

# **Developing a Multidisciplinary Engineering Program at Arizona State University's East Campus**

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## **Abstract**

The purpose of this paper is to present some key elements of the design process used to create a new multidisciplinary undergraduate engineering program and document the emerging program model. The program will be housed in the newly created Department of Engineering at Arizona State University's East Campus and will award a BSE in Engineering degree; the program will seek accreditation under the ABET general engineering criteria. The new engineering program is being developed from a clean slate by a founding team that will begin implementation with its inaugural freshman class in Fall Semester of 2005. Elements of the design process discussed include: a preliminary planning process that focused on data gathering and feasibility assessment; the design process for student and program objectives and outcomes; the development of brand identity; design of a curricular structure; design of required engineering competencies that form a common foundation experience; and the design process for identifying program concentrations. Some observations and next steps are also presented.

## **Introduction**

In July of 2003, a feasibility assessment and preliminary planning process was initiated for creation of an engineering program at ASU East Campus. This process resulted in a plan to develop a new engineering program at ASU's East Campus. The need for this program is driven by the rapid population growth of the Phoenix metropolitan area, capacity restrictions at ASU's Tempe campus and at other state universities, forecasts of engineering student and industry demand, and a desire to develop a polytechnic campus at ASU.

Unlike many curriculum development or reform efforts, the development of this new program began with a blank slate. This has given the founding faculty team unprecedented freedom and flexibility in the design of this program, resulting in the development of a novel and flexible curriculum that we believe will address the needs of engineering graduates in the modern, global workplace.

In this paper, we provide some background, and then describe several of the processes used to develop the program and its curriculum. In particular, we present the planning process leading to

the program creation, the development of program objectives and outcomes, the development of brand values, and creation of several aspects of the curricular structure to achieve these brand values.

## **Background**

There are three public universities in Arizona; Arizona State University (ASU), The University of Arizona (U of A), and Northern Arizona University (NAU). All of these universities offer engineering programs. ASU is located in the Phoenix metropolitan area, which is the fourth most populated metropolitan area in the US with over 3.4 Million people. The Greater Phoenix population has increased by 59% since 1990, compared to the US rate of only 17%. ASU currently has a fulltime equivalent student population of over 60,000 students on its three campuses and plans to accommodate 90,000 students by 2025. This growth will be accommodated through a significant extension and restructuring of ASU's existing multi-campus structure. As part of this restructuring, ASU is developing the ASU East Campus, located in Mesa Arizona, into a polytechnic campus; renaming the East campus to the Polytechnic campus is currently pending final legislative approval.

Currently the ASU East Campus houses three colleges with a combined enrollment of approximately 4000 students. The College Technology and Applied Science has programs in Aeronautical Management Technology, Information and Management Technology, Mechanical and Manufacturing Engineering Technology, Electronics and Computer Engineering Technology, and Computing Studies. The College of Agribusiness has programs in Professional Golf Management, Pre-veterinary, Food Management, and Food Science. The East College has programs in Applied Psychology, Applied Biological Science, Business Administration, Elementary Education, Exercise and Wellness, Human Health, and Nutrition.

The Ira A. Fulton School of Engineering at ASU's Tempe Campus offers traditional discipline specific engineering degrees and has a current undergraduate enrollment of just under 5000 students; this enrollment is not expected to increase. Forecasted demand for engineering education at ASU by qualified students will exceed this capacity by more than 1000 students within five years; these students will not be accommodated on the Tempe Campus due to limited capacity. The new engineering program at the East campus is (partially) a response to these projected needs. However, a primary constraint on the design of this program is that there be no duplication of the Fulton School of Engineering programs.

## **The Preliminary Planning Process**

The feasibility and planning process, begun in July 2003, consisted of data gathering and analysis, development of an implementation plan, and generation of proposals to the Arizona Board of Regents (ABOR) for authorization to implement a new program at ASU. This process culminated in August 2004 with ABOR approval of a BSE in Engineering Degree at ASU's East Campus. Shortly after ABOR approval, a team of founding faculty was assembled to begin program implementation with the goal of first offering curricula in the Fall Semester of 2005.

The data gathering and analysis process included a forecast of engineering education demand for ASU and an assessment of projected economic trends and needs for the state of Arizona. Engineering education literature was collected and examined and an analysis of non-discipline specific engineering programs was performed. In addition, site visits were made to five of the programs. A team of Tempe Campus and East Campus faculty members conducted an assessment of Strengths, Opportunities, Weakness, and Threats (SWOT) of a new engineering program and proposed a set of ranked program design attributes. Focus groups were conducted with three constituent groups including: current engineering students, recent engineering graduates, and industry. These activities produced a good set of planning resources (the bibliography presents a partial list of these resources).

