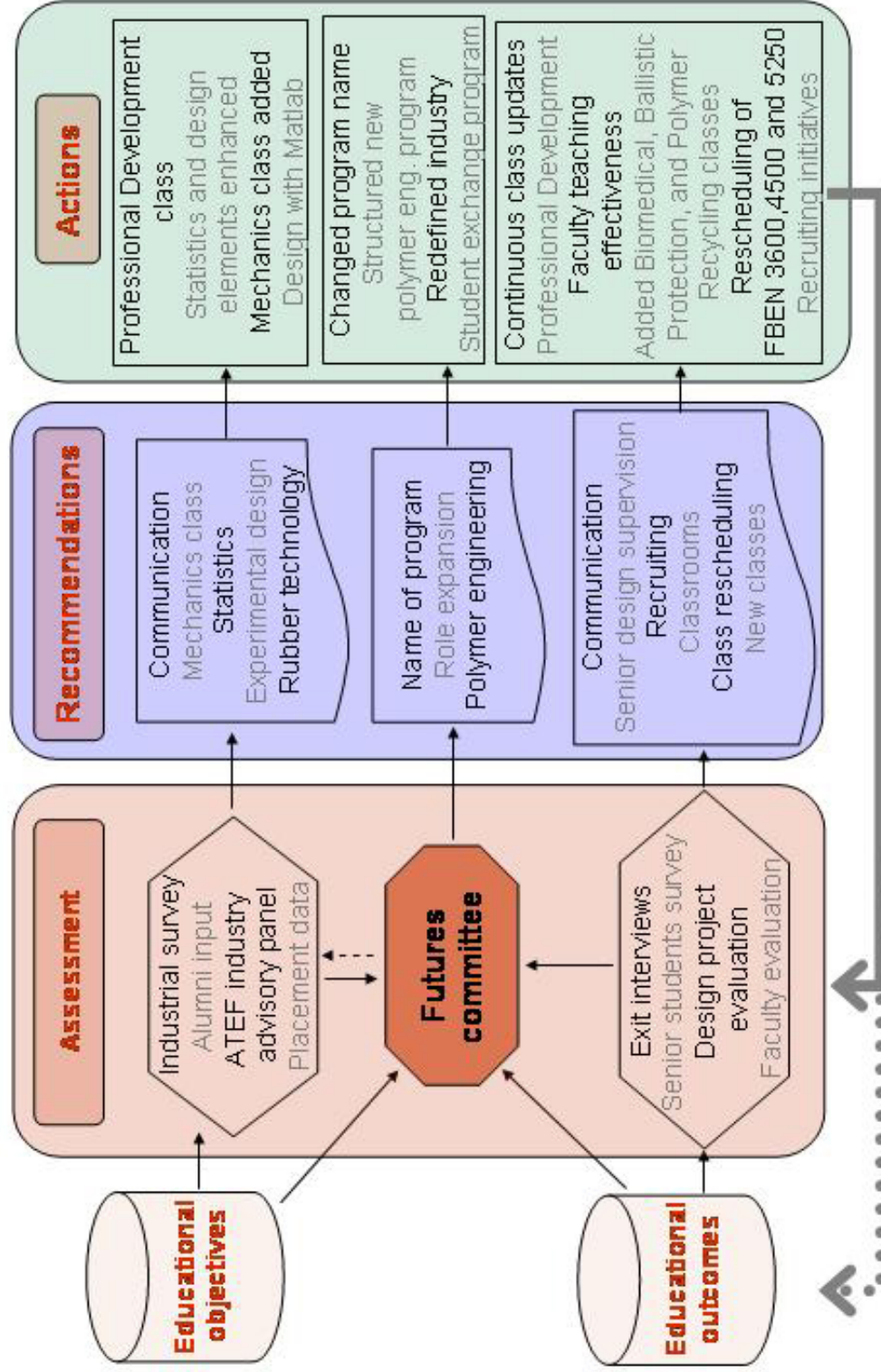


*The Cycle of Continuous Improvement in Fiber Engineering*

# Flowchart for Continuous Improvement



## *Introduction*

The following is a summary of efforts taken to assess the degree of success of the program objectives and outcomes, recommendations made by different constituents, and actions taken to implement these recommendations. This is done with the intent of expanding on and clarifying material in the Self Study Report. **This document was prepared in response to concerns expressed by the reviewer and should be viewed as a supplement to the original Program Self Study Report.**

