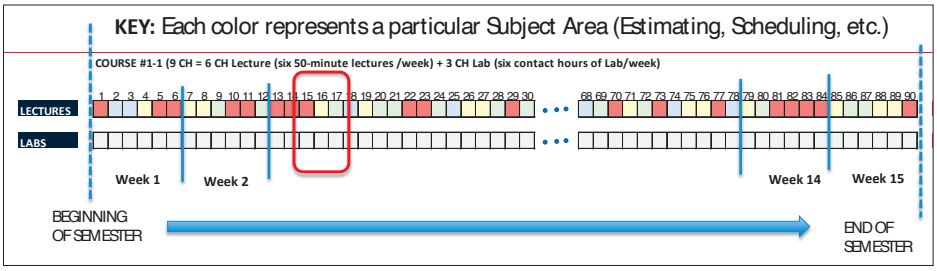

Figure 6: Typical structure of a 9-CH course

Content and Topic Integration of Individual Courses

The content of each course was originally determined based on an analysis conducted by an assigned faculty team. It was anticipated that this would be just a starting point and that more work will be needed to find the „optimal" course content and to determine the „best" way to integrate the various subject areas within a given course. Using an imaginary course shown in Figure 6 as an example, we should be able, for example, to provide a convincing rationale for why and how the specific topics for lectures 15, 16, and 17 (representing three different subject areas) were chosen? Also, are these sessions synchronized in a meaningful way from the students' learning point

of view? Fine-tuning of individual courses and the search for the „optimal“ integration of topics has been an „unending“ work.

More Expensive System

This new educational model is more expensive than the previous model mainly due to a significant lab component (which requires splitting classes in multiple sections), co-teaching and team-teaching, complex course coordination, and the need for course managers. For example, as it can be seen from Figure 7, delivering CM 300 course, which is a 9-CH („Published“ CH) course, actually requires more than 30 CH („Actual“ CH) — an increase of 300%.

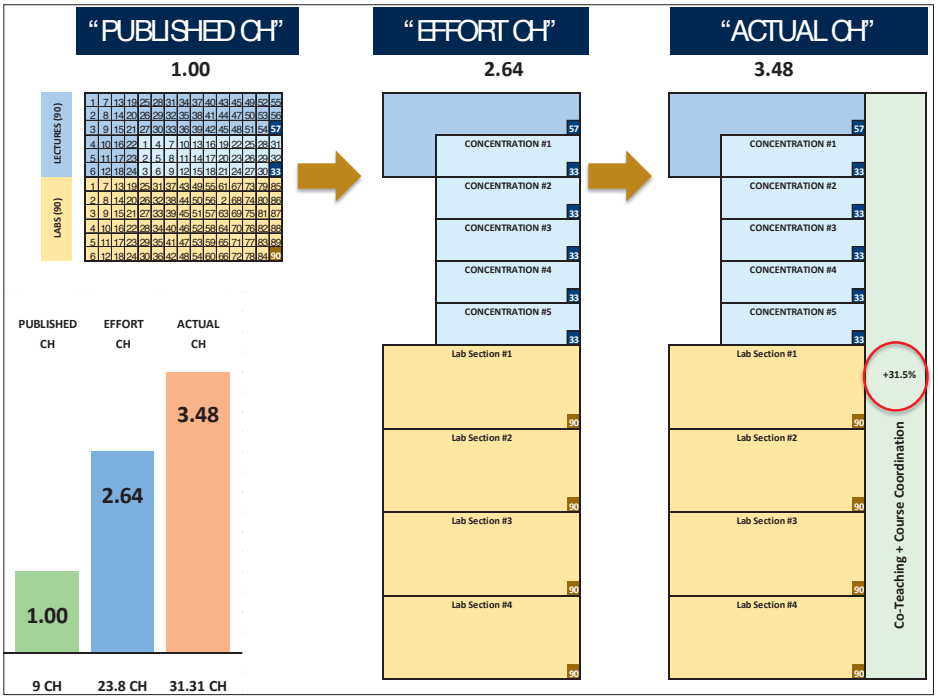

Figure 7: Actual cost of delivering CM 300

5. NEXT STEPS

As it has been suggested in the preceding discussion, the „fine-tuning“ of this unique educational model will take years of additional work. As an example, just in the Fall 2021 semester there were 12 meetings in which we worked on a number of topics related to the curriculum transformation.