The information assembled in the data gathering and analysis process formed the basis for development of an implementation plan that was presented to ASU's administration. Upon ASU administrative approval of this plan, formal proposals were submitted to ABOR for program and department authorization. In August of 2004, ABOR approved the implementation of a BSE in Engineering Degree housed in a new Department of Engineering at ASU's East Campus; both the degree and department were to be independent of the Fulton School of Engineering.

A key recommendation of the implementation plan was the hiring of a committed, multidisciplinary founding team that would be responsible for detailed planning and implementation of the new program and whose members would join the Department of Engineering. It further recommended that the founding team have a clean slate in the planning and implementation process and be full participants in developing a vision for the new program. The implementation plan used for ASU and ABOR approval was to be considered as a preliminary recommendation and serve as a resource to the faculty. Six faculty from the Fulton School of Engineering (two electrical, two mechanical, one civil, and one industrial engineering) and one administrative associate agreed to transfer to the Department of Engineering as the founding team. Although the slate was considered clean, the founding team shared a common desire for substantive and effective engineering reform.

Preliminary preparation for the design process included participation in an NSF Chautauqua on Critical Thinking in Science and Engineering by several of the founding faculty; this served as a team building experience and as a source of additional background information. In addition, some of the preliminary planning process documents and assembled literature were examined and discussed. The following sections describe some of the key design processes and results.

### **Designing Program Objectives and Outcomes**

The founding faculty agreed that a rigorous and comprehensive system of program assessment and continuous improvement was necessary to ensure long-term success. As such, the development of a draft set of objectives and outcomes as a standard for the program was the first team design activity. The engineering program will seek ABET accreditation under the general engineering criteria as soon as possible, and development of program objectives and outcomes is a central component of this accreditation. Note that in addition to ABET required objectives and outcomes related to student performance, the founding faculty felt that it was essential to define objectives and outcomes related to program characteristics.

The design of objectives and outcomes began with an affinity process. In this process, each team member was asked to generate a set of desired characteristics for the new program and to put each one on a sticky note. These were then placed on a white board. The next step in the process was clarification, in which each of the characteristics was briefly defined and discussed to develop a general understanding of the intention of the characteristic. Once clarified, characteristics were grouped into similar areas by physically grouping the notes; where necessary, alternate groupings were enabled through duplicate notes. Grouping was followed by a discussion phase, from which a consensus on four groupings emerged: Desired Program Characteristics, Desired Outgoing Student Characteristics, Desired Incoming Student Characteristics, and Other Desired Characteristics. All the characteristics were then entered into a spreadsheet. The Desired Program Characteristics and the Desired Outgoing Student Characteristics eventually became the basis for the program objectives and outcomes.

To develop the program objectives and outcomes, each member of the team was asked to evaluate each of the Desired Program Characteristics using the following scale: 2 = required, 1 = desirable, 0 = do not know, -1 = undesirable, and -2 = must exclude. The evaluations of all team members were entered into the spreadsheet and averaged. Discussion was then opened for all program characteristics and team members were permitted to change their evaluations based on the discussion. Most discussions were generated by characteristics that had a high evaluation variance. This process generated 59 program characteristics.

### **Table 1 Program Objectives and Outcomes**

#### **Program Objective A**

The program establishes a strong relationship with students as they enter that continues after graduation.

#### **Program Objective B**

The environment and pedagogical approach connects engineering, science, math, and technology to real-world problems

#### **Program Objective C**

The program has an excellent reputation based on the quality of its graduates.

#### **Program Outcomes**

1. X% of the students who enter the program graduate; the median time to graduation is Y years.
2. Faculty are able to conduct and assess student learning activities using modern engineering pedagogy.
3. Students, faculty, and staff feel that they are valued members of the Engineering Department and are happy with their experience at Poly Tech
4. The engineering program has a reputation for excellent learning and teaching.
5. Students are "proud" to have our degree
6. The program is responsive to industrial needs
7. The program supports the needs of a diverse student population.
8. The department provides a collegial environment for faculty, staff, and students.
9. Industry prefers students with a degree from ASU Polytechnic Engineering.
10. The program supports applied research consistent with College of Technology and Applied Sciences (CTAS) and department aspirations.
11. The program is appropriately funded.
12. The program provides intellectual leadership.

