A New Sophomore Engineering Curriculum -- The First Year Experience

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Introduction

During the 1995-96 academic year, Rose-Hulman offered a new sophomore engineering curriculum as part of its participation in the National Science Foundation funded Foundation Coalition. This paper will briefly describe the curriculum and discuss the assessment of the first year of the program.* The Rose-Hulman/Foundation-Coalition Sophomore Engineering Curriculum consists of two parallel course streams -- applied mathematics and engineering science -- and integrates material both across and within these streams. This curriculum is required of all electrical and computer engineering majors and is an option for mechanical engineering and civil engineering majors. Assessment was an important part of the first year program with emphasis on providing information to faculty for improving the effects of the curriculum on student learning.

Characteristics Of The Sophomore Curriculum

The process of curriculum development began in the Summer of 1994 with planning by an interdisciplinary team of faculty. In the Fall of 1995 the team proposed the curriculum with the following characteristics:

- It replaced the present engineering science and mathematics courses now taken by all disciplines with a series of courses that focus on engineering science, engineering practice, and mathematics.
- It was built on the belief that there is a core body of knowledge and experience that all engineering students should see by the end of their sophomore year, including Conservation and Accounting of extensive properties as key fundamentals and Modeling of the real world as a key engineering activity.
- It placed increased emphasis on Engineering Practice, e.g. the design process, the importance of communications, the role of economics in engineering decisions, and the importance of teamwork.
- It stressed the importance of linking material across the curriculum through careful sequencing, coordination, and integration of topics.

A fifteen member team met during the summer of 1995. This team finished the details of the Rose-Hulman/Foundation-Coalition (RH/FC) Sophomore Engineering Curriculum (SEC). The team included faculty from each of the engineering disciplines, mathematics, physics and chemistry. This team also included three students.

Outcomes Of The Curriculum Development Process

Curriculum Goals and Structure

During the third phase of the development process, goals were established for the new curriculum. These are listed in Figure 1. Course goals and objectives that supported the seventeen curriculum goals were developed for each course in the curriculum. The curriculum is organized into two course streams -- applied mathematics and engineering science -- that are taught in a coordinated fashion. The material in each course stream has been selected and sequenced to enhance student learning by reinforcing and revisiting topics both across and within the two streams. The structure of the curriculum is illustrated in Figure 2..

*For a complete description and discussion of the Foundation Coalition Sophomore Curriculum at Rose-Hulman, see, "A New Sophomore Engineering Curriculum -- The Rose-Hulman Experience, " *Proceedings,ASEE Conference, 1996 Session 1230.*

Students who participate in theRH/FC Sophomore Engineering Curriculum should

.....develop a strong background in engineering science,
.....develop an understanding of modeling,
.....be able to apply a common problem-solving approach built around the application of conservation and accounting principles and constitutive relations,
.....continue to develop effective communication skills,
.....be proficient in applying standard statistical procedures and quality control concepts,
.....develop a strong background in mathematics,
.....be encouraged to be inquisitive and self-motivated learners,
.....develop an appreciation for engineering as a profession and begin to develop an identity as an engineer.
.....be able to work effectively in teams and recognize the importance of individual responsibility in team efforts,
.....be able to apply computer tools appropriately,
.....be comfortable working with ambiguity,
.....be familiar with the overall design process,
.....be able to locate and retrieve both technical and non-technical information,
.....be introduced to safe and effective use of instruments,
.....appreciate the role of creativity in engineering,
.....develop a recognition of the benefits of the new curriculum, and
.....be encouraged to have fun learning.

Figure 1 - Curriculum Goals

Assessment

The assessment process for the first year implementation focused on providing faculty with feedback on the curriculum for the purpose of providing information which could be used to improve both course content and delivery. During the Fall quarter, a survey was developed based on input from faculty to be given to students at the end of the quarter and at mid-term of the second quarter. During the third quarter focus groups were held with about 30% of all students who were completing the three quarter sequence of courses. At the end of the third quarter, students who were in the curriculum and students taking comparable courses in the traditional curriculum were invited to take a shortened version of the FE exam.

