

The effect of Auburn University's Business-Engineering-Technology program on the predisposition towards entrepreneurship in business and engineering graduates
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Abstract

The unique Business-Engineering-Technology (BET) minor at Auburn University trains business and engineering students in teamwork and entrepreneurship. All eleven graduates of the first BET class (May 2003) and 19 graduates from the second BET class (2004) were surveyed to assess their entrepreneurial skills, knowledge and abilities. Their responses were compared against Auburn University norm for graduating seniors. The norm was developed using 254 responses from business and engineering students who were cohorts of the BET students.

In this lock-step program, students design and develop three different products and matching businesses to exploit their products. Over the two years, they prepare three written project reports and presentations which include product details, a business plan, one prototype and financial analyses. The written reports and presentations are graded. The assessment described in the paper does not use these student deliverables. We are considering the use of an assessment that would incorporate these student deliverables too.

The results of the comparison between BET and non-BET graduating seniors in Tables 1 and 2 shows that BET students consider themselves more knowledgeable and skilled in entrepreneurship and teamwork than their peers graduating from the two colleges. However, when compared to their peers, students going through the B-E-T program are no more predisposed to entrepreneurship upon graduation than their peers

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graduating at the same time from the colleges of engineering and business at Auburn University. It appears from this study, knowledge, skills and abilities do not translate into a desire for entrepreneurship in graduating seniors who may average 22 years of age at graduation. This phenomenon and an explanation for it will be investigated in future studies. Based on the first three offerings of this program, the program will see some revisions, which are included at the end of this paper. **[Key words: Cross-disciplinary teamwork; entrepreneurship; undergraduate business students; undergraduate engineering students; business and engineering collaboration]**

Introduction

A relatively new minor for business and engineering students called the Business-Engineering-Technology Program (B-E-T) at Auburn University trains students in cross-functional teamwork and entrepreneurial skills. The motto of the program is “Launching New Product Through Teamwork.”

The unique two-year, lock-step program (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. In the past, the Thomas Walter Center has developed courses and studied cross-functional teamwork among business, industrial design and engineering students [1, 2, and 3].

The program is considered a minor that supplements any and all majors in the two colleges. This program, which began in fall 2001. The program admits equal number of business and engineering students to the program each fall. The first BET class of 11 graduated in spring 2003, and the second BET class of 19 graduated in 2004. Currently, there are 19 students (14 majors) in the third BET class, and 24 students (15 majors) in the most recent class admitted in 2004.

Students must apply this competitive program in their junior year and 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).

The high-achieving students in the program, by and large, have a broad perspective coming into the program, or they seek to further 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 cover business and engineering issues.

The significance of this program. In technology-intensive firms, which employ a large number of engineers, the success of the new business ventures and intrapreneurial 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.

The program is expected to prepare students for employment and/or 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.

Program delivery

One reason for the success of the program is that the faculty members from the two colleges provide a successful role model for smooth-working cross-functional teamwork

for the students to believe in the viability of the notion of cross-functional teamwork among business and engineering students.

Since the inception of the program, six core faculty members including the directors of the Center have provided an exemplary role model for cross-functional teamwork with absolutely no attrition among the core group during this time, except for one retirement three years into the program. The core group represents six disciplines; three from business and three more from engineering.

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.

Business and Engineering Topics covered 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 is 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 of 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 is 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.

In class projects, cross-disciplinary student teams develop several new products, and learn to write business plans, and develop pro-forma financial statements for proposed businesses. In 2004, one team was made of four Auburn University BET students and four more from the University of Plymouth were part of the same team. The teams travelled once to each other's campus for a few days of consultations accompanied by one professor. The final presentation was in April 2004 by the team of eight students when the Plymouth students visited Auburn University.

Student Team Deliverables and Outputs

During this lock-step program, students make several deliveries or outputs at the end of each of the four semesters. The following are some of the student outputs relevant

to entrepreneurship required of them in three stages over a period of two-years (see details of course numbers in the Appendix):