Program characteristics were then mapped to program objectives and outcomes. One team member with extensive ABET experience was asked to create a first draft. The draft was then open to comment and modification by the group. Table 1 shows the resulting list of program-related objectives and outcomes. The 'X' and 'Y' in Outcome 1 represent values that have not yet been finalized.

To develop the objectives and outcomes related to student performance, each member of the team was asked to rank each of the Desired Outgoing Student Characteristics using the following scale: D = Deep, C = Cursory, N = None. Rankings were made in two contexts: characteristics necessary for all students and characteristics necessary for some students. The highest ranked characteristics for all students were then mapped to student objectives and outcomes using the same mapping process as the program objectives. Table 2 shows the results.

### **Developing Brand Identity**

An important step in the design process was the development of brand identity. Brand identity is a reflection of a program's mission, vision, values and competitive position. It is a mixture of attributes, tangible and intangible, which, if executed properly creates value and influence. It also can align internal decision making and behavior in ways that are consistent with the brand and, therefore, with the department's mission, vision, values and competitive position. The development of brand identity was a valuable mechanism for refining and clarifying the team's collective vision for the program.

The director of marketing for ASU facilitated several sessions with the founding team to develop brand identity. The team was first asked to create a position statement that addressed the following areas: who we are, what we do, who we do it for, who else offers a similar service for our constituency, and how we are different to target audiences. The team collectively created this position statement in a two-hour planning meeting. As a second step, each member of the team was asked to prepare an elevator speech; an elevator speech is a short presentation describing the new program that could be made in the time it takes to ride an elevator. Each member of the team prepared and then presented their elevator speech. An analysis of the speeches identified characteristics of the program that were valued by all team members (and included in the brand identity) and elements that were valued individually.

The team was then asked to further clarify brand identity by articulating three to four words or phrases that describe the brand values. This process led to some of the most spirited discussions in the design process. After several iterations, the following values that articulate the department's brand were developed:

- Engaged Learning
- Agility
- Focus on the individual

These values are related to the program mission as follows. The program is built around the concept of engaged learning: discovery-based education and learning by doing. Classrooms are defined not as lecture halls but as engineering studios. Courses are delivered not as lengthy exercises in theory but as integrated opportunities to apply knowledge in real-world projects. The

## Table 2. Student Objectives and Outcomes

### Student Objective A

Graduates will successfully transition into a broad range of flexible career options, including industry, government, and graduate engineering and professional education.

### Student Objective B

Graduates will apply their strong foundation of modern engineering skills and specialized knowledge to design solutions to problems within the context of social and economic realities.

### Student Objective C

Graduates will provide technical leadership within a broad range of engineering and non-engineering settings.

### Student Outcomes

1. Graduates communicate well both orally and in writing, and are professionally articulate to technical and non-technical audiences.
2. Graduates think critically, clearly identifying and using evidence, criteria, and values in their thinking.
3. Graduates can acquire, organize, critically evaluate, and use data.
4. Graduates can couple technical knowledge to issues such as manufacturability, economic impact, public health and safety in the context of global society and culture.
5. Graduates understand and can use the engineering method.
6. Graduates have a strong foundation of engineering fundamentals and a strong technical competence in at least one focus area.
7. Graduates understand and can apply ethical principles
8. Graduates have the ability to create, manage, and work on successful interdisciplinary teams.
9. Graduates have the ability to learn and use industry contemporary technical tools (e.g. Labview, CAD).
10. Graduates are proficient in the application of computers and other information technology as engineering tools (especially for design and simulation).
11. Graduates are self directed learners.
12. Graduates understand the entire life cycle of engineered artifacts.
13. Graduates have a high level of realistic self-confidence, can deal with uncertainty, and demonstrate dynamism, agility, resilience, and flexibility.
14. Graduates can design and build.
15. Graduates are proud of their degree.
16. Graduates are familiar with the following concepts and can apply them appropriately in their engineering activities:
  - The role of computers, communications, and other information technology as components of engineering solutions.
  - Fundamental environmental systems and processes (e.g. energy utilization, water cycle, carbon cycle)
  - Quality, statistics, and improvement processes
  - The multiple roles of engineering in organizations (e.g. business, government, academic)
  - Manufacturing processes
  - Fundamental business processes and concepts: marketing, sales, manufacturing, finance
  - Legal issues of engineering (e.g. contractual issues, regulatory, intellectual property )
  - The physical phenomena that are important at different scales (macro, micro, nano) in systems, processes, and material properties.
  - Fundamental biological systems and processes (e.g. cells, genetics, inheritance)
  - students have experience in manufacturing processes
  - Stochastic modeling
  - Entrepreneurial new product development