## *Assessment and recommendations*

Alumni, faculty, industry and students' assessments are continuously applied to suggest improvements within a specific class, restructuring or adding a whole class, impacting educational effectiveness of faculty or enhancing the program as a whole. Program educational objectives are assessed using industrial surveys, input from alumni, input from Alabama Textile Education Foundation Advisory Panel as well as monitoring of the placement data of students during the first years of their career. The program educational outcomes are assessed via exit interviews, senior student surveys, design project evaluation forms as well as faculty evaluation of the impact of different classes on specific outcomes. The Futures Committee is viewed as the pinnacle of our assessment and evaluation strategy. Its membership represented most of our constituents, and included assessment and recommendation for improvement.

### Industrial survey

*Please refer to Program Self Study Report*

### Alumni visits

Many of our graduates come for a visit of their former department, presenting their company or current job responsibilities in the form of a seminar, recruiting new graduates for their companies, or visiting their former advisor or friends in the Department. The department is keen on soliciting feedback from these graduates regarding their experience in the department and how its educational elements impacted their professional careers. For example, during one of these visits, Mr. Andy Short (2001) visited the department to give the graduate seminar on his work on the manufacture of C/C composite brake-pads for airplanes at A-Carb, Kentucky (see p.5, *Program Self Study Report*). The departmental ABET committee used this opportunity to meet with him on February 24, 2003, to get feedback and suggestions for the program. He recommended receiving a stronger background in statistics and design of experiments as well as in mechanics of materials. This information was presented to faculty members in charge of relevant classes and was implemented in the same year in STAT 3010.

Mr. Christopher Timpson (2000), who is the technical manager for a subsidiary Dupont-Sabanci in North Carolina and is working on the design of cord and fabric constructions for power transmission products, suggested that we include in our curriculum a class on rubber chemistry and technology. A portion of this topic is presented in the newly developed class on environmental issues (rubber manufacturing and recycling/reuse, see section "Actions").

### Placement data

*Please refer to Program Self Study Report*

### Futures committee

In a strategic planning retreat attended by the entire faculty, a decision was made to create a committee to help map a strategic vision to guide our footsteps into the future in the wake of economic and political uncertainties. A Futures Committee was formed consisting of three faculty members, three students, one each from fiber engineering, textile management and technology, and textile chemistry, and three industrial representatives (one of which is the current director of Alabama Textile Education Foundation). The charge set for this committee from the faculty was "...to discuss and recommend to the Department Head and Faculty a vision of how the Department should proceed with its mission over the next decade in order to maintain its relevance."

During committee meetings the following issues were discussed: i) current program objectives and how they prepare students for their professional careers, ii) economic situation and the impact of free-trade agreement on the long-term prospects of the industry, iii) possible programmatic changes to expand the role of the department by redefining the industry.

After long discussions, the committee presented its conclusions to the Department Head for short term enhancement of the program along with a long term vision for the department. The committee stressed the need to expand the departmental effort to all industries that use fibrous materials. A specific recommendation was presented to change the "Textile Engineering" program name to "Fiber Engineering". A similar suggestion to change the department name was put on hold in fear of losing legislative support within the State of Alabama. The title change was presented as a precursor to a more drastic and ambitious evolution of the department's mission into fiber and polymer engineering within the next few years. A department name change will be necessary at that time with the support of the legislature. Another recommendation from the committee included adding an undergraduate Mechanics of Materials course to the Fiber Engineering curriculum to support a better understanding of the behavior of fibrous materials. (*also refer to p.4 in Self Study Report*)

### ATEF industry advisory panel

The Alabama Textile Education Foundation (ATEF) was initially founded in 1953 by a group of alumni from the Department of Textile Engineering to provide scholarships for textile engineering students and operating funds for the Department. Its mission is to assist educational institutions in providing educational facilities and advantages to students in various branches of learning. Initial funding was provided by several textile companies and dues from "friends" of the Department. ATEF's role was later expanded to include an advisory role to the Department and the Department Head, who is an *ex officio* member. The Board meets twice yearly. In its capacity as an Advisory Committee, members of ATEF were provided with early drafts of the ABET self-study for comment.

