THE *Engage* PROGRAM: FIRST-YEAR TEAM DESIGN TO COMPLEMENT AN INTEGRATED CURRICULUM

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Abstract *- The Engage program is a fresh approach to integrating freshman engineering topics and team design that is in its sixth year of implementation at the University of Tennessee. This initiative is a broad approach, addressing academic, personal skill development and socialization needs of first-year students. Team design projects are designed to complement each segment of the yearlong curriculum and increase in difficulty as the year progresses. The objective is to teach the students that design is a natural process closely related to problem solving skills they already possess. They experience success as a designer, have a positive team learning experience, and learn that design success will be a fun part of being an engineer. Engineering undergraduates or graduate students in a Counseling Psychology program provide facilitation for each team. A formal coursework program has been developed to train undergraduate engineering students as facilitators for first-year design teams. This paper shares the development process of this program, reports quantitative comparisons of Engage student success to the success of students following a more traditional curriculum, and follows the quantitative and qualitative assessment of the team program.*

Index Terms – integrated curriculum, first year design, teams, team facilitation.

INTRODUCTION

Engineering education in the United States has changed in response to a fundamental re-thinking of the methods used in design education and to industrial pressures to integrate the people skills of communication and teamwork into the engineering curriculum [1] [2]. The call for change has been well documented. In the report *Shaping the Future[3].* the National Science Foundation (NSF) insists that education should be more than an acquisition of facts. Science, technology, engineering, and mathematics (STEM) education is being encouraged to become more holistic through engaging students in the larger campus setting and creating a sense of professionalism among them. Performance skills are also being discussed in the engineering education community, with respect to personality type, learning styles, improved learning in groups, socialization for working with others, and interpersonal skills. In the December 1998 issue of the American Society for Engineering Education's (ASEE) magazine, *PRISM*, society president Ernest Smerdon writes about how not just domestic educators, but the entire international engineering education community is faced with the challenge of teaching performance-type skills: "From Utah to the Ukraine and from Milwaukee to Manila, industry is demanding that our graduates have better teamwork skills, communication abilities, and an understanding of the socio-economic context in which engineering is practiced." [4]

To be effective in the modern engineering workforce, today's engineering students need to learn the skills of problem formulation, visual and tactile thinking, idea generation, and communication to complement their traditional analytical skills. These abilities are essential for creating successful engineering teams that use individual member skills to master the complete design problem solving "cycle." A modern curriculum must balance different instructional techniques to educate students with effective analytical, team, and design skills. The *Engage* program at the University of Tennessee College of Engineering (UT-COE) attempts to create this balance through its innovative approach to first-year engineering education.

In its sixth year of implementation, the *Engage* program combines traditional freshman engineering topics with team design concepts. The initiative is a broad approach that addresses the personal skill development and socialization needs of entering freshmen engineering students in addition to their technical preparation. The program uses an environment of collaborative learning with faculty and graduate assistants as mentors, integrating the subject matter of the freshman year and teaching problem solving and design by application. The program also seeks to address the increased retention of engineering students with a conscious awareness of the inclusion of under-represented groups.

BACKGROUND

From the early 1970's through the late 1990's, the freshman engineering program at the UT-COE consisted of five traditionally-taught classes. Topics included graphics, computer tools, statics, and dynamics, as well as a one-hour freshman seminar. These courses were staffed by their

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respective departments within the College of Engineering, with three different departments responsible for their administration. The freshman program contained no design content or team experience, except as occasionally provided by an individual instructor.

However, in the mid-1990's, the UT-COE began to question the effectiveness of this teaching formula. Results from a survey of faculty members in all departments, comments from the College's Board of Advisors and an appointed Faculty Advisory Committee, and student retention data all pointed to the need for improvements in the freshman program. Recommendations from the NSF coalitions, the Accreditation Board for Engineering and Technology (ABET), and industrial advisory boards reinforced UT's findings. In the fall of 1996, a team was put together to redefine freshman engineering and to improve students' educational experience in their fundamental courses. This development team included seven faculty members from the College of Engineering, two representatives from industry, a student representative, and a psychologist with expertise in team building and assessment.

The fundamental objectives for the new program were twofold. The program would need to increase learning in traditional engineering subjects while improving the level of student retention. Simultaneously, it would also need to provide students with a more effective introduction to engineering practice by exposing them to design methodology, team problem solving, communication skills, and professional perspective. Therefore, the development team's central dilemma was to find a way to continue teaching essential skills while finding the time and techniques to effectively address new topics within the existing freshman year credit hours. The program the team proposed, now known as *Engage*, combines the original five Freshman Engineering courses (a total of 13 credit hours) into two six-hour integrated, team-taught courses (a total of 12 credit hours).

