AC 2009-2007: IMPACTS OF STUDENT COURSE SELECTION ON SUBSEQUENT CAREER TRAJECTORIES

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Impacts of Student Course Selection on Subsequent Career Trajectories

Abstract

In 2002, the College of Engineering at the University of Iowa adopted a curriculum that allowed students significantly more options in selecting electives than previously. Specifically, students could apply up to 21 semester hours (out of 128 required to graduate) to an Elective Focus Area (EFA). While it was expected that most students would select an EFA within their major discipline, the curriculum specifically allowed students to use this EFA in non-technical ways. For example, it could be used to allow a student to take any minor offered at the University of Iowa. This paper explores how students in the Civil Engineering program at the University of Iowa have used the EFA option since 2002, and what impact this has had on their subsequent career trajectories.

Introduction

The Civil Engineering Curriculum and the College of Engineering Core Curriculum at the University of Iowa were revised in 2002. The 'New Curriculum' was adopted by the College of Engineering faculty in 2001, and the first class graduated in spring 2006. The curriculum was revised upon the recommendation of a Curriculum Advancement Task Force (CATF) charged by the Engineering Faculty Council (EFC) and the Dean of the College of Engineering to recommend changes to the undergraduate and graduate curricula and programs to give engineering students an education that reaches beyond technology. The CATF documented the following vision for the undergraduate programs:

> *The College of Engineering undergraduate programs are designed to draw on the broad resources of The University to attract the best and brightest students and prepare them to be engineers who will succeed in a workplace filled with diverse people, attitudes and ideas; compete in the global marketplace; work effectively in multidisciplinary teams; and confidently understand, use and develop modern technology. The programs distinguish the College from others in the region and build on the recognized strengths of The University to offer unique opportunities for students wishing to pursue a wide range of career options; as engineers whose education goes beyond technology.*

The CATF document put forward two defining characteristics of all engineering programs at The University: flexibility in support of individual student aspirations and a commitment to student success. In voting to approve the CATF document, the faculty of the College of Engineering adopted the following specific characteristics for all engineering programs (Biomedical, Chemical, Civil, Electrical, Industrial, and Mechanical Engineering):

- Each program is to require 128 semester hours.

- There shall be a set of common core courses that enables students to enroll in engineering with an undeclared major and to change majors without loss of credit through the end of the third semester.
- To ensure education beyond technology, provide flexibility for students to develop thematic options, and complement the technical content of the curriculum, all programs shall have a pool of 36 semester hours (s.h.) of elective courses. The student's portfolio and plan of study guide the selection of appropriate electives. The electives are used to fulfill two College requirements: 1) A general education component of 15 semester hours that ensures focused studies in non-technical areas; and 2) The remaining 21 semester hours provide flexibility for students to pursue a formal minor in an approved area or earn a certificate in a multidisciplinary area (e.g., Technological Entrepreneurship, Health and Biological Sciences, International Business, Law and Engineering) developed by the College in collaboration with other colleges on campus, or build strength in a technical focus area, or pursue a tailored program of study as permitted by the policies of the major program.

In the final curriculum guidelines adopted by the Faculty in June 2001, the above general descriptions of ways to package the 21 s. h. of flexible electives were adopted as recommendations, rather than requirements. Each program was given the freedom and responsibility to develop its own "Elective Focus Area" procedures and specific guidelines, according to their own disciplinary requirements and constraints.

Between May 1999 and June 2001, the College Curriculum Committee worked on the details of the proposed new core curriculum, in close consultation with the Departments of Mathematics, Physics and Astronomy, and Chemistry and prepared a detailed proposal that was adopted by the Engineering faculty in June 2001. Details of course content, delivery, and administrative structure were further elaborated during the summer and fall, culminating in final faculty adoption of the new core curriculum on February 19, 2002. The entering first-year students in Fall 2002 began their academic careers under the new curricula.

