Preparing UG entrepreneurs and intrapreneurs through cross-disciplinary partnership between engineering and business colleges.

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Entrepreneurship in technology-intensive industries requires close cooperative work between engineers and business professionals. The premise of a new program at Auburn University is that cross-functional teamwork skills that enable business and engineering students to work together on several projects lays the foundation for entrepreneurial success later in their careers. The program has two major components; one addresses sustained development of cross-functional skills, and the other imparts business and engineering knowledge and skills to business and engineering students.

An unique two-year joint minor (16 semester credits) for business and engineering students in their junior and senior years is offered through the Thomas Walter Center for Technology Management, Auburn University; the Center is a creation of the two colleges. This Business-Engineering-Technology (B-E-T) program, which began in fall 2001, is a joint effort of the colleges of business and engineering. The program admits selected equal number of business and engineering students to the program each fall. The program now has a capacity of 15 business and 15 engineering students each year. The students entering this competitive program in their junior year have a minimum GPA of 3.0 and the class average GPA of the two entering classes has been about 3.5 (average GPA for the colleges is about 2.8). See Table 1 for the composition of the group admitted in fall 2002.

The high-achieving students in the program, by and large, have a broad perspective coming into the program, or they seek to broaden their perspective through the program. These students are flexible and adjust well to unfamiliar circumstances. They enter the program voluntarily. The program takes them out of their comfort zones defined by traditional business and engineering curricula.

The program stresses cross-functional teamwork, entrepreneurship, strategic use of technology, and hands-on experience with new product development. The lock-step program keeps engineering and business cohorts together for two years continually working on a number of projects, which include business and engineering issues. Over the two-year period, the students

1. Develop cross-functional teaming knowledge, skills and abilities (KSA).

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2. Students learn to depend on team members from other disciplines.
3. Business students learn to understand engineering students and learn to ask the right questions about engineering problems, and vice versa. Business students begin to understand how engineers "think," and vice versa.
4. Show marked improvement in the confidence with which engineering students handle problems that have a mixture of engineering and business issues, and vice versa.
5. Pick up the necessary skills and confidence to address engineering and business issues necessary to be a successful independent entrepreneur, or an intrapreneur within large corporations.

We believe that this program at Auburn should be of interest to selected engineering and business colleges in the USA.

In technology-intensive firms, which employ a large number of engineers, the success of the new business ventures and intraprenueral efforts depend on the ability of engineers and business professionals to work together. In technology-intensive new startups too, engineers and business professionals need to work with each other in an understanding manner.

Over a period of two-years, the BET program prepares talented engineering and business graduates to work effectively across business and engineering disciplines. Students enter the program as juniors and complete the minor as graduating seniors.

The program prepares students for employment and entrepreneurship by educating business students to understand and appreciate engineers' perspectives while making business decisions. Similarly, the program prepares engineering students to develop a comprehensive view of business organizations, to be sensitive to business issues while making engineering decisions, and to work effectively with non-engineering functions.

The need for sustained cross-functional work
Competitive, technology-intensive firms depend on multidisciplinary teams composed of personnel responsible for key business and engineering activities for successful and rapid product development, marketing, supplier development, and so on. However, undergraduate programs in engineering and business schools lack **sustained programs** for developing cross-functional teaming knowledge, skills and abilities in their students. The two year B-E-T program is meant to build strong and lasting cross-functional teamwork skills among cohorts.

Cross-functional teamwork skills in our students are developed through workshops, instruction, and through team exercises in the six courses in the B-E-T minor. Based on an earlier NSF project completed by the Center on cross-functional teamwork, we believe that cross-functional teamwork skills developed in students over a single course are limited. A two-year sequence of courses can provide a stronger foundation for the development of cross-functional teamwork skills.

Program course content

Engineering curriculum provides depth in engineering topics but does not prepare them to grasp and consider business issues in decision making. The contents of the six courses that make up the BET program (see the Appendix for course description) corrects this imbalance over a two-year period. Business curriculum, on the other hand, provides business students with breadth covering marketing, management, economics, finance, and accounting, and depth in one area. Generally, business students are averse to engineering subjects. The six BET courses introduce engineering concepts to business students in a problem-solving, case-oriented environment without mathematical sophistication. Business students have remarked that they learn engineering concepts from engineering students in their teams; this is a welcome result of our program. Student teams have a balanced number of business and engineering students.

A Summary of the BET Program

1. Engineering and business students are jointly enrolled in and learn in cross-functional teams in six courses that are taught by engineering and business faculty teams.
2. The program requires *collaboration among faculty from engineering and business.* As many as 10 teachers from the two colleges participate in the program.
3. The program uses extracurricular day-and-half-long summer retreats for students to develop their teamwork and leadership skills (costs borne by industrial sponsors or Auburn University).
4. The program is supervised and managed by the Thomas Walter Center (TWC) for Technology Management, which is a joint effort of the two colleges since 1989 created by an endowment and a grant from a private foundation. The Center has conducted a NSF funded project on developing cross-functional teamwork among engineering and business students.
5. Six courses were designed exclusively for the B-E-T program. These courses are not accessible to non B-E-T students. The courses use textbooks, lectures, guest speakers, readings, films, diagnostic cases, case analyses, term projects, and a two-semester design project.
6. Students use 360-degree feedback using an instrument developed by an industrial psychologist for giving end-of-semester feedback on teamwork to students.

