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## **AC 2012-3452: TRAINING APPLES TO PERFORM LIKE ORANGES: A LOOK AT UNIVERSITY TEAMING EDUCATION**

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# **Training Apples to Perform Like Oranges: A Look at University Teaming Education**

## **Abstract**

To effectively function in the workplace today, people must be proficient in their technical skills and must also be able to function as an effective team member. In the workplace they must work well with people of different disciplines and motivations. Universities have recognized this need and have adapted their curriculum to place additional emphasis on teaching the skills necessary to be an effective team member. Yet universities, constrained by their organizational structure and missions, cannot completely mimic the realities of the workplace business environment. Classes have a finite length and students quickly learn that any problem can be endured through the academic quarter instead of truly working out a sustainable solution. Teams composed of members with similar expertise are often willing to cover for the weaker team member due to the short team life which is usually measured in weeks. In teams with mixed expertise, grades earned are often based on a combination of individual/team effort versus solely on the team product. Faculty continually grapples with questions such as “can a team member be fired” and “if not, what are the realistic consequences?” School is a learning environment where student learning is fostered and students are given second chances. Academic culture, by its very nature, is opposed to unfairness, dire consequences, swift punishment and the harsh reality encountered in the world and specifically, the workplace. Considering these types of issues leads one to wonder how well the university education prepares a student to be successful in a real world team environment.

This paper investigates this question through a comparison of university teams to business teams. Criteria for comparison includes team member motivations, level of commitment, technical competence, discipline, team moral and culture, and personality conflicts. Students participating on interdisciplinary teams as well as single-expertise teams were surveyed to determine their mastery of basic team skills. Recent California Polytechnic State University- San Luis Obispo (Cal Poly) graduates from Architectural Engineering, BioResource & Agricultural Engineering, and Agricultural Systems Management programs were surveyed to determine the effectiveness of their teaming education in the business world. Industry Advisory Boards for these respective programs were surveyed to define the teaming expectations in the business world. Additionally, faculty with industry backgrounds were surveyed and questioned on the differences between the two environments.

Problems with university culture that do little to expose students to the harsh realities of career expectations were identified and analyzed. Based on the results of these surveys and analysis of teams’ performances, recommendations are presented to better shape the university process of enhancing development of effective teaming skills.

## **Introduction**

The university system creates a teaming environment for two primary reasons: improve the educational process and meet industry demand for more capable team members. The university environment, as an incubator for an effective industry team member, can be improved by

creating a culture that retains the university pedagogical focus while using a more realistic team setup to teach critical concepts of teamwork. This paper investigates the shortcomings and strengths of the university team process as perceived by students, faculty and industry partners based on work performed by faculty in departments of Architectural Engineering and BioResource and Agricultural Engineering at California State Polytechnic University, San Luis Obispo (Cal Poly). It suggests improvements to the university teaming environment to create more effective team members that can seamlessly enter into the business world.

### **University Teaming Environment**

The motto of Cal Poly is “learn by doing”. This hands-on-approach is instilled in these students from the time they enter the university. Team experiences are considered integral to the success of the university. Both the Architectural Engineering (ARCE) and BioResource and Agricultural Engineering (BRAE) Departments at Cal Poly extensively use teaming to enhance their learning environments.

Throughout their course work, the ARCE and BRAE Departments utilize extensive *formal* and *informal teaming* throughout the students’ academic experience. Formal teaming is defined as teams that are formally created within the classroom environment and whose output is graded as a team endeavor. Informal teaming occurs when student-formed teams collectively work towards a better understanding of class work while still being evaluated on an individual basis. There is very little formal teaming education provided to the students through their tenure at the university. The students learn to work in these team environments by trial and error. However due to the number of teaming experiences throughout their university education, most students feel relatively comfortable with their teaming skills. <sup>1</sup>

In both departments, students work in teams within their first two years in school. Freshman students are immediately placed into teams in BRAE 128 and assigned a basic project involving analysis, design, and/or testing of some component or system. The ARCE program follows suit in their ARCE 211 Structures course. Here, students investigate the lecture concepts in informal teams of two or three people. In both programs students work as part of team at least once a year as they continue through their respective curriculums.

In addition to traditional courses, both departments integrate interdisciplinary courses into their curriculum. This is often the first opportunity for the engineering students to work with majors from other departments on a common project. Many of the ARCE students take an interdisciplinary course, informally called the Integrated Project Delivery (IPD) course <sup>2</sup>. This course brings together students from four departments; Architectural Engineering, Architecture, Construction Management and Landscape Architecture. The IPD course is structured around a quarter long design project. During the 10 weeks, student teams create a schematic level design that includes programming, drawings, estimates, and construction scheduling. The teams are composed of members from the four different departments.