outcome of the program is the agile engineer, a lifelong learner with a comprehensive set of skills appropriate to the needs of today and tomorrow. Agility also characterizes the program itself: streamlined, purposeful and flexible in adapting to changes in pedagogy, knowledge or the needs of its stakeholders. We also express the brand value of agility through its unique ability to cross or eradicate traditional boundaries between engineering disciplines, enhancing innovation through the synergistic combination of previously bounded boxes of knowledge. Lastly, the engineering program is focused on the individual student. Each person is valued for his or her unique skills. We measure our success by the quality of each individual's education and our effectiveness and responsiveness in meeting their individual learning needs.

### **Development of the Curricular Structure**

The high-level design of the curricular structure that embodies these values has mostly been completed, and detailed design of individual components of the curriculum is beginning. The curricular structure includes an engineering foundation in the first two years and primary and secondary areas of concentration in the third and four years. Large projects in every semester coupled with problem-based learning that is woven throughout the curriculum embody the brand value of discovery. Significant options in the choice of primary and secondary concentrations as well as a flexible modular structure for the engineering foundation embody the value of flexibility.

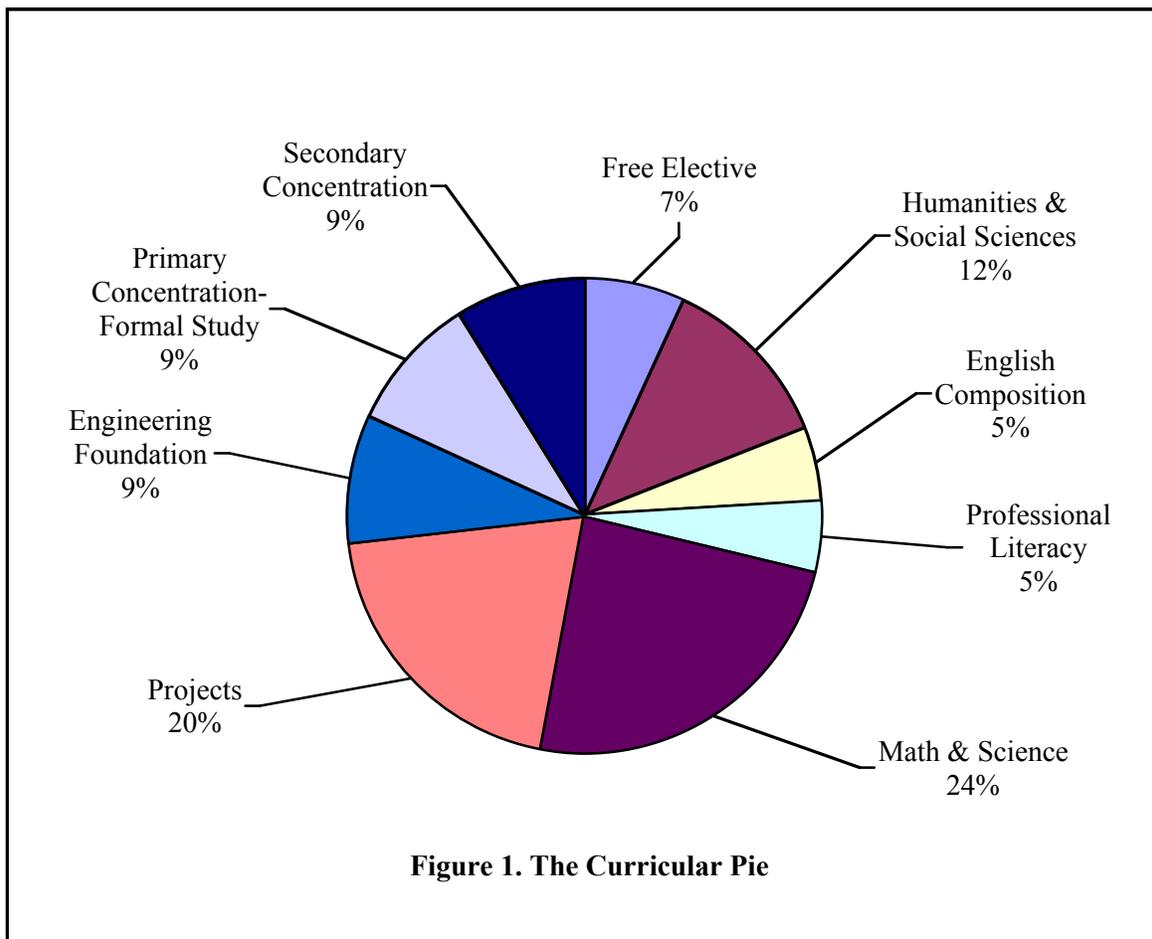
Our 128 hour curricular structure has the major components illustrated in Figure 1. Some of the categories and credit hour numbers are dictated by either university or ABET requirements. The specific breakdown of credit hours is: 15 hours of humanities and social sciences, 6 hours of freshmen composition, 6 hours of literacy and critical inquiry that is based in the professional program, 32 hours of math and science, a project course every semester (totaling 26 hours), 11 hours in companion foundational courses, 11 hours of formal upper division instruction in a primary area of concentration in engineering, 12 hours in a secondary area that may or may not be inside engineering and 9 hours of unrestricted electives. The primary area of concentration includes significant upper division project experience and therefore is in fact a much more extensive experience than the secondary.

