

Theme-Based Redesign of the Duke University ECE Curriculum: The First Steps

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Abstract. Historically, undergraduates in Electrical and Computer Engineering (ECE) at Duke University have had ample exposure to theoretical foundations and design experiences within the framework of a flexible curriculum. Students have benefited from the combination of curricular flexibility and rigorous coursework, and over the past two decades courses in the core curriculum have seen incremental changes in both content and structure. The overall structure and intent of the core curriculum, however, has not been examined during this time, is circuit-centric, and does not fully reflect modern curricular philosophies and approaches to learning or engineering education. The current curriculum is further limited in that the core courses do not offer a vertically integrated thematic introduction to ECE as a discipline nor are they reflective of the broader scope of the ECE field of study. In 2003, NSF awarded Duke a planning grant for curriculum reform. The goals of our curriculum redesign are to maintain our curricular flexibility while introducing a theme-based structure focused on major concepts and principles, and to integrate this theme throughout the core and the technical focus areas. This theme, Integrated Sensing and Information Processing, reflects the active research areas of the majority of the ECE faculty, and embodies key concepts of all components of ECE within a real-world framework. During the planning phase, we developed and implemented an assessment plan and obtained baseline results, investigated modern pedagogical techniques and integration approaches, and defined a process for our curriculum redesign. In 2004, NSF awarded Duke a curriculum redesign implementation grant. In this paper, we describe results from our initial assessment activities and plans for the coming years. We also describe the process by which we are redesigning our core curriculum, including the design of a theme-based introductory course that introduces fundamental concepts of ECE through coursework and a real-world design project and laboratory experience. The structure of the new core and theme-based structure will also be presented. [This work was supported by NSF EEC-0431812].

Introduction

The Department of Electrical and Computer Engineering (ECE) in the Pratt School of Engineering at Duke University is committed to a significant redesign of the undergraduate curriculum. To provide the best possible undergraduate education for Duke students, an innovative ECE curriculum will be developed and implemented. The new curriculum has been under active development since mid-2003, when the department

was awarded a one-year planning grant from the National Science Foundation (NSF). A follow-on implementation grant was also recently awarded. The curriculum will be focused around a theme, Integrated Sensing and Information Processing (ISIP), which reflects key concepts governing the future of electrical and computer engineering as well as the active research areas of the majority of the ECE faculty.

While the redesign encompasses the entire four-year curriculum, a particular emphasis of the redesign will be on the students' early years in the core curriculum when retention issues are the most critical. Specifically, the foundation of the new curriculum will be a freshman-year laboratory-based design experience called "Fundamentals of ECE," and denoted ECE 27. This innovative course introduces concepts fundamental to the entire ECE curriculum and their practical applications through a tight coupling of coursework and a real-world design project and laboratory experience. Our project will be built around a model of a "plug and play" sensor bench - wherein we can introduce students to various sensor types (environmental, biological, etc.) as well as the systems analysis and processing tools necessary to obtain and manipulate sensor measurements to achieve some desired objective.

As part of the curriculum reform, we will also focus on restructuring the core curriculum so that it provides more balance and emphasizes fundamental ECE concepts within the construct of the instructional theme. In particular, we will reduce the core set of courses from five to four and restructure the information presented. In addition, we will modify the structure and content of upper-level technical courses to be consistent with the curricular theme. Significant effort will be devoted to developing new theme-based design courses that integrate core technical competency achieved in the various technical tracks and draw upon the active research programs of the faculty. One new design course will revisit the system from the introductory course, including redesign of each of the components, providing a completely seamless curricular option of initial design, core courses, technical electives and final design. A second design course will focus on development of wireless integrated sensing and processing networks for applications closely linked to faculty research projects. Finally, we plan to integrate MATLAB throughout the curriculum in order to provide a modern, cohesive simulation and analysis platform.

Preliminary Assessment Efforts and Results

Historically, undergraduates in Electrical and Computer Engineering (ECE) at Duke University have had ample exposure to theoretical precepts and design concepts within the construct of a broad curriculum. Students pursue a wide variety of interests, as evidenced both by the fact that 67% of our students obtain a double major and by the increasing number of our students who seek employment outside of traditional engineering disciplines. Of the students pursuing double majors, almost 80% combine ECE with another field of engineering or with computer science. The remaining 20% pursue second majors in the liberal or fine arts, in fields such as economics, foreign languages, or music. We feel it is important to retain these opportunities for

interdisciplinary study. For example, the ECE department begun requiring Biology as part of our curriculum.