The motivation for the revision to the Civil Engineering Curriculum included: 1) a desire to provide a more contemporary and attractive overall vision for the Program; 2) to streamline the course sequence for the Program's four technical areas (environmental, hydraulics & water resources, structures and materials, and transportation) offered in a dual sub-track arrangement (Civil and Environmental); 3) to better match the Program's Objectives and Outcomes; and 4) to assure that the Program meets ABET's semester hour (s. h.) requirements for science, mathematics, and professional knowledge. The process used in developing this new curriculum is described in Nixon et al. (1)

Motivation 1 arose in part from a broad, nation-wide sense that civil engineering must affirm and invigorate its image and its role in society. Discussions in the civil engineering profession (2) have stressed the role of civil engineering in developing and maintaining society's physical infrastructure (transportation, structures, water supply, environmental well-being, together with facets of information management, economics,

and public policy). That role behooves civil engineers to know more about the overall workings of society's physical infrastructure and how infrastructure is managed. These concerns have been evident in the civil engineering profession for some time (3,4), and need to be addressed. In short, civil engineering education is required to provide a more holistic view of the role of civil engineers in society. Therefore, the Program modified its curriculum to better acquaint students with the broader role of civil engineering, to provide students the ability to apply knowledge in four technical areas central to that broader role, to instill in students the sense of connectivity with other technical disciplines, to include a better base knowledge in science, and to emphasize the importance of communication.

Motivation 2 responded to the faculty's wish to enhance the balance and flow of technical knowledge through the Program's curriculum. In particular, some equitable re-distribution of student (semester hour) time is needed in order to cover the four technical areas.

Motivation 3 addressed the mismatch between the Programs Objectives and what we were actually offering.

Motivation 4 follows directly from the need to ensure the Program meets ABET recommendations regarding the nature of curriculum content. The new curriculum conforms to the requisite semester hours (s. h.) of science, mathematics, and professional components recommended by ABET.

The purpose of this paper is to examine whether the more flexible curricular approach adopted by the department is serving to undermine the ability of students to pursue careers in civil and environmental engineering. If it is, then clearly changes will have to be made. However, it must be noted that this is only a preliminary investigation at this stage – only two classes of students have graduated since the curricular changes were put in place. Nonetheless, this paper is intended to establish a method by which we can track this issue going forward.

Elective Focus Areas

The primary goal of the Elective Focus Area (EFA) course selection is for the student to achieve *exposure and depth of study* in an area that is complementary to their degree in Civil and Environmental Engineering. With this in mind, the EFA policy was developed by the CEE faculty and is enforced by each student's advisor and the CEE Curriculum Committee.

Several sets of EFA plans are offered as 'recommended EFAs' on the EFA plan form. The current EFA recommendations are found on the CEE web site. Two EFA plans are designed for students who want a broad exposure to civil and environmental engineering practice. They are called "Civil Engineering Practice" and "Environmental Remediation and Control." Eight additional EFA plans are described. These EFA plans provide broad training in civil and environmental engineering but also allow a more specific focus. The most popular of these EFAs include "Engineering for a Sustainable World,"

"Management," "Structures, Mechanics, and Materials," and "Water Resources Engineering." In addition to these ten recommended EFA plans listed below, interested students may propose an original EFA that is not on this recommended list. A title is required and the list of proposed courses must meet published guidelines.

Table 1: Standard Civil and Environmental Engineering EFAs.

Civil Engineering Practice
Environmental Remediation & Control
Entrepreneurial Career Path
Environmental Health Engineering
Engineering for a Sustainable World
Management
Structures, Mechanics, & Materials
Transportation Engineering
Urban & Regional Planning
Water Resources Engineering

Student-tailored EFAs must meet the guidelines required for all EFAs. First, the set of courses chosen must support the student's career or life plan and be described as such on the EFA form. The discussion must be acceptable to the advisor and the CEE Curriculum Committee. Second, a non-technical EFA (e.g. music, art, theater, dance, women's studies, a foreign language, history, etc.) must be completed as part of a minor in that field and, therefore, each course must be part of a sequence of an increasingly challenging curriculum. Third, the set of courses chosen must demonstrate depth of learning in a particular area. An assortment of introductory courses is unacceptable.

