Int. J. Engng Ed. Vol. 21, No. 2, pp. 222–227, 2005
Printed in Great Britain.

0949-149X/91 $3.00+0.00
© 2005 TEMPUS Publications.

Lessons Learned in the Implementation of E-Teams*

BURTON V. DEAN, ASBJORN OSLAND and MICHAEL SOLT
Department of Organization Management, Sa José State University, San José, CA 95192, USA.
E-mail: osland_a@cob.sjsu.edu

In the spring semester 2003, the San José State University (SJSU) initiated the formation of E-teams and launched its first business plan competition (BPC). The Entrepreneurial Society, a student-run organization, and several faculty and community advisers organized the E-teams and the BPC. 'E' is for excellence and entrepreneurship, as promoted by NCIIA. E-teams are composed of students from various colleges within the university, and they are engaged in developing new products and services leading to viable business plans. Our objective was to provide business, engineering, industrial design, and computer science students with the entrepreneurial skills to start businesses. The lessons learned are discussed in the paper.

INTRODUCTION

DURING THE SPRING semester 2003, the San José State University (SJSU) initiated the formation of E-teams. E-teams are promoted by the National Collegiate Inventors and Innovators Alliance [1] and are composed of students from various colleges within the university, and are engaged in innovation. We initiated the process with three departments in the colleges of Engineering, Science, and Humanities and Arts, each interfacing with three departments in the College of Business (i.e. management and organization, finance, and marketing). Our objective was to provide business, engineering, industrial design, and computer science students with the entrepreneurial skills to start businesses.

In this paper we describe the implementation of an E-team interdisciplinary effort aimed at writing business plans, the first step in the process of commercialization of innovation. Even though we are in the initial stages of our endeavor, we report here on our first business plan competition (BPC), discuss feedback from faculty and students who participated in the E-teams process, and describe our planning for the 2003–4 academic year.

THE IMPORTANCE OF TEAMWORK TO ENGINEERING EDUCATION

The Accreditation Board for Engineering and Technology specifically states that engineering programs must demonstrate that their graduates have the ability to function in multi-disciplinary teams [2]. Numerous examples of teamwork in engineering education can be found [3–8], and SJSU's Industrial Design students, who participated in the E-teams, are another example. The National Association of Schools of Art and Design requires that students work in interdisciplinary teams and also have a knowledge of disciplines such as marketing, economics, organizational psychology and systems theory [9]. AACSB, the accrediting body for major business schools, makes reference to student collaboration in its 25 April 2003 accreditation standards: '. . . faculty members should encourage students to collaborate. Students should have both formal and informal opportunities to develop cooperative work skills. Intellectual tasks in some parts of the program should require collaborative learning' [10]. These standards also specify that 'students should have opportunities to work together on some learning tasks. . . . Students need to acknowledge their responsibilities to their fellow students by actively participating in group learning experiences' [11]. Business professors routinely assign team projects. However, including other disciplines in the E-teams was new to SJSU.

IMPLEMENTATION OF E-TEAMS AT A LARGE STATE UNIVERSITY

The implementation of E-teams is a challenging task and we found that there were numerous issues to address. These included: teamwork, coordination, mentors, complementary activities, and assessment.

Teamwork

Groups have been a feature of higher education for decades. As early as 1963, Dean [12] described groups as an educational tool. Anwar and Rothwell [13] reported on the importance of team-based collaborative problem-solving in an engineering

* Accepted 17 October 2004.

technology class. They listed the following implementation results:

- Teams needed facilitation and leadership to ensure that all members participated.
- Teams learned to work on tasks concurrently rather than approaching the entire project sequentially.
- Team members with experience in teams were able to actively participate from the start.
- Team-based instruction helped people prepare for industry.
- Team members developed an appreciation for their interdependence; the success of one depended on the success of others.
- Role rotation (leader, recorder, and member) helped students develop these skills.
- Students became less insecure about their knowledge and abilities.

Anwar and Rothwell concluded that focusing on the team process dramatically improved the students' ability to work and problem-solve in teams.

Colbeck, Campbell and Bjorklund [14] studied the implementation process and reported additional concerns. The sample included students from two predominantly Black institutions, one selective private school, three land-grant universities, and one urban commuter school. When interviewed, students reported a number of difficulties with the E-teams approach. These are listed below (in italics) with our additional commentary:

- *Students received little or no guidance from faculty about how to work cooperatively in teams*. E-teams should be supported by management faculty who can teach teamwork and group problem-solving skills to E-team members.
- *Few teams were able to unite around a common goal; students had differing goals that reflected their backgrounds and personal aspirations*. Students from the various disciplines must be taught to see how their contribution is crucial to a successful business plan and is complemented by the skills and attributes of the other disciplines.
- *Interpersonal conflict related to gender and ethnic differences can result in negative experiences for some students*. SJSU's student population is approximately 59% minority, 27% white and 14% of unknown ethnicity and 54% are women. Though students have considerable experience with diversity, prejudices between groups exist and faculty need to be sensitive to difficulties when they occur. Andrew Carrillo [15] investigated the effects of team diversity on team performance in a graduate-level, project-based course in which teams of three to four members worked on projects for seven months. The overall diversity of the team was based on such factors as gender, personality preferences, ethnic background, educational background, and work experience. The statistical results showed that both the high and low diversity score groups showed improvement over time, with the high diversity group showing greater improvement over the low diversity group. The middle diversity groups showed little improvement and actually worsened over time. Diversity, while a challenge, is not necessarily a roadblock.
- *The authors suggest that group projects would be useful throughout the curriculum. Students learn from early experiences that they carry forward to their capstone courses.* Osland and Hancock [16] suggest a variety of ways in which participation can be taught. One cannot assume that students will somehow participate actively in a capstone course when they haven't had any experience doing so. In the holistic university environment, various aspects of student life could be used to develop participation skills.
- *Faculty should not simply ask students to assign themselves to groups. Criteria could include experience in group work and with specific people in the class. Working with different people could broaden the students' experience. Faculty also need to be sensitive to how minorities and women are distributed in the groups.* Faculty can ensure that various functional specialties (e.g. marketing, finance, etc.) are represented as well as native speakers or others who have demonstrated effective communication abilities.

Feland and Fisher [4] reported on the success of using team-based education at the Air Force Academy, a change that occurred in 1998, and their results reinforced some of Colbeck, Campbell and Bjorklund's findings. They found that the benefits of this approach included:

- better CAD/solid modeling skills;
- improved teamwork skills;
- improved ties between theory and practice; and
- increased awareness of advanced manufacturing technologies.

While facing increases in both hours of instruction in the curriculum and expectations of their performance, students responded positively to the changed curriculum: student ratings and grades both increased substantially, beginning in the semester in which the changes took place.

Coordination

Coordination at a large university of primarily commuter students was challenging. Ideally, an E-team course would be scheduled in which different disciplines participate together. However, at SJSU such scheduling was difficult because the two business courses that focused on business plans filled up quickly with business students, thereby precluding the registration of students from other disciplines. We are contemplating scheduling participating classes from various disciplines at

the same time and holding plenary meetings from time to time for all interdisciplinary classes that will feature lectures or presentations by the various professors. Having classes scheduled at the same time would facilitate interdisciplinary team meetings and E-team projects.

Using Dean's project management course as a structural coordinating mechanism worked well. Dean teaches a method he calls project management of innovative startup firms (PMIS) [17]. He demonstrates that eight basic tasks exist in every startup, and that applying the Critical Path Method to the activities in these tasks, along with corresponding precedence relations and activity durations, yields status reports on the startup firm, as well information that is useful in the startup's business plan. During spring 2003, PMIS was applied in 13 E-teams and in three startup firms in Silicon Valley. The 13 project management teams of two students each joined other technical and business student E-teams. In each case, the joint E-teams prepared business plans. In some E-teams, the project management teams were also responsible for developing elements of the E-team's business plan. This method worked well in monitoring the progress of the various teams across disciplines and arranging for mentoring or technical assistance when necessary, as well as encouraging both students and faculty where needed.