Despite these strengths, three limitations of our curriculum are: 1) it is somewhat circuit-centric, and as such does not achieve the conceptual balance that we believe is appropriate for modern electrical and computer engineering education; 2) it reflects only a portion of the balance of interests and research strengths of the ECE faculty and 3) the curriculum does not incorporate modern curricular philosophies and approaches to learning or engineering education to the degree we would like.

Specific areas for improvement identified by recent assessment efforts include [1]:

- **Need for more of a coherent, overarching framework that integrates basic principles of ECE.** Core courses are not as well interrelated as they could be, so no cohesive picture necessarily emerges as a student progresses through the curriculum. These limitations may affect student retention, especially for underrepresented minorities and women.
- **Need for more exposure to technical focus areas prior to advanced course sequences.** Students must choose which advanced topics sequences they will take without having had substantial previous exposure to their content, and with limited understanding of the context or relationship of these areas within ECE. Students are then committed to taking two courses in each focus area to fulfill breadth and depth requirements.
- **Moderately unbalanced coverage of fundamental areas of ECE.** The core curriculum does not provide a balanced coverage of the three fundamental subdisciplines within ECE: electronics, systems/information processing, and computers. Instead, the current core curriculum is weighted towards circuits and devices.
- **More flexible course sequence requirements.** The current requirement that students take two courses in each of two focus areas does not allow the “generalist” student, interested in more breadth, nor the “specialist” student, interested in more depth, to tailor their course selection to fit their interests.
- **Broadening of design courses.** Some of the currently available design courses are somewhat dated, and not as many aspects of ECE are reflected in the design courses as would be preferable. Design courses, like the core curriculum, are more heavily focused on circuits and devices than on information processing.
- **Better integration of computational tools.** Software platforms for modeling and data analysis are not employed consistently across courses, particularly in the core courses.

Results from a recent Educational Benchmark Inc. (EBI) survey of our students confirmed that they too perceive these opportunities for improvement in our curriculum. However, this survey was of limited utility since students provided only quantitative, not qualitative, data, and were not asked to distinguish between *importance* and *quality* of various aspects of the curriculum. To better understand the results, we teamed with a

consulting company, Acuity Edge, to perform an in-depth follow-up study of student perception of both the current and planned ECE curricula.

The first component of this follow-up study was an initial survey of current and recent graduates focusing on broad issues such as the quality of teaching, the quality of the laboratory experience, and the quality of design experiences offered. Students were asked to rate both the importance and quality of a range of topics using questions that paralleled those in the EBI study. For example, students were asked to rate instruction in their ECE courses based upon factors such as teaching, feedback on assignments, and teacher/student interaction. Students were also asked for qualitative input for each of 15 EBI-based questions since both types of data provide useful and different information [2]. Analysis of the resulting data suggested that students were generally pleased with their educational experience, and that the three curricular areas the respondents felt needed some improvement were teaching, laboratory facilities and relationship between lab and course, and design experiences. These results support our faculty's assessment of areas needing curricular reform and improvement.

The second component of this follow-up study was a student focus group that was designed to elicit detailed input about the current curriculum and to discern reactions to the planned curriculum. The results from the focus group validated the results of the initial broader survey and provided additional interesting qualitative data. Current Duke students (juniors and seniors) were in general pleased with the current curriculum, but voiced similar opinions about the areas in which the current curriculum could be improved. Furthermore, these students were enthusiastic about the planned new curriculum structure. We believe that these new assessment results provide strong support for the likely impact of the planned curricular changes.

Structure of the New Curriculum

Our goals are to revise the overall structure of the curriculum while incorporating the ISIP theme, to provide continuity by emphasizing the interrelatedness of ECE topic areas, and to incorporate innovative pedagogical techniques and hands-on experience throughout the curriculum while maintaining our curricular flexibility. The ISIP theme is compatible with the broader themes, e.g. biology, economics, computer science, that our students currently pursue with their electives.