This concentration structure provides significant flexibility to the student. One feature of this approach is that the secondary area of concentration need not be inside engineering. For example, by combining the secondary with the unrestricted elective hours and the humanities/social science hours, a student could take 30 hours of economics, 27 hours of literature, or 21 hours of Chinese as part of a program of study that culminates in a Bachelor's degree in engineering. Of course, the secondary and electives could also all be engineering, a choice that many students are expected to make.

The curricular structure developed at the University of Aalborg that relies heavily on projects and problem-based learning has provided the model that we adopted to realize the brand value of discovery-based learning. Therefore, in our curriculum there will be a project experience in each of the eight semesters in the program of study. These projects will be accompanied by formal instruction in separate courses. These formal courses will utilize a problem-based learning approach, but will not included large projects, since multiple large projects in a single semester

can easily overburden the student. Our goal is to replace lecture halls with engineering studios. One key to curricular success is the projects. They must be carefully selected, since many of our student outcomes and objectives will be primarily pursued and assessed in the projects.

To support project selection in the first two years of the curriculum, we introduce flexibility through a modular approach to the foundation engineering content. This material will be packaged as a set of small modules, each one credit hour in size. Every semester, a set of modules that integrate well with that semester's project will be selected and taught in a companion course, thus enhancing both the value of the project as an integrating experience and the student's chances of success in the project. This flexibility comes at the cost of some variability in the actual content of the sophomore year from year to year, and adjustments will be required as the students flow into the upper division. Following the Aalborg model, we hope to evaluate the projects through an extensive oral examination in which any student on the team is expected to be able to explain how any particular foundational topic was used in the project. Hopefully, student uncertainty in exactly what is supposed to be known will be counter-balanced by a greater certainty in what is known and an ability to apply it contextually.



As we write this we are about to start the development of our first modules. We conceive of a module as a mastery-based learning experience. Most of the foundational material is very standardized, with hundreds of textbooks available that cover substantially the same set of common topics using a standard notation. The student will be expected to read such formal material and then take a test. If the student fails the test, then a diagnosis will be made as to why the failure occurred. A corrective learning experience will follow and the student will be given another chance at passing the test. At the foundational level, much of this can be carried out either by computerized methods or by well trained teaching assistants.

While working on modules, the student will typically interact with the faculty in a formal course in which class time is devoted to 4 of these modules. These four modules may be from what is normally viewed as a very disparate set of courses e.g. one credit hour of networks, an hour of thermodynamics, an hour of engineering economics and an hour of materials engineering. The exact selection will be made in conjunction with the project selection. Instead of lectures however, class time is devoted to problem based learning activities that lead the students into an exploration of how the modules fit together. We envision that all content will be developed and implemented by curricular teams.

### **Design of the Engineering Foundation**

The engineering foundation represents the set of competencies that we believe are important for **all** students in the program to obtain. The set of competencies was considered to be the elements that would result in the desired outcomes. The previously describe results of the process for designing student and program objectives and outcomes from desired program and student characteristics was a primary guiding reference for the development of the foundation. As previously described, the results included an individual and summed team evaluation of the desired student and program characteristics.

