

**BESTEAMS:  
Building Engineering Student Team Effectiveness  
And Management Systems**

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### Abstract

The current paper introduces the BESTEAMS Project. BESTEAMS seeks to transform the professional engineering environment into one comfortable for all by training engineering students to recognize and accept diverse learning, communication, and behavior styles in their colleagues. Here we report the findings of our student focus group sessions on type and amount of team training students get before working in a project and their perceptions of differences in team member behavior that fall along gender, ethnic, or learning styles lines. We also present the first data from two student focus groups conducted after the BESTEAMS pilot team training was done in the course.

#### 1. The BESTEAMS Project: Building Student Team Effectiveness

BESTEAMS stands for Building Engineering Student Team Effectiveness and Management Systems. The BESTEAMS Partners are: BESTEAMS Partners are The Catholic University of America (CUA), Morgan State University (MSU), the United States Naval Academy (USNA) and the University of Maryland (UM) engineering programs plus the Center for Teaching Excellence at UM. This partnership represents a wide spectrum of cultural environments with diverse student and faculty populations. We include private and public universities, a historically black college and university (HBCU), a military academy, and majority institutions.

The BESTEAMS Project seeks to transform the professional engineering environment into one comfortable for all by taking action to train engineering students and faculty in recognizing and accepting diverse learning, communication, and behavior styles in their colleagues. We propose our Engineering Project Team Training System (EPTTS) as the means to achieve this change. The EPTTS includes information on personal learning styles [Kolb81], gender and racial diversity, and how they manifest in teamwork. The potentially sensitive diversity issue is approached along the more neutral avenue of individual learning style diversity. Discovering learning style differences interests students and paves the way for the EPTTS' short segments on effective team skills and the manifestations of gender and racial diversity in mixed-gender and mixed-racial teams.

## 2. Teams Are Now a Fixture of Engineering Education—Let’s Capitalize on Them!

A 1996 Industry workshop sponsored by The Society of Manufacturing Engineers identified major competency gaps between their expectations of students with Engineering BS degrees and their experience with new graduates. The number one competency gap was in the area of teamwork, particularly understanding diversity, team building and teamwork skills [SME97]. In response to growing industry dissatisfaction, future university engineering education accreditation requires *the ability to function in teams* as a student learning outcome [ABET97]. It’s a good requirement because team-based content in the curriculum has been shown to improve learning and retention of underrepresented minorities in non-engineering fields [Barr93, Cent97, Smit97, Bele86, Wank93, Full90]. It’s a challenge to develop effective programs that will allow engineering faculty to teach engineering team development skills in their courses. Some may even ask, “Why bother?”

The BESTEAMS Program is creating training materials that will support faculty in teaching team skills. Not only will improving team skills increase students’ marketability but it provides an opportunity to improve the engineering learning environment for *all* students. This is possible because the project team in engineering is becoming a major vehicle for student social and learning interactions. Social interaction with peers and the influence of positive engineering class experiences are major factors contributing to the persistence of junior and senior women in engineering and science programs [Brai98]. We can assume the reverse, supported by research and our own anecdotal observations, that poor socialization among engineering peers and uncomfortable junior and senior class experiences contribute to what Ginorio labels “the alienating science and engineering educational climate” [Gino95]. Uncomfortable climate leads to feelings of alienation and losses of confidence that may end in an exit from the field of study [Nair95]. Similar studies lead to similar conclusions about minority members in engineering.

We propose to use the proliferation of project teams as a way to positively structure an important segment of an engineering student’s learning experience. This can only happen if we provide motivated faculty members with effective training materials and other faculty members with motivating training materials. In our search for compelling motivation, we first sought to identify the status of training for team engineering project experiences.

## 3. BESTEAMS Partnership Gap Analysis Studies on Effective Teams.

Results gathered by the BESTEAMS Partnership Gap Analysis Study (beginning in 1997) reveal a hole in the curriculum in the area of student team training for effective project work. The gap analysis included both faculty interviews and student focus groups on engineering project team effectiveness.

### 3.1. Faculty Interviews: We Have the Will but Not Necessarily the Way

The major observations from our faculty interview process are reported elsewhere [Mead98 and Mour98] but can be summarized as follows:

- Widespread commitment exists for the use of student project teams in engineering.

