

**AC 2010-659: ANTELOPE VALLEY ENGINEERING PROGRAM: A CASE STUDY
IN A DIVERSE REGIONAL PARTNERSHIP**

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Antelope Valley Engineering Program: A Case Study in a Diverse Regional Partnership

Abstract

The framework for a case study on a locally-enabled ABET accredited engineering degree objective program is discussed. A unique partnership has developed not only to create the program, but also to sustain it. The case study methodology and framework will be used to elucidate the constitution, motivations, actions, and effectiveness of the partnerships in developing a sustainable local engineering program. The information developed through the case study should illustrate the effects and efficacy of educational leadership applied to the partnership efforts. This paper details the case study framework, creates a structure for the current partnership participants, and introduces the local engineering program history.

Introduction

In the Antelope Valley (AV) of California, a unique partnership developed in 2004 to address regional industry needs for hiring engineers from ABET accredited programs. It creates an interesting and necessary case study on the application of leadership to a social entrepreneurial enterprise¹ that is intended to develop a sustainable and regionally scalable² local engineering education program. This is a purposefully driven case study that has a specific agenda and outcome in mind.

The Antelope Valley of California is also known as Aerospace Valley. The AV is home to Edwards AFB, where space shuttles still occasionally land. The space shuttles, the Air Force B1 and B2 aircraft were assembled at Air Force Plant 42. And, the Mojave Space Port is where Burt Rutan's Scaled Composites won the X-prize. The AV also supports divisions or subsidiaries of many of the major aerospace prime contractors, as well as NASA Dryden Flight Research Center, China Lake Naval Weapons Center and the Air Force Research Laboratory's Propulsion Sciences Division. Because of the unique, remote, desert environment, companies based in the AV have difficulty recruiting and retaining engineers from out of the area³. This retention difficulty has exacerbated a "perfect storm"⁴ resulting from the confluence of the retirement of the baby boom generation of aerospace engineers, low total employment in the aerospace sector⁵, and the increase in foreign competition for engineers. Couple to this retention problem the drive for economic development in the AV region, the attention of the Base Realignment and Closure (BRAC) Commission paid to the organizations resident on the local air force base, and understanding that the local aerospace industry exists at the whims of congressional funding, the motivation for sustaining an engineering education presence in the region is evident. The motivation and the influence of aerospace employers have enabled the local community college to develop a strong engineering and STEM education focus⁶. However, the AV is also the last land area available for Los Angeles County expansion. The low cost of housing compared to that of the rest of the county has created an influx of low wage earning individuals and families. The poor college preparedness rate for regional high school graduates of just 21.5%⁷ is symptomatic of the demographic shift toward an increasingly socio-economically disadvantaged population⁸ and indicative of a lack of university "pull". An engineering education presence in the region is necessary to develop a locally educated workforce to support the resident DoD and aerospace

industry missions. The “right stuff” mentality that exists in the AV has driven the formation of partnerships to support a local engineering educational presence. This case study is framed in an attempt to understand and exploit this highly motivated attitude and the unique partnerships.

The local engineering program in the Antelope Valley, established through the cooperative efforts of several public university and community college organizations currently engaged, faces the challenge of achieving sufficient support to become self sustaining and advance the cause of replacing a withdrawing public university engineering program in the region within the context of the state public university system. This effort is not without precedent and it does not lack a successful model to emulate. A situation very similar in many respects to that faced by the institutional development underway in the Antelope Valley was faced successfully in the State of Washington in the development of a branch campus system during the 1980s. The situation in Washington State was reviewed in a case study to understand the policy determination process that proved successful in establishing the branch campus system⁹.

According to de Give and Olswang, the conditions prior to the establishment of the branch campus system were not too dissimilar from those that currently exist in the Antelope Valley today. The authors explained that, in Washington 30 years ago, the Puget Sound area existed as an economically diverse area with booming population growth while the region east of the Cascade Mountains was heavily reliant on the Hanford nuclear industry in the tri-cities area, some industrial diversity in the Spokane area, and agriculture elsewhere. This is a very large geographically dispersed area of over 22,000 square miles. The Antelope Valley is also geographically dispersed although it is much smaller at approximately 9,000 square miles. The parallel between the Hanford nuclear industry in Washington State and the aerospace industry in the Antelope Valley are unmistakable. Both of these government funding dominated areas were and still are heavily influenced by the whims of congressional funding which drive their local economies. The Antelope Valley does have industrial diversity but it is not sufficient to counterbalance cycles in government aerospace investment. Agriculture, mining, and alternate energy sources in the form of wind and solar power energy generation form additional economic opportunities.