Each team member generated a list of required competencies and was asked to particularly focus on competencies outside of their discipline (e.g. what does a mechanical engineering team member think is an important electrical engineering competency). ABET Criterion 3 a-k were included in this list of required competencies. As with the affinity process, the lists were merged, discussed, and clustered into similar competencies.

Opportunities for mapping the engineering competencies into the curricular structure included embedding the competencies in: modules, projects, engineering courses, or in general education courses. Each team member next voted on where the competency should be placed. Competencies were allowed to be placed in multiple elements of the curricular structure. Examining the individual voting, the team collectively made a draft mapping of the competencies to the curricular structure. The results of this mapping are shown in Table 3. ABET Criterion 3 a-k are identified by a letter in parentheses.

Many team members have previously experienced the problem of trying to stuff everything that everyone thinks should be required into a curriculum. We struggled with a identifying criteria that would help us determine what competencies would be in our program. The curricular design currently has room for 12 one hour modules in the foundation. We have identified 20 modules as

shown in Table 3. The Aalborg model that projects determine the content eventually provided an approach that allowed us to keep all of the modules in the design. Content is determined by materials that are needed to successfully complete a project. We do not expect that there will be a perfect relationship between the projects and the modules and that some modules will be taken by students who are not using them in projects.

This approach shifts the program design activity to that of designing good projects that represent breadth in engineering for the foundation years. While the faculty will determine what projects are implemented in the foundation, student will have input in project selection. Projects will progressively become more open ended in the primary concentration and in the capstone. We expect that the modules will also serve as a reference and resource for these latter projects.

### Development of Concentrations

A next task was the determination of what concentrations to initially design. A primary concentration consists of about 20 hours of engineering content. A secondary concentration consists of about 15 hours of study.

**Table 3. Mapping of Engineering Competencies to the Curricular Structure**

One Hour Modules	Embed in Engineering Courses	Embed in General Ed Courses
Mechanics of materials I Mechanics of materials II Dynamics I Dynamics II Thermo Science I Thermo Science II Materials I Materials II Design in Context Ethics and Professionalism Signals & Instrumentation I Signals & Instrumentation II Computer Competency I Computer Competency II Manufacturing Processes I Manufacturing Processes II Mechatronics Systems Modeling Engineering Economics Digital information manipulation	Critical Thinking Communication Teams Experiments and Data Product Dissection Design in Context (j) a knowledge of contemporary issues physical phenomena at different scales Using electronic lab equipment (d) Interdisciplinary Teaming (i) Life long learning (h) global and societal engineering impact (a) apply mathematics, science, and engineering Students understand the entire product lifecycle (support, disposal ...) Students understand the interplay between engineering, global society, and culture. (f) professional end ethical responsibility (g) an ability to communicate effectively (c) an ability to design a system, component, or process Digital manipulation of information (b) an ability to design and conduct experiments, as well as to analyze and interpret data (e) an ability to identify, formulate, and solve engineering problems	How Technology Works Infrastructure Knowledge Personal finance Learning Skills Ethics Communication (j) a knowledge of contemporary issues interaction btw living & non-living materials & systems new trends in life sciences and medicine Basic scientific literacy (i) Life long learning (h) global and societal engineering impact Critical Thinking Students understand the interplay between engineering, global society, and culture. Students understand fundamental environmental systems and processes (e.g. energy utilization, water cycle, carbon cycle)

While we felt that it was important to offer students concentrations that could be identified with traditional disciplines, we also recognized that the limitation of 20 hours of study would require a more focused design. We also recognized the opportunity to offer complimentary primary and secondary concentrations where both concentrations had a different focus from the same traditional discipline. While the structure is flexible and presents many unique opportunities, limited resources require a careful selection of initially offered concentrations.

The team developed a list of 21 potential concentrations and 15 decision attributes. A ranking and rating process was used to select these concentrations and attributes from much larger lists. We are currently using a decision matrix with weighted attributes to help guide the selection of the concentrations. Table 4 shows the concentrations currently under consideration and the attributes against which the concentrations are evaluated with the weight of the attributes. The table is not presented as a decision matrix below due to space limitations in the format of this paper. Our decision matrix has all of the concentration on the Y axis and all of the attributes on the X axis. An evaluation of each concentration against each attribute is currently being performed. Eventually all of the evaluations values will be multiplied by the attribute weight and summed to produce a final evaluation value for each concentration.