Within the BRAE Department there are similar interdisciplinary experiences. One of these is where groups are formed between BRAE majors and Agricultural Systems Management (ASM) majors. For BRAE students, this is part of an Equipment Engineering course, while the ASM students participate via their Project Management course. In this collaboration, students with many different specializations come together to work on a project. The intent is that they

execute the project through problem identification, conceptual design, detailed design, construction and testing. The concept is for the BRAE students to contribute their design expertise while the ASM group delivers organization through economic analysis and project management. Both sides contribute equal fabrication effort to the projects. The scope of these projects is unique from one group to the next, and is typically comprised of various industry-sponsored engineering problems. This is a sequence that begins during the middle of the Fall academic quarter, and culminates at the end of Winter quarter for a total of 15 weeks.

These university teams are intended to function similar to a “real world” business team where each team member is a subject matter expert in a single area with little overlap of specialties between team members. For many ARCE students this is their first real teaming experience in an environment similar to the business world. For the BRAE students, it is a rapid emersion into a team of people with varied and unfamiliar technical abilities. The student’s teaming skills learned in the peer to peer environment are tested in this new mix of disciplines. All the students face communication challenges due to differing expectations, motivations and departmental cultures. Although some of the classic project management skills such as scheduling are taught in these courses there is little formal training in communication.

Feedback from students in the ARCE and BRAE interdisciplinary courses show that although the majority of students feel comfortable with their teaming skills within the course and lab environment, they are often frustrated with the performance of their peers<sup>3</sup>. Some of the frustrations indicate there is need for additional education in team dynamics to help the students better understand their team members’ behavior and the interdependency of the different disciplines in creating a cohesive project.

Additional clarification was sought on the use of teams within the university system as compared to the business world. There are seven faculty members from the BRAE and ARCE Departments that come from consulting backgrounds with business experience varying from 12 to 30 years. Informal discussions on the effectiveness of the university teaming education and its similarities to teaming in the business world indicated the following conclusions<sup>4,5</sup>.

- Since most teams in the university environment are composed of similar expertise and most business teams are composed of difference expertise there are not strong similarities except in the interdisciplinary classes.
- The use of teams in course layouts is deliberately chosen to mimic the use of teams in the business world.
- The students leave the program with some basic teaming skills due to the large number of teaming opportunities within their curriculums.
- In the ARCE Department only one of the four faculty members works directly with the teams to increase their teaming skills.
- While design skills are up to par at the university, management skills are lacking, and show the biggest opportunity for improvement. This is evident in the initial poor use of delegation and tracking of individual responsibilities during student projects.
- Delegation in short-term university projects isn’t always enforced, and stronger individuals often just do the work rather than holding other team members accountable to their initial commitments.

- University teams are often assigned and don't put students through an employee vetting and hiring process of selection based on skills, experience and attitude. This can result in dysfunctional and unbalanced teams that do not resemble those assembled in industry. While imperfect, this type of team contributes to a positive (and maybe painful) experience where students must learn to quickly deal with personalities and skill sets that don't always mesh.

### **Effectiveness of University Teaming Education**

The effectiveness of the ARCE and BRAE teaming environments has been analyzed through student and graduate self-surveys. Three primary surveys have been taken;

- A. ARCE Design Labs- Over a period of three years ARCE Students have completed end-of-quarter of surveys.
- B. ARCE Integrated Project Delivery Class (IPD) - Architectural Engineering, Architecture, Construction Management and Landscape Architecture completed end-of-quarter surveys.
- C. ARCE and BRAE Department Graduates with typically one year of industry experience were surveyed as a one-time effort.

A. ARCE DESIGN LAB SURVEYS - In ARCE senior level design labs; ARCE 451 Timber and Masonry Design and Constructability Laboratory and ARCE 372 Steel Design and Constructability Laboratory students, six classes of approximately 16 students each were asked the following questions over a period of three years<sup>6</sup>:

- *Do you think you are a better team member because of what you learned on the team projects?*

The majority of the students stated yes.

- *What did you learn about team dynamics by working as a team on the third and fourth project?*

Answers centered primarily on the need for clearer divisions of workload and expectations over the quality of the final project. There was an often stated concern that some students misused the teaming concept and did not do their fair share of the work.

Roughly one quarter of the students stated that they had not learned anything new about teaming or team dynamics. Typically these students were the stronger team members and often held leadership roles in outside organizations.