While students are required to submit their EFA form no later than the first semester of their junior year, they may change their EFA at any time thereafter, with the understanding that this may require them to take extra courses. This is intended to accommodate the student who initially has a strong interest in one area, that changes (perhaps because of work experience) into another area.

Figure 1 is a chart showing the distribution of EFAs selected during the first three years that the new curriculum affected potential graduating seniors. It is obvious that many of the students selected tailored EFAs, but the primary reason for that was over specification of many of our technical EFAs as most of these had seven specific courses required. As a result of course scheduling and student schedule conflicts, many students were only able to fit five or six courses into their EFA plan of study.

Figure 2 identifies the specific titles of the tailored EFAs created by students. Of the 188 EFAs selected by students, 120 were student tailored (see Figure 1). However, as shown in Figure 2, 83 of these tailored EFAs were in areas directly related to civil and environmental engineering (specifically: general civil, general environmental, structural engineering, architecture, consulting practice, water resources, structural practice, construction management, sustainable design, and environmental water resources). The 37 non engineering selections included Geology, German, Management, 3-D Design, Chinese, Art History, Entrepreneurial, and Biological Systems. Of these, only 7 are truly non-technical, so it is fair to say that most students selected civil and environmental

engineering EFAs, about one sixth selected technical but non-engineering EFAs and only 7 selected completely non-technical EFAs. This is consistent with one intent of the EFA program, that it would allow some small percentage of students to pursue non-technical interests while still obtaining an engineering degree.

