Ignite: A New Paradigm for Curriculum Design and Deployment In Undergraduate Industrial Engineering Education

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Abstract

This paper describes a process for achieving major reforms to the undergraduate industrial engineering curriculum at the University of Tennessee – Knoxville (UTK). The work described has been funded by the National Science Foundation (NSF) and has as its main goal the development of a new paradigm for baccalaureate engineering education. The model under development in UTK's Department of Industrial and Information Engineering is called *Ignite* and will build on seven years of experience in improving the quality of engineering education through the *Engage* freshman engineering program, which began as an NSF sponsored activity. *Ignite* will build on these experiences and also incorporate the findings and specific recommendations of the Boyer Commission on Educating Undergraduates in the Research University. Though discipline-specific, our intent is to develop a curriculum and pedagogy that can form the basis for a new generic template in undergraduate engineering education that can be deployed on a national scale.

Ignite's reformed curriculum will enable the transition from the traditional model of loosely connected individual courses to a modular structure of highly interconnected courses. Teaching methods will also undergo a radical change. An *integrated learning experience* will replace *demonstrate-then-emulate* methods. The focus will be on problem-based, cooperative, and service learning exercises; research; information technologies; and faculty teaming.

The design methodology described begins with the creation of a knowledge base consisting of program learning outcomes, content elements, and teaching resources. From the knowledge base, a process is implemented leading to a new modularized integrated curriculum that will be team-taught, will include innovations in teaching and assessment methods, and will use graduate teaching assistants in a novel way. The paper is organized in four sections: making the case for change, a proposal for innovation, a paradigm-changing methodology, and roadblocks and keys to success.

1.0 Making the Case

Three decades ago industrial engineering departments were commonplace throughout industry. These departments, and the IE's who staffed them, played a role similar to that of a consultant. If a department had a problem, or simply was looking for a better way to do or measure something, it would contact the IE department, and the project would be assigned to one of its engineers. IE's gained a reputation as *trouble-shooters* or *efficiency experts*, because they possessed a set of skills that enabled them to analyze processes and systematically design better, more efficient methods. Today organizations still depend on the training and expertise of industrial engineers to

find improvements and to help solve problems. However, the environment in which this work is carried out is dramatically different than it was in the 1970s. IE's no longer work on focused projects within the confines of a specialty group, and IE departments have all but disappeared. IE's are hired by companies to work on multi-disciplinary design teams, lead Six Sigma quality improvement projects, participate in procurement, or manage information. Industrial engineers come in contact with customers and vendors, and must effectively work with plant personnel at all levels. Their duties require communications, interpersonal, and team skills at a much higher level than in the past. And, above all, IE's need to be able to take a systems perspective.

The IE discipline has always proudly boasted that its members were systems engineers, even though projects conducted through IE departments were generally concerned with small components of a larger problem with little consideration to the system-wide impacts. Today the IE graduate contributes to major decisions in such areas as the design of supply chains, the allocation of resources to support lean production, the design of complex management systems with intricate feedback and intervention capabilities, and the design and operation of quality management programs. The consequences of these decisions are far-reaching and have strategic implications.

While the world has been changing dramatically, ironically few major changes have been made to the baccalaureate-level industrial engineering curriculum that is common to most ABET-accredited U.S. programs. In addition, the research suggests that traditional pedagogy may be inconsistent with the teaching practices that work best in engineering education. Clearly there is a critical need to develop a comprehensive plan to *reengineer* the design and delivery of industrial engineering education.

A decade ago, two independent studies (Myers and Ernst (1994) and Board of Engineering Education (1995)) emphasized the need to move engineering baccalaureate curriculum in a direction that incorporates a set of non-technical skills, e.g. teamwork and communications. More recently, the Boyer Commission (1998) report made a case for strengthening the quality of baccalaureate education at research universities. This study called for universities to take advantage of the immense resources of graduate and research programs in order to create a new kind of undergraduate experience that is only possible at research universities.

With the advent of ABET-2000 criteria and new studies, the necessity for a reformation of pedagogy has become widely accepted as well. Specifically, in response to a growing discontent by industry of the lack of preparedness of fresh graduates entering the workforce, incorporating elements of active, cooperative, and problem-based learning and the use of new instructional technologies to deliver stimulating, interactive lessons, has become an imperative (Felder (2004)).