The case study conducted by de Give and Olswang revealed a strategy of coalition building. They modeled the effort as a tactical pyramid with a base composed of discrete alliances between policy makers.

Clustered at the top was a collective force of special interests bonded to each other and to the branch campus concept through a complex web of exchanges and assurances woven by the efforts of powerful policy actors with an arsenal of favors to accomplish this strategic objective (p. 306).

This model started with a grass roots effort by community elites, with entrepreneurial skills, that recognized the linkage between the solutions that they sought and policy making at the state level. Such an effort is underway in the Antelope Valley and can benefit from adopting this model tailored to address the development of the coalition building required to achieve the strategic objective of securing a sustainable and regionally scalable public university degree granting engineering program.

Setting the Stage: Program History

In 2004, the local engineering program began its current incarnation as a degree – objective program with a single ABET accredited university. Prior to 2004, the program that existed in the Antelope Valley was not well-defined with a degree objective. A junior-year only program was administered by three universities in the California State University (CSU) system and provided only lecture course delivery by correspondence or interactive broadcast to students in the Antelope Valley. The Joint Engineering Program (JEP) was enabled by funding from the university Chancellor's Office and allowed students to transfer to either of two engineering degree granting universities in the CSU system, but postponed the inevitable matriculation issues, and junior-year laboratory classes, to the student's senior, but usually not last, year. Because of low student enrollment and dissatisfaction with the JEP by both the local employers, who did not benefit, and the two partner universities, the JEP ended in spring semester 2004.

At the close of the JEP, a partnership of local engineering employers, city, state, and federal government agencies motivated a single university to offer programs to provide mechanical and electrical engineering baccalaureate degrees to students locally through a combination of interactive broadcast lectures and locally taught engineering laboratory courses. Industry/Government support for the program included temporary funding for an electrical engineering professor's salary and an Intergovernmental Personnel Agreement (IPA) detailing a government researcher to teach mechanical engineering. These degree-granting programs matured into the local engineering program.

The local engineering program students transfer into the upper division only program and rely on the local community college to satisfy lower division coursework. A model of the current programs, shown in Figure 1, was developed by Santarelli which illustrates the interconnectedness of regional state universities, and the articulation with the community colleges¹⁰. Students can complete their degree objective without attending the main campus. While many of the amenities of a main campus are not available, student services and diversity of programs exist through the presence of a second comprehensive university in the building where lecture classes are taught. Professional societies, extra-curricular activities, and other amenities, secondary to the delivery of curriculum, that are necessary to create well-rounded graduates are currently being addressed on an ad-hoc basis and frequently by the students themselves.

The program started with very low enrollment, two students, and limited experimental capability. From 2004 to 2007, one electrical engineering student had to commute 200 miles to take a laboratory class and mechanical engineering students made use of improvised facilities on the Air Force Base for a required laboratory class. However, in spring and summer of 2007, laboratories for mechanical and electrical engineering were completed and a new full-time director was hired. With the realization of tangible laboratory facilities and ability to offer all classes necessary to graduate on the local campus, a recruiting drive and outreach efforts commenced. The program can now claim 9 BSME and BSEE graduates, and 13 master's degree graduates, with 21 BS degree seeking students currently enrolled in the program. The numbers of graduates will more than triple at the baccalaureate level and another 4 to 6 master's degrees

will be awarded prior to the conclusion of the spring 2011 semester. Recruiting for the local program was suspended starting in fall 09 due to the performing university's decision to phase out of the Antelope Valley. But, the program continues to increase in student population with co-op students from the main campus taking classes during their work experiences, students relocating from the main campus, and individuals taking classes by concurrent enrollment from other universities.