Conclusions drawn by the Futures committee were presented to the ATEF board. They concurred with the Futures Committee's recommendation to change the name of the degree and suggested removing the word "textile" from the department name as well. (*also refer to p.4 in Self Study Report*)

### Exit interviews

Exit interviews are conducted with graduating seniors in order to determine their experiences, both positive and negative, throughout their time in the Department. Each senior, prior to graduation, is asked to sit for a confidential exit interview with the Department Head. Their feedback is taken into consideration at many levels. The topics covered in this interview include, but are not limited to:

1. What caused the student to choose textile/fiber engineering as a major?
2. Which TE instructors were particularly effective or ineffective?
3. Which courses (TE or University) were particularly valuable or not valuable?
4. Regarding your experience what would you keep or change?

Keeping confidentiality, the Department Head shares the perceived strengths/weaknesses with the faculty. Among the changes arising from these interviews were:

- a. Rescheduling of FBEN 3600 & FBEN 4500.
- b. More effective supervision and evaluation of the senior design courses.
- c. Cosmetic changes to make the learning environment more attractive.
- d. Additional support for student organizations.

Also, some students mentioned classes that they wish to see added to the list of current courses as electives or as required classes to explore new areas and emerging technologies in textile and fiber science and engineering. Three classes were added in response to this request (refer to section on "Actions").

During exit interviews seniors are asked how they learned about the department. Strategies that led to a student's applying such as special workshops and projects were reinforced. Different recruiting initiatives were undertaken such as Civil Air Patrol Summer Camp and Polymer Detective to attract quality students with a known interest in science and engineering.

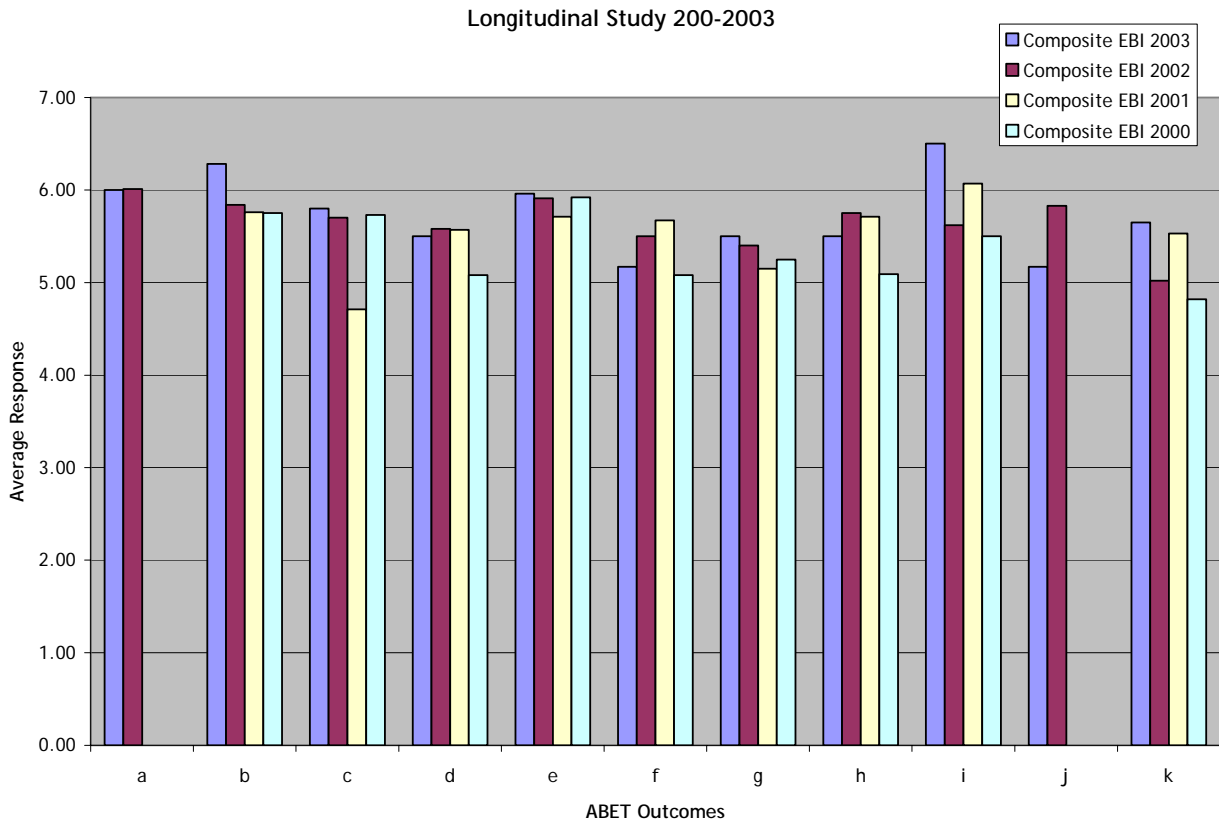
Students also mentioned that they were attracted by hands-on projects, especially those that were exciting. Construction of composite skateboards and snowboards were added to the introduction to fiber engineering course (ENGR 1110) and the Formula 25 Hovercraft Team was formed. This year information on skateboards and the Hovercraft Team were displayed during E-Day, the College's Annual Spring Open House for high school students and parents. The number of students and their parents who visited the Department that day exceeded past visitors by a factor of three.