Basis for the *Engage* Program

The format of the *Engage* program was developed from a consideration of the capabilities and interests of incoming students. In the 1980's, researchers gathered a large database of information from engineering students who were given the Myers-Briggs Type Indicator [5]. For the first time, the engineering student population could be understood in terms of *preferred learning modes*, and reasonable comparisons could be made to students in other disciplines. This and other data [6] showed that while entering engineering students were slightly biased towards left-brained linear thinkers, a significant shift towards this preference occurred during the undergraduate years. The traditional undergraduate engineering curriculum seemed to actively encourage students with certain learning preferences while discouraging others.

Studies have shown the selectivity of traditional engineering curricula to be problematic. Several learning models have been applied by engineering educators, including the Kolb (4MAT) model [7], the Hermann model, and models based on the Myers-Briggs test [8]. This body of work is consistent in arguing that engineering problems are best solved when approached with a sequence of different viewpoints, all of which must be given proper consideration to ensure a successful result. Individual students, regardless of their preferred learning mode, must be given practice in using a variety of other viewpoints in order to be successful problem solvers. In addition to analytical skills, students must also know how to formulate problems, think visually, generate ideas, and communicate with others. This wide-ranging skill set is difficult for any student to master, giving importance to the concept of engineering teams where the individual skills of team members are needed to master the complete problem solving "cycle." The *Engage* development team believed that successful curriculum reform must reflect this reality and should offer multiple teaching techniques to maximize student learning and interest.

DESCRIPTION OF THE *ENGAGE* PROGRAM

A pilot program of the *Engage* curriculum, with 60 students enrolled, was offered during the 1997-1998 academic year. The program was scaled up to 150 students in the following year (1998-1999). Beginning in the 1999-2000 academic year, all entering freshmen at the University of Tennessee were enrolled in the program (approximately 500 students per year). A new division of the College of Engineering, called the Engineering Fundamentals Division (EFD), currently administers the *Engage* curriculum.

Academic Environment

The *Engage* Program is focused in a central location, the *Engineering Freshman Village*. The village includes traditional classrooms, computer classrooms and a computer lab, a free-access hands-on lab space, a team design-project work area, a separate study area, faculty offices, and student-assistant offices, all housed in a single building.

Every effort is made to develop a sense of community among the students, the graduate and undergraduate staff, the office staff, and the faculty [9]. The immersion of faculty and student staff members in the village helps to meet this goal. Their presence in the village also ensures that resources are available to meet the varying needs of students, who come from diverse backgrounds and consequently bring with them a wide range of both academic and social abilities. The academic climate in the village is one in which students are encouraged to acquire new knowledge and skills. Opportunities are built into the curriculum structure so students can get the help they need to survive their entry into the rigors of an engineering career.

Organization and Structure

EFD faculty members are selected from the departments of the UT-COE. They receive short-term appointments of three to five years from the Dean of the College. During their tenure with the program, faculty members are expected to research effective teaching methods, assess the overall value of the freshman experience to the College of Engineering, and initiate necessary improvements. They are expected to be able and willing to work as a team with their colleagues. his faculty interaction reinforces the village concept to the students and serves as a model for them as they develop their own teaming skills.

Curriculum

Two integrated, six credit courses, EF 101 and EF 102, have been developed to meet the objectives of the Engineering Fundamentals Program. EF 101 teaches computer skills, graphics skills, and problem solving in the context of engineering science. EF 102 presents concepts of statics and dynamics, relying heavily on the foundation developed in the first semester. The basic building block of the curriculum is the instructional cycle. Topics covered in class typically have four to six instructional cycles, termed *modules*, which conclude with a quiz over the material in that module.

Each cycle uses multiple teaching components in order to maximize student learning and interest. One component is a traditional, one-hour lecture in large classroom format (150 students), in which EFD faculty present new concepts for that cycle. These concepts are then reinforced by laboratory exercises, where students in small work groups spend an hour in a physical homework lab. The lab involves simple hands-on experiments designed to provide students with a physical representation of abstract concepts. The labs are proficiency-based, requiring that students demonstrate understanding of basic principles. The cycle continues with an analysis and skills session, in which students meet with a team of two graduate teaching assistants in groups of 25-30 students. This recitation-style session teaches mathematical, computer, and graphical skills that can help students effectively apply the concepts they have just learned.