- *Did you learn as much in a team where workload was shared as compared to an individual assignment?*

The majority of the students felt there was an improvement in learning due to the peer to peer interactions. Many students felt competent in many areas due to the team process of questioning and review.

B. ARCE IPD STUDENT SURVEYS – All students are required to take a survey. The class size varies from 40 to 70 students per quarter. The survey questions are based on a rating system

of 1 to 5 with 5 indicating mastery of the subject. One of the courses primary learning objectives is to *function effectively on an interdisciplinary team*. At the conclusion of the quarter, students from the four departments rated their growth in learning to *function effectively on an interdisciplinary team*. Although the results varied from quarter to quarter the general trend indicates:

- 16% percent of the students felt there had been no growth,
- 41 % felt there had been a modest amount of growth (one point increase out of five), and
- 33 % felt there had been moderate growth (2 point increase out of five).

Based on a total of five points with five being high, the average incoming rating for the students' ability to function effectively on an interdisciplinary team is a 3.22 as compared to the final score of 4.13 indicating a growth of 28%. Reported survey data is based on three quarters of data spread over the three years the IPD course has been taught<sup>7</sup>.

The surveys indicate that during the university educational process students feel they have learned to be an effective teaming member. In addition they feel that a teaming environment increases their technical knowledge. However it is not clear if the teaming tools that the students learn will translate out of the university environment and into the business environment.

C. ARCE and BRAE DEPARTMENT GRADUATES - In order to determine the effectiveness of the students' education, recent graduates were surveyed<sup>1</sup>. All of the respondents currently function on an internal team as part of their employment. Thirty six percent of the respondents also work in external teams. All respondents felt that the university experience prepared them to function on a team. Sixty four percent of them were satisfied with the extent of the education that they had received in this area, while thirty six percent felt that more could have been done. The most commonly stated area for improvement is the need for, and practice with, additional communication tools. There were limited conclusions that could be drawn due to the small sample of survey data.

In summary it is clear that students feel that they are better prepared to be effective team members at the conclusion of their university experience than when they entered the university. The question is: can universities do an even better job of creating effective team members? To answer this question one must understand the business teaming environment.

### **Business Teaming Environment**

ARCE and BRAE graduates are employed by firms that utilize their technical and project management knowledge. The Advisory Boards from both departments were interviewed to determine the effectiveness of the graduates.

### **ARCE Graduates**

Cal Poly ARCE graduates tend to gravitate to structural engineering consulting companies or larger consulting firms with many in-house disciplines. For the structural consulting firms it is common for the firm to be sub-consultants to architectural firms and to work as part of large external teams. Within the larger consulting firms it is common for the structural individuals to be part of an internal team. For both types of firms it is uncommon for the structural engineer to take the lead role on the team. Teamwork is critical and difficult in this environment since team leaders are likely to have different skills, needs and viewpoints. Additional information was

sought to better understand which additional skills would be beneficial to the structural engineer striving to be successful on these large multi-discipline teams.

The ARCE Advisory Board, composed of 15 professionals, was canvassed on what qualities they look for in effective team members<sup>8</sup>. They stated effective team members are people who;

- speak up with an idea but once a direction is decided will work as a team to make it a success,
- are confident and assertive,
- know how to listen,
- have a personality to mesh with others, and
- those who can establish and maintain relationships with clients.

The responses focused on the need for strong interpersonal and communication skills. Currently there is no formal university education in this area with the exception of a technical writing class.

There was no discussion on the need for specific technical skills. One hypothesis for this is that since the Advisory Board is largely composed of Cal Poly Alumni or people that are aware of the ARCE program's rigor they may have assumed that all potential candidates met a technical threshold.

### **BRAE Graduates**

BRAE Department graduates typically find jobs with a more diverse group of employers, primarily but not exclusively, in agriculture. The BRAE graduates initially gravitate toward product and process design-based work and once in their career, often move into project and/or operations management. Many graduates find themselves working in agricultural processing and machinery design and development, while a large number focus on irrigation system design and management. The remaining graduates often seek other engineering roles in construction, manufacturing, and R&D.

The BRAE graduate often starts their career in the role of a designer, then moves up to a project engineer position where they oversee small projects. While starting out, they are likely the only engineering resource within this project, but they will find themselves interfacing and coordinating with other disciplines. Pending good performance, this role can evolve into becoming an engineering team leader, and then into project engineering management. To move through this progression, strong teaming skills are required to break out of the "white lab coat" engineering stereotype and utilize more than the mere technical background gained while at the university.

Industry Advisory Board members for BRAE group were surveyed through an email questionnaire<sup>9</sup>. Like the discussion with the ARCE Advisory Board, the BRAE questions were directed towards identifying traits of a good team member, and traits of a good team as a whole. Responses from this advisory board had some similarities but also varied from the ARCE responses. Key traits of successful team members included:

- To be technically-sound in their expertise, yet cross-functional in their abilities.
- Ability to work closely with other specializations.
- To be able to communicate valuable input to a project.

- Committed and willing to take ownership in a project.
- Accountable for their actions and overall project performance.
- Become intimately involved in knowing all facets of a project.
- Having a clear view of the metrics for their project, their team, and themselves.

These answers were very characteristic of the types of companies for which these Board members worked, managed or owned. These Board members typically operate in a project or process environment, where they are successful only if they meet the needs of their stakeholder. Whether these stakeholders are internal or external to the Board member's company, there wasn't much differentiation in their response as to what comprises a good team member.

### **Differences Between University Teaming and Business Teaming**

There are four fundamental differences between the teaming environment in a university and that in the business world.

1. In the academic environment the only consequence for poor performance is a poor course grade. Students are required to take courses in which they have little interest and may perform the bare minimum to pass. Of the 40 to 60 classes that a student will take in their university career, many students don't see a single letter grade as a strong motivator. In the business world an employee may be severely reprimanded or terminated based on a single event.
2. The short life of a team affects team development. It is not unusual for stronger team members to cover for weaker team members since most academic teams exist for no more than one quarter (ten weeks).
  - a) The artificial construct of a ten week team duration allows many students to put up with poor behavior rather than trying to address problems and force change. The frustration will take several weeks to build at which point the hard working students will feel there is not enough time remaining to effect any meaningful change. Examples of poor behavior that are tolerated are not attending classes or other team mates not doing their share of the work.
  - b) Many academic teaming experiences occur in teams where there are similar backgrounds allowing for team members that are technically strong to cover for team members that are struggling. It is not uncommon for teachers to purposely create this learning environment to encourage peer to peer learning. If grades are a motivator for the stronger student they will often cover for the lower performing student by doing more than their share of the work.

In the business environment there are similar parallels but they exist informally. Usually the behavior is only tolerated in a business environment for a short amount of time. In a business environment it is more common that everyone "pulls" their own weight.

3. Although the university uses teaming as a learning environment, grades are usually assigned based on individual performance. It is not uncommon to assign a team grade, then modify that grade based on individual effort. Much of this is based on the concept of



academic fairness within the university, the need to reward growth and the common belief that a course grade is a measure of individual work. Faculty grapple with questions such as: should a student that is “saddled” with a poor performing team but is performing at a high level be penalized? The need to assign individual grades is often justified by the deliberate team organization of placing technically strong and weak team members together to create a learning environment. This individual accountability undermines the team concept and limits the reward for good team behavior.

4. Within the business world, each firm creates a corporate culture with a clearly defined criterion of acceptable behavior that is adhered to by the employees. This construct models behavior such as appearance, timeliness, work effort and creates a unifying presence. There is not a similar construct in the academic environment. In fact there is a celebration of differences and differing behavioral patterns among the departments. This lack of consistency creates conflict where there are no clear “rules” to follow.

### **Improvements to the University Educational Process**

While the university education system creates a reasonably effective team member there are changes that can be integrated into that education to improve it. In order to better simulate a true industry team environment and create a stronger teaming education, instructors at the university level must force organization, adaptation, and peer evaluation in ways that may be contrary to standard university protocol and academic culture in general.

*Teach basic teaming skills in all classes that utilize teaming.* Currently the students are given no formal education in teaming skills. A minimal amount of direction offered early in their teaming experience would enhance the students’ ability to function effectively on a team. As the students and teams mature, an introduction into basic scoping and scheduling will increase the tools available for effective teaming.

To implement this concept will require a shift in faculty thinking. It is generally accepted that faculty only teach in areas where they have an expertise. However if basic teaming is to be taught wherever it is used, all faculty will need to teach it. Tools and aids can be developed to simplify this transition.

*Force organization by unscheduled auditing.* Business organization is based on established protocol that is documented on an ongoing basis. The documentation is used extensively to control the direction of a project or ongoing process. It is common in the university environment to require similar types of documentation; however these documents are rarely used and only updated if there is a due date. The requirements for submitting the documents for review at regular intervals are clearly defined as part of the grading process. This allows students to “cook the books” and build a façade of being organized. Since the students are not using the documents as they were meant to be used, they never realize the relevance of them. Many of these documents include dynamic documents such as changing schedules, budgets, work breakdown, and weekly action items. By conducting unscheduled auditing of a project folder, the students are forced to keep these organizational tools current. To update them and not use them would become more difficult than actually using this documentation hereby forcing students to realize their value. The requirement would need to be clearly defined early in the quarter and the consequences harsh as students will test the faculty on the issue.