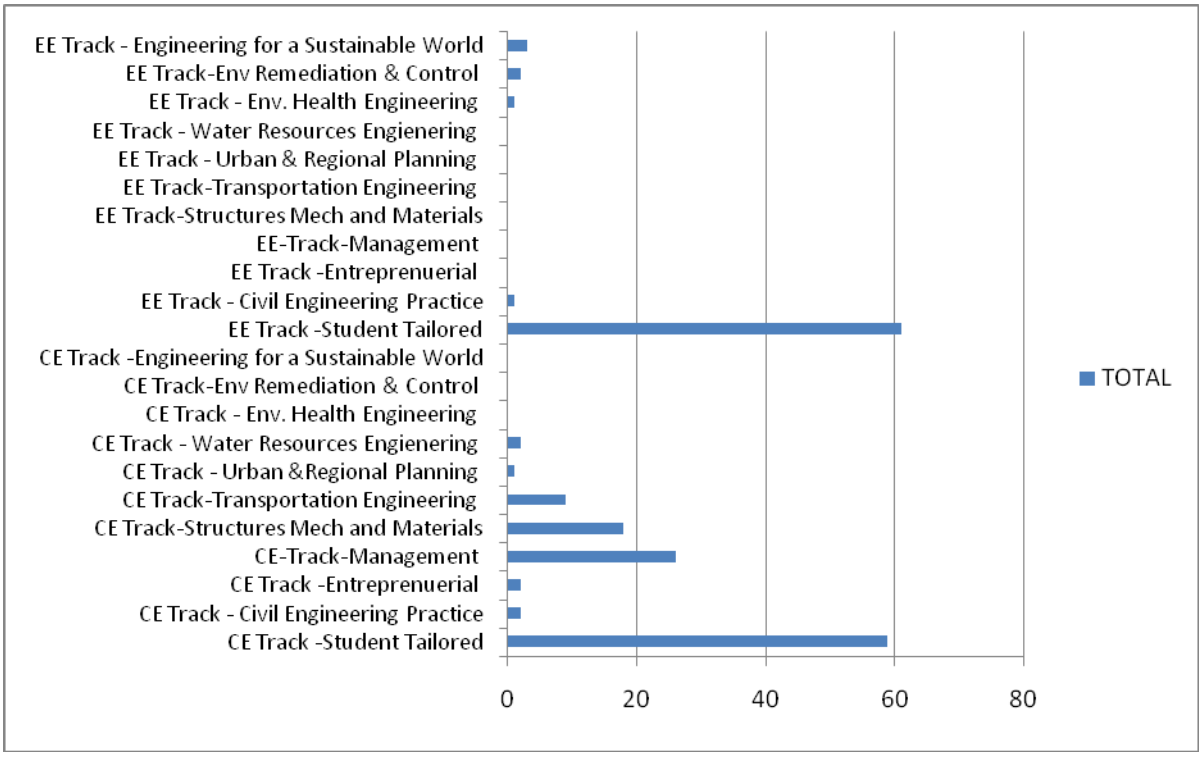

Figure 1: EFA selections during the years 2005-2007

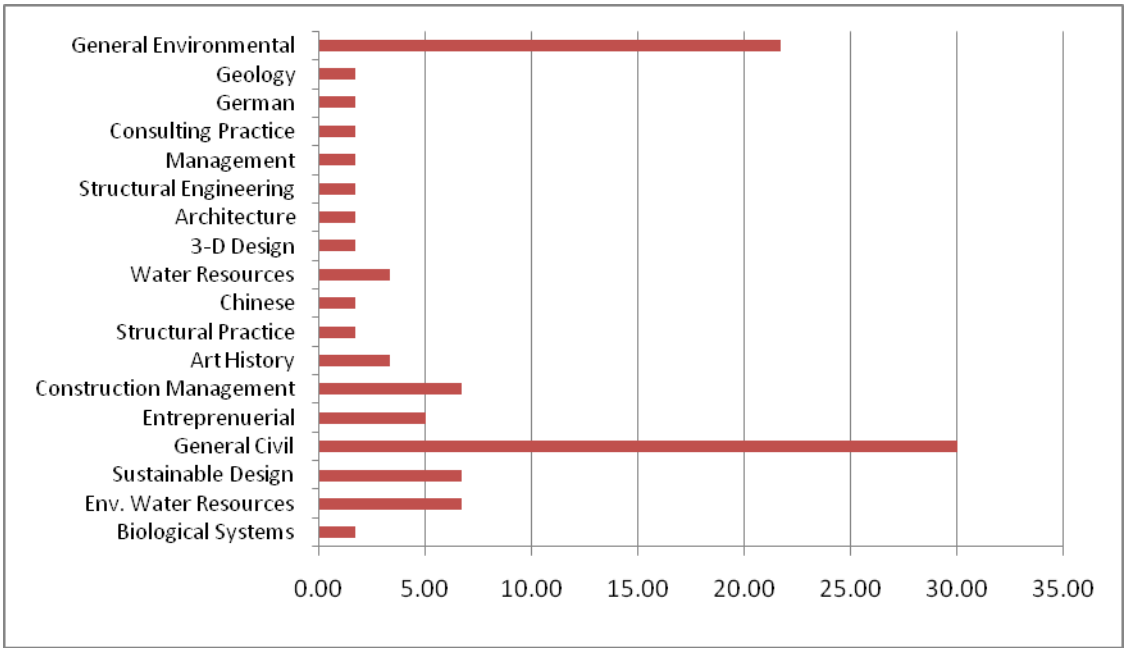

Figure 2: Specification of Tailored EFAs during Academic Years 2005-2007

The information on student EFAs has been collated slightly differently in figure 3 showing the semester hours in three broad categories – engineering, business, and liberal arts.

EFA	subtrack		Credit hours		
	Civil	Environmental	business	lib arts	Eng
Student Tailored	38	25			
Biological Systems		1		18	3
Env water resources		4		27	57
sustainable Design		4		27	57
Civil Practice	1	1	3	18	21
Entrepreneurial	3		54		9
const. Management	4		33	18	30
Art History	2			42	
struct. Prac	1		9		12
unknown		1		15	6
Chinese		1		21	
Resources	2			9	33
3-D design	1			18	3
architecture	1			21	
struct eng.	1			9	12
practice/management	1		9		12
Consulting	1		15		6
Environmental +		13	18	78	185
German	1			21	
General Civil	2				42
Geologic	1			18	3
CEE+	16			48	288
CE Practice	1	1			21
Entrepreneurial	1		18		
Management	14		294		
Structures	15			6	291
Transportation	9		6	6	177
Urban and Regional	1			21	
Water Resources	2			6	36
Env Health		2	3	9	30
Env. Remediation		3		6	57
Green Engineering		1		9	12
Total	81	32	462	471	1403
Total Students		113			
Total EFA hours					2336

Figure 3: Semester Hours for Students Taking EFAs 2002-07.