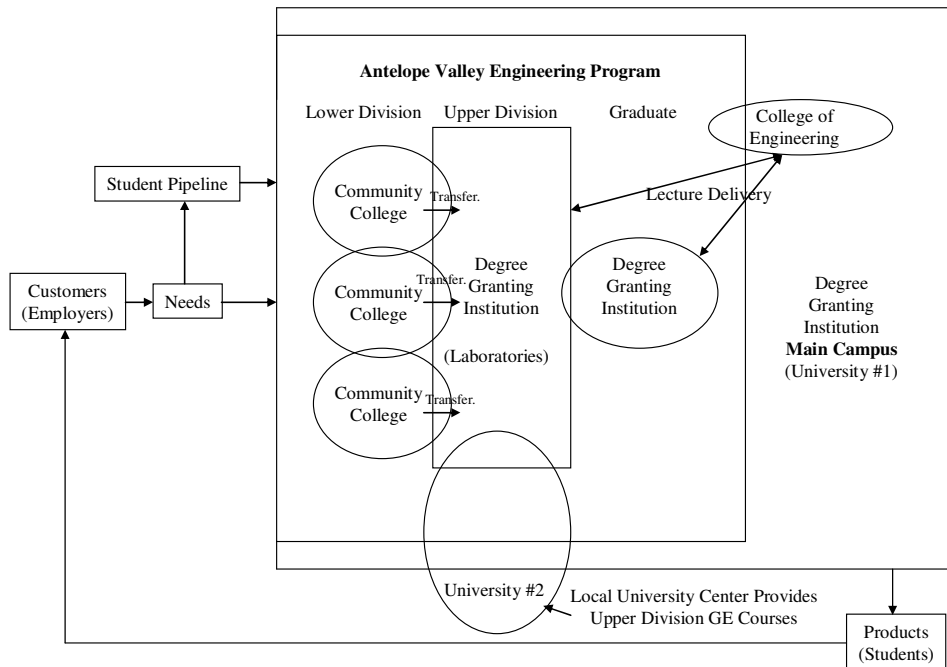


Figure 1: Antelope Valley Engineering Program Model in its Current State of Evolution

The decision to phase out of the Antelope Valley by the current university was based on the understanding that these programs would not, and could not, be provided at the expense of the campus or the College of Engineering beyond reasonable time commitments from faculty and staff, enrollment revenues, or without sufficient numbers of students to make them viable. In the end, disproportionate time commitment from faculty and staff on the main campus, the continued lack of self-sustaining funding for operations, along with an aging broadcast infrastructure, chronically under-enrolled sections in the Antelope Valley, and long-distance physical efforts in a region well outside the geographical service area of university, all factored into the decision to phase out¹¹. However, needs data from industry, a serious and sustained regional college-going culture development effort underway since 2002, and a close industry/government/education consortium relationship indicated that a properly planned and executed second round of enterprise creation is warranted.

Even though the student pipeline now appears to be capable of providing students in sufficient numbers to achieve the desired level of enrollment, the economic and political environment affecting the university budget precludes the opportunity for state supplied enrollment compensation. Additionally, the assumptions made at the inception of the current program regarding the type of industry/government support that was available were in error. The regional government and major corporate industry partners are capable of, and are, providing a great deal of support for the local program but they have limitations and constraints on the types of support that can be provided. Those limitations appear to have not been well understood. The challenge now is to develop a program that is primarily supported by student fees and augmented by the government/industry partners where appropriate to the benefit of the main campus as well as to the local program. The government/industry/engineering program partnership has been significantly strengthened as a result of an industry needs study that was conducted in late 2007 and early 2008⁴. The study produced an understanding of the region's government/industry employer (engineering program customers) requirements for engineering graduates, established that the market was sufficient to support a local program, and allowed networking and relationship building to occur. As a consequence of the needs study it was possible to reconstitute the local engineering program advisory board such that its composition is now customer leadership centered.

However, it is the partnership, the network of organizations and individuals motivating the local engineering program, not solely the program's advisory board, which is the focus of this case study. The constituency of these partnerships is unique in that both city and federal government entities are participating in what is primarily a state government function. The partnerships have evolved from a few self-serving and politically active individuals into a network of grass-roots organizations, educational institutions, and government organizations at all levels. It has already motivated the JEP, enabled and evolved the current incarnation of the local engineering program, and is in the process of reinventing itself to sustain the local engineering program goals and activities with another University. Capturing and organizing the information about the constitution and activities of these partnerships are some of the purposes of this case study. It is hoped that understanding how these partnerships support and enable sustaining the local engineering program will be valuable to other educational organizations that are employing external boards and consortia to address sustainability.