The change of the major's name to Fiber Engineering was done in part to address recruiting and retention issues. The name was approved for the 2003-2004 academic year but did not appear in official university publications because the approval occurred after the deadlines for changes passed. The name change will appear in the 2005-2006 catalog. (*also refer to p.4 in Self Study Report*)

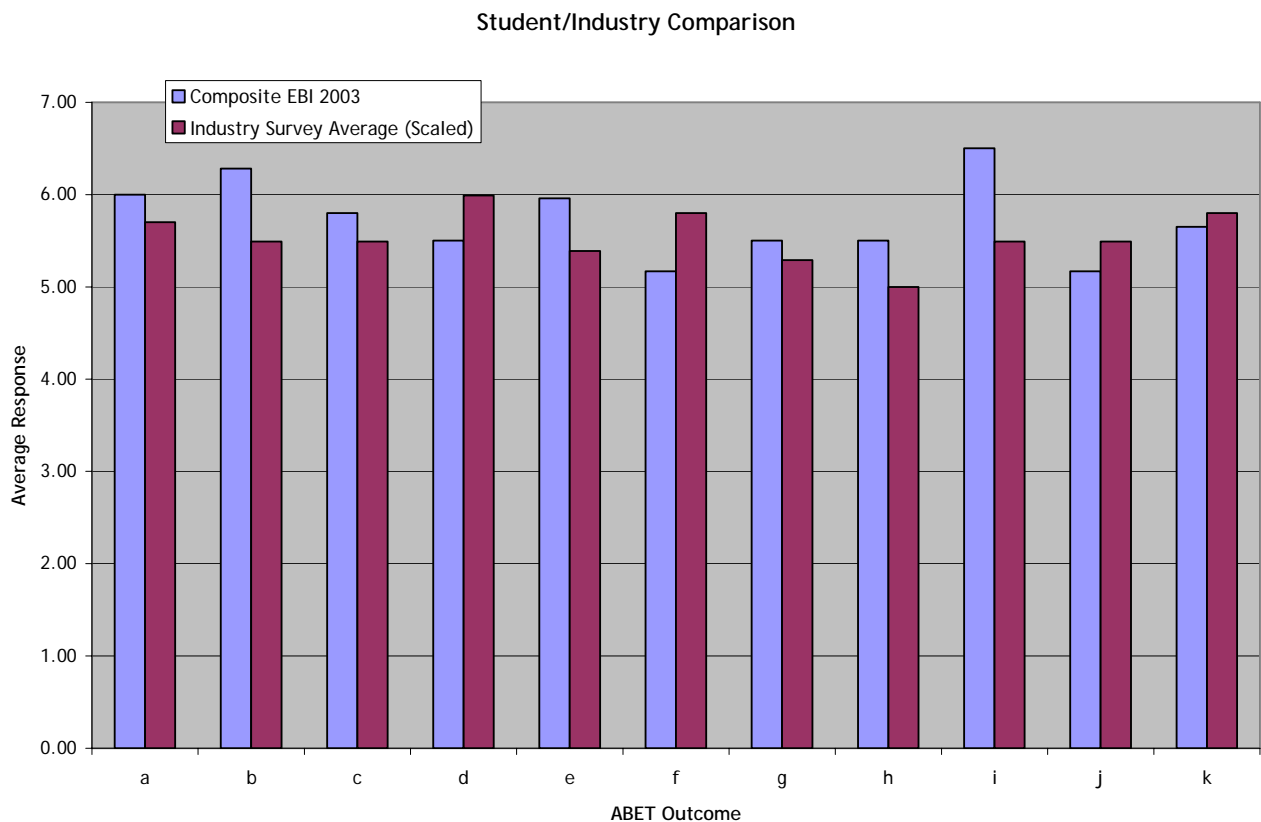
### Senior student survey

Every year a senior student survey is conducted through the College of Engineering to assess various educational objectives under the Engineering Benchmarking Initiative (EBI). Questions are asked about general college education as well as specific education relative to each

department and compared to results from other universities. Due to the limited number of textile engineering program in the US, the program is listed at “other” in the survey. Numerical results show Textile Engineering as above 5 in all questions, out of a maximum value of 7, in 2003, as shown in the Figure 1. Figure 2 illustrates a comparison between the industrial survey conducted by Textile Engineering, with values scaled up to a maximum value of 7, used to assess educational objectives and the EBI survey for 2003 used to assess the educational outcomes.



**Figure 1:** EBI results for Textile Engineering in the years 2000 – 2004 (for a to k indices, please refer to Program Self Study Report)



**Figure 2:** Comparison between EBI survey and industrial survey (for a to k indices, please refer to Program Self Study Report)

The data presented in Figure 2 indicate that there is generally good agreement between our students' self-evaluations and how their employers see them. Because we use employer comments as part of the continual assessment of the relevance of our courses, these data provide the Department with a secondary method of measuring program outcomes.