1. First semester (BUSI/ENGR 3510)—develop a new product in a team made of business and engineering students, and write a business plan with cash flow projections for 3 to 5 years. The team output includes a team report and team presentation; both are graded. A sample of products: a hammer, golf club, a razor, beach chair reading lamp, etc. This is the first attempt at design and development of new products including a business plan and financial projection.
2. Second semester (BUSI 3530)—in this course on entrepreneurship, students are given a deeper exposure to entrepreneurial concepts and practice, and are required to design and develop a product and a matching business to exploit the new product. Once again, students teams develop a product and a business plan with cash flow analysis for 3 to 5 years. They conduct patent and relevant searches to their product in this course. They learn additional material on intellectual property rights in the following course BUSI 4540. A detailed written report and presentation by the teams are graded in BUSI 3530..
3. Third and fourth semesters (BUSI 4970 and 4980)--This is a two-course sequence in which the teams are required to use the design process systematically to design new products for form and function. The first semester is structured around the book *Product Design and Development* by Karl Ulrich, Steven Eppinger. At the end of the first semester, a product concept from many competing concepts is adopted by each team to pursue in the second

semester. The book is very helpful in blending the business and engineering talents in each team. At the end of the second semester, a very detailed project report and presentation accompanied by a prototype is delivered by each team. Again the report details product design, business plan, and pro forma financial statements. The report and presentation are graded. Examples of products, an improved ironing stand, soft-drink bottle handle, etc.

As shown above, BET students do three different projects in the two years. Each time the product and team members are different. Experiential learning is a substantial part of the learning experience on entrepreneurship. The last project in the fourth semester is much more polished and thorough compared to the first and second projects completed by students. Their learning in the area of entrepreneurship grows with each semester. The teachers are able to witness the growth as our students progress through the BET program. We are working on other assessment methods to strengthen and broaden the scope of assessment reported in the next section.

Comparing BET students to University-Wide Benchmark

In order to assess if BET students are any different in their predisposition to entrepreneurship upon graduation, we developed norms for comparison based on Auburn University graduating seniors who are peers to BET students. The norms were used a benchmark to compare BET students.

Establishing Auburn University norms for assessment. The norms were derived from graduating students (265 in 2003, and 188 in 2004) in the colleges of business and engineering in 2003 and 2004 (see Tables 1 and 2). This approach to

assessment using university or college norms to compare a selected group of students has been used by others [5].

Questionnaire development. We developed a survey questionnaire to administer to graduating seniors at the end of the academic year 2002-2003, when the first class of BET students graduate. The questionnaire items are included in Tables 1 and 2, which compare BET students against the norm developed in 2003 and 2004. A few questions on entrepreneurship in the tables have been used by other researchers. The questions, “I could write a business plan,” (Item 3 in Table 2) and “I could perform a patent search” (Item 10) are similar to two items in the 24-item questionnaire on entrepreneurship used by Wang and Kleppe [5]. Our questions on entrepreneurship are, by and large, more specific and narrower than the ones used by Wang and Kleppe [5].

The questionnaires were given to the graduating class during May 2003 and 2004 in most departments in engineering and the capstone business policy course in business. Students, who did not return the survey questionnaire, were not contacted; thus the participating on the benchmark was purely voluntary. All 11 graduating BET students 2003 and 19 in 2004 were surveyed and the scores for BET students are compared against Auburn University norms in Tables 1 and 2.

***** Insert Tables 1 and 2 here*****

BET students think they are better prepared to be entrepreneurs. Based on the t-tests reported in Tables 1 and 2, BET students have scored significantly better than their peers in all items except the first item “I am considering or thinking about starting my own business” (Table 1, $p = 0.28$; Table 2, $p = 0.33$ —both are not significant). It

means that, at the time of graduation, BET students are similar to graduating seniors in business and engineering in their interest in starting a new business.

However, the t-tests for items 2 through 9 in the two tables confirm that the BET students believe that they are significantly more knowledgeable and skilled than their peers graduating from the colleges of business and engineering; they score better on every item in 2004 (p values are $< .01$ for questions 2-9 shows that BET students are better prepared)—a marked improvement in 2004 over 2003. That is, BET students think that they are better prepared than their peers to start and run a new enterprise.

Changes for the Future

As of fall 2004, the program completed three years. Using the experience gained during those years, the following changes were proposed in fall 2004 to college and university curriculum committees to improve and refine its focus. The changes were approved in Nov. 2004. The following are the changes which will take effect starting fall 2005:

1. The two courses in the Appendix namely, Entrepreneurship and E-Commerce (3 credits) and Strategic Management of Technology and Innovation (3 credits) were combined into once course called Entrepreneurship and Strategic Management of Technology and Innovation (4 credits). This was done to eliminate redundancies between the two courses, and to remove the emphasis on e-commerce in content and the title of the course.
2. A 1-credit course on Leadership was added. It replaces the current Leadership retreat.