Our planned changes to the curriculum include:

- Develop a theme-based introductory course that introduces fundamental concepts associated with an ECE curriculum through coursework and a real-world lab-based design project. By introducing students to the “big picture” early in their engineering education and by using diverse applications in the laboratory, we expect to positively affect student retention, especially for underrepresented minorities and women.
- Restructure the core curriculum so that it provides more balance and emphasizes fundamental ECE concepts and design within the construct of the instructional theme. We anticipate that this will also affect student retention rates.

- Modify the structure and/or content of upper-level technical courses to be consistent with the curricular theme.
- Develop new theme-based design courses that integrate core technical competency achieved in the various technical tracks and draw upon the active research programs of the faculty.
- Integrate MATLAB throughout the curriculum in order to provide a modern, cohesive simulation and analysis platform.

The development of an integrated theme-based curriculum has been implemented at other institutions to improve educational outcomes [3-6], although the level of success has varied due to the degree of correspondence of the theme with other institutional strengths [3]. We have selected a theme that we feel embodies the key concepts of electrical and computer engineering within an easily understandable, real-world framework. As such, it provides a unique and innovative educational platform on which to educate our students. This theme leverages the inherent research strengths of our faculty in ISIP, as well as our departmental-level investment in full-time teaching-oriented faculty.

Overview of the Present ECE Curriculum

The Duke University Pratt School of Engineering defines the basic structure of the engineering curriculum for the four departments within the school. Emphasis is placed on integrating a rigorous engineering, mathematical, and natural science education with Duke's highly respected liberal arts courses. Students take a minimum of 34 courses, thirteen of which are engineering courses within the department of their major. The ECE Department at Duke offers a Bachelor of Science degree with a major in Electrical and Computer Engineering (ECE). There are currently 186 students who have declared ECE as their primary major and 109 students who have declared ECE as a second or dual major. The ECE curriculum is managed by the departmental faculty via the Undergraduate Studies Committee (UGSC), the Director of Undergraduate Studies (DUS), and the departmental administration.

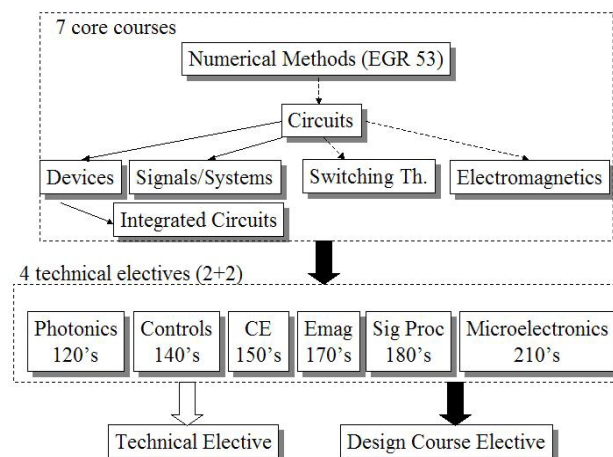


Figure 1. Current ECE Curriculum.

The ECE curriculum requires each student to take a set of seven core courses (six ECE courses plus one programming/numerical methods course). The core courses that are currently required are:

- Numerical Methods
- Introduction to Electric Circuits
- Introduction to Electronics: Devices
- Signals and Systems
- Introduction to Switching Theory
- Introduction to Integrated Circuits
- Electromagnetics

In order to provide both intellectual depth and flexibility, the curriculum requires students to take two pairs, or sequences, of upper-level technical electives. Each sequence is chosen from six areas of concentration (see central box in Figure 1): Photonics, Controls, Computer Engineering/Digital Systems, Electromagnetics, Signal Processing and Communications, and Microelectronics.

Curricular Theme: Integrated Sensing and Information Processing (ISIP)

Our goal in this effort is to develop a new, innovative curriculum for the ECE department that focuses on ECE fundamentals within the construct of real-world integrated system design, analysis, and problem solving. We will modify the curriculum structure, with a primary focus on core courses and a secondary focus on design courses, to implement learning within a curriculum-wide theme and to provide vertical integration with a modern computational tool, MATLAB. We will rebalance the core curriculum to better represent the three central topics of ECE defined by Lee and Messerschmitt [7]: electronics, information systems, and computer science. The technical electives will be similarly matched to our theme, to improve the transition to in-depth exploration of areas of student interest.