2.0 A Proposal for Innovation

2.1 Research Objectives

Combining the recommendations of Boyer and Felder, we propose a new model of undergraduate engineering education that will attempt to achieve the following twelve objectives.

Objective 1: Make research-based learning the standard.

A new model should promote active learning and tie concepts to applications. This can be achieved by developing a hierarchy of open-ended (real-world) problems with increasing complexity that will be given to students starting at an early level of the curriculum. As students progress, and the level of complexity increases, opportunities for participation in research can be introduced.

Objective 2: Construct an inquiry-based freshman year.

Curriculum reform must begin in the freshman year. The University of Tennessee, with support from the National Science Foundation, has implemented a freshman engineering fundamentals program called *Engage*. *Engage* is uniquely designed to provide a firm grounding in inquiry-based learning. Our proposed model builds on these foundations and employs feedback mechanisms that will further improve the Engage experience of engineering freshmen.

Objective 3: Build on the freshman foundation.

The proposed model will provide a curriculum that extends inquiry-based learning, collaborative experiments, and communications beyond the freshman year to all four years of the engineering program and beyond.

Objective 4: Remove barriers to interdisciplinary education.

A new model must create mechanisms for greater interdisciplinary interactions both internally (across academic departments) and externally (across industrial functions). This will include, but not be limited to, the facilitation of customized programs, such as double majors and minors that will provide opportunities for cross-fertilization of concepts campus-wide. Specifically, opportunities need to be identified to integrate emerging research areas, such as information, bio- and nano-technologies.

Objective 5: Link communications skills and coursework.

Graduates from baccalaureate programs need to be proficient in written and oral communications. A new model therefore must make communications skills a fundamental building block in assessment plans and must play an important role in grading schemes throughout the four-year program.

Objective 6: Use information technology creatively.

To be innovative a new curriculum must take advantage of the potential that educational technologies offer in improving student learning. As curriculum development takes place, the proposed process should attempt to employ technology-based teaching aids and strive to introduce materials and exercises that will expand computing skills.

Objective 7: Culminate with a capstone experience.

The model that we propose will provide students with experiences, throughout the program, that represent the culmination of inquiry-based learning throughout all prior coursework - broadening, deepening, and integrating all concepts and applications into a functional and professional context. With the integrated modular design that we propose, students will experience real-world problems with increasing layers of complexity throughout their program. When they reach the last semester there will be no need for an independent capstone course, since each student will have "lived" the capstone through a four-year progressive experience. Service learning opportunities will also be incorporated where possible during the junior and senior years.

Objective 8: Educate graduate students as apprentice teachers.

Mentoring is important to student learning. However, most academic departments do not have the faculty resources to provide extensive mentoring at the undergraduate level. We believe that this requirement can be met effectively by utilizing Ph.D. students as apprentice teachers. These graduate students would contribute to the delivery of the education package in ways that fully indoctrinate them in the modern teaching methods and, at the same time, provide them opportunities to be mentored themselves and evaluated by departmental faculty.

Objective 9: Change faculty reward systems.

To be effective a new model must recognize and reward commitment to teaching and provide incentives for undergraduate participation in faculty research programs. Changing reward systems will not be easy. Nevertheless, a principal aim of the new paradigm will be to create a "culture of teaching" that emphasizes the prestige of exceptional teaching and the linkages between teaching and research.

Objective 10: Cultivate a sense of community.

The new model will strive to make learning an enriching experience of association with people of diverse backgrounds, ethnicities, cultures, and beliefs. Interests of students of all backgrounds should be satisfied. Creating a village experience helps to break down barriers and broaden perspectives.

Objective 11: Update content and teaching methods to be more consistent with the research on how engineers learn.

The new paradigm for engineering education should be consistent with the research findings that recommend replacing the traditional *teach and test* methods with learning based on realistic problem-solving, cooperative team environments, and the exposure to multidisciplinary service opportunities [Felder and Brent (2003)].

Objective 12: Engage faculty in the scholarship of learning and teaching.

There is a pressing need to better integrate content across individual courses. Our proposed model accomplishes this by replacing the traditional 3-credit-hour course structure with a modular approach that depends on faculty collaboration through team teaching. Faculty teams will jointly own an entire level of the program, and will be responsible for the content, pedagogy, assessment, and student progression.

2.2 Conceptual Design

The fundamental idea behind our model is to transition from a curriculum of individual loosely connected courses, taught using *demonstrate-then-emulate* (i.e. teach and test) methods, to a modular approach consisting of a network of highly interconnected courses. The intent is to replace traditional methods with an integrated *learning experience* that will incorporate elements that are problem-based, cooperative, and that accommodate service learning. The expected outcome will be graduates who, compared with their counterparts from traditional programs, can better cope with the unstructured nature of the problems they will encounter on the job, will be better equipped to operate in a team environment, and will be more fully prepared to engage in continual education. On the process side, there are also some positive expectations. The new model will force faculty integration – of ideas and pedagogy – and will streamline the degree. Students should have a much better idea how all the pieces fit together to make the whole, and, because redundancies will be eliminated, the total number of hours in the program will be reduced.

The typical baccalaureate curriculum in industrial engineering consists of courses that are largely independent with only a loose structure to connect them. In addition, students are required to take a number of subjects from other departments (such as statistics, economics, and accounting) and the relevancy of these courses is often unclear. Our model uses a building-block structure with an increased emphasis on discipline content, and incorporates elements of problem-based (PBL), cooperative, and service learning.

We propose a green field design, reengineering the curriculum from the foundation blocks up, and that will take full advantage of the seven-year investment in human capital and experimentation associated with the University of Tennessee's *Engage* freshman engineering program.

2.3 The Curriculum Model: *Engage*, then *Ignite*.

To generate broad enthusiasm for our model, we have given the new paradigm a name: *Ignite*. The idea is that the education experience is a building process. Students will first *Engage*, then *Ignite*. This name also captures the first letter in each of the words in our department's name (I&IE) and in the correct order. The framework of *Ignite* is shown below as Figure 1.

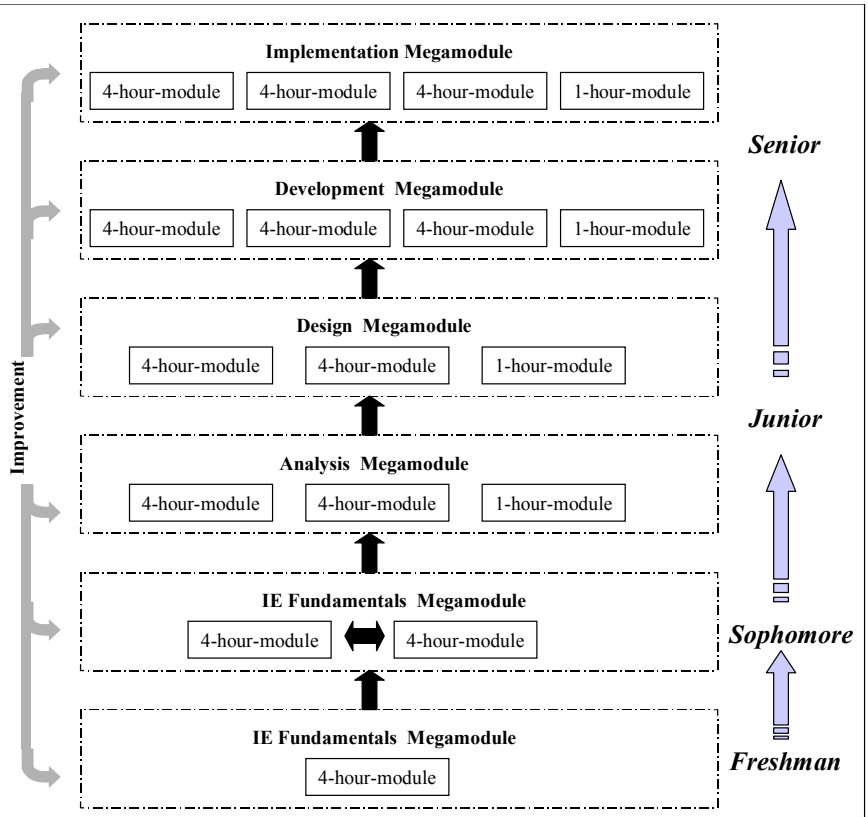

Figure 1: Proposed Structure for *Ignite*

The introduction of one industrial engineering subject in the freshman year and two at the sophomore level will add some foundation material earlier than under traditional formats where students must wait until the junior year to start taking courses in their major. The purpose of the foundation material is to introduce students to some fundamental knowledge subjects, while they are still taking basic science and math courses. This structure also offers the potential to establish a bridge between the lower-division industrial engineering courses and the *Engage* engineering fundamentals program. It is intended that subjects covered in the lower division I&IE courses will build skills in areas such as computing, data analysis, economic analysis, machine and problem-solving processes, and human capability.

The plan is to create thirteen 4-credit-hour modules and four 1-credit- hour modules to create an "industrial engineering experience" that will span the four-year program. The sequence for the upper-division courses will follow a track consistent with the engineering process: viz. *analysis, design, development,* and *implementation*. Feedback loops will integrate the fifth element in the engineering process, *improvement*, as tools are introduced at each level and the exchange of information across levels is applied to overall program improvement. Reinforcing the experiences gained through *Engage*, *Ignite* will heavily emphasize cooperative and problem-based learning techniques. There will also be opportunities for service learning, hands-on applications, and the ability for undergraduate students to participate in research projects.

2.4 Modularized Courses

As Figure 1 illustrates, the curriculum will consist of seventeen content modules. All of the modules in a given semester form one large block of industrial engineering content called a megamodule. Each megamodule will be the responsibility of a faculty team. The idea is design a pedagogy that will introduce material "just-in-time" as students need it and when they can appreciate its value. Each megamodule will be broken down into 4-hour and 1-hour modules to facilitate scheduling and accommodate a "traditional-based" grading system (no one wants to award a student a single grade for 12 semester hours of coursework). On the latter point, an assessment scheme will be devised that will link specific skills to courses. For example one course might include grade proficiency in the proper application of some algorithm, another course might assess skills in critical thinking and creativity, while another might evaluate teaming, leadership, and interpersonal skills.

Students will be given open-ended problems, case studies, research questions, or challenging issues that they will be required to study and generate opinions, conclusions, or recommendations. Some of the work will be done in teams, some individual. Some tasks will require formal professional presentations. Some of the presentations will be on projects that are generated from real-life problems in industry, and will be critiqued by industrial engineering practitioners or managers. One possibility is to have major team projects on either real or contrived problems (with increasing levels of complexity as students progress through the program). Major events would occur when teams report out on their findings. These would occur several times during the semester and would require formal presentations. The presentations would be before a group of peers and also a panel of judges. The panel would consist of at least one industrial engineering professor, an external invited member who has an interest in the project, and a faculty member from a kindred subject matter area (e.g. finance, logistics, management science, etc). Part of a student's grade would be based on the real-time feedback given by the panel at the conclusion of the presentations (similar to the "*American idol*" format).

The megamodule design will be the result of a methodology that begins with the creation of a knowledge base and culminates with a new modularized integrated curriculum, and owned by a faculty team that will be held accountable for innovations in teaching and assessment methods to ensure the achievement of program objectives. The methodology is described in the following section.

3.0 A Paradigm-changing Methodology

Our methodology consists of several stages as follows: Stage 1: Program Mapping; Stage 2: Course Decomposition; Stage 3: Modularization; Stage 4: Changing the Pedagogy; Stage 5: Developing a Student Assessment Plan; Stage 6: Resolving Some Critical Issues; and Stage 7: Formulating an Implementation Strategy.

3.1 Program Mapping

Before the curriculum design began, the department had to decide what the program is intended to do and identify the critical concepts required to achieve the purpose. Using the broad

framework suggested by Figure 1 (Fundamentals-Analysis-Design- Development-Implementation-Improvement) the process was initiated. Input was received, via a survey (see Figure 2), of alumni and the department's Industrial Advisory Board**;** brainstorming among the faculty; and benchmarking of other industrial engineering programs. This input was used to create a main list of concepts relative to industrial engineering. The mapping process then required the concepts to be arranged from the broadest to the most specific. Related concepts were grouped, and the groups were then linked.

Part II: Systematic Approach

Please indicate the degree to which industrial engineers in your organization apply these steps in your organization by circling a number from 1 (least) to 5 (most).

A. Analysis *An Industrial Engineer:*	Entry Level Least				Most	3-5 years after graduation Least				Most
1. Identifies the root cause of problems	1	2	3	4	5	1	2	3	4	5
2. Adequately describes the problem/current situation (Graphically)	1	2	3	4	5	1	2	3	4	5
3. Determines the cause of the problem	1	2	3	4	5	1	2	3	4	5
4. Identifies feasible alternatives	1	2	3	4	5	1	2	3	4	5
5. Assesses risk	1	2	3	4	5	1	2	3	4	5
6. Selects and uses appropriate methods to analyze data	1	2	3	4	5	1	2	3	4	5
7. Effectively resolves conflicts	1	2	3	4	5	1	2	3	4	5
8. Determines an optimal solution	1	2	3	4	5	1	2	3	4	5

B. Design *An Industrial Engineer:*	Entry Level Least				Most	3-5 years after graduation Least				Most
1. Designs a production system (manufacturing, delivery, and scheduling)	1	2	3	4	5	1	2	3	4	5
2. Uses appropriate analysis methodology	1	2	3	4	5	1	2	3	4	5
3. Conducts an experimental design	1	2	3	4	5	1	2	3	4	5
4. Evaluates designs	1	2	3	4	5	1	2	3	4	5
5. Participates in the design improvement process	1	2	3	4	5	1	2	3	4	5
6. Leads the design team	1	2	3	4	5	1	2	3	4	5

C. Development *An Industrial Engineer:*	Entry Level Least				Most	3-5 years after graduation Least				Most
1. Creates a prototype of the proposed solution	1	2	3	4	5	1	2	3	4	5
2. Selects hardware, software, and equipment vendors.	1	2	3	4	5	1	2	3	4	5
3. Tests prototype against requirements	1	2	3	4	5	1	2	3	4	5
4. Performs configuration management	1	2	3	4	5	1	2	3	4	5
5. Manages the development process	1	2	3	4	5	1	2	3	4	5
6. Manages the use of resources for development activities	1	2	3	4	5	1	2	3	4	5

D. Implementation *An Industrial Engineer:*	Entry Level Least				Most	3-5 years after graduation Least				Most
1. Validates the solution after implementation	1	2	3	4	5	1	2	3	4	5
2. Develops a cost justification	1	2	3	4	5	1	2	3	4	5
3. Evaluates a design	1	2	3	4	5	1	2	3	4	5
4. Coordinates the implementation effort	1	2	3	4	5	1	2	3	4	5
5. Evaluates outcomes	1	2	3	4	5	1	2	3	4	5

E. Improvement *An Industrial Engineer:*	Entry Level Least				Most	3-5 years after graduation Least				Most
1. Participates in continuous improvements programs	1	2	3	4	5	1	2	3	4	5
2. Participates in break-through improvement programs	1	2	3	4	5	1	2	3	4	5
3. Leads a team in improvement efforts	1	2	3	4	5	1	2	3	4	5
4. Instructs in the proper use of improvement tools	1	2	3	4	5	1	2	3	4	5
5. Participates in the implementation if improvement ideas	1	2	3	4	5	1	2	3	4	5
6. Participates in the selection of viable improvement projects.	1	2	3	4	5	1	2	3	4	5

Figure 2. Survey Pages for Program Mapping

3.2 Course Decomposition

The existing program consists of fifteen 3-hour courses and one 2-hour course for a total of 47 credit hours. As a first step toward modularizing the course structure each of the sixteen courses will undergo a decomposition process. The sixteen courses will be clustered into *focus blocks*. For example, one focus block might be operations research, another manufacturing systems, and still another human factors. Once consensus has been reached on the blocks and the assignment of courses, curriculum design teams will be formed for each block. A design team will consist of no fewer than two and no more than three members and will include the lead faculty for each course in the block. The curriculum design teams will be asked, for each course in its respective block, to develop a list of outcome-related learning objectives, consistent with Felder and Brent (2003). Then, using the learning objectives as a guide, the team will construct a concept map for each course, illustrating semantic relationships, and maintaining consistency with the program map. The teams will also provide details on what learning resources are used and which learning objectives and/or concepts are supported by each resource. All of this data will be used to create a knowledge base similar to the one described in Hoermann et. al. (2003).

