Upper Level Interdisciplinary Courses in the Engineering Curricula

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Abstract: A new type of ID courses has been developed that explores the emerging areas of engineering. The goal here is to expose engineering students, regardless of their discipline, to technologies that have not yet matured, but are likely to. The primary driver is to induce a sense of excitement in the new and evolving engineering disciplines. The course is organized into short modules with multiple lecturers, and at a technical level not to exceed the science and math requirement of a typical junior student. First edition of the course was taught in Spring 2001. During academic year 2001/02 this course will be taught twice. Feedback from both instructors and students are extremely positive. Presentation will include description of the course structure, our experience (administrative and academic) thus far, and an analysis of course assessments.

Background. Since 1994, every entering engineering student follows an integrated curriculum map designated as the new Drexel Engineering Curriculum (tDEC). Four main features of this curriculum are curricular integration at the lower level, emphasis on experiential learning, teaching by engineering faculty in the lower curriculum and the requirement of interdisciplinary (ID) courses in the upper curriculum. Previously various authors from Drexel have reported on the first three features (ref). In this paper we address our progress on the ID courses in the curriculum.

Motivation. We expect new engineers of the 21st century to work in a team environment where the team members may be of different discipline. Furthermore, the undergraduate preparation at Drexel is designed to include integrated courses in the upper curriculum somewhat similar to the freshman/sophomore courses. Over the years, we developed several interdisciplinary courses. Examples are: Engineering Biotechnology, Quantum Structure of Materials, Statistical Analysis of Engineering Systems, Fundamentals of Manufacturing, Concurrent Engineering, and Process Physical Chemistry. These courses are content driven, and enabled a student to acquire detailed knowledge about the subject matter, provided the student has adequate prerequisites. That is, these courses are designed for a specific discipline. For example, concurrent engineering, although is interdisciplinary in character, is primarily for mechanical engineering students, while the process physical chemistry is designed for a junior in chemical engineering curriculum.

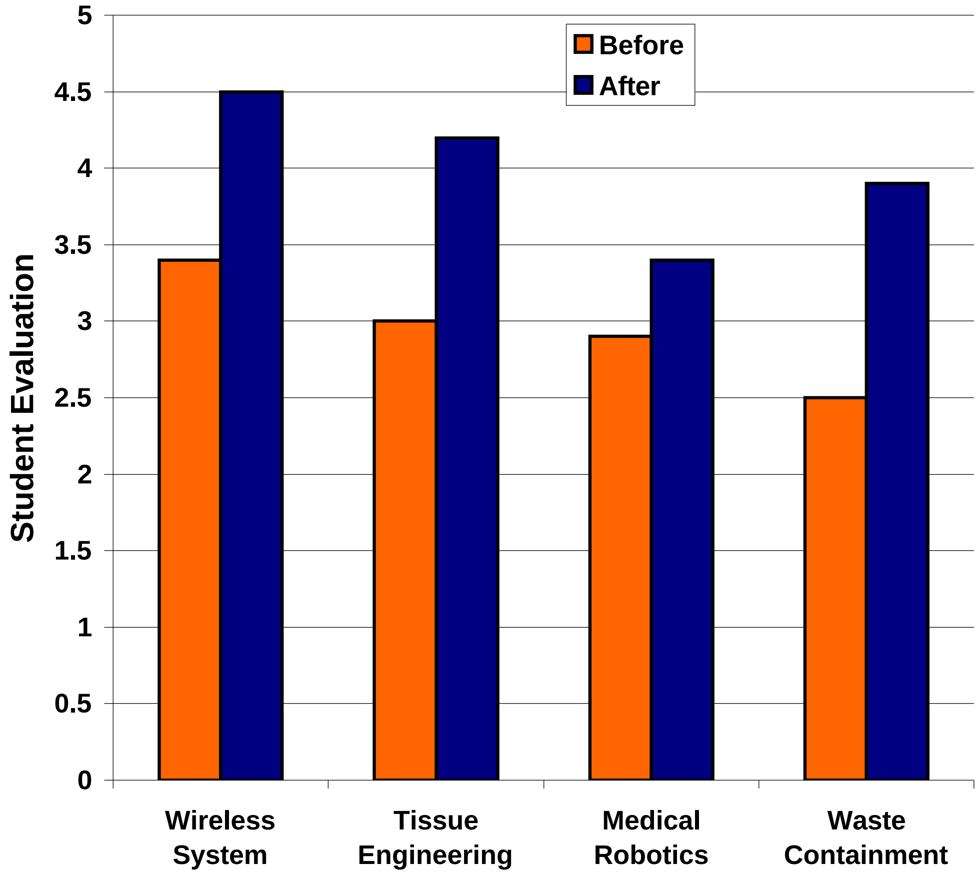
Consider the case of teaching an advanced topic in engineering to a student who does not have the “dove-tailed” prerequisites. A new type of ID courses has been developed at Drexel that explores the emerging areas of engineering. The goal here is to expose engineering students, regardless of their discipline, to technologies that have not yet matured, but are likely to. The primary motivation is to induce a sense of excitement in the new and evolving engineering disciplines. The course is organized into short modules with multiple lecturers, and at a technical level not to exceed the science and math requirement of a typical junior student. The latter requirement ensures that advanced prerequisites are not necessary enabling students from all disciplines to take the course. Further, the emphasis is on the conceptual framework, rather than on mathematical analysis.