*Force Change.* Traditional academic protocol says that providing a very clear procedure with expected outcomes and deliverables is the job of an instructor. The need for clarity is closely aligned with the need to create an equal and fair learning environment. This is contrary to what a graduate will find in the workplace. Project criteria and multiple owners with differing expectations are constantly changing contrary to the static educational environment. Many of the student complaints in interdisciplinary courses focus on this area such as “teachers are not in concert, requirements keep changing, no clear direction”. Creating a dynamic but carefully-orchestrated scope of work where students are exposed to change will allow for a unique learning environment that will channel the student frustration into learning how to anticipate and adapt to change.

*Create Ongoing Peer Evaluation.* Team behavior that operates in a vacuum without feedback is of little value. Instructors are constantly balancing the need to provide meaningful feedback with the large amount of effort required to generate this feedback. Feedback on projects where teams are designing and exploring different avenues can be time consuming since there is little redundancy in what is being submitted for review. As a result many projects are orchestrated to limit the creativity of submittals into clearly defined work packages that are manageable to grade in a reasonable time frame. An opportunity is missed by not employing students to offer meaningful evaluations of each other’s work. While the students may not always be able to offer significant comment on technical merit, most students can comment on the clarity and logic of the approach and presentation.

A reasonable methodology is to adopt with modifications the business concept of the “360 degree review” as described by Heathfield <sup>10</sup>, “where each employee has the opportunity to receive performance feedback from his or her supervisor, peers, reporting staff members, coworkers and customers. 360 degree feedback allows each individual to understand how his effectiveness as an employee, coworker, or staff member is viewed by others. The most effective 360 degree feedback processes provide feedback that is based on behaviors that other employees can see.” Application of the 360 degree review is common in industry. In the discussions with the BRAE Advisory Board the use of 360 degree review was mentioned as an internal method to create team growth. Since this type of feedback is not common in academia the students’ first reaction will be to say everything is great, “it’s a 10 out of 10.” The concept will only work once certain roadblocks are overcome. The idea that growth can only occur when honest communication happens needs to be discussed with the students. Feedback needs to occur throughout the course to create a feeling of trust among the students allowing open and truthful dialog to occur. Careful development of questionnaires that require meaningful responses is necessary. Asking what can be done to improve the project and what went well with the presentation often elicit valuable comments. Follow-up by faculty at the beginning of the quarter is essential so that students realize that their opinion matters and then they will offer meaningful input.

## **Next Steps**

Future work falls into two major areas; refinements to self-surveys and development of metrics to measure team growth. Currently much of the conclusions are based on self-surveys. There are differing opinions as to validity of self-reported surveys but as stated by Chiochio <sup>11</sup> “because teams have the best understanding of how well their team performs tasks in relation to their objectives” self-reported surveys will continue to be the main focus for developing data.

Refinements in the questions are needed to more clearly establish areas for improvement of teaming skills. In addition, the refined surveys need to be distributed to a larger survey pool.

Additional metrics need to be developed to measure team growth throughout the students' academic career. One potential metric is the development of a series of exercises that measures critical team concepts such as communication or organization. These exercises would be given twice; early in the quarter when the teams are new and again at the end of the quarter when the teams are established. A comparison of exercise success would be a measure of the teaming growth.

### **Conclusion**

It is evident that students perceive that their university education prepares them to be an effective team member in the business world. However discussions with business leaders show they still see a need to train the graduates in basic teaming skills.

A review of the team university experiences indicates that with some minor modifications in the course layout additional teaming knowledge can be easily taught. Changes to the educational process should occur throughout the students' time at the university. Simple changes at the freshman and sophomore level by adding basic instruction in teaming will reap results throughout their university education. A change needs to occur to create a more dynamic teaming environment where project management tools are integrated into the classroom rather than simply being a fixed deliverable. Teams who are comfortable with their use of these tools will be capable of adapting to change allowing a class project to successfully move from a static environment to a dynamic one. Change happens most quickly where there is acknowledgement and accountability. By utilizing continual peer review, students will be able to ramp up, test and improve their team skills. The continual use of feedback will create a constant learning environment allowing for rapid team growth. Although additional work is needed in this area even these simple changes will better prepare a graduate to quickly become an effective team member in the business world.

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