- Few faculty members have formal training in teaming skills and most provide virtually none for students.
- Current engineering research studies focus on team formation and not on team training.
- Most faculty members have developed ad-hoc procedures to form teams.
- Most faculty members are unaware of the impact of mixing genders on a team.
- Poorly functioning teams are as big a headache for instructors as for team members.

The results of our small set of interviews indicate that strong commitment exists for engineering faculty to continue using team projects. The team project environment is upon us. We believe there will always be a number of faculty members open to trying new team training systems built around sound education principles. We also believe that a training system with a *proven track record* would additionally sway many faculty members who simply want to eliminate poor team performance from their courses. The time to develop high quality team training materials is now.

### 3.2. Student Focus Groups: Some Teams Fail to Thrive in Our Own Backyards

The course instructor’s opinion is only one side of the team effectiveness evaluation equation. We must also determine the engineering student’s assessment of the current team project environment. To do so, we developed a protocol for conducting student focus groups. (See Table A in the Appendix.) Student facilitators organized, conducted and summarized data collected from ten focus groups conducting across three of the BESTEAMS Partners. Table 1 summarizes the demographics of the student participants in the focus groups. The left column of Table 2 holds the questions we used in our Gap Analysis series of focus groups.

Table 1. Student Focus Group Participant Demographics (12/97-3/98)

Focus Group Location & Type	Student Count	Men	Women	Majority Count	Underrepresented Minority Count
<b>University of Maryland</b>					
Pilot	8	6	2	4	4
Mixed 1	5	2	3	5	0
Mixed 2	6	5	1	5	1
Women 1	4	0	4	3	1
Women 2	4	0	4	3	1
Minority 1	8	8	0	0	8
Minority 2	4	4	0	0	4
<b>Morgan State University</b>					
Mixed	7	5	2	1	6
<b>The Catholic University of America</b>					
Mixed	6	3	3	6	0
Women	5	0	5	2	3
<b>Totals</b>	<b>57</b>	<b>33</b>	<b>24</b>	<b>29</b>	<b>28</b>

Table 2. Student Focus Group Questions Revised for Fall 1998 and Spring 1999 Sessions

<b>BESTEAMS Student Focus Group Questions</b>	
<b>For Students who have participated in project team experiences</b>	<b>For Students who have undergone the BESTEAMS EPTTS Pilot Team Training</b>
What are some of the courses in which you work in student groups or teams?	How did the team project work for you? Was the team process successful, why or why not?
What kind of preparation do you get before working in groups?	What kind of information or skills did you learn this semester about working in teams that you hadn't learned before? Did you use the books provided during the team training?
What kind of preparation do you want before working in groups?	What kind of preparation do you want before working in groups? What suggestions do you have for helping future students in your class learn to work effectively in teams?
How do you form or structure student teams? What are your preferences?	How do you form or structure student teams? What are your preferences?
Have you observed differences in behavior of mixed gender, ethnic, or learning style groups? If yes, what differences did you observe? Did these differences influence team performance and success? If so, how?	Have you observed differences in behavior of mixed gender, ethnic, or learning style groups? If yes, what differences did you observe? Did these differences influence team performance and success? If so, how?
What could be done to help teams become effective as soon as possible? How long does it take for a team to begin to work well together?	What could be done to help teams become effective as soon as possible? How long does it take for a team to begin to work well together?
What are the most typical problems that you experience when on teams or groups?	What are the most typical problems that you experience when on teams or groups?
How do you know when a team is not working well? What are the signals?	How do you know when a team is not working well? What are the signals?
How do you handle problems? How should problems be handled?	How do you handle problems? How should problems be handled?
How does the evaluation strategy on the project affect team member performance (e.g., one grade for all versus individual grades for each member's part)?	How does the evaluation strategy on the project affect team member performance (e.g., one grade for all versus individual grades for each member's part)?

Other papers report the results of the focus groups in more detail [Mead98, Mead99, Mour98]. Some of the observations motivating the BESTEAMS Project are summarized here

- Students generally receive no team training prior to their team experiences.
- It is easier in many ways to be on a team of students *just like you*.
- Gender differences abound:
  - ❖ Female students report difficulty in achieving equal standing on a team.
  - ❖ Women were less likely to be given physically demanding tasks.