The curriculum will be organized around the theme of Integrated Sensing and Information Processing (ISIP). This theme bridges the disciplines of physics, devices, mathematics, electromagnetics, signal processing, computer engineering, communications and controls, with the goal of building systems and networks of systems for specific applications. It not only clearly instantiates ECE focus areas individually, but it also provides a unique and appropriate platform for integration across focus areas. ISIP as a concept considers sensing system design and operation without regard to traditional subsystem boundaries and interconnect structures – and thus it can be used in an educational setting to teach design and operation with much less regard to traditional course boundaries. In addition, ISIP provides a strong fundamental framework from which our graduates can address problems in new and evolving areas, such as biological and biomedical applications.

Theme-Based Introductory Course

The central concepts of Electrical and Computer Engineering relate to the sensing, transmission and manipulation of energy and information. We have organized our introductory course around four of these concepts: 1) how to interface with the physical world, 2) how to transfer/transmit energy/information, 3) how to extract/analyze/interpret information, and 4) how to organize and store information. An innovative component of the planned curriculum is an introductory course that develops these four topic areas within the ISIP theme. We have tentatively titled this course “*Fundamentals of ECE*”.

In this design- and synthesis-oriented course, students will build a prototypic ISIP system, such as a weather-monitoring station or a biomedical monitoring system. To create this system, students must work with sensors that transduce environmental information, must create analog signals that can be transmitted and received wirelessly, must use logic to display the results, and must interpret and calibrate their results based on subsequent testing. Fundamental concepts of the ECE curriculum will be introduced on a “need to know” or “just in time” basis, including circuits and devices, systems and systems analysis, logic and computers, and electromagnetics [8]. Through this synergistic presentation and organization of topics, students will gain an understanding of each sensor/device at the physical level, then understand the input/output characterization or how the device operates at the system level, and finally gain an understanding of how the device interconnects with other elements as a component of a larger system. By taking this rigorous real-world design course at the outset of their studies, students will gain a much broader picture of ECE. This framework also permits tight coupling of lecture and laboratory instructions, as concepts introduced in lecture can be immediately made tangible through concrete laboratory sessions. The diverse exposure to ECE topics, combined with the sense of accomplishment associated with completion of a complex project, will serve to energize their progress through the remaining curriculum. Similar courses have been well received [4,8], indicating its likely high impact upon our students. The novelty of our approach lies in integrating this initial design experience throughout the remainder of the curriculum.

Fundamentals of ECE will be developed as a course that, while rigorous and demanding, captures students’ imagination and creativity. An instruction manual will be carefully written as a part of the course development so that the lab/design experience is not simply a “paint-by-numbers” soldering exercise. Students will design and analyze components of the ISIP system prior to building a particular subsystem in the lab. Within the context of the course, other examples of ISIP systems taken from faculty research projects will also be introduced. MATLAB will be used to simulate components and systems to solidify the idea of simulation/testing as an integral part of the design process.

The ISIP-based *Fundamentals of ECE* course will provide substantial advantages to the planned curriculum revision. It will introduce all of the major areas of ECE in the first year, using the ISIP theme concept to illustrate how each area contributes to multiple components of an entire system. Current engineering education literature suggests that such early experiences with real-world aspects of a curriculum are key factors in student interest, long-term understanding and retention. Furthermore, the course will link each discussion of a concept, device, analysis technique, or system to the future core and advanced classes that will discuss that topic in more detail. This will allow students to anticipate future extensions of the concepts in their other courses, to appreciate the overall

organization of the curriculum, and to select their future courses based in a principled *experience-based* manner. Students will more easily recognize the relevance of later course material, because they will understand how newly developed skills could have improved their earlier work with a real-world application. The improvements in the overall integration of the curriculum should also enhance retention rates [2-6].

Redesign of the Core Curriculum and Technical Electives

Another major component of the planned revision will be to restructure our core curriculum. We will balance coverage of the three main areas comprising ECE, electronics, systems, and computers [7], so that students' exposure to these concepts more closely matches real-world demands. This redesign will require a reapportioning of the material previously covered in three courses: *Circuits*, *Devices*, and *Integrated Circuits*. Some of the material historically presented in *Circuits* will be distributed throughout several of the new core courses, and some will be integrated with a redesigned version of *Integrated Circuits*, which will become a technical elective. Much of the *Devices* material will remain in the core, with some content presented in the new introductory course. The *Electromagnetics* course will remain in the core curriculum as it provides the physical background for many key concepts in the technical electives and design courses. The core courses will each be linked to the introductory course so that the relevance of their material is more easily understood. MATLAB exercises will be integrated into each course. This will take advantage of a highly regarded modern computational tool, to facilitate the transition from rote to exploratory learning [2-6].