The Silicon Valley Center for Entrepreneurship (SVCE) (http://www.cob.sjsu.edu/ent/index.html) at SJSU is a structural mechanism for bridging the chasm that exists between colleges and is led by Dean. He is an experienced senior organization and management professor who has developed a network of personal and professional relationships that allow him to collaborate with faculty and others outside the College of Business. The membership of the steering committee includes chairs from science and engineering as well as business professors.

The E-team advisory committee (ETAC), formed in February 2003, was another coordination mechanism that we found to be essential. It consisted of the seven technical and business faculty supervisors of E-teams, two successful entrepreneurs, and the president of the student Entrepreneurial Society. The objectives of the ETAC were to administer, monitor, direct, and coordinate E-team activities. ETAC, together with the student Entrepreneurial Society, engaged in two additional critical activities: (1) arranging for monthly talks by Silicon Valley entrepreneurs and venture capitalists and (2) planning and executing the first SJSU BPC in May–June 2003.

Mentors

During spring 2003, the SVCE recruited volunteer Technical Service Advisers as mentors who were invaluable in assisting with technical concerns and assessing marketing and business plans.

Complementary activities

Complementary activities supporting the E-teams developed to date include:

SJSU's student-run Entrepreneurial Society (http://www.e-society.org/): The Entrepreneurial Society is a student group that is pivotal to encouraging student interest and involvement in entrepreneurship. It organized special seminars in marketing and finance for the BPC.

Entrepreneurship seminars (http://www.e-society.org/events/index.html): Recent talks (including one by Apple co-founder Steve Wozniak) have been attended by hundreds of members from SJSU and the community.

BPC (http://www.cob.sjsu.edu/ent/busplan/introduction.html): The 2003 BPC was the output of the E-team process with the ultimate goal being new venture creation. Student teams competed internally in three rounds. The BPC was sponsored by the Entrepreneurial Society and was successful in large part due to the efforts of mentors, advisers, and judges from Silicon Valley. Given the importance of real-world assessment, all the final round judges in the E-Society's 2003 BPC were active in entrepreneurship practice. They were: 1) venture capitalists Ziya Boyacigiller, Formative Ventures; Rick Ellinger, Osprey Ventures; John Hall, Horizon Ventures; and Eric Hardgrave, Acuity Ventures; 2) angel investors Harold Nissley, International Angel Investors and Bill Paseman, founder of Calico Software; and 3) Jim Robbins, Executive Director, Environmental Business Cluster. The 2003 winners were Mohamed Aslam Ali and Ilya Ronnin, both recent SJSU MBA graduates, who received incubator space at the Environmental Business Cluster and the Software Business Cluster, respectively. They both moved into their incubator spaces. Mohamed also holds a Ph.D. (1992) from Oregon State University. His business plan is focused on converting used automobile tires to activated carbon to be used in water filters. He also won the BPC held in conjunction with the Minority Business Development Agency Youth Symposium on 9 August 2003 in Oakland, California. Mohamed has obtained a formal commitment for $5 million of the $6 million required to complete the project. Ilya and his partners have developed a $30,000 software-driven add-on for machine tool lathes to do the work of computerized machine tools that cost $1 million or more. United Airlines purchased one of their tools. He and his partners have also been approached by angel investors and venture capital firms as a result of winning the SJSU BPC.

ASSESSMENT

The ultimate objective of the E-teams and BPC was the creation of new ventures, and two were in

Table 1. Majors of respondents

Engineering (n = 1) Industrial Design (n = 8)	%	Business	%
9	18	41	82

Table 2. Numbers of graduate and undergraduate respondents

Graduates	%	Undergraduates	%
21	42	29	58

Table 3. Did you have a clear agenda or goal for each meeting?

YES	%	NO	%
21	42	29	58

Table 4. Frequency of E-team meetings

One per week	%	Two per week	%	1–2 times in the semester	%
34	68	4	8	12	24

fact created. We also wanted students to develop an interest in entrepreneurship. In May 2003 ETAC asked the E-teams for feedback, through a process roughly comparable to a course evaluation, to see if the process was leading toward the goal of new venture creation through effective business plan development. Fifty students, graduates and undergraduates of the 90 surveyed responded, a response rate of 56%. (A significant timing problem occurred with the administration of the assessment survey in that one engineering class of 30 graduate students did not get the survey soon enough to fill it out.) The following tables summarize the assessment results.