- ❖ Women were more likely to experience frustration over not being heard.
- ❖ Women must be more “aggressive” to get attention from male team members.
- Race and Ethnicity differences are sometimes acknowledged (often reluctantly):
  - ❖ Cultural norms are seen as complicating the team decision making process.
  - ❖ Asian students are sometimes held to a higher standard of academic performance than U.S. citizens are.
  - ❖ African American students appear to expect a greater level of socialization on their project teams.

We discovered that diversity on teams in our institutions results in conflicts, stereotyping, and signs of alienation, as predicted by the literature. This is a danger to our programs because it signals the existence of a climate that is not conducive to retention of women and minority students.

#### 4. Bridging the Gap: Parallel Strategy of Team Skill Training and Diversity Awareness

Traditional engineering students are analytical, logical and have decisive styles of interaction but overemphasis on these skills and how to improve them has led to gaps in engineers’ skills in relating to each other in team settings [Wank93]. Add to this a lack of training in basic team operation and you have described the starting point for the typical engineering student team experience. The BESTEAMS Project strategy to fill the training gap consists of two tracks: (1) teaching the basics of team skills, and (2) teaching students about learning style diversity as a wedge into discussions of diversity of all kinds.

The BESTEAMS Engineering Project Team Training System (EPTTS) includes short segments in both major areas. In our pilot implementations of the EPTTS, we have faculty team facilitators lead the class in a two-hour lab session of team training. An introduction to the pilot version of the training is described in this section.

##### 4.1. Team Skill Training

The EPTTS pilot program includes training in basic team skills. Our intent is to give each student some guidelines for effective team functioning. The material we currently use for this segment of the training is, “Learning in Teams: A Student Guide,” written by Graham Gibbs and published by the Oxford Centre for Staff Development. It is a manual for successful team performance that provides ten pieces of advice for conducting a team learning experience. The manual includes discussions of team formation, member roles, responsibility sharing, and peer evaluation.

##### 4.2. Diversity Awareness through the Filter of Learning Style Focus

The tougher part of our training is the development of tolerance and appreciation for diversity in team members. Here our strategy is to teach team members about a kind of diversity that is interesting to them but not overtly tied to gender, racial, or ethnic diversity. A person’s learning style is the area on which we focus our diversity awareness segment of the EPTTS.

We've chosen learning styles as the focus for our EPTTS for two reasons. First, there is intrinsic value in a student knowing his or her own style. Students who know their own learning style are more confident in their studies, earn better grades, and can apply their acquired knowledge more generally to their course work [Clax87]. It also has been shown that learning style education for team members in industry is valuable in identifying the strengths of individuals [Clax87].

The second reason for focusing on diversity of learning styles is that it can serve as a filter for discussing other types of diversity. During the EPPTS, a faculty facilitator guides the students through an exercise on problem solving from different learning style perspectives. Students complete a Kolb learning style inventory and discover their own style, and that of their teammates. The exercise can continue to include demonstrations of the value of working in groups with diverse learning styles.

There is debate in the literature (that will not be taken up here) but research does suggest that learning styles can fall somewhat along gender lines. In any case, once diversity of any type is discussed, the students can then be shown effective ways for dealing with differences during team operation. In this way, the focus on learning style diversity presents a teaching opportunity for dealing with all types of diversity, as is included in the EPTTS.

#### 5. Preliminary Results using our Learning-Style Focused EPTTS Intervention

The BESTEAMS Partnership has piloted our EPTTS in five courses during the 1998-99 academic year. At the time of this writing, we were able to conduct focus groups on two teams from these courses. One group was comprised of freshmen to senior civil engineering students at Morgan State University and the other was made up of mechanical engineering students in a senior level project course at the University of Maryland. Their demographics are shown in Table 3. Clearly our small sample of trained students leaves us with only anecdotal observations. More focus groups must be conducted to support or modify these findings

Our limited number of responses included the following observations:

- Women were more open to the learning style training than men.
- Women who have undergone the training display more interest in outcomes than the men do.
- Having different learning styles represented on your team is good for your project because you can approach the same problem from different perspectives.
- The team skill books were useless to some teams. (One respondent said that a good book would be one titled, "You are all different, get over it!").
- Learning styles of women are different than those of men because women are more verbal.
- Everyone already knows what he or she needs to know to learn more effectively.