**Table 4. Components of the Concentration Decision Matrix**

<b>Concentrations</b>	<b>Attributes</b>	<b>Weight</b>
Simulation Engineering	Market for graduates	0.93
Integrated Product Development	Has a passionate faculty champion(s)	0.89
Instrumentation and Measurement	Program market niche	0.79
Global Engineering	Viable cost in terms of startup effort	0.75
Manufacturing	Extensive, expensive new facilities are not mission critical	0.70
Sustainable Environment	Helps recruit students	0.70
Controls	Technically beneficial to Arizona Industry	0.70
Mechatronics	Fits into technology forecast	0.70
Energy and Power	Enough faculty want to participate	0.65
Nano Technology	Has broad application across engineering domains	0.65
Entrepreneurship	Favorable ROI	0.61
Transportation Systems	Enough competence in the area	0.61
Design your own	It is interdisciplinary	0.51
Mechanical	Socially beneficial	0.47
Embedded Computing	Technology Faculty want to participate / interest	0.33
Automotive Engineering		
Electrical		
Bio Technology		
Human Factors		
Microelectronics		
Aero Engineering		

We are currently gathering data and normalizing the data for each of the attributes. For example, to evaluate the interest of the faculty from technology departments we presented the current program design and proposed concentrations to each of the technology departments on the East Campus. Faculty were then asked to rate the level of their interest in participating and to rate how important the development of the concentration would be to the campus. These evaluations were averaged and normalized as inputs to the “Technology Faculty want to participate/interest” attribute. As another example Industrial Advisory Boards are providing input to the “Market for Students” attribute. Students are providing input to the “Helps Recruit Students” attribute.

We do not expect that the first implemented concentrations will all come necessarily from the top three or four evaluated concentrations. We expect that some of the concentrations will be redefined and perhaps morphed together. We also have identified meta-criteria to help guide the selection of the eventually offered concentrations. An example of a meta-criterion is that each of the founding faculty members must be able to identify one of the concentrations that they desire to help develop. A significant value of this process is that it provides focus for the discussion and evaluation.

### **Observations and Next Steps**

The development of a new engineering program from a clean slate has been an exiting and rewarding experience for all team members. Although the presentation of the design process was a sequential process, the actual process was iterative. The design process used many formal design and decision tools, most of which were very useful in achieving broad consensus. The breadth of engineering reform developed would not have been possible without strong leadership from a dean and provost with extensive ASEE leadership experience and an understanding of engineering education. We have also benefited from feedback and advice from many other institutions and members of the engineering coalition.

The founding team has a strong sense of commitment and has developed a cohesive vision and a model that we believe will make a difference. However, we have also identified some potential problems. In our experience, most engineering faculty do not have much pedagogical training and are not current on engineering education and learning theory literature. We are concerned with the process of training new department faculty and helping them understand and appreciate the vision and fully participate in the continuous improvement process. We also are concerned about the resource efficiency of implementing a problem-based curriculum. Many individuals from programs that have experimented with pervasive problem-based learning have indicated that the approach is resource intensive. As a program within a public university we must implement a model that is as resource efficient as a traditional approach. We hope to attain much of the needed efficiency through computerized modules and industry support.

We are also committed to pervasive assessment and continuous improvement as we experiment with learning approaches. We are concerned with both the design of the assessment and the resources needed to gather and analyze the data. We believe that legacy faculty workload models have not sufficiently valued these activities.

We are significantly redesigned the freshman year and are actively participating in the design of every course the students should take. This includes a redesign of a two semester sequence of the Mathematics of Change (formerly known as calculus) with an emphasis on modules, contextualization, and visualization. We are working with the applied biology department to create a first semester course on the engineering of biological systems and we are designing a general education course that addresses historical significance of engineering and technology and examines aspects of the future of engineering and technology. We will also begin design of an introductory physics course that will incorporate simulation and visualization. Finally, we are designing a literacy course as part of ASU general education requirements that will focus on engineering topics. We will also develop and test two one-hour computer-based modules them. We are currently designing the first year projects and problem-based activities and implementing them as a team to test the design and as a training exercise. We have also agreed to teach two introductory engineering courses for the Fulton School of Engineering in the Spring Semester. We plan to use these courses to test some of our first semester curriculum and assessment.

During the Spring Semester we plan on conducting two sessions with our industrial advisory board. We also plan on hiring up to six additional faculty members.

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