An Evolving Model for Delivering Engineering Education to a Distant Location

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Abstract

A unique approach has evolved for providing ABET accredited undergraduate engineering education for the residents of the Greater Antelope Valley and adjacent regions in the high desert of California. Industries in the high desert have expressed a strong desire to train engineers locally. This desire stems from the unique attributes of the high desert which make attracting and retaining new graduates from other areas difficult. The model that is evolving provides only upper division instruction from the degree granting institution. Upper division instruction is provided through the use of interactive live-broadcast lectures and classes that combine students from the distant and main campus locations. A regional university center hosts the laboratories required for upper division students and is centrally located with respect to the population distribution. This approach requires the development of partnerships with the region's community colleges to provide the explicit lower division curriculum that students require to meet their degree objectives.

This paper will describe the model in its current state of evolution and report on its effectiveness for providing undergraduate engineering education to a distant location. The characteristics of the industry being serviced and the demographics of the region will be discussed as will the history that has driven this model's evolution. The necessity for the partnerships that have been formed to support this effort will be described. This paper will also report on current events that are likely to impact the model's continuing development.

The Greater Antelope Valley

A unique approach to provide ABET accredited undergraduate education for the residents of the Greater Antelope Valley and adjacent regions in the high desert of California has been evolving out of an industry driven desire to train engineers locally. This desire stems from the unique attributes of the high desert which make attracting and retaining new graduates difficult[1].

The Greater Antelope Valley is a triangular region extending from Ridgecrest, CA at the northern apex to Gorman, CA near the western apex, and the communities of Lake Los Angeles and Pearblossom, CA near the eastern apex[2]. The region defined as the Greater Antelope Valley is often referred to as Aerospace Valley. The Aerospace Valley reference is due to the fact that the Greater Antelope Valley is the home of Edwards Air Force Base which also hosts NASA Dryden Flight Research Center, the Mojave Space Port, the China Lake Naval Air Weapons Station, and Air Force Plant 42 at Palmdale Airport. These facilities have hosted the manufacture and flight test of such notable aircraft and space flight hardware as the Air Force B1 and B2 bombers, the Lockheed L-1011 airliner, the North American Aviation X-15, the Space Shuttle, the *Space Ship One/White Knight*, the world's largest liquid rocket engine (Rocketdyne F-1), and many others. As a result of the development, assembly, and test activities conducted in this region, industry is dominated by engineering disciplines at all degree levels. Regions adjacent to

the Greater Antelope Valley include Victor Valley, Apple Valley, communities in the Tehachapi Mountains, and the region around Barstow, CA that includes Fort Irwin and the Marine Corps Logistics Base.

The high desert of California presents a unique environment to its residents. Joshua trees, yucca plants, and scrub cedar populate the landscape. Large dry lake beds present perfect landing areas for high performance experimental aerospace vehicles. Rainfall, in inches per year, rarely achieves double digits and the wind and sun can best be described as utility grade. It is hot and dry in the summer and cold and dry in the winter. Social amenities, such as major sports, arts, and entertainment venues, in the region's communities are minimal. The population of the Greater Antelope Valley is nearly 500,000 but it is geographically dispersed throughout the region with the largest concentration in the cities of Lancaster and Palmdale[2]. It is the minimal social amenities and the treeless habitat that make retaining and attracting people from other regions of the country difficult for employers.

The demographics of the region are changing dramatically. Located in the northernmost part of Los Angeles and east Kern Counties, the Antelope Valley has maintained lower housing costs than exist in the Los Angeles metropolitan area. Lower housing costs coupled with investor use of Section 8 housing has attracted an influx of low wage earning individuals, families, and minorities. This is evidenced by the fact that Antelope Valley High School District students qualifying for a free lunch program have increased from 28.1% to 53.7% over the last ten years with two of the 13 responding high schools reporting qualifying student populations that exceed 70%[3]. This trend is reflected in the high school district demographic data shown in Figure 1.