Development of Course Modules. Several faculty members of the college of engineering were invited to participate in developing short course modules for the ID course. Twelve volunteered with the inducement of modest funding for salary support. Each were asked to develop a 25-page manuscript in Scientific American style with appropriate graphics for a target audience of engineering students with no more preparation than the sophomore level mathematics and science. The manuscript is to start from a basic framework and build through to current state of technology. For example a module in biotechnology would start from basic principles of genetic engineering and build to such advanced topics as: manufacture of recombinant proteins, gene therapy, DNA-typing, pharmacogenetics, or others.

Twelve faculty (out of 90) in the college were invited to participated in the course development. Topics offered were: Network security, Fiberoptics, Medical robotics, Laser Based NDE, Smart drugs, Tissue engineering, Waste containment, Conducting polymers, Surfaces at atomic dimension, Biotechnology, Wireless Communications, Emerging Internet Technologies, Earthquakes, and others. The faculty also developed two-week problem sets and instructional power point slides. All the material related to the course modules, lecture notes, powerpoint slides and exercise problems were posted at the course website. Thus, the course contents were all self contained and eliminated the need for any specific textbooks

Spring 2001 Course. In Spring 2001, four course modules were used for organizing the ID course under the title, Emerging Engineering Technologies. About 16 students, mostly seniors, from four disciplines – Mechanical, Civil, Electrical and Chemical, took the course. The specific modules included were: Tissue Engineering, Wireless Communications, Waste Containment and Medical Robotics. Explicit course objectives were stated as: develop an understanding of, and an appreciation for current and future research directions in wireless systems, develop an understanding of, and an appreciation for current and future research directions in medical robotics, develop an understanding of, and an appreciation for current and future research directions in waste containment and management, and develop an understanding of, and an appreciation for current and future research directions in tissue engineering. The course met twice a week for 90 minutes each. An introductory lecture was used for describing the course structure and organization. Each module was presented and discussed in four meetings, and the fifth meeting served as a summary and quiz period.

Course Assessment. At the end of the course the students were surveyed to obtain their response to several questions. With regard to the course objectives stated, the students were asked to assess their knowledge prior to and after taking the course, in the specific module on a score of 1 to 5, one being the least. Figure below shows how they evaluated



the effect of the course on their understanding of the four course modules. The data show that there was a significant improvement in their exposure to the four course modules. The difference between after and before is a measure of the value added by the new ID course, and correlated to the students' assessment of the instructor's teaching evaluation. In the same survey the students were also asked the question: "Did the course have a multi-disciplinary perspective?" The student responded on a scale of 1 to 5, with 5 representing "very great extent" and 1 representing, "not at all". The average response was 4.3, suggesting that the students do perceive the course content as interdisciplinary.

In the comment section of the assessment survey, the student had various comments. The three main ones are: (1) Learning new technology in different fields is good concept. (2) Suggest offering this to freshman/sophomore and pre-juniors. They will have a chance to view the various engineering technologies. This could be a factor in their deciding what track to pursue or even change tracks. (3) Four modules is heavy, reduce the modules to three. The first comment was repeated by several respondents suggesting that the students who took the course do value the interdisciplinarity of the course. The second comment suggest that the students would like an exposure to the emerging technologies so that they can better select their majors. The third comment suggest that the course content was too packed and full.

Future Direction. We have accommodated the third comment and have reduced the number of modules to three. A winter edition of the course is currently being taught with the modules on fiber optics, emerging internet technologies and smart pharmaceuticals. A spring quarter course will discuss biotechnology, earthquakes and cholesterol.

Acknowledgement. The development of this program was partially funded by Gateway Coalition. The Gateway Coalition is supported by the Education and Centers Division of the Engineering Directorate of the National Science Foundation (award numbers EEC-9109794 & EEC-9727413).