It can be seen in figure 3 that the percentage of EFA hours that are engineering hours (60%) is much greater than either business (20%) or liberal arts (20%) these figures do not track precisely with figures 1 and 2 because some technical EFAs include either business or liberal arts courses.

Impacts on Students

As a preliminary evaluation of student success under the new curriculum, the College of Engineering Student Development Center surveyed the December 2006 and May 2007 graduates just before graduation and three months after graduation. Twenty four out of

35 students responded. Of those who responded, 16 had positions with civil engineering companies, and the other 8 were pursuing graduate degrees, as shown in Table 2

Table 2: Civil Environmental Engineering Graduates for December 2006 and May 2007

Year Matriculated	**Year Graduated**	**Job Title/Other**
Fall 2003	Spring 2007	Civil Engineer I
Fall 2005	Spring 2007	Assistant Engineer
Fall 2003	Spring 2007	Staff Engineer
Fall 2002	Spring 2007	CivilTech/Civil Engineer I
Fall 2002	Spring 2007	Graduate School
Fall 2002	Spring 2007	Graduate School
Fall 2003	Spring 2007	Graduate School
Spring 2004	Spring 2007	Graduate School
Fall 2004	Spring 2007	Graduate School
Fall 2004	Spring 2007	Graduate School
Fall 2003	Spring 2007	Graduate School
Spring 2002	Spring 2007	Project Engineer
Fall 2002	Spring 2007	Design Engineer I
Fall 2003	Spring 2007	Design Engineer
Fall 2003	Spring 2007	Civil Engineer I
Fall 2003	Spring 2007	Civil Engineer I
Spring 2002	Fall 2006	Graduate School
Spring 2002	Fall 2006	Civil Engineer I
Fall 2002	Fall 2006	Structural Engineer
Fall 2003	Fall 2006	Structural Engineer
Fall 2003	Fall 2006	Assistant Civil Engineer
Fall 2002	Fall 2006	Civil Engineer I
Spring 2002	Fall 2006	Environmental Engineer I
Fall 2003	Fall 2006	Civil Engineer I

It seems apparent on the basis of table 2 that the use of EFAs has not undermined the ability of students to pursue careers in civil and environmental engineering, or at least, not yet. The department will have to continue to track student performance in this regard to ensure that this ability continues and is not undermined in the future. Note that for this sample of students, all those who went on to graduate school did so to pursue graduate

degrees in either civil or environmental engineering. In past years, some graduates have gone on to other disciplines in graduate school (e.g. law).

In the ideal it would be possible to relate individual student EFA selections to individual student scores in the FE exam. However, while most of our students take the FE exam, we currently have no way of collecting such individual data and thus no clear correlation between EFA selection and FE exam performance is possible.

Conclusions

In 2002 the College of Engineering and the Department of Civil and Environmental Engineering adopted a new curriculum that allowed students to take 21 semester hours (out of a total of 128 hours required) in an elective focus area that could be non-technical. Since that curriculum change, 80.3% of the Civil and Environmental Engineering students have selected engineering EFAs, while 3.7% have selected completely non-technical EFAs (the balance chose EFAs that were technical but not engineering). On the basis of a survey of graduates in 2006 and 2007, students have had no difficulty pursuing careers in civil and environmental engineering, in spite of the fact that they can pursue significant non-engineering coursework as they progress toward their degrees. Continuing observations will be made to ensure that this remains the case.

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