#### Design project evaluation

Special forms were designed and implemented to evaluate senior design projects. These forms are attached to the *Program Self Study Report*. Question on this evaluation form correspond to ABET outcome as follows:

#### *Oral Presentation*

Speaking ability: 3g

Quality of Visuals: 3g, k

#### *Written Presentation*

Introduction: 3h, g, j

Background / Literature Review: 3a, b, e, g, j

Theoretical Background: 3a, b, e, g, j

Experimental Procedures: 3a, b, c, d, e, g, k

Discussion and Conclusions: 3b, g, h, k

Tables and Figures: 3a, b, g, k

If it is a team project, evaluation of the team performance: 3d

Faculty evaluation

Faculty members were asked to evaluate students' performance for each outcome for every class they teach using a rating from 1 (not at all) to 5 (completely) of how the course meets these objectives. Table 1, below, contains the ratings for this year.

Table 1: Faculty evaluation of student performance in each outcome for academic year 2003-2004:

Program Outcomes	ENGR 1110	FBEN 2100	FBEN2250	FBEN2500	FBEN 3300	TXTN 3310	FBEN3400	FBEN 3600	FBEN 5250 (4250 in Self Study)	FBEN 4500	FBEN 4910	FBEN 4920	FBEN 5100
3a	4	5	4	3	4	5	5	4	5	4	4	5	4
3b			5		5	4	5					5	3
3c	5		5		5		4	5	5	5		5	4
3d	5		5		5		4	4		4			4
3e	4	4				4		5	4	5	4	5	
3f	3			3				4		5			
3g	4		4		5		5	4		4	3	5	
3h	3			4	3				3				4
3i	3	5		3		3			3		4	4	3
3j	3	4	3	4			5	3	4	3	5	5	4
3k	4	5				3		4	4	5	5	5	4

These data support the data in Figures 1 and 2 that the program outcomes are generally being achieved, but there is also room for improvement in some areas, such as the need for life-long learning (3i).