In the new curriculum, there will be four core courses beyond *Fundamentals of ECE*, tentatively titled "*Circuits and Devices*", "*Signals and Systems*", "*Logic and Computer Architecture*", and "*Electromagnetics*" (see Figure 2). These courses will require a major redesign and reorganization of existing instructional material, for three reasons: 1) they must provide a foundation for more in-depth junior and senior level technical electives, 2) they must be conceptualized within the ISIP theme, and 3) they must be tightly coupled to each other. Novel laboratory and MATLAB exercises will be developed or modified to support each of these courses. We describe the planned changes to these core courses in the following paragraphs, noting particular examples of their integration with the ISIP theme and each other.

The new *Circuits and Devices* course will contain much of the material from the previous *Devices* course. However, as new devices and circuit analysis techniques are developed, reference will be made back to the places within the *Fundamentals of ECE* project where such devices and techniques are utilized. For example, students will discuss and evaluate alternative designs for the temperature sensor portion of the weather station. The effects of ambient temperature on the accuracy of the components will be considered, and new devices will be introduced for use in temperature-sensing applications. Sensors based on MEMs and nanoscale phenomena will be discussed to illustrate current revolutions in device technology.

The new *Signals and Systems* course will modify our previous *Linear Systems Theory* course to cover new topics and to better integrate our curriculum theme. For example, in

our current course, students create an AM radio to teach the signal processing concepts associated with modulation and frequency-domain processing, although they do not explore the underlying circuit design. Due to the popularity of this project, we will continue to use the radio as a means to teach modulation, but we will incorporate new elements so that students analyze the circuits and devices used to perform the necessary processing. This will provide an important link to their previous *Circuits and Devices* course. Furthermore, from their *Fundamentals of ECE* course, students will have had cursory exposure to topics like scaling, superposition, and the Fourier Transform. Here, these concepts will be applied to extensions of the weather system, like the online calculation of wind chill. We will also develop MATLAB-based exercises in which students develop and analyze an indoor temperature control system and an irrigation control system using the actual signals measured by the weather station.

Our new *Logic and Computer Architecture* course will focus on how digital systems can be used to make decisions and control devices using logical devices. As introductory material historically presented in *Introduction to Switching Theory* will be covered in *Fundamentals of ECE*, we will focus on computer architecture and its applications. Course material will be tied to *Fundamentals of ECE* by discussing how systems respond to interrupts within the context of managing and responding to user input commands, such as when changing the display of the weather station. Special-purpose hardware alternatives to the microcontroller used in the weather station will also be discussed. Note that detailed consideration of the microcontroller architecture and programming will be studied in subsequent computer engineering elective courses.

Our existing *Electromagnetics* course provides students with fundamental knowledge in sensing using electromagnetic fields, and will remain one of our core courses. As a result of faculty research interests, this course is already oriented towards sensing problems. We will modify the existing course to include components associated with integrated sensing and to reference the radiofrequency components studied in *Fundamentals of ECE*. As examples, reflection and transmission will be discussed in the context of subsurface sensing; measurement of reflection coefficients will be related to the inference of soil properties; buried targets will be treated approximately as subsurface layers, whose properties then can be estimated; and discussions of antennas will be enhanced to incorporate sensor design for integrated sensing.

In the current curriculum, students take two two-course sequences of technical electives to enhance the breadth and depth of their study. We will maintain the requirement of four courses in the revised curriculum, but will enhance flexibility by allowing students to take different combinations of courses within the topic areas (e.g., 2+2, 3+1, 2+1+1). This modification addresses the goal of flexibility in the revised curriculum. The generalist student could take, under the new curriculum, two courses in one area and one course in each of two other areas. On the other hand, a student wishing to obtain greater depth in one particular area could select three courses in that area, and one course in a different area. This enhanced flexibility preserves both the goals of breadth and depth, but allows students to design a curriculum that is more specifically targeted to their own, often interdisciplinary, goals [7].