In the design component of the course, all engineering freshmen are assigned to groups of approximately five students at the beginning of each semester. Throughout the semester, these groups apply what is currently being taught in other parts of the course to *design, build, and test* team projects. The projects, which increase in difficulty as the year progresses, range from foam-core chairs to rubber-band-powered vehicles to egg-launching catapults [10]. These team activities introduce students to engineering design and allow them to experience the same decision-making processes as practicing engineers.

UNIQUE DESIGN EXPERIENCES IN *ENGAGE*

Team design projects in *Engage* are designed to complement each segment of the yearlong curriculum. Through these projects, it is hoped that students:

- learn that design is a natural process closely related to problem solving skills they already possess,
- experience success as designers,
- have a positive team learning experience, and
- learn that design success is fun and somewhat compensates for the rigor of engineering study.

The Details of the Design Process

Students meet three hours weekly in a converted shop for the team design section of the course. At the start of the program, they are immediately put into teams and given a project that requires collaboration, planning, estimation, and knowledge of accuracy and significant figures before any of these topics are discussed formally. This project sends the message to the students that they already know how to solve significant problems and that we can show them how to organize their efforts and can teach them tools to increase their problem solving abilities.

Elements of the design method are formally introduced and practiced as the projects become more difficult. For first year students, the appropriate design methodology must be very simple and intuitive. It must correlate with problem solving methods the students have used before. One specific example of this approach can be seen in the way we introduce the Pugh chart [11] as a concept selection technique. The chart is presented as a convenient way of assigning numbers to the advantage-disadvantage lists that students often use for making decisions. Our overall methodology employs a variation of the problem solving methods discussed in Lumsdaine and Fogler [12].

Our objectives for the first semester include providing students experience with oral and written reports, team roles, project planning, appropriate problem specifications, background searching, and idea generation. The final two projects (of five during the first semester) involve designing and building devices out of simple materials and testing them. The projects are tied to topics being discussed in other sections of EF 101, thus providing *real* objects to be drawn in graphics and practical examples of the technical material. For example, the design and construction of a foam-core chair complements the discussion of free body diagrams and “pre-statics” topics.

In the second semester, only two design problems are assigned, giving students time to integrate what they have already learned about design and to go through each step of the design process for each project. Additional requirements are introduced, such as using a concept selection technique, performing basic experiments on the concepts generated or materials used, and predicting the performance of devices before testing. To match the technical content of EF 102, the first project is “static,” typically a structural design where students can perform a predictive truss analysis. The second project is “dynamic,” where students utilize their new knowledge of MATLAB programming to create a predictive program for a device with changeable inputs. In the past, bungee egg drops, pendulum devices, and catapults have been used for this project. For a more complete description of EF 101 and EF 102 projects, refer to Table 1.

The Importance of Teams to Design in *Engage*

Placing students on project teams is a key component of community building in *Engage*. Students are assigned to a five-member team as soon as classes begin each semester. The teams are put together based on student gender, ethnicity, Math ACT score, and Myers Briggs data. We have experimented with several formulas for team formation. Our current one favors diversity of problem solving style but similarity of academic ability and other factors. This process creates teams that have some, if not most, of the skills needed for creatively executing projects. It also facilitates students meeting other students and developing study groups and friendships.

Along with the design aspects of the projects, students are in a formal setting for learning team behaviors. It was recognized that students must learn teaming and interaction skills just as they learn analytical skills. As a result, a facilitator training program for engineering students was designed, as described in detail by Seat et al. [13]. This program, which utilizes upperclass engineering students to facilitate freshman design teams, was developed around two constructs. The first construct is that communication and teaming skills are learned skills that are not modeled or taught in most engineering academic and work settings. The second is that engineers are problem solvers and, therefore, must be taught teaming skills in a rules-based format that caters to this cognitive style [14].

Each freshman team has a facilitator who is at least a second-year student and has previously completed the *Engage* program. These facilitators help teams work together and provide guidance on such topics as project planning, brainstorming, and presentation skills. Team Developer [15] is used as a text and diagnostic tool to assist facilitation. They also provide general mentoring as needed throughout the year to help *Engage* freshmen make the transition to college life. Facilitators are effective in helping freshmen to gain a perspective of the rigor of engineering school and the overall purpose of teaming. The facilitators mediate volatile team dynamics and help teams resolve issues that can range from non-performance of a team member to over-functioning of other team members. This closely supervised interaction gives upperclass engineering students practice in advanced teamwork and performance skills while providing all freshmen with exposure to a role model. Approximately 70% of *Engage* students report a positive team experience for the first semester, and this percentage increases substantially for the second semester.