## *Actions*

In response to the aforementioned assessment and recommendations the following actions were taken as an integral step of a continuous improvement effort:

### Mechanics of Materials class added

*Please refer to Program Self Study Report*

### Statistics and design of experiments added

A series of lectures on experimental design were added to STAT 3010 course taught by a faculty from the department. This addition was due to feedback received from alumni about what they felt was missing in their introductory statistics course. This course is among the highest rated in the Department.

### Design using Matlab®

Exercises involving the use of Matlab® to analyze engineered fabric structures were added to FBEN 5250. FBEN 4500 was modified to include a section on the design of textile composite materials using Matlab® instead of the home-built software used previously. Students are expected to implement their understanding of basic equations used in the modeling and create a program capable of calculating the stiffness matrix and elastic properties of a composite with various fiber volume fractions. This work was done in response to comments made by alumni on the need to enhance design aspects and computer skills.

### Professional development class

Besides a technical background which is provided by the various courses offered by the program, communication skills, ability to work in teams, creativity and critical thinking are most crucial to a successful career of our students. Although the students have the opportunity to practice presentations (e.g., FBEN 3400) and work in small teams in laboratory sessions or on homework assignments, the need for the implementation of a new “Professional Development Class” was recognized. Each class period provides the student with a different aspect of the above mentioned skills as well as evaluation and instant feedback on his/her work. Shortcomings in student performance are identified and corrected. This class is currently being developed under FBEN 4970 Special Topics class.

### Changed program name

*Please refer to Program Self Study Report*

### Structured new polymer program

In response to Futures committee recommendation a new Polymer Engineering program was structured. It is expected that this program will expand the role of the department, help it re-identify its mission within the new economic reality, and drive it into a brighter future. A revised curriculum is listed in Appendix A. A faculty search is underway for a new polymer position and the program is planned to be submitted for approval in the spring of 2005.

### Redefined industry and student exchange program

The industry hiring graduates from our program has shifted away from traditional areas in regard to manufacturing focus and market place. Presently companies are looking for graduates with

extended background in specialty products of fiber, polymer or composite origin, and state-of-the-art technologies. Due to the globalization of the market place students with a broader world view are preferred for top positions. As a consequence, the Department of Textile Engineering is now offering an undergraduate exchange program with a German university (Reutlingen University of Applied Sciences) to broaden the experience of the students. Each spring semester two Auburn students spend one semester in the program of the host university in Germany, while two German students visit Auburn in fall for one semester.

#### Continuous update of class contents

Many of our classes change over the years to accommodate feedback from student exit interviews, input from alumni, teaching evaluation sheets and self evaluation at the department level and the faculty personal level. Changes may include:

- a. Introduction of recent technological advances and new industrial developments.
- b. Added emphasize on critical thinking.
- c. Practical skills through lab experiments and utilization of computer tools.
- d. Encouragement of creativity through class projects, presentations and posters.

#### Faculty teaching effectiveness

With the implementation of the Biggio Center for Enhancement of Teaching and Learning at Auburn University faculty has taken advantage of the available assistance concerning teaching and learning styles and effective assessment through seminars and workshops offered by the Center. The Center sent one faculty member from the department to an NSF workshop with the topic of including “Case Studies in Science” in the classroom to tie class material closer to industrial reality. A summary of the workshop will be presented to the faculty in form of a seminar. Further, one faculty member is chairing the Senate Teaching Effectiveness Committee which is actively working on revising Auburn University’s teaching evaluation forms to provide better feedback and more meaningful interpretation.

#### Biomedical, ballistic protection and polymer recycling classes added

FBEN 2500 Biomedical Textiles has been added to the program (see also p. 4, *Program Self Study Report*). The course covers the basics for students interested in the growing medical and medical supplies industry. Topics include fibrous and polymeric materials used for sutures, artificial grafts, tissue, bone and joint replacements, super absorbents, hydrogels, and more.