3.3 Modularization

Using a data clustering technique, new course megamodules will be constructed according to the framework shown in Figure 1. A megamodule includes all of the content and resources necessary to satisfy the learning objectives at a specific level of the course. For example, one megamodule covering *analysis*, would be taught in the first semester of the junior year, and would consist of two 4-hour courses and one 1-hour course. The megamodule content will be fully integrated and would be consistent with nine credit hours of undergraduate coursework.

Based on those concepts that have been included in a particular megamodule, individual faculty members will be assigned to that megamodule team (e.g. the Analysis Team). The team will then be charged to develop a set of outcome-related learning objectives and develop pedagogical and assessment strategies for achieving them. It will be the responsibility of the team to divide the megamodules into the individual course modules based on the objectives and assessment schemes.

3.4 Changing the Pedagogy

In adopting a new teaching paradigm there are a number of pedagogical challenges to be met. As the culture transitions from directed instruction to a problems-based approach, several characteristics of the constructivist approach will be observed in the teaching and learning process. These characteristics are based on the cognitive learning and developmental theories discussed in the work of Dewey, Vygotsky, Piaget, and Bruner (cited in Roblyer, Edwards, & Havriluk, (1997)). Implications for the development of instructional activities include the following:

1. Problem-oriented activities that are open-ended, and multi- or interdisciplinary.
2. Visual formats that allow creation of mental models.
3. A rich learning environment containing a variety of hands-on resources.
4. Cooperative group work, emphasizing shared intelligence.
5. Learning through exploration and discovery.
6. Authentic assessment, emphasizing the qualitative nature of student work.

The emphasis will change from *what the teacher does* to *what the student learns*, and will be assessed through outcome measures in line with ABET requirements.

Important components in this teaching and learning model include activities that stress situated cognition and anchored instruction. Through situated cognition, what students learn and how they learn it are not separated (Brown et al., cited in Roblyer et al. (1997)). Anchored instruction (cited in Roblyer et al. (1997)) combines situated cognition, cooperative learning, and scaffolding.

Through scaffolding, the teacher-expert provides assistance to the student-novice in the development of understanding and acquisition of knowledge (Vygotsky, cited in Roblyer et al.(1997)). This assistance simplifies the learner's role, rather than the task, until the learner develops the capability for completing the task alone (Grabe and Grabe (1998)). Collaborative

teacher-student and student-student activity is stressed. The teacher must step out of the role of content deliverer and into the role of facilitator of learning, mentoring and coaching the student as he/she takes a more active role in his/her personal learning, constructing his/her knowledge of the given subject.

The "coach" mediates student functions by providing assistance during the planning, implementation, analysis, and application phases of learning. During *planning*, the coach mediates by having the student clarify goals and objectives, determine indicators of achievement, anticipate strategies and decisions to achieve goals, and identify the data gathering focus and procedures. During *implementation*, the coach observes evidence of achievement, and the use of strategies and decision-making procedures. During *analysis*, the coach mediates by having the student reflect upon what has been accomplished. The student will summarize impressions and assessment of the event, recall information that supports impressions and assessment, compare planned with performed strategies and decisions, compare planned with achieved results, and infer relationships between goal achievement and strategies. During *application*, the coach mediates by having the student synthesize new learnings, prescribe new applications, reflect on the coaching process, and recommend refinements.

3.5 Developing a Student Assessment Plan

In addition to reforming teaching methods and sequencing, and the integration of content, the success of *Ignite* will require a radical change in the way that student performance is assessed. If done properly, *what* is assessed should follow directly from each megamodule's set of learning objectives. *How* each objective is assessed will be up to the megamodule team. The positioning of the individual courses (within each megamodule) answers the question of *where* the assessment will occur. Because the *Ignite* paradigm converts small 3-hour courses into large blocks, ranging from 4 to 17 hours, a single grade awarded to a megamodule could make or break a student's GPA. Therefore, it is proposed that each megamodule be broken down into course modules, as shown in Figure 1, primarily for the purpose of assessment. This means that within a megamodule a student is required to enroll in all courses associated with that megamodule. The objectives will then be distributed across the courses by the megamodule team. For example, students might be assessed in one course on the ability to execute an algorithm, in another course on the ability to demonstrate critical thinking, in another course on presentation and negotiation skills, etc.