Challenges observed by faculty were: combining too many tasks and too many student activities, and having a weak feedback loop. The E-team concept arose in fall 2002 and was grafted onto the spring 2003 MBA A New Venture Finance course, but no appropriate Marketing course, was concurrently scheduled, so Marketing activities were also carried out in the New Venture Finance course. The students were working full time, taking other courses, and covering Finance 'content,' so expecting them to complete a business plan, concurrently with product/service development, was perhaps

Table 5. Chance of becoming an entrepreneur in the future

Very much	%	Significantly	%	Somewhat	%	Not at all	%
5	10	12	24	25	50	8	16

Table 6. Challenges faced by E-teams

Challenges	Number	Percentages
Communication issues	4	6.89
Team building/division of work	16	27.5
Time constraints	8	13.79
Problems in estimating market size/financial projections/feasibility of the product	30	51.74
Total	58	100

Table 7. 'What support was particularly useful?'

Type of support	Number	Percentages
Lectures/seminars/training sessions	17	30.35
Mentors (faculty, industry experts/entrepreneurs)	22	39.28
Group/peer support	10	17.85
Feedback from faculty/advisers	7	12.5
Total	56	100

Table 8. Team members' suggestions for future improvements

Suggested Initiatives	Number	Percentages
Remove time constraints: Begin early/Two-semester coursework	25	50
Improving group work and monitoring processes	13	26
Set up eligibility criteria for participation in E-teams	8	16
Make available primary research data	4	8

too much to ask. Former entrepreneurs serving as advisers to specific teams noted shortcomings in both pace and achievement compared to 'real life' in Silicon Valley. The bottom line, however, was that all those involved still believe the approach was beneficial.

LESSONS LEARNED AND THE ROAD AHEAD

In early July 2003, ETAC met in Monterey, California, for an all-day planning session for 2003–4 that led to the formation of two working subgroups. One, the Academic Working Group, was aimed at implementing E-teams during the 2003–4 academic year and bringing to the process the lessons learned during spring 2003. To address the issues raised in the student assessment, the Academic Working Group was committed to:

- ensuring that students begin E-teams in a timely manner by asking for a hypothetical executive summary in the second week of the semester;
- establishing regular deadlines and milestones to monitor progress;
- where possible, spreading the plan over two semesters;
- improving group process through experiential exercises;
- assuring that all team members have the necessary foundation skills;
- nurturing the strong collaboration that exists between faculty across colleges;
- reinforcing mentorship relationships with industry experts and the local incubators;
- continuing regular meetings of faculty and mentors to critique and coordinate activities; and
- encouraging strong E-teams to carry business plans to incubation and eventual start-up.

The second subgroup, the Business Working Group, was aimed at linking entrepreneurship education at SJSU and entrepreneurship practice in the San José area, the warp and woof of the tapestry of local entrepreneurship. Over the next year, the Business Working Group is focusing on the Second Annual BPC as a mechanism to link students and faculty at SJSU with mentors, advisers, entrepreneurs, investors, and support services organizations in Silicon Valley. One key feedback we received from the first BPC was that students didn't have enough time. Hence, we plan to have students in the fall semester 2003 develop a business concept and initial marketing assessment leading to a New Venture Fair in December 2003. This Fair is to include startups from the local incubators as well. We want to foster enthusiasm for innovation so that students will be involved in E-teams in 2004. Then in spring 2004 the E-teams will develop a complete financial plan. The BPC will be held in June 2004.

To gauge our progress, we plan to benchmark our activities against the better programs that already exist to learn from the best practices in BPC. UT-Austin, MIT, the University of Maryland, Rose-Hulman Institute, and other institutions have mature programs with a wealth of experience from which we can benefit. Stanford's Technology Venture Program has a list of the engineering entrepreneurship programs currently in existence that will be useful in this endeavor. Our goal is to facilitate new venture creation thereby attaining excellence in entrepreneurship education that is attractive and exciting to SJSU students and faculty, and to the broader Silicon Valley community.

REFERENCES

1. Source (5/15/03): www.nciia.org.
2. Accreditation Board of Engineering and Technology, Criteria for accrediting engineering programs, 1, www.abet.org (2002).
3. J. M. Feland, Building teammates: Bringing better team skills to design courses, Proceedings of the American Society for Engineering Education Annual Conference (2002).
4. J. M. Feland and C. Fisher, Cramming twenty pounds more into a sophomore design tool kit: Increasing curricular loads on design students and enjoying it!, Proceedings of the ASME International Mechanical Engineering Congress and Exposition, and ASME Curriculum Innovation Award Honorable Mention (2002).
5. C. S. McMahon and J. P. Lavelle, Implementation of cross-disciplinary teams of business and engineering students for quality improvement projects, *Journal of Education for Business*, **73** (1998), pp. 150–157.
6. S. Anwar and W. J. Rothwell, Implementing team-based collaborative problem solving in ET: A case study, *Journal of Engineering Technology*, **14** (1997), pp. 34–38.
7. T. Kiely, Innovation congregations, *Technology Review*, **97**, (1997) pp. 54–61.
8. R. Wilson and T. Costlow, Rethinking education, with an emphasis on teams, *Electronic Engineering Times*, **1050** (1999), pp. 130138.
9. *National Association of Schools of Art and Design Handbook* (2002).
10. Source (8/27/03): http://www.aacsb.edu/accreditation/brc/standards-4-25.pdf, p. 52.
11. Source (8/27/03): http://www.aacsb.edu/accreditation/brc/standards-4-25.pdf, p. 53.
12. B. V. Dean, Group research as an educational tool, Proceedings of the 3rd International Conference on Operational Research (1963), pp. 471–489.
13. S. Anwar and W. J. Rothwell, Implementing team-based collaborative problem solving in ET: A case study, *Journal of Engineering Technology*, **14** (1997), pp. 34–38.

14. C. L. Colbeck, S. E. Campbell and S. A. Bjorklund, Grouping in the dark: What college students learn from group projects, *The Journal of Higher Education*, **71** (2000), pp. 60–83.
15. A. Carrillo, Different levels of diversity: Its effect on a team's performance. Presentation given to the Design Division, Department of Mechanical Engineering, Stanford University (Winter 1999).
16. A. Osland and T. Hancock, Preparation of students for case discussion: Nurturing participation across the curriculum. Unpublished manuscript.
17. B. V. Dean, The project management approach in the 'systematic management' of innovative startup firms, *Journal of Business Venturing*, **1** (1986), pp. 149–160.

Burton Dean is the Director of SJSU's SVCE. He is also a professor in SJSU's Department of Organization & Management, where he has served since 1985. He was previously Department Chair. He began his 50-year career as an electrical engineer. Prior to joining SJSU, he was Chairman of the Department of Operations Research, Weatherhead School of Management, Case Western Reserve University. His research interests include entrepreneurship, strategic management, operations management, and project management. He is the author of six books, more than 30 chapters and 100 papers and is listed in *Who's Who in America* and 30 other biographies.

Asbjorn Osland joined SJSU's College of Business in August 2002 as an Associate Professor of Organization & Management. He received his M.B.A. and Ph.D. degrees from Case Western Reserve University. He is on the Steering Committee of the SVCE. He previously served as the MBA Program Director at George Fox University in Oregon. He has published refereed articles and cases dealing with international management and entrepreneurship. He has taught in Spanish in Managua, Nicaragua. He worked for eleven years in Third World development in Latin America and West Africa. He also served as the HR manager for Chiquita in Panama.

Michael Solt is a Professor of Finance at San José State University and a member of the SVCE Steering Committee. He was awarded M.B.A. and D.B.A. degrees by Indiana University. Besides teaching at SJSU since 1991, he has taught at Santa Clara University and the University of Cincinnati, as well as in Singapore and France. Dr. Solt has published extensively in refereed and professional journals. He is professionally active in the Silicon Valley community. While at SJSU, he was selected as the College of Business Outstanding Undergraduate Instructor in 1995 and a University Teacher Scholar in 2000.