A Ballistic Resistant Materials class that contains an in-depth discussion about categories of ballistic threats including guided projectiles, explosive blasts, thermal flash threats, fragmentation threats and multi-component munitions was added. It introduces fibers used in constructing materials to counter these threats including Aramids, extended chain polyethylenes, PBO and M5 fiber. Fabric types and structures of fabrics used with the above fibers are discussed. The use of ceramics and various metals is covered for high-end threats. The fluid penetration dynamics of projectiles and applications of chaos theory to bullet penetration dynamics are discussed. This class is currently being developed as a Special Topics class.

A new class was developed that covers environmental issues of liquid, polymer and fiber waste (same course title, currently taught as free elective) which has great relevance for the graduates of our program because environmental issues are not only a legal challenge for companies but

also a cost factor. The students are introduced to conventional and novel methods of effluent recycling and treatment with specific attention to textile waste, as well as fiber and polymer degradation and recycling/reuse issues. The course includes the design of an effluent treatment plant for a specific waste water composition, a laboratory session on polymer identification, and a student presentation on a topic taken from a polymer recycling and reuse case-study. This class is currently being developed under FBEN 4970 Special Topics class.

#### Rescheduling of FBEN 3600, 4500 and 5250

FBEN 3600 has been moved to the fall semester and FBEN 4500 to spring semester to better accommodate the student schedule and background necessary for their classes. FBEN 5250 was also moved from the spring semester to the fall semester at the suggestion of students.

#### Recruiting initiatives

In response to students' suggestions regarding recruiting efforts, the following initiatives were taken:

*Civil Air Patrol E-Tech Camp:* The Department of Textile Engineering hosts each summer the Engineering Technologies Academy (E-Tech). Other departments participating in the effort include Aerospace Engineering and Aviation Management in the College of Business. Last year twenty students come to Auburn, designed and manufactured textile composite airfoils and tested them in an air tunnel.

*Polymer Detective:* As part of the Science Olympiad, Textile Engineering has joined the College of Sciences and Math by offering the "Polymer Detective", a laboratory session on polymer and fiber identification within a forensic setting. The best high school students in the country participate in this annual event. The past two years, between 15 and 25 students were involved in the polymer segment of the Science Olympiad.

*Study Abroad:* The Department of Textile Engineering and the University of Applied Science at Reutlingen, Germany, recently established an academic interchange program that allows students of each university to spend one semester abroad. The goal of this program is to raise international awareness and prepare students of an increasingly global marketplace. It also acts as a very attractive recruitment tool.

*Hovercraft Team:* The Formula 25 Hovercraft Team, based in the Department of Textile Engineering, is building a hovercraft for competition in the Annual National Hovercraft competition in 2005. The Auburn team is part of the College of Engineering's *War Eagle Motorsports* and is comprised of student from engineering disciplines including fiber, mechanical, and industrial, as well as students majoring in industrial design.