The facilitator program has been very popular as student facilitators realize the many applications of the material in their own career development. As a result, the program has been developed into a 15-hour minor specifically for engineering students, sponsored by the UT College of Education's Counseling, Deafness, and Human Services department. The minor gives students theoretical background, applied experience, and a credential in improving performance in technical task work and team interaction. Courses are staffed by Ph.D. candidates with backgrounds in education, counseling psychology, and human services. In the three core courses of the minor, students receive classroom instruction, facilitate two freshman teams, and receive supervision regarding their facilitation performance. They take two other courses in supporting disciplines to complete the minor.

ASSESSMENT RESULTS

Data from the initial years of the *Engage* program have encouraged us that we are accomplishing our goal of improving the freshman engineering experience at UT. We believe our method, which uses early design education and teaming, creates student enthusiasm and teaches an engineering approach to problem solving that gives first-year students a realistic exposure to the profession. These statements are supported by the results of comparisons between *Engage* students and those in the traditional first-year engineering program.

During the pilot year of the program, we gathered extensive student feedback through class surveys and focus studies. This data was used to iterate on each aspect of the program and prepare for the transition year. Qualitative data from the pilot year, along with the pilot students' progression data, was very positive and was used to obtain final approval from the College of Engineering faculty to implement the program. From this point, our emphasis shifted to gathering data to produce a realistic assessment of some of the measurable effects of the program. The following discussion focuses on data gathered during the two phase-in years that could compare the new program with the traditional program. The areas studied include student performance, comparison of *Engage* student attitude with students at other engineering schools, and student graduation. This basic data could be easily measured, and it represented immediate, short-term, and long-term effects of the new curriculum.

Experimental Description

The 60 students who participated in the pilot program of *Engage* in 1997-98 were chosen by the College of Engineering. This group (termed the *pilot* group) specifically reflected the demographics of the previous year's freshman class. An examination of previous student entry data suggested that student demographics vary only slightly from year to year. Students in the pilot program were invited to participate but were also given the option of remaining in the traditional program. Almost all of the students asked to participate chose the pilot program. The demographics of the pilot group are presented in Table 1. The control group for the first year consisted of first-time freshmen registered with the College of Engineering's freshman advising center. Because all students in the *Engage* program were required to be enrolled at least in pre-calculus, the control group was

ENGINEERING FUNDAMENTALS 101 ENGINEERING APPROACH TO PHYSICAL PHENOMENA			
Assignment	**Objective**	**Duration**	**Deliverable**
Introductory Module: Team Name and Logo Teams choose a team name and create a team logo	Serve as an icebreaker; set up team expectations	1 week	Hand-drawn logo and informal oral report to discuss logo design process
Module 1: What is the Volume of Neyland Stadium? Teams required to come up with an engineering estimate of the volume of the campus football stadium.	Teach engineering estimation, data gathering, sources of error, and units; introduce written report format	2 weeks	Three to five page written report using standard report format
Module 2: Traffic Study Teams required to gather data and propose a solution to a campus traffic congestion problem.	Practice written report format, with emphasis on developing a clear problem statement; learn to collect and represent data using Excel and MATLAB	2 weeks	Written report with computer representation and plotting of data; data must support report recommendations
Module 3: Mechanical Dissection of Electrical Appliance Teams learn about reverse engineering by studying an existing product and discussing design decisions.	Adapt report format to oral presentations; generate posters with PowerPoint	2½ weeks	Oral poster report
Module 4: Stepo-Stool Teams construct a step stool from a single 32x40-inch piece of foamcore. Stools must have three steps at set heights and must be able to withstand weight of two staff member "steppers."	Apply information about free body diagrams, vectors, and moments; draw design in drawing package; design, build, and test a simple device; introduce design method and emphasize research and alternate idea generation.	2½ weeks	"Idea generation" report consisting of preliminary sketches; written report including free body diagram of design
Modules 5 & 6: Rubber Band Tractor Pull Teams design, construct, and test a rubber band powered tractor from a given kit of materials. Tractors scored on their ability to transfer energy as measured by raising a weight.	Practice design method and idea generation; apply knowledge of free body diagrams, moments, friction, and concept of energy; organize oral report; produce computer-aided drawing of student device	5 weeks	Tractor testing; conceptual preliminary reports showing adherence to design method; final 8-10 minute oral report using PowerPoint; Mechanical Desktop drawing of tractor

ENGINEERING FUNDAMENTALS 102 APPLICATIONS OF STATICS AND DYNAMICS			
Assignment	**Objective**	**Duration**	**Deliverable**
Project 1 (Statics): Bridge Over Trouble Gorge Teams design, construct, and demonstrate a bridge that their team must use to cross "Trouble Gorge." Materials are purchased from a company store, and bridges are evaluated on the weight supported divided by cost of the bridge.	Demonstrate the stages of the design process; perform truss analysis; perform truss calculations in MATLAB; perform engineering cost analysis	7 weeks	Oral preliminary report; bridge demonstration; written final report with appropriate predictions for design
Project 2 (Dynamics): Big Orange Sports Simulator (BOSS) Team must design, construct, and test a device that simulates sporting events using a given kit of materials.	Demonstrate the stages of the design process; provide example of particle dynamics and work and energy calculations; predict performance using MATLAB	8 weeks	Oral preliminary report; participate in simulated sports competition; final written report documenting performance prediction calculations; Mechanical Desktop drawing

also restricted to students enrolled in pre-calculus or a more advanced math course.

1997-98	*Pilot*	*Control*
Total Students	60	254
% Female	20%	20%
% Caucasian	88%	79%
% Afro Am	7%	13%
% Asian	3%	6%
Average Math ACT	27.1	26.2
Average Comp ACT	26.1	25.5
Average HS GPA	3.55	3.43

1998-99	*Transition*	Control
Total Students	150	244
% Female	24%	16%
% Caucasian	79%	87%
% Afro Am	14%	11%
% Asian	4%	1%
Average Math ACT	26.9	26.8
Average Comp ACT	26.2	25.8
Average HS GPA	3.58	3.43

Table 1: Demographics of *Engage* & Control Groups (Years 1&2)

In the second year, all freshmen were invited to participate in the transition group during summer orientation until the maximum group size of 150 was reached. Since this number of students was estimated to be approximately one-third of the entire freshman class, no attempt was made to balance the demographics of the transition group with the rest of the class. The demographics of this group (termed the *transition* group) and the corresponding control group are also presented in Table 1. Again, the control group was composed of first-time freshmen students registered with the College of Engineering's freshman advising center who were also enrolled in pre-calculus or a later math course.

Student Academic Performance

To compare academic performance between *Engage* and traditional students, common finals in statics and dynamics were given to both groups during the pilot and transition years. The multiple-choice exams had up to ten different answers for each problem. Possible answer choices included results of common mistakes, such as sign errors and incorrect assumptions. It was not possible to give common finals for the graphics and computer programming courses due to significant differences in the curricular content between *Engage* and the traditional program.

Table 2 summarizes the performance of the four groups on the statics final. The *No Errors* entry is the average for all questions of the percent of students who got a given problem completely correct. The *Common Errors* entry is a similar average for students who made a simple error on the problem that resulted in an incorrect answer. This number mirrors the awarding of partial credit that is common on engineering exams. In both years, the *Engage* students did considerably better (an average of 13%) than the traditional students.

	Fall 1997		*Fall 1998*	
	Pilot	*Control*	*Transition*	*Control*
No Errors	44	37	50	36
Common Errors	71	57	69	52

Table 2: Performance on Common Statics Final

Similar results for the dynamics final are presented in Table 3. The Engage students again performed better than traditional students, with an average improvement of 6% on this exam.

Another goal of the Engage program was to better prepare students for entry into their respective engineering departments. A measure of this goal was student performance in their first departmental course. This comparison is shown in Table 4. Engage students outperformed their counterparts with the traditional freshman preparation in every course. All of these positive differences were statistically significant.

	Fall 1997		**Fall 1998**	
	Pilot	*Control*	*Transition*	*Control*
No Errors	45	37	45	36
Common Errors	65	58	59	60

Table 3: Performance on Common Dynamics Final

Course	*Fall 1997 Freshmen*		*Fall 1998 Freshmen*	
	Engage	*Control*	*Engage*	*Control*
Civil Engr 210	--	--	3.38	3.06
Chem Engr200	3.50	2.82	3.42	2.75
Elec Engr 201	2.50	2.12	2.73	1.85
Engr Sci 231	3.00	2.72	2.70	2.34
Mech Engr331	2.79	2.47	2.78	2.32
Indus Engr202	--	--	3.17	2.75
Matl Sci 201	3.09	2.75	2.66	2.34
Nuc Engr 203	2.88	2.63	3.18	2.74

All differences are significant at 95% confidence level
-- Less than 2 Engage students in the course

Table 4: Average Course Grade in First Departmental Engineering Courses

Student Attitude Survey

The *Engage* program participated in a cross-institutional study using the *Pittsburgh* freshman attitude survey [16] to provide comparison data with freshman engineering programs at other institutions. Sixteen institutions participated in this study during the 1998-1999 academic year. Schools administered the survey at the beginning of the freshman year and at the end of the first semester or first year, depending on institutional preference. Changes in student responses over the course of the year that were found to be a statistically significant for the *Engage* program are provided below [17].

1. Students thought engineering to be less of an exact science then they did at the beginning of the year. This was the case at 5 of the 16 schools in the study and is thought to be a characteristic of programs that include design and applied problem solving. The other 11 institutions were statistically neutral on this point.
2. Students indicated a higher self-assessed confidence in their background knowledge and skills then they did when they first started engineering. On this question, 13 schools reported no change, two schools demonstrated a positive trend, and one school had a negative trend.
3. *Engage* students indicated a higher self-assessed confidence in their communication and computer skills than they did at the beginning of the year. This was the case at 9 of the 16 schools.
4. *Engage* students indicated a higher perception of their engineering attributes at the end of the year. This was also the case at 5 of the other 16 institutions.

Student Graduation

One of the goals of the *Engage* program was to improve graduation rates for engineering freshmen. At the University of Tennessee, the average time to graduation is slightly more than five years, as more than 40% of the students are enrolled in a five year co-op program. Generally, six years is necessary to get a complete graduation picture for an entering class. At five years from entering, 43.3 % of the *Engage* pilot class has graduated in engineering compared to 25.5% of the control group entering at the same time. At four years from entering, 17.9% of the *Engage* transition group has graduated in engineering, compared to 6.1% of their control group. Although incomplete, this data is very encouraging as to the long-term effects of the *Engage* program.

Assessment of Facilitator Program

Upperclass students who work with the freshman teams as part of the facilitation program have been asked about their experience as facilitators [18]. Almost all facilitators gave an overall positive evaluation of the training experience in terms of learning how to work better in groups. Facilitators also related how the training was helpful in other areas of their life.

> *"My listening and discussion skills have improved considerably as well as my understanding of others."*

> *"Although the focus was on facilitating a freshman team, I learned a lot about myself in the process."*

> *"This experience has been one of my most valuable at the University of Tennessee. No other single course I have taken at the University has as much application in my career and my life as this one does."*

In the pilot program, reaction forms were given to members of the freshman design teams to provide feedback on facilitators [19]. Eight of the 12 teams in the pilot program reported a favorable reaction to the facilitation. Three of the teams conveyed neutral to negative responses. The remaining team provided completely negative responses to the facilitation.

Some of the positive comments freshman students made were related to communication:

> *"They helped us to cooperate as a team and helped us to learn to listen to one another's ideas and be more open to them."*

Team members also commented on the help facilitators gave with structuring the project:

> *"He was a great help in keeping our team together and on task. He was always there for us whenever we needed him, even out of class."*

Finally, team members appreciated the facilitator's objectivity:

> *"The best thing about having him on the team was having someone with a neutral standpoint to keep us all off each other's back."*

While the design teams in the *Engage* program provide a team design learning experience for freshmen, these teams also provide a valuable experience for upperclass engineering students. Facilitating freshman teams allows upperclass students to develop skills in expressing themselves in the team context and to understand the role of group dynamics and leadership in technical tasks.

CONCLUSIONS AND FUTURE WORK

The *Engage* program is an innovative curriculum designed to meet the changing needs of today's freshmen engineering students. It includes many traditional engineering topics but also adds training in design, team dynamics, communication, and other skills often lacking in traditional programs. By paying careful attention to pedagogical issues and teaching problem solving through design, the *Engage* program has succeeded in increasing graduation and retention rates in the UT College of Engineering, as well as improving student grades and overall performance.

The task of producing "whole engineers"—engineers who are skilled communicators and work effectively with other people—can be a difficult one. However, the *Engage* Program is seeing positive results from its efforts to instill these traits in its students through team design projects. A longitudinal study by Dr. Elaine Seat of *Engage* is examining the performance of traditional students, *Engage* students, and *Engage* facilitators in senior-level design courses. Preliminary results show that *Engage* students and facilitators have a more successful experience in later design courses than traditional students do. We believe this effect is due to their team training and experiences in *Engage*. Complete results of this study will be published at a later date.

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