The final three courses in the revised curriculum will consist of two track-specific courses and one track-independent design elective. The track-specific courses will be chosen by students to complement their career goals. While development of these track-specific courses is not a primary component of this application, such courses may emerge as the new core curriculum is developed. The track-independent elective will be an advanced course, ECE Design, that will provide hands-on experience with real-world applications of ECE. Students in this course will choose from a set of potential design projects, compiled both from existing design courses and new design experiences that complement the ISIP theme. Students will consider all aspects of a single application, from conceptualization of the basic physical principles involved to marketing a robust and cost-effective device via a start up company. Teams of students will work on different subsystems of the project, and collaborations across teams will produce one cohesive design, demonstration, and report. The complete structure of the new curriculum is shown in Figure 2.

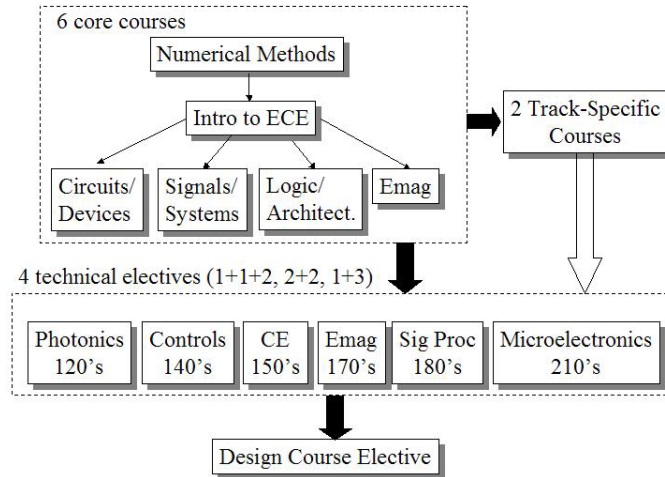


Figure 2. Planned ECE curriculum.

Supporting Activities

There are several additional activities that are being pursued in an effort to enhance the undergraduate curriculum as part of the curriculum revision. These activities focus on enhancing teaching, assessment, and team-building exercises. As each activity is in the initial deployment stage, we briefly discuss them here. Our initial assessment activities indicated that teaching effectiveness could be improved. Our goal in this area is to assist instructors in improving their teaching skills. We have begun providing the following resources to provide such assistance: (1) one pedagogical techniques workshop facilitated by outside experts per semester, (2) a one-day roundtable event each year to draw upon educational ideas and best practices from leading ECE institutions, (3) provide a handbook of “collective wisdom”, (4) provide continuing education/training on relevant engineering software, (5) provide assistance in developing online evaluation forms.

In terms of assessment, our goal is to improve both the individual faculty assessment process and to institute a formal department/curriculum-level assessment process. Some of the details of the second goal are provided in the next section. In terms of individual faculty assessment, we have contracted with an outside consulting firm to assist us with this effort. In addition to updating dated course evaluation forms, we will be continuing to conduct senior exit interviews and surveys, and will conduct exit interviews with students taking new courses associated with the curriculum revision. We will also continue to support department-initiated surveys and focus groups, which have proven to be effective in our initial efforts.

The ECE faculty is committed to creating an ECE program that truly reflects, through its very structure, the mission of the Pratt School: to be bold, personal and interdisciplinary. The core of our program remains the core of most undergraduate programs: the classroom and laboratory experiences that are the crucible of disciplinary learning. To build on this core, we are creating additional student-faculty experiences that aim to 1) enhance the personal development of students; 2) engage students and faculty together in consideration of the world's greatest opportunities and challenges; 3) provide new means of thinking with the conscious consideration of learning and creativity through art and building. In addition, these activities will build a sense of community in ECE, significantly enhance the differentiation of our ECE program from others; and will strongly leverage Duke's strengths overall.

To achieve this, we will institute four group experiences, one per academic year. One experience will be "Engineering and Art: An Integrated Learning Experience". The goal of this experience is to educate students on the current knowledge about creativity, learning and design through integrated art and engineering projects. Another experience will focus on "Leadership: Developing Personal Potential." Leadership develops over time and cannot be explicitly taught. That said, leadership can be enhanced through the conscious consideration of great leaders and the tools that enhance their effectiveness. In partnership with the Fuqua Business School and the Masters of Engineering Management (MEM) program in Pratt, we will create a Leadership Institute that all of our students will participate in.