One cannot address the activities of the partnerships without recognizing the powerful leadership paradigms at play within its membership. The direct application of leadership tools and perspectives, like data-driven management, understanding customer requirements, and relationship building, helped to evolve the partnerships into their present form. Since another evolution is in process, capturing the effects of the application of "soft science" tools and perspectives to this predominantly "hard science" trained group is important to justifying engineering educational program leadership objectives.

Why a Case Study?

The case study is one of a number of qualitative research traditions that include narrative inquiry, phenomenology, grounded theory, and ethnography¹². Creswell¹³, describes case studies as follows:

Case studies, in which the researcher explores in depth a program, an event, an activity, a process, or one or more individuals. The case(s) are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time (Stake, 1995).

Elliot and Luke¹⁴, however, argue that case studies are not a method of inquiry but rather a tool for data generation and interpretation that, most likely, cannot be generalized. In fact, their discussion of case study as "... a form of deliberative reasoning (*phronesis*) about a situation in which there is a political imperative to act" (p.101) seems appropriate to the case described herein.

In this case study, an activity will be explored, in depth, bounded by time and activity and sequentially described through publication as the study matures. The purpose of this case study is to understand the processes required to successfully address a predetermined agenda and a defined outcome. This case study is purposefully driven in that it is being used to define, organize, understand, record, and report on those processes that are successful and those that are not. It is a method of data collection and self reflection that will allow organized and directed planning and decision making. It is purposeful, as well, in that this study is applying research in a very pragmatic way to accomplish a strategic objective for the local engineering program effort. The strategic objective is the development of a sustainable and regionally scalable local engineering program offered by a nationally recognized public university.

Methodology

The agenda being employed for this study, is first to utilize strong regionally based partnerships to develop a coalition focused on enticing a public university to offer engineering programs to replace the existing withdrawing university. The time frame for the successful accomplishment of this effort commenced with the fall 2009 semester and will conclude at the end of the spring 2011 semester. Secondly, and largely in parallel with the first agenda item, is the refocusing of the coalition on sustaining and developing the ability to grow the enterprise. This second agenda item overlaps the first but will extend for four years and concludes with the termination of the existing sustaining support activities currently committed to this endeavor. It is hoped that periodic reporting as this case unfolds will be useful to social entrepreneurs, educational leaders, and policy makers faced with similar engineering education program sustainability issues.

In this case the researchers are not only observers but they are participants in that they intend to provide leadership and capitalize on resources in utilizing the existing diverse regional partnerships to develop and direct a coalition, using the previously mentioned agenda, toward the case study outcome and the strategic objective. Data collection methods and tactics will largely evolve as the study progresses but field notes will be maintained throughout the effort and a case record developed. This methodology will include a review of documents and artifacts. Interventions will be planned and documented. Direct observation will be employed as may participant observation, interviews, and surveys. A case study data base may also be required. A

study protocol is under development and will include the necessary direction required by 45CFR46.101 (b) for the protection of human subjects.

The tools applied included data-driven management, using survey instruments to change the consortium dynamic, branding, process documentation, social entrepreneurial business plan development, advancement and networking. Applying these tools has already had the effect of reconstituting the industry advisory board for the current program, defining the enterprise¹², increasing student enrollment, ensuring degree objectives could be met, and improving outreach and awareness of California A-G requirements in the local high schools.

Existing Partnership

The Washington State model of a tactical pyramid illustrates the required coalition for this case. However, the local engineering program tactical pyramid has three levels rather than the two levels described in the Washington State model (see Figure 2). As in Washington State, this enterprise has a broad community activist-driven base with a few key powerful enablers at the top. All the people and organizations in the pyramid have a common understanding that a regional state university baccalaureate engineering degree granting program in the AV is needed, but each for its own reason. Organizing current partnership participants into a tactical pyramid allows the categorization of the roles and responsibilities of each participant so their individual motivations may be addressed. Analysis of the quality of each participant's activity will allow gaps to be identified.