We invested 695 person-hours in these discussions with additional 300 + hours of preparation time. One of the outcomes was a 300-page document of original scholarship material.

Some of the most pressing items that will be the focus of our attention in the next 1–3 years are: improving and increasing the use of co-teaching and team-teaching; refining the integration of various subject areas within a single course and across the entire curriculum; finding the optimal lecture-lab ratio; consolidation of the number of instructors involved in teaching a single course; eliminating 9-CH courses and limiting all courses to 6-CH; further improvement of course „Project" assignments; more efficient utilization of actual projects' documentation from the Project library; and ensuring that technology integration in curricula and study plans are up-to-date, responsive to market needs, relevant, and effective in preparing students for future careers.

6. CONCLUDING REMARKS

At the moment, we have insufficient data to provide a reliable answer to the questions like: Does the new model lead to improved learning? or, Are the „new" CM graduates better/ more competent than their predecessors following the „old" model? It will take, perhaps, 5 more years before we will be able to fully assess the success of this new educational model. Based on our experience with several cohorts that have already graduated, we feel optimistic about the quality of our graduates and the prospect that they will quickly develop in top-notch professionals. We have, however, limited „hard" data to support our optimism, mainly the data coming from the direct measurement of 20 ACCE Student Learning Objectives (SLO) which we conduct each semester. First round of *Employee* and *Alumni* surveys will be conducted in 2023 (these surveys are typically conducted 3 years after graduation) and with that data and more input from the industry we will be able to assess the direction and success of our transformation. We do have some anecdotal evidence that we are on the good path. For example, an industry executive who manages two of ours Construction Work Experience courses shared his impressions about our students in the email that was addressed to the SCMT faculty: „*You ...should be extremely proud of the product of students you are putting out into the Construction Industry. The future of construction is in great hands with students from this department and it is easy to see why over 200 companies come to the career fair in search of Purdue CM students.*" Another encouraging indicator is that the first two cohorts of students who followed the new curriculum produced the winners of the prestigious national essay competition sponsored by the Associated

General Contractors (AGC) two years in a row (2021 and 2022), which is an unprecedented accomplishment.

Even if we „confirm" that the proposed model is indeed superior and that it brings clear advantages compared to a more „traditional" approach, the question that remains to be answered is, how suitable it is for adoption by other institutions? We do recognize that the complexity of the model may make it very difficult for other institutions to adopt. However, even if the suggested model proves to be too complicated for adoption as a „whole", we believe that there are some aspects of our approach worth studying that other institutions can benefit from.

Željko TORBICA

JEDINSTVENI MODEL OBRAZOVANJA MENADŽERA U GRAĐEVINARSTVU SA PURDUE UNIVERZITETA — STEČENA ISKUSTVA

Sažetak

Program Menadžment u građevinarstvu na Univerzitetu Purdue je razvio unikatan model obrazovanja za studente na dodiplomskim („redovnim") studijama. Proces transformacije načina studiranja se pokazao ekstremno komplikovan sa nizom unikatnih izazova koji nisu obrađeni u postojećoj naučnoj literaturi. Članak ukratko opisuje pomenuti model obrazovanja sa listom glavnih izazova. Cilj diskusije je da se razmene iskustva i ideje koje bi mogle da unaprede dodiplomske studije nezavisno od discipline studiranja. Usvajanje ovog modela, kao celine, od strane drugih institucija može da se okarakteriše kao komplikovano, međutim, izučavanje i implementacija nekih aspekata modela mogu da budu od potencijalne koristi za zainteresovane institucije.

Ključne reči: upravljanje u građevinarstvu, obrazovanje, integrisani nastavni program