Table 3. BESTEAMS Trained Student Focus Group Demographics

Focus Group Location	Student Count	Men	Women	Majority Count	Underrepresented Minority Count
University of Maryland	8	6	2	4	4
Morgan State University	6	3	3	0	6
<b>Totals</b>	<b>14</b>	<b>9</b>	<b>5</b>	<b>4</b>	<b>10</b>

## 6. Discussion and Future Work

We hoped that the learning style focus of our team training would be a neutral way in which to begin a discussion of issues of diversity and the problem associated with working with a heterogeneous group of people. In one of our trained groups we found that the EPTTS had the desired effect. Learning styles interested the students and they came to believe that diversity in styles was positive for a team project experience.

What we found in one of our groups is that our strategy was met by prejudice of an unanticipated kind: the label of being “touchy-feely!” Several responses from this group indicated that they found the whole learning style education segment useless. These students really do not believe that team skills can be taught. They believe that the project experience is, as it should be, a “sink or swim” experience. This has taught us that we must motivate the students to learn about team skills just as we must motivate some faculty members to teach team skills.

At the time of this writing, we continue to pilot the BESTEAMS Engineering Project Team Training System (EPTTS) in engineering courses with team projects. In the long term we hope that discovering learning style differences interests students and paves the way for the EPTTS’ short segments on effective team skills and resolution of differences in team operation. We pursue the testing and improvement of the EPTTS because we believe that adoption of effective student team training materials can bring about lasting change in the engineering work environment as our students are better trained and enter the workforce with improved team skills.

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Table A. Student Focus Group Protocol Development Highlights

Task	Comments
<b>Establish Subject Groupings</b>	<p>We chose to conduct at least 2, 1 ½ --2-hour long focus groups in three configurations with a target of 6—8 students in each group:</p> <ul style="list-style-type: none"> <li>• Mixed participants without grouping for special characteristics,</li> <li>• Women participants only, and</li> <li>• Traditionally underrepresented participants only.</li> </ul> <p>Initial focus groups were held at each university on students who had received standard institutional training (usually none) for group participation. Current efforts include conducting focus groups of students who have participated in BESTEAMS pilot team training.</p>
<b>Create a Set of Questions</b>	<p>The student focus group questions. Were developed from the faculty member interview questions and evolved into their current form after conducting several focus groups.</p>
<p><b>Establish Participant Selection Protocols</b></p> <p>Protocol Varies by Institution and Level of Team Training Received</p>	<p><b>Initial UM Focus Groups</b></p> <p>We obtained a random sampling of College of Engineering students with Junior standing or above (to ensure that they had a team project experience). We created the following system for soliciting participation:</p> <ul style="list-style-type: none"> <li>• We established dates and times for each group and determined its configuration.</li> <li>• Student Assistants called from the list and filled openings in each group and asked about pizza and beverage preferences.</li> <li>• The initial contact by the student assistant was followed up with an e-mail or a phone call by one of the faculty researchers thanking the students in advance for their participation and re-confirming logistical details.</li> <li>• A second e-mail or phone contact was made to remind students of their focus group commitment on the day before it was scheduled.</li> </ul> <p><b>MSU, CUA, and USNA Focus Groups</b></p> <p>Student volunteers were solicited by institution liaison.</p> <p><b>Trained Focus Groups</b></p> <p>Student volunteers from classes that received the BESTEAMS pilot training were solicited by institution liaison.</p>
<b>Conduct Pilot Focus Group</b>	<p>We convened a pilot focus group facilitated by the BESTEAMSS assessment specialist to test our question set and determine the range of possible responses.</p>
<b>Revise Protocol</b>	<p>We made three significant observations from our pilot group:</p> <ul style="list-style-type: none"> <li>• More summation time was needed after question discussion.</li> <li>• Not all questions would be covered formally, but many were naturally addressed by the student discussions.</li> <li>• Even the promise of pizza for participants may not be sufficient inducement to participate. Personal contact was needed!</li> </ul>
<b>Select and Train Student Facilitators</b>	<p>The nature of the focus group called for the use of student facilitators. Upper division student in a specialized team training program (UM’s IBM-TQ Program) served as facilitators for the next 6 focus groups held at UM. One of the faculty researchers facilitated the first session at MSU and BESTEAMS undergraduate student researchers conducted the remainder groups.</p>
<b>Conduct Groups</b>	<p>Student facilitators conducted the focus groups and summarized the data in written format.</p>