3. Another 1-credit course on Teamwork was added. It replaces the current Teamwork retreat.

Concluding Note

Our data shows that our students show statistically significant gains in entrepreneurial skills and knowledge compared to their peers in the two colleges. Using a nine-item scale, we found that, although B-E-T students have gained significant knowledge and skills in entrepreneurship, they are not any different from their peers from the two colleges in their desire to start a business.

Research questions arising from this study are: What determines the desire to be an entrepreneur in a graduating senior? Why do business and engineering students seek the knowledge and skills to be an entrepreneur? When and how do graduating seniors from business and engineering colleges use their entrepreneurship knowledge and skills? Is the age of the BET students a factor in their desire to be an entrepreneur? Is there likely to be a delayed effect on BET students? This phenomenon and an explanation for it will be investigated in future studies.

Our assessment shown here is data-intensive and quantitative. We are considering the use of student written reports, prototype and presentations for additional formal assessment. The challenge is to reduce student reports (which run into several pages; one is 176 pages long), presentations and prototypes into some meaningful quantitative criteria.

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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)

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).

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)

Table 1

A comparison of BET students against Auburn University norms on entrepreneurial skills, knowledge and abilities in business and engineering graduates, 2003.

Scale:

1 = I strongly disagree

10 = I strongly agree

	Questionnaire items	Bus n = 157	Engg n = 97	BET n = 11	All n = 252	BET vs All (t-test) ¹	Signi- ficance
1	I am considering or thinking about starting my own business	5.3	5.2	6.64	5.36	-1.14	.28
2	I am better equipped to start my own business	6.1	5.8	8.27	6.11	-2.54 ^a	.01***
3	Now, I could make an adequate business plan for a new business	6.1	5.2	8.36	5.89	-3.37	.01***
4	Now, I could develop a new product	5.5	5.6	7.91	5.72	-3.02	.01***
5	Now, I could develop a plan to market a new product or service	6.4	5.5	8.27	6.22	-3.2	.01***
6	Now, I know all the essential business issues to be addressed in starting a new business, or I know where to get the information from.	6.2	5.3	8.00	6.04	-2.48 ^a	.02**
7	Now, I know the essential engineering-related issues to be addressed in launching a new product, or I know where to get engineering information.	5.4	6.6	7.55	5.88	-2.1	.06*
8	Now, I could prepare a website for a new business	5.4	5	7.64	5.4	-2.5 ^a	.01***
9	Now, I know the options for funding a new business	6.3	4.8	8.09	6.04	-2.6 ^a	.01***
10	Now, I know how to obtain a patent to protect an invention or a proprietary idea	5.4	4.7	8.55	5.14	-3.8 ^a	.00***

1 = Unequal variance

a = equal variance

* = p < 0.1

** = p < 0.05

*** = p < 0.01

Table 2

A comparison of BET students against Auburn University norms on entrepreneurial skills, knowledge and abilities in business and engineering graduates, 2004.

Scale:

1 = I strongly disagree

10 = I strongly agree

	Questionnaire items	Bus n = 102	Engg n = 67	BET n = 19	All n = 188	BET vs All (t-test) ¹	Signi- ficance
1	I am considering or thinking about starting my own business	5.6	5.2	6.63	5.45	-0.42	.33
2	I am better equipped to start my own business	6.34	6.12	8.68	6.5	6.11	.01***
3	Now, I could make an adequate business plan for a new business	6.34	5.84	8.68	6.27	7.52	.01***
4	Now, I could develop a new product	5.67	6.03	8.32	5.95	6.46	.01***
5	Now, I could develop a plan to market a new product or service	6.39	6.06	8.53	6.42	7.04	.01***
6	Now, I know all the essential business issues to be addressed in starting a new business, or I know where to get the information from.	6.62	5.5	8.42	6.3	8.09	.01***
7	Now, I know the essential engineering-related issues to be addressed in launching a new product, or I know where to get engineering information.	5.54	6.57	8.16	6.14	5.06	.01***
8	Now, I could prepare a website for a new business	5.34	5.16	7.68	5.49	4.71	.01***
9	Now, I know the options for funding a new business	6.34	5.3	8.37	6.11	7.01	.01***
10	Now, I know how to obtain a patent to protect an invention or a proprietary idea	5.41	4.33	8.47	5.31	3.12	.00***

1 = unequal variance

* = $p < 0.1$

** = $p < 0.05$

*** = $p < 0.01$

End.