A key to the success of *Ignite* is the on-going project experience. One approach that is under consideration is to develop rubrics that will enable the consistent quantification of qualitative assessment data. As each program level is assessed, the feedback can be used for improvement and also as the basis for changing the design of the curriculum at the next level. The purpose of these rubrics will be to track the development of skills over time to insure that student learning is on target.

Other assessments will be based on outcomes (with information obtained from internal and external constituencies) and classroom performance (with information obtained internally on the process). Constituency information will include such sources as alumni surveys, exit interviews, and industrial surveys. Classroom performance will be based on formative assessment methods

in which an instructor assesses the effectiveness of instruction and student learning. This can be accomplished in any one particular class meeting or in a series of class meetings. Neither constituency nor classroom assessments are adequate by themselves, but together can provide a comprehensive assessment plan.

3.6 Resolving Some Critical Issues

A number of issues, resulting from differences in student matriculation patterns, learning modes, and learning skills, must be resolved during the planning cycle. Some important issues also arise from organizational and administrative constraints. The following is a partial list of some questions that need to be addressed as part of an implementation strategy.

1. How can *Ignite* accommodate transfer students? How can course credit be granted for coursework previously taken in a more traditional curriculum?
2. How can *Ignite* support the co-op program? Is there a way to grant course credit for co-op experience?
3. What happens if a student fails a course? If other courses in the module are passed, is there/should there be a provision for make-ups?
4. How can faculty be equitably rewarded for contributions to *Ignite* during the planning and implementation phases?
5. How will *Ignite* address the needs of exceptional students? Can it accommodate an Honors track? Can it serve as a bridge into Graduate school for these students?

Issues such as these are very important and the success of the implementation stage will depend on their satisfactory resolution. In order to avoid any preconceived biases, we have approached our model in an unconstrained fashion, deliberately ignoring any of the complicating constraints or accommodations. During implementation, the model may need to be modified as each issue is dealt with in turn. The rationale is to thoroughly examine each obstacle for validity before flexing the "ideal" (unconstrained) model in any way.

3.7 Formulating an Implementation Strategy

Once the model has broad departmental support, the planning will focus on formulating a realistic implementation strategy. As *Ignite* represents a radical departure from the existing system, the new program will need to be phased-in over a four-year period. During the phase-in, assessment tools will be in place to monitor progress and identify areas needing improvement. For this phase we have partnered with the University of Tennessee's Institute for Assessment and Evaluation, under the leadership of Dr. Russell French. In collaboration with our local assessment experts, we will develop a set of performance metrics that will help to ensure that our curriculum project stays on purpose and meets its stated goals and objectives.

4.0 Roadblocks and Keys to Success

Faculty will face some taunting challenges as they become involved in the planning and implementation stages of this project. It is hoped that the process will be inspirational and, true to the program name, will ignite a spark of enthusiasm in everyone who participates.

The first hurdle that must be overcome is the strong sense of ownership that faculty have over the courses they teach. Over the years professors accumulate test banks, class notes, supplementary materials, and the like, to support their own personal styles of teaching. With the new paradigm most of the old materials, habits, and pedagogy will need to be discarded. Faculty will no longer have autonomy over how and what students are taught, and how they are to be assessed. Under *Ignite,* all decisions will be made by the megamodule team. Individual teaching duties must support team-established learning objectives. Each team member will therefore need to develop teaching materials and practices that are in accordance with team standards. It may be desirable for members to present and defend his/her ideas/materials before peer colleagues. This "time in the pit" could be invaluable in eliminating redundancies, assuring continuity and consistency, and guaranteeing that learning objectives are being satisfied.

The second major obstacle will be developing a climate where faculty are willing to commit additional time to teaching. With pressure to do research and publish, the percentage of faculty effort available for teaching is diminishing. The level of collaboration necessary for the success of *Ignite* will likely increase the overall time investment per student credit hour. One possible alternative is to provide faculty with the option to trade-off participation in *Ignite* for other metrics used for tenure and promotion decisions.

5.0 Summary

In this paper we have described a planning process that will reengineer the industrial engineering curriculum at the University of Tennessee, and possibly result in a new template for engineering baccalaureate education. Our plan builds on reforms that have been implemented in the basic math and science requirements (during the first two years of engineering education) and on achievements that have previously been funded by NSF relating to the *Engage* fundamentals program. During the planning phase an ongoing process will strive to build consensus and shared faculty ownership for the new paradigm of educating future engineers.

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