Course survey

The course survey asked students to respond to items related to their preference for and/or satisfaction with the coordination of courses, course delivery, workload, and computer usage. This survey was given to students who were enrolled in the MA211 and ES201 sequence. As one might expect, responses covered the full range of possible answers. However, there was generally agreement among the respondents on specific items. Students generally reported that the connections made between MA211 and ES201 were both clear and helpful to their learning. They also reported a preference for class discussion and small group discussion as helping them to learn over lecture and individual problem solving. The use of computers

	Sophomore Year Courses		
	Fall	Winter	Spring
Applied Mathematics	Applied Mathematics I MA 211	Applied Mathematics II (MA 212)	Applied Mathematics III (MA 213)
Engineering Science		Fluid & Thermal Systems (ES 202)	
	Conservation & Accounting Principles (ES 201)	Electrical Systems (ES 203)	Analysis & Design of Engineering Systems (ES 205)
		Mechanical Systems (ES 204)	

Figure 2 - RH/FC Sophomore Engineering Curriculum

was seen as beneficial in MA211 and homework was viewed as enhancing their learning in both courses. A majority of the students did not perceive the workload during the first quarter as being any greater than their classmates who were taking comparable classes. In preparing for class, students reported seeking help primarily from other students or the text.

Focus Groups

Two focus groups were held with Electrical Engineering and Computer Engineering students and one focus group with Mechanical Engineering students only. All students in the focus groups were currently finishing the three quarter sequence of the SEC. These focus groups were held at the end of the third quarter. Generally, the students expressed that the underlying idea of the SEC was strong and had the potential to be a very good curriculum. They saw the communication among the professors and the emphasis on accounting and conservation principles as being very positive and helpful. Students generally felt the curriculum gave them a broader view of engineering and better prepared them for their upper level courses. The Mechanical Engineering students reported that it was their impression that the curriculum was better suited for ME's than ECE's. ME's also stated that they thought learning about a variety of systems made it easier to grasp concepts. In addition, they stated that, for ME's, the biggest selling point was the well-rounded engineering education they had gotten. All students were very positive about the availability of the faculty.

Students expressed concern about what they perceived to be the overwhelming workload in the Winter quarter. As a result of these student concerns, a council was developed to provide students with a formal mechanism to have continuous dialog with faculty about the curriculum. Students felt the council was helpful should be continued. In addition, they suggested spreading the workload out among the three quarters. They also wanted to see more cross-disciplinary work to solve complex systems problems in ES205 using all the systems they'd learned in previous quarters. They were generally positive about group work but preferred choosing their own groups as opposed to being assigned by the faculty members. They also expressed concern about labs which they did not perceive as reinforcing the course material but were very positive about those labs which were.

For the most part, students were positive about the curriculum and all those who participated in the focus groups felt that they had benefited from the experience. They commented that they felt they had a strong base in the engineering sciences and had developed the ability to solve an engineering problem outside their major area.

Sample EIT/FE Exam

In order to collect some comparison data on students' abilities to solve fundamental engineering problems it was decided to create a "mini" EIT/FE trial exam. The test was developed from a sample EIT exam. The number of items was reduced to allow students to complete the exam in a two hour period. Faculty who were NOT teaching in the SEC were asked to select items from the exam in the chosen areas. The items were not screened by the SEC faculty. The test was given on a "volunteer" basis and students were paid a stipend for their participation. All students completing the three quarter SEC sequence and all other engineering students currently enrolled in a fluids class were invited to participate. A total of 51 students actually took the test--23 from the SEC and 28 non-SEC students. Of these students, 38 were sophomores (20 SEC and 18 non-SEC). An item analysis will be done to determine if there are differences between the two groups in the number of correct responses on the different types of problems. The analysis is currently being run and a summary of the findings will be given at the conference.

Retention in Electrical and Computer Engineering

Another metric of interest to the ECE department was the number of students continuing in ECE after beginning their sophomore year as ECE majors. The data indicates that, in fact, the percentage of students retained in ECE was consistent with, and in some cases surpassed, previous years.

Future Assessment Plans

During the summer of 1996, the faculty team will be looking at the assessment results from the first year to assist in continued improvement of the curriculum. Plans have begun to revise the assessment strategy as well. Surveys will be revised and the pilot FE exam will be evaluated. It is also

planned to continue to track the students who have finished the first year of the curriculum into their junior year courses. Additional focus groups will be held with SEC students as they progress through upper-level courses to determine their perspective on the program.

The SEC faculty is committed to the value of the assessment process as providing valuable information for curriculum improvement. Although the assessment is generally performed through the Office of Academic Services and Assessment, the faculty are involved in the decisions regarding the content of the assessment process and the evaluation of assessment results.

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