In the third experience, students will consider "Global Issues: Opportunities and Challenges". Great issues face us today. Panel sessions currently presented in the Pratt School of Engineering at Duke are excellent examples of the scholarship and action that is present on Duke's campus related to economic, political and healthcare challenges. Students and faculty will be engaged (over a meal) together- on a monthly basis- with Duke leaders to discuss these issues. This activity could be coupled to international summer opportunities after the junior year. Finally, students will engage in "Leadership Revisited", and The Leadership Institute will be revisited and enhanced

Curriculum Design Procedure

In this section we describe the curriculum design process that we have adopted, and discuss the roles and responsibilities of the key personnel. The timeline associated with

the first stage of this process (core course design) is also discussed. Our goal in year 1 of this effort was to redesign the core curriculum and begin planning for the implementation process. In parallel, we are holding two workshops (one of which has already occurred) and one best practices round table. We are also continuing our assessment practices, including targeted assessment efforts, and senior exit interviews.

There are several considerations and tradeoffs associated with the curriculum redesign, and each of these has played a role in the design procedure that we have implemented. For example, we want to extract value from our current curriculum while at the same time incorporating innovative ideas into the new curriculum. In order to proceed effectively, we need to develop incentives for the most involved participants, while ensuring equity and fairness for good morale. We also want to provide opportunities for ample team interactions, while still empowering individuals to make progress. Finally, we want to develop sufficient structure to guide the instructors challenged with designing each course, while at the same time allowing sufficient flexibility so as not to encroach upon individualism.

In order to achieve our goals, and to carefully ensure consideration of each of these tradeoffs, we developed a series of roles to effect the organization necessary for the reform process. The key roles that have been developed and assigned are (1) course leader, (2) theme team, (3) approval team, (4) advisory team, and (5) project manager. These roles are discussed in terms of the first stage of the curriculum reform: core course development. There is one course leader for each new core course, and these individuals are charged with ensuring that a new course syllabus, instructional materials, and instructional guidelines are developed. These individuals are the guardian for the course learning objectives, and build a team to achieve their goals by drawing on faculty from the group associated with the course objectives. The theme team is a group which consists of the leaders of the reform effort, and they are charged with ensuring that the theme-based signature is present in each course, and as such are the guardians of the theme-based elements of the new curriculum. The approval team is a department-level group charged with ensuring that the new courses and materials meet educational and university specifications. This group is not actively involved in the details of the curriculum redesign, but are actively involved in the educational mission of the department. The advisory team is a group of department-level and school-level faculty, as well as outside individuals representing industry and academia. This group provides a sounding board for advice, as well as providing a reality check when necessary. Finally, the program manager is the PI of the project, and their role is to ensure that progress is made and that reform objectives are met.

With this structure in place, a process to achieve reform was also developed. For the core course redesign process, this process consists of four stages which will take place sequentially over the course of approximately 15 months. The first phase, termed “Course Mapping”, is also referred to as the deconstruction phase. In this phase we are reducing the current core courses to fundamental building blocks and developing new ideas for course improvement. In this phase, the majority of the work has fallen on the course leaders, with several team interactions between course leaders and the theme team.

This phase will be completed in early January of 2005. The second phase involves the actual design of the new courses, and is called “Restructuring and Realignment”. In this phase we will apply the new paradigm that has been developed for a theme-based curriculum to develop the new courses. In this phase, we anticipate bi-weekly meetings between the course leaders and theme-team to ensure that the goals of the project are met and to enhance course-to-course integration. Laboratory components for each course will also be specified. Four months are allotted for this process.

The third phase, which again falls primarily under the purview of the course leaders is the “Materials Creation”, or rebuilding phase. In this phase the course leaders, again in conjunction with the team of faculty that they have created, will develop all of the materials necessary to teach the new core course. The course leaders and theme team will continue to meet to ensure integration, meetings with the advisory team will continue, and meetings with the approval team will be initiated. Five months are allotted for this process. Finally, in Phase 4, the “Approval” process will be finalized. This process will include interactions between the course leaders, advisory and approval groups.

Conclusions

We have begun an extensive ECE curriculum redesign. Our initial assessment results allowed us to pinpoint opportunities for improvement and brainstorm strategies for this improvement. We have created a streamlined course structure, which is consistent with an educational theme and have begun development of the new core courses. To support our activities, we have developed a curriculum design process that incorporates an extended support structure for management of the reform process. The first phase of this process, design of the core, theme-based ECE curriculum is on schedule to be completed by the end of the fall semester, 2005.

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