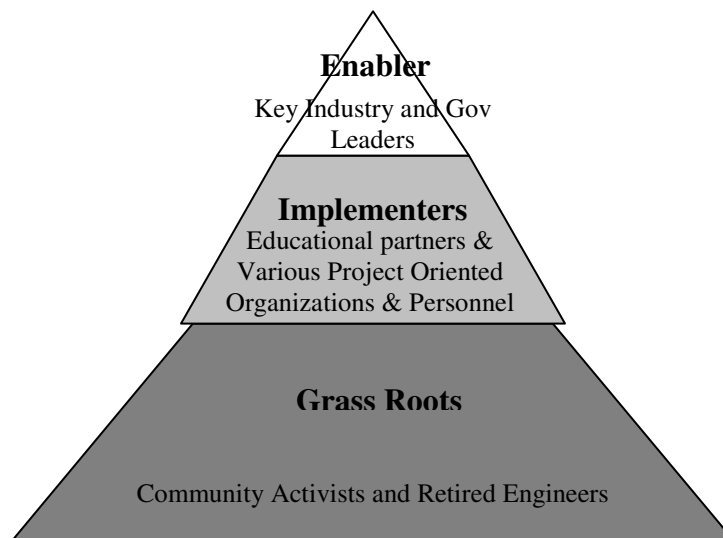


Figure 2: Tactical Coalition Pyramid

The broad-base, or grass roots level, participants include political activist retirees from the local air force base, engineers from local industry, the local community college faculty, some regional community college instructors and administrators, the members of the board

of trade, members of local chapters of professional societies, the staffs of state government representatives, the staff of a comprehensive state university, faculty from the college of engineering, dedicated individuals from the local workforce and an National Academy of Engineering director. Each of these participants provides resources that are contributed to the sustainment effort because they believe the AV needs an engineering educational presence. Resources provided at the grass roots level include people's time and expertise, word-of-mouth advertising, students and curriculum, engagement with practicing engineers, and activism.

At the mid-level of the pyramid are a small collection of active implementers who execute resources from both the base and top levels for the purpose of sustaining local engineering degree programs. These implementers include the program director, local city government, a branch of one DoD organization resident on the local Air Force Base, the Vice President of a comprehensive University, the Dean of the current college of engineering, key individuals from the local community college, and the board of trade. Their activities include: the creation of the laboratory capability by executing funding secured by the top-level partners with the support of the base-level partners, winning grants by collaborating with the local community college partners and the main campus, and support of the student pipeline development through joint outreach efforts. A novel project-based outreach course was developed¹⁵, implemented, and sustained with the support of base-level partners.

The apex of the pyramid is inhabited by three key individuals: the state senator, the director of a DoD organization resident of the local air force base, and a manager from a local Aerospace company. These individuals enable this enterprise by providing resources, leadership, using their influences to create more resources, motivating paradigm shifts, and conducting negotiations between implementing organizations. Other organizations, such as the university Chancellor's office, are not actually an active part of the current partnerships, but provide useful support. Collaboration with a major private university's Organizational Leadership program has provided valuable insight into organizational behaviors and educational research.

The tactical coalition pyramid that is described developed as a result of enterprise creation activities undertaken by the Program Director beginning in summer 2007, after the first students graduated from the program. The advisory board before 2007 was driven by community activists and other grass roots supporters rather than by university personnel. It was reconstituted in 2007 by the new director to address the engineering program, rather than community support goals. The recent membership and roles of the members have not changed significantly with the withdrawal of the current degree granting university. The Apex of the pyramid has been expanded to include key leadership from the air force base, NASA, and the local naval facility. While driving the program early, recent activities of the grass-roots base have been limited while negotiations between higher level partners and a new degree granting university partner are in progress. It will be necessary to re-engage the grass-roots base once a degree granting partner is established. The case study will need to capture those activities.

One observation about the membership and perspective of this tactical coalition pyramid is the overwhelming preponderance of engineers and hard-science trained individuals. At one point even the mayor of the City had a B.S. degree in engineering (previous city mayor). At the grass-roots base level, only the personnel from the comprehensive University and the staffs of the political representatives do not have engineering degrees. At the middle, implementer, level, only the Comprehensive State University Vice President and some city government personnel do not have degrees in engineering. At the apex, enabler level, two of the three individuals have degrees in engineering. While this observation speaks to power of the engineering discipline, it may also highlight a weakness in the constitution of the current partnerships. However, this may also be a case where leadership may be particularly effective because of its conscious and deliberate application of “soft skills”. The effects of this observation will unfold during the course of this case study.

Another observation of the coalition pyramid is that it is bereft of large private donors. The pyramid is led and motivated by people with a vested interest in local engineering education who lack the fiduciary flexibility of private parties. It was observed in reference four that local philanthropists suffer from donor fatigue. The need, and ability of the implementers, to attract private donors will be captured as part of the case study.

Evidence of the influence of the grass-roots partners in the local educational community is noticeable. The high school outreach class developed with the local program is oversubscribed without advertising. Strong Project Lead the Way (PLTW) programs exist at five local high schools. An engineering club has been established at the local community college. In the middle schools, a network of STEM teachers has been established and supported with interactive laboratory equipment and curricula. The local university engineering recruiters have noted a cessation of information requests from students not prepared to enter engineering baccalaureate programs. Bellwether transfer classes at the local community college, such as differential equations and circuit analysis, are now at capacity when they enrolled fewer than ten students in the past. The evidence of the effects of the coalition will need to be gathered and carefully analyzed during the case study.

Summary

This case study effort is completely pragmatic in approach. Not only are the researcher-participants conducting this study to understand what community partnerships exist to support the educational effort and how they work, but are also using the case study as a device for organizing information, conducting analyses, and documenting results. The coalition development can profit from addressing observed partnership fragmentation and through increasing the diversity of support at the top of the tactical pyramid. Documenting the effects of leadership and sound management practices will provide important insight into the efficacy of this discipline. And, publicizing the motivations and methods of the strategic partnership that sustains the novel local engineering program will be of value to other organizations.

References

1. Santarelli, K. W., (2010). Developing an Extension for Engineering Education: Testing the Entrepreneurial Skills of Key Participants. Submitted for consideration. *2010 American Society for Engineering Education Annual Conference & Exposition*. Louisville, Kentucky. June, 2010.
2. Contemporary Issues in the Entrepreneurial Academy. (2009). *ASHE Higher Education Report*, 34(5), 37-61.
3. Skeen, J. (2007, May 7). Homegrown: 2 engineers to be the first of their kind. *Daily News*, p. 3.
4. Santarelli, K. W. (2008). *Developing a regional learning center for engineering*. Ann Arbor, MI: UMI Dissertation Publishing.
5. Camhi, E. (2005). Editorial: Addressing the workforce shortfall. *Aerospace America* Vol 43, no.1. AIAA.
6. Valiotis, C. (2008). Improving Conceptual Understanding and Problem Solving Skills In Introductory Physics Courses Using the Socratic Dialogue Method. Paper presented at the 2008 American Society for Engineering Education Pacific Southwest Annual Conference, Phoenix, AZ: ASEE.
7. California public schools - district report. Retrieved 11/9/2009, from California Department of Education: <http://data1.cde.ca.gov>
8. Greater Antelope Valley Economic Alliance. *Discovering the opportunities: labor, lifestyles, Los Angeles all within reach!* (2009). (Economic report). Lancaster, CA. Greater Antelope Valley Economic Alliance.
9. de Give, M. L., & Olswang, S. G. (1999). The making of a branch campus system: a statewide strategy of coalition building. *The Review of Higher Education*, 22(3), 287-313.
10. Santarelli, K. W. (2010). An evolving model for delivering engineering education to a distant location. *Proceedings of the 2010 American Society for Engineering Education Zone IV Conference*. Reno, NV. March, 2010.
11. Lancaster University Center. (2009). Website. http://www.csufresno.edu/engineering/departments_programs/lancaster/index.shtml
12. Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research*. Thousand Oaks: Sage Publications.
13. Creswell, J. W. (2003). *Research design: qualitative, quantitative, and mixed methods applications* (2nd ed.). Thousand Oaks: Sage Publications, p. 15.
14. Elliott, J., & Luke, D. (2008). Epistemology as ethics in research and policy: the use of case studies. *Journal of Philosophy of Education*, 4287-119. doi:10.1111/j. 1467-9752.2008.00629.x.
15. Shelley, J.S., & Bowen, M. (2009). Innovation in engineering outreach: Engineering 11 as a tool for recruiting minority students to engineering. *Proceedings of the 2009 American Society for Engineering Education Annual Conference & Exposition*. Austin, TX. June, 2009.