## Appendix A: Curriculum for proposed program in Polymer Engineering

	<b>COURSE NUMBER</b>	<b>COURSE NAME</b>	<b>HOURS</b>	<b>PRE-REQ</b>	<b>OFFERED</b>
1	ENGL 1100/1107	English Composition I	3		
2	ENGL 1120/1127	English Composition II	3	1	
3	ENGL 2200/2207	Great Books I	3	2	
4	ENGL 2210/2217	Great Books II	3	3	
5	HIST 1010/1210 UNIV 2710/2717	Core History I	3		
6	HIST 1020/1220 UNIV 2720/2727	Core History II	3		
7	ANTH1000/GEOG1010/PSYC2010/ /SOCY1000/1007/UNIV1010/1017	Core Social Science - Group I	3		
8	ECON 2020/2027/POLI 1020/1027/1090	Core Social Science - Group II	3		
9	ARCH2600/ARTS1710/1720/1730/ /MUSI2730/2737/THEA2010/2707	Core Fine Arts	3		
10	PHIL 1020/1030/1040	Ethics	3		
11		Free elective or ROTC	3		
12		Technical elective or ROTC	3	Dept. Appr.	
13	MATH 1610/1617 (P)	Calculus I	4	MATH 1130/1150	
14	MATH 1620/1627 (P)	Calculus II	4	13	
15	MATH 2630/2637	Calculus III	4	14	
16	MATH 2650	Linear Differential Equations	3	CO: 15	
17	MATH 2660	Linear Algebra	3	14	
18	CHEM 1030/1110/1117 (P)	Survey of Chemistry I	3	CO: 13	
19	CHEM 1031/1111/1118 (P)	Survey of Chemistry I Lab	1	CO: 18	
20	CHEM 1040/1120/1127 (P)	Survey of Chemistry II	3	18	
21	CHEM 1041/1121/1128 (P)	Survey of Chemistry II Lab	1	CO: 20	
22	CHEM 2070	Organic Chemistry I	3	20	
23	CHEM 2071	Organic Chemistry I Lab	1	CO: 22	
24	CHEM 2080	Organic Chemistry II	3	22	
25	CHEM 2081	Organic Chemistry II Lab	1	CO: 24	
26	PHYS 1600	Engineering Physics I	4	CO: 13,27	
27	PHYS 1601	Engineering Physics I Lab	0	26	
28	PHYS 1610	Engineering Physics II	4	26 CO: 29	
29	PHYS 1611	Engineering Physics II Lab	0	CO: 28	
30	COMP 1200 (P)	Intro to Computing - MatLab or C	2		
31	INSY 3600	Engineering Economy	3	15, 30	
32	ELEC 3810	Fundamentals of EE	3	CO: 16	
33	ENGR 1100 (P)	Engineering Orientation	0		
34	ENGR 1110 (P)	Intro to Engineering (Textile)	2		SPRING
35	ENGR 2050	Statics	3	26, CO: 15	
36	ENGR 2200	Intro to Thermo, Fluids, & Heat	3	18, 28, CO: 16	
37	ENGR 2350	Mechanics of Materials	3	35	
38	STAT 3010	Statistics for Engineers & Scientists	3	13	
39	<b>FBEN 2xxx</b>	<b>Polymer Science for Engineers</b>	<b>2</b>	<b>22</b>	
40	<b>TXTN 3310</b>	<b>Structure &amp; Properties of Fibers</b>	<b>4</b>	<b>20</b>	FALL
41	<b>FBEN 3400</b>	<b>Intro. to Dyeing &amp; Finishing</b>	<b>4</b>	<b>39</b>	SPRING
42	<b>FBEN 3yyy</b>	<b>Polymer Engineering Properties</b>	<b>3</b>	<b>24</b>	
43	<b>FBEN zzzz</b>	<b>Polymer Physical Chemistry</b>	<b>3</b>	<b>24,36</b>	
44	<b>FBEN 5510</b>	<b>Polymer Chemistry</b>	<b>3</b>	<b>42</b>	
45	<b>FBEN 5610</b>	<b>Textile Finishes</b>	<b>3</b>	<b>41</b>	
46	<b>FBEN 4910</b>	<b>Textile Engineering Design I</b>	<b>3</b>	<b>SR</b>	
47	<b>FBEN 4920</b>	<b>Textile Engineering Design II</b>	<b>3</b>	<b>46</b>	
48	<b>UNIV4990 EN-1</b>	<b>GRADUATION</b>	<b>0</b>	<b>Sr. credit</b>	

				check
	<b>TOTAL HOURS</b>		<b>128</b>	
	*COMP 1201	Optional Lab for COMP 1200	1	
	<b>TXTN 2920*</b>	<b>* Industry Project</b>	<b>3</b>	Dept. Appr.
	<b>TXTN 4967*</b>	<b>* Honors Readings</b>	<b>I - 3</b>	Honors Coll.
	<b>TXEN/TXMT/TXCH 4970*</b>	<b>* Special Topics</b>	<b>I - 3</b>	Dept. Appr.
(P)	Denotes courses required for pre-engineering			
	* Optional technical elective			
	New Pre-req, Co-req needed?			