Teambuilding Retreats and Workshops (Summer/spring retreats)

Traditional engineering and business courses offer students opportunities to work in teams. However, these teams are often homogeneous in discipline, single discipline teams, which unfortunately, do not emphasize the team-building processes and interpersonal skills that are critical to team success. As part of the desire to build teaming skills in students, one-and-half-day training retreats are offered in the spring/summer months as part of the program at no expense to the students.

The retreat fosters teamwork, team building, unity, interdependence, fun, and getting to know each other. The retreat format features large and small group activities that include the use of “low and high ropes” courses.

An industrial psychology professor trains the students on "Tools for Teamwork" and 360-feedback. At the workshop, he provides each student with a custom-designed workbook for use/reference during the two years in the program; they could use it as a reference on teamwork even after graduation. His workshop covers topics including but not limited to:

- Effective communications in teams
- Principles of meeting management
- Tools employed by effective teams
- 360-degree feedback.

What is 360-degree feedback?
360-degree feedback is a process, sometimes referred to as multi-source feedback, multi-rater feedback, or upward feedback. All of these terms refer to the process of obtaining feedback from superiors, peers, and subordinates, as well as a self-rating on pertinent behavioural dimensions. Each member of student teams will rate every member of the team including a self-rating. The self-rating and team-member rating, and team ratings are combined to prepare the 360-degree feedback to individuals and teams.

The 360-degree feedback instrument gathers data on nine dimensions, which are:

1. Agreeableness
2. Communication
3. Conflict resolution
4. Conscientiousness
5. Collaborative problem solving
6. Extraversion
7. Goal setting
8. Meeting management
9. Planning and task coordination

Business and Engineering Topics by the Courses in the Program
Various business and engineering topics are covered by the courses in the program. The list of broad business topics covered by the sequence of courses includes, but not limited to:

1. Business plan and its components
2. Marketing
3. Financial reports and accounting practices
4. Manufacturing and design for manufacturing
5. Management or people, production, and other resources
6. Economic principles
7. Sales and distribution
8. Entrepreneurship, technology management, innovation
9. Strategic issues in business
10. Communication

The list of broad engineering topics covered by the sequence of courses includes but not limited to:

1. Engineering units and standards and their use
2. The design process
3. Principles of energy and thermodynamics
4. Engineering materials and their selection
5. Principles of electrical, mechanical, and industrial engineering
6. Decision making and decision models
7. Engineering issues associated with the design and production of selected products such as golf balls and golf clubs—these are diagnostic cases.
8. Engineering issues associated with Ford Explorer and Firestone controversy, and several similar real-life cases—another diagnostic case.

The first batch of students will graduate in May 2003. In a few years, we expect to gather information on how the graduates from our program fared in regards to entrepreneurship and other success factors. (NOTE: We expect develop data comparing BET graduates with others prior to graduation. The first batch graduates in May 2003.)

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James O. Bryant. Jr., Associate Dean for Cross Disciplinary Studies and Director, Thomas Walter Center for Technology Management, Auburn University, is responsible for developing joint programs between the Samuel Ginn College of Engineering and the College of Business. Dr. Bryant is the director of the new Business-Engineering-Technology Program that leads to a minor offered jointly by the colleges of engineering and business. He is the former director of the USEPA's Southern Regional Radon Training Center. He has over 30 years experience in environmental engineering, education and training. Dr. Bryant has extensive international experience primarily in Latin America and the Middle East. He served as a consultant to the World Bank to evaluate training and certification of water quality personnel in Mexico, served as training manager for USAID water systems development project in Yemen Arab Republic, and assisted USAID to develop terms of reference for institutional development of the Egyptian water and wastewater sectors. Dr. Bryant holds degrees from Clemson University (B.S.Ch.E. and Ph.D.) and Rice University (M.S.).

Table 1: Second Batch of BET Students

(Classes start date: Fall 2002; recruited in spring 2002)
Individual GPA > 3.0, average GPA 3.5 – 3.6

Major	# of Students	Male	Female
CHEN	2	1	1
ELEC	3	3	
SWEN	4	3	1
AERO	1	1	
MECH	1	1	
CSCI	1	1	
INSY	2	1	1
CIVIL	1		1
Total engineering	15	11	4
Total business	16	9	7
Total all	31	20	11

Legend:

AERO	Aerospace Engineering
CHEN	Chemical engineering
CIVIL	Civil Engineering
CSCI	Computer science
ELEC	Electrical engineering
INSY	Industrial Systems Engineering
MECH	Mechanical Engineering
PBUS/BUS	Pre Business or Business major
SWEN	Software Engineering

Appendix I
A description of the six courses forming the B-E-T program

ENGR/BUSI 3510: **Introduction to Business and Engineering** (First offered in fall 2001 for juniors, semester 1 in the sequence)

An innovative teaching approach here is to use several **Diagnostic Case Analyses** where students are encouraged to identify business and engineering issues associated with complex business problems with a strong engineering component.

ENGR/BUSI 3520: **Integrating Business and Engineering Theories with Practice** (Semester 2. First offered in Spring 2002).

BUSI 3530: **Entrepreneurship and E-Commerce, (first offered in spring 2002)**

BUSI 4540: **Strategic Management of Technology and Innovation**
(Semester 3. First offering fall 2002). Selected case studies included in this course are: ATT Automotive, BMW AG: The digital auto project, Duriron: Cell manufacturing, Boeing 777 development, Campbell Soup Company, Spin Master Toys (A), Plus Development Corporation, and Quantum Corporation.

ENGR/BUSI 4970 and 4980: **Capstone Project I (1 credit) and II (3 credits)**
(Semesters 3 and 4. First offering fall 2002 and spring 2003)