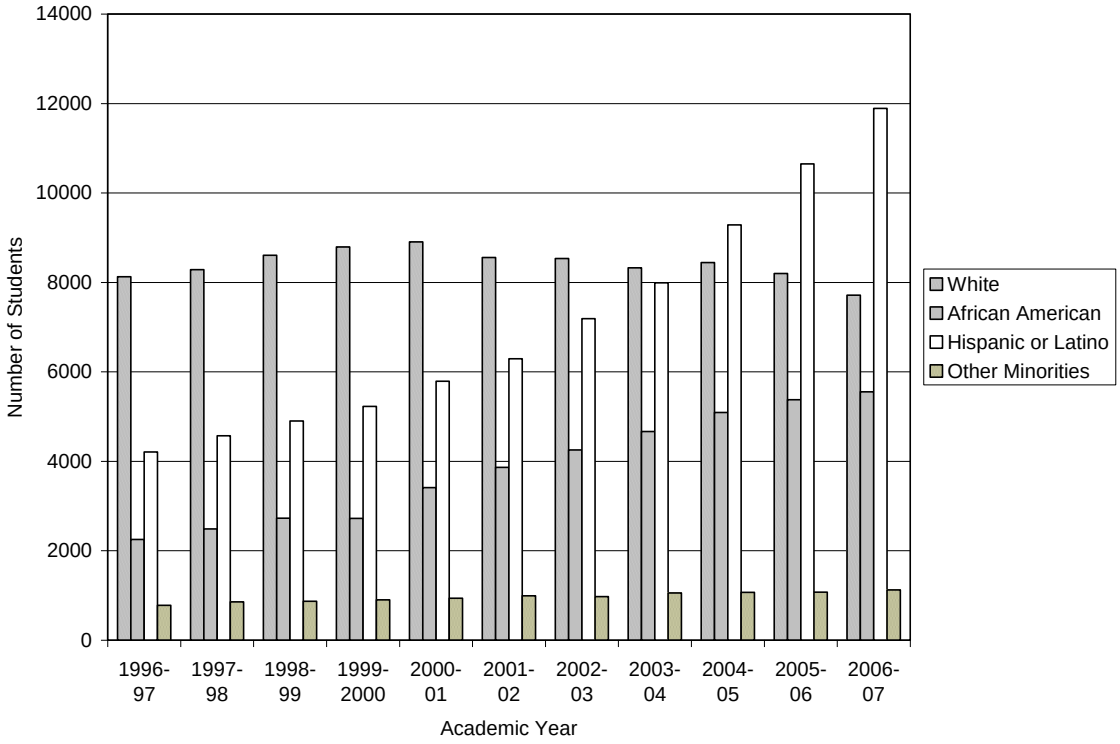

Figure 1: Antelope Valley Union High School District ethnicity trend, 1997to 2007[4]

The number of high school graduates that meet the University of California/California State University admission requirements is lower in the Greater Antelope Valley than in the state. According to the California State Department of Education only 21.5%[4] of students graduating from the Antelope Valley High School District in the 2007/2008 academic year were prepared to meet admission requirements. Both the County of Los Angeles and the State of California preparedness rates exceed the district preparedness rate by more than 10%.

For many years the Antelope Valley has been underserved, in math, science, and engineering, by higher education. Students either have had to leave the region to obtain their education or they have had to commute long distances to the nearest universities. Commute times from this region to any established campus offering engineering easily exceed one and a half hours at a minimum, can be unpredictable, and much longer depending on the weather, traffic conditions, and the student's starting location. Students from Ridgecrest at the northern end of the Greater Antelope Valley, under the best conditions, are over three hours away from any university. The alternative to long commutes has been to leave the area to obtain an education. Figure 2 summarizes data from the Greater Antelope Valley Economic Alliance which clearly shows a significant reduction in the population in the 20 to 24 year old age bracket. The trend indicated in Figure 2 is representative for communities throughout the region.

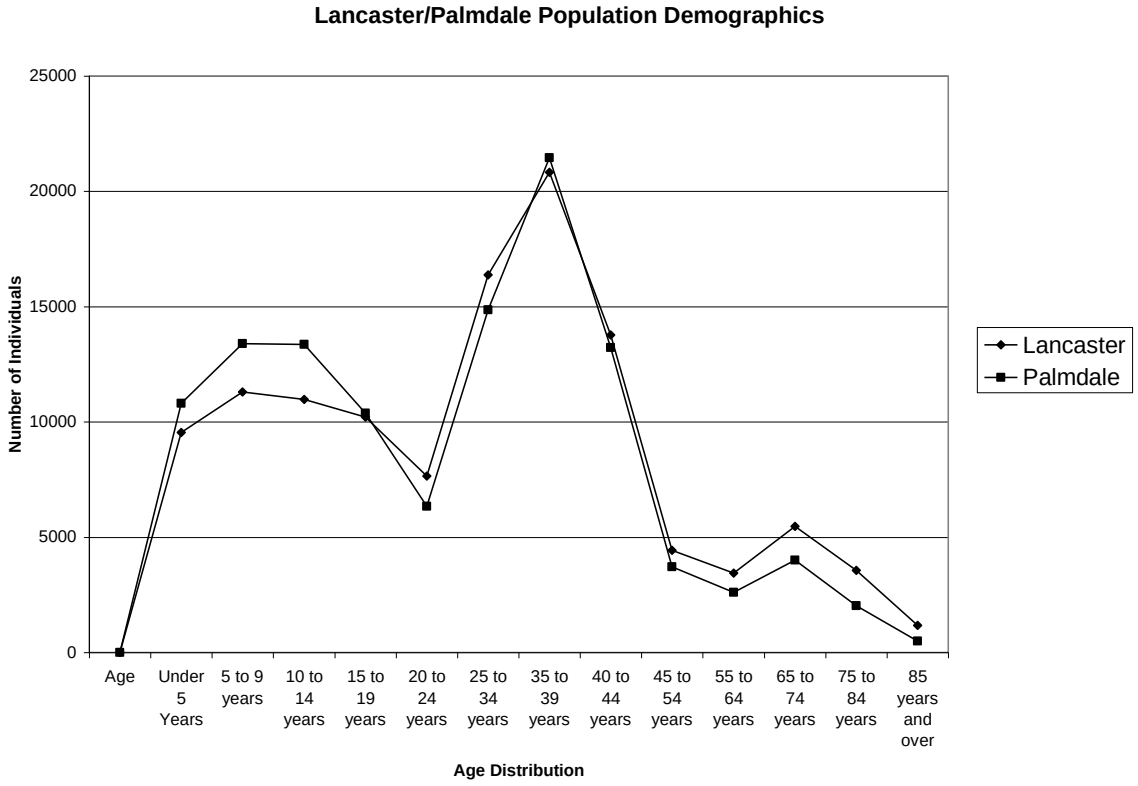

Figure 2: Population Distribution by Age for Lancaster/Palmdale Shows a Signification Reduction in the College Going Age Bracket[2]

The unique high desert environment, the paucity of social amenities, the changing demographics, and the performance of the region's schools couple together to make it difficult for the region's

industry to attract and retain newly graduated engineers. Failure to retain personnel is expensive. Replacement costs reportedly run one to one and a half times the annual salary of the individual being replaced[5]. Faced with pending retirements and the difficulty in retaining personnel recruited from outside the region, industry, government organizations, local communities, and the education community have banded together to focus on math, science, engineering, and technology education, and formed (in 2002) the Math, Science, Engineering, and Technology (MSET) Consortium to increase the college going student population and to educate and graduate engineers locally. The initiative is known locally as *Homegrown*[6].

The Need for Engineering Education in the Antelope Valley

The need for engineering education in the Antelope Valley is multifaceted. The industry requirements for attracting newly graduated engineers and for retaining personnel stem from the pending retirement of the baby boom generation that heavily populates engineering, not only in the Antelope Valley but, throughout the nation[7]. There is also a need to inspire young people to enter the profession and to serve the changing population of the region by providing local higher education opportunities.

The region is also experiencing growth in solar and wind power generation as well as in other green technology industry. Photovoltaic and Rankine cycle solar power plants have been constructed or are in the permitting phase of development. The Tehachapi wind farm is being significantly expanded. Other green technology industries, such as ethanol production, are also entering the region.

Even without the new business opportunities developing within the Antelope Valley, industry data indicates that there is a need for 200 to 300 engineering graduates, at the bachelor's level, annually[4]. The industry need for engineers by discipline is shown in Figure 3. The data indicates that mechanical and electrical engineering followed by aerospace engineering, at both the baccalaureate and graduate levels, comprise the greatest need. The data used to develop Figure 3 was derived from a 25 question survey delivered to 171 organizations, within the region, that employ engineers. Organizations in the communities of Victorville, Barstow, and Tehachapi that are adjacent to the region also received the survey questionnaire. A response rate of 33% was achieved. The survey was developed using a panel of experts and a pilot study was conducted using organizations that employ engineers outside of the population surveyed but still in Southern California. Customers also expressed an equally important need for graduates that are able to communicate and present effectively. This requirement indicates the need to focus on both written and verbal presentation and communication skills[4].

The regional population demographics indicate the need for a public university in order to assure access to an education by the large underrepresented population. A local engineering program offered by a public university will help create a college going culture and it will provide a defined action plan for obtaining a college degree. Such a program will provide a destination for students who cannot afford to leave the area or who do not desire to leave for various reasons.

The poor University of California/California State University preparedness rate amongst the region's high school graduates creates a necessity for partnering with the region's community

colleges. Dr. Les Uhazy, Dean of Math, Science, and Engineering at Antelope Valley College, has reported that remediation rates in mathematics typically approach or even exceed 90% of the incoming freshmen at Antelope Valley College[8]. By partnering with community colleges remediation is not an issue that the degree granting institution needs address directly. However, the required remediation rate does point out the need to partner with multiple community colleges in order to obtain a sufficient successful transfer rate into the upper division engineering program. The remediation rate also points out the need for communities to address root causes at the elementary, middle, and high school levels.

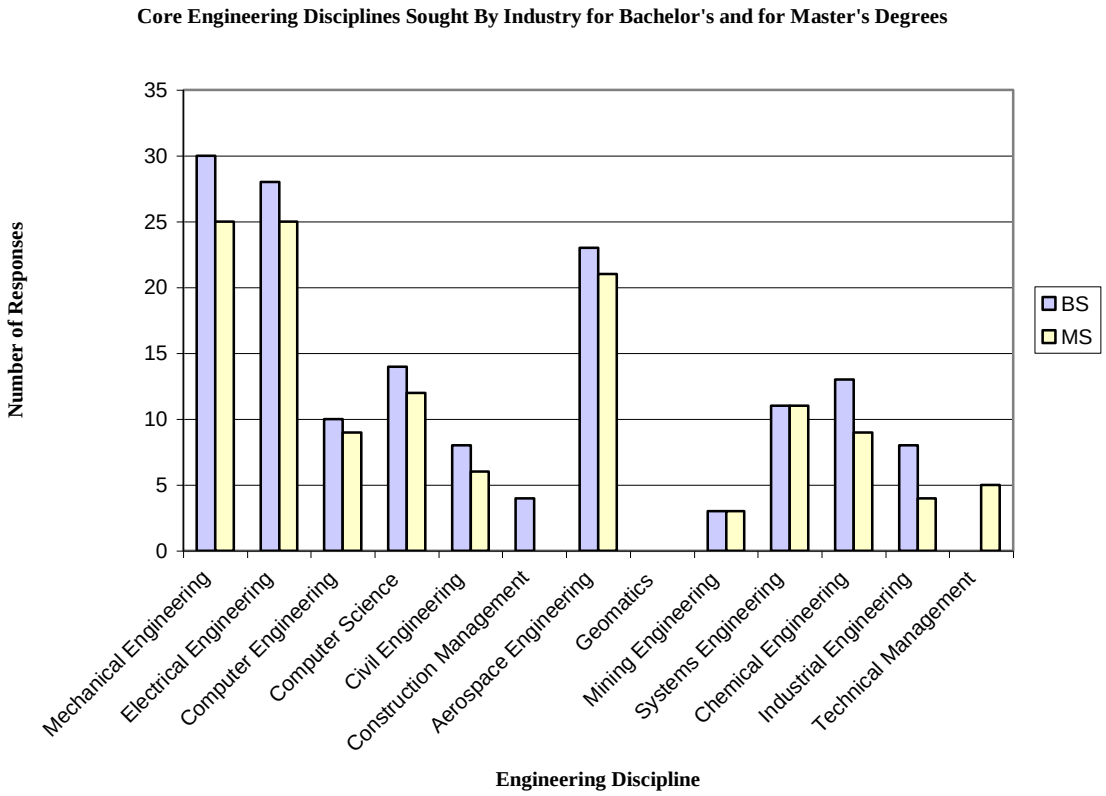

Figure 3: Industry Need by Engineering Discipline[4]

Program History and Development Background

The Antelope Valley Engineering Program derives its heritage from a graduate program initiated in 1975 to support the Test Pilot School (TPS) at Edwards AFB. In the late 1990s, the TPS eliminated the requirement for a master's degree in engineering. At approximately the same time the communities and industries in the region began to recognize the need to have a local baccalaureate program.

In 2002 the CSU Chancellor's office became involved and funded a joint engineering program involving multiple universities. The Chancellor's office funding was used to establish state-of-the art live interactive broadcast classrooms at three university locations. The Joint Engineering Program

was designed to provide a local junior-year curriculum in engineering established on the Antelope Valley College campus. No upper division labs, however, were offered. Upon entering their senior year students were to choose the campus at which they would complete their degree objective.

In 2004 the City of Lancaster completed renovation of the Challenger Memorial Center, creating the Lancaster University Center. This event initiated the evolution of the existing program. Program development was initially inhibited by the lack of engineering laboratories. In 2007 the City of Lancaster completed construction of a building to house the mechanical engineering laboratory and also completed renovations within the Lancaster University Center for an electrical engineering laboratory and for faculty offices. Laboratory equipment has been supplied by the Air Force Research Laboratory and the Engineering Directorate at Edwards AFB as well as by a cooperative Department of Education Title V grant administered by Antelope Valley College. Faculty and staff have been supplied by the Air Force Research Laboratory through Intergovernmental Personnel Agreements executed with the degree granting institution.

The basic mission of the engineering program in the Antelope Valley is to provide a high-quality academic program, offered locally, that supports infrastructure development and the economic growth of the high desert region[9]. This mission has guided the evolution of the model, to its current state, for delivering engineering education at a distance. A more recent effort, that has also guided this evolution, is the research into industry needs and industry capabilities for supporting the program. This effort was initiated by defining customers and products.

Customers define the purpose of a business, or an institution, through an understanding of what it is that satisfies the customer's expectations, behaviors, situations, realities, and values. In order to obtain this understanding, who the customer is becomes the crucial first step in understanding the customer's needs (Drucker, 2001)[10].

In order to move forward with the development of this model a realistic approach suggested by Bailey and Bennett[11] which identifies employers as the customer and students as the product of higher education has been adopted. Figure 4 shows the customer/product relationship within the context of this model. Maguad[12] further defines this customer – university – product relationship.

Customer-driven organizations are effective because they are fully committed to satisfying and anticipating customer needs. The future success of colleges and universities will increasingly be determined by how they identify and satisfy various customers[13].

Products: This view helps us to focus on the end result of the students' educational process and identify the relevant skills and information that they will have upon completing the process of a course[14].

The evolving model is driven by customer (employer) needs. Identified customer needs are used to drive planning and decision making by the university/community college partnerships and by the various community consortiums that address educational needs in the elementary, middle, and high school districts (pipeline) throughout the region. This customer driven approach is consistent with Tyler's seminal work on curriculum development[16] and on Dewey's work which provided an understanding of the sources of educational objectives[17].

Employers in the region have recognized the need for a local program to educate engineers. According to an official statement from Edwards AFB,

The entire aerospace industry has a problem acquiring sufficient engineers to absorb additional work. It is critical for the long-term preservation of Edwards Air Force Base to be able to locally recruit from an educated workforce to fulfill its Department of Defense flight test missions[15].

It should be noted that Edwards AFB is the largest single employer in the region with approximately 12,000 civilian and uniformed personnel involved in the flight test mission approximately 20% of whom are engineers. China Lake Naval Air Weapons Station accounts for another 6000 government employees and uniformed personnel with approximately the same percentage of engineers.

Model Description

The model that is evolving, in the Antelope Valley, is an alternative to the traditional brick and mortar undergraduate engineering education (see Figure 4). In this model, upper division instruction only is provided by the degree granting institution and requires the development of partnerships with the region's community colleges to provide the explicit lower division curriculum that students require to meet their degree objectives.

Upper division instruction is provided through the use of interactive live-broadcast lectures and classes that combine students from the distant and main campus locations. Instruction is also bidirectional in that some instruction originates from the distant location which takes advantage of individuals from the highly skilled workforce. The Lancaster University Center hosts the laboratories required for upper division students and is centrally located with respect to the population distribution.

Lower division engineering, general education and laboratory experiences are provided by the community colleges, primarily through direct contact lecture and laboratory classes. The development of the lower division curriculum occurs in partnership with the community colleges and is in the process of being designed to be consistent between the participating community colleges such that course articulation with the degree granting institution is simplified. Curriculum and advising are the subjects of Memorandums of Understanding with each of the partner community colleges. Student advising is accomplished jointly between specified counselors at the community college and the staff and faculty at the university extension and main campus. Students are encouraged to review their progress each semester as they progress through their undergraduate (including lower division) curriculum and are provided with advising sheets detailing the program with course numbers from both institutions.

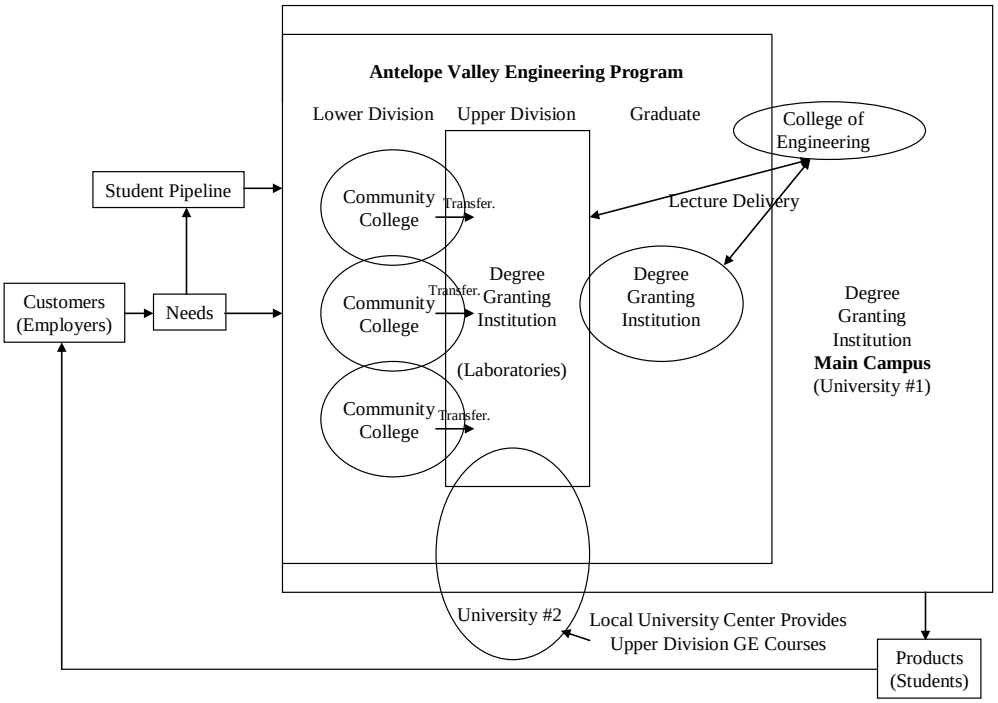

Figure 4: Antelope Valley Engineering Program Model in its Current State of Evolution

The advising sheets provide the students with the explicit course requirements by community college course number and descriptor as well as the upper division requirements once the student has successfully transferred (see Figure 5). The first four blocks of the advising sheet define the lower division requirements while the second four blocks provide the student with the information required once the transfer is accomplished. A separate advising sheet is developed for each participating community college. Multiple community college partnerships also provide students with the opportunity to obtain classes, known to articulate for their degree objective, from more than one campus. A close relationship between students in the lower division and the degree granting institution is facilitated by a community college counselor designated to support the engineering program. The counselor refers students to the upper division staff for advising appointments which allows the staff to provide encouragement, offer advice, and track student progress through their lower division curriculum. Students are encouraged to meet with the upper division staff each semester during their lower division experience. The students' close relationship with the degree granting institution during their lower division experience also helps to assure that students stay on their study plan and can transfer successfully.

California State University Fresno
Antelope Valley College
Mechanical Engineering Program
Recommended Program Sequence

Bachelor of Science Degree **http://www.csufresno.edu/luc/**

Student_____ID#_____Advisor_____

Telephone_____Catolog Year_____Grad Date_____

E-Mail_____

ADVISING SHEET **MAJOR CODE: 054402**

Fall First Semester at AVC		**Spring Second Semester at AVC**	
Name (Units)	**Taken**	**Name (Units)**	**Taken**
Math 150 – Calculus I – (5)	_____	Math 160 – Calculus II – (5)	_____
PHYS 110 – General Physics and Lab –(5)	_____	Phys 120 – General Physics and Lab(5)	_____
ENGR 110 – Intro to Engineering – (1)	_____	ENGR 115– Basic Engineering Drawing-(3)	_____
ENGL 101 – Freshman Comp/Area A2- (3)	_____	Comm 101 – Intro to Speaking/Area A1-(3)	_____
CIS 161 – Intro to C Programming –(3)	_____	Phil 105 – Ethics/Area C2-(3)	_____
Art – Area C1-(3)*	_____		
Fall Third Semester at AVC		**Spring Fourth Semester at AVC**	
Name (Units)	**Taken**	**Name (Units)**	**Taken**
Math 250 – Calculus III –(5)	_____	Math 230 – Differential Equation –(4)	_____
ENGR 230 – Circuit Analysis-(4)	_____	ENGR 130/L – Material Science & Lab –(4)	_____
ENGR 210 – Statics-(3)	_____	Hist 107 or 108 – US History/Area D1-(3)	_____
Chem 110 – Chemistry and Lab/Area B1-(5)	_____	Econ 101 or 102 – Economics/ Area D3-(3)	_____
POLSI 101 or 102 – Political Science/Area D2-(3)	_____	BIOL 101 – Biology/Lab Area B2&3-(4)	_____
PHYS 211 – General Physics and Lab –(5)	_____		
Fall Fifth Semester		**Spring Sixth Semester**	
Name (Units)	**Taken**	**Name (Units)**	**Taken**
ME 125 – Engineering Stats in Experimentation-(3)	_____	ME 116 – Fluid Mechanics-(3)	_____
ME 112 – Engineering Dynamics-(3)	_____	ME 118 – Fluid Mechanics Lab-(1)	_____
ME 115 – Instrumentation & Measurement Lab-(1)	_____	ME 136 – Thermodynamics-(3)	_____
ME 134 – Fundamentals of Machine Design-(3)	_____	ME 140 – Advanced Engineering Analysis-(3)	_____
CE 121 – Mechanics of Materials(-3)	_____	ME 2 - Computer Applications in ME –(1)	_____
ME 95 – Engineering Product Development-(2)	_____	PHIL 316 – Philosophy (CSUB) – (5 QTR)	_____
*Completion of Writing Exam	_____		
Fall Seventh Semester		**Spring Eighth Semester**	
Name (Units)	**Taken**	**Name (Units)**	**Taken**
ME 145 – Heat and Mass Transfer –(3)	_____	ME 155 – Elements of Systems Design –(3)	_____
ME 154 – Design of Machine Elements –(3)	_____	ME 166 – Design –(3)	_____
ME 156 – Advanced Thermodynamics –(3)	_____	ME Tech Area B – 3 units	_____
ME 159 – Mechanical Engineering Lab –(1)	_____	ME 135 – Engineering Product Design-(3)	_____
ME Tech Area A – 3 units	_____		
PLSI 304 – Political Science (CSUB) – (5 QTR)	_____		

6 units Technical Area A courses: select from ME 137,142, 144, 146, 162 or 164 3 units Technical Area B courses: ME 180, 190, 191T, ECE 121, 121L, 155
*Art – Recommended 100,101,102,110,or 147
*** Additional Requirement: Must pass the university writing exam or take IT 198W online course during the fifth semster.**

Figure 5. Example advising sheet for mechanical engineering

The curriculum represented by the advising sheets was developed using a subset of the degree granting institution's catalog requirements. The full range of electives was not made available due to the need to limit the number of classes being broadcast. The limitation resulted from the limited number of class rooms outfitted with broadcast technology. The lower division curriculum was developed in cooperation with the local community college. A combination of existing classes, modified classes, and newly developed classes resulted in a lower division curriculum offered by the community college that meets the requirements of the degree granting institution.

The result, of this approach to initial curriculum development, is similar to other programs that accept large numbers of transfers from satellite campuses such as Penn State. This approach was used due to an awareness of the Penn State model on the part of involved industry (customer) personnel in the initial curriculum development effort. The differences in the Penn State model and the environment in which this model is being evolved are, however, significant. Penn State is a single system. The California State University and the California Community Colleges are two completely distinct organizations each system having its own Chancellor and Board of Trustees. Additionally, each campus in both systems operates with a great deal of independence. The independence has allowed a great deal of flexibility and working across the two systems has, perhaps surprisingly, not posed any impediments to this evolution.

University #2, shown in Figure 4, is a manifestation of the regional consortium that has developed in the Antelope Valley. University #2 is another California State University that has established a center in Lancaster but it does not have an engineering program. Due to the local convenience that University #2 provides, a Memorandum of Understanding (MOU) was established with the engineering degree granting institution to provide upper division general education requirements to the Antelope Valley Engineering Program students. University #2 does provide, however, various student services that would not otherwise be available. The same MOU that provides for upper division general education requirements also provides for such services as student health service, library, and *Interactive Television (ITV)* technicians that also provide examination proctoring and that handle transmission and distribution of student homework assignments.

Because of the distance from the main campus (over 200 miles) engineering laboratories were established at the distant site in the spring and summer of 2007. Laboratories were developed because the laboratory experience is essential to the quality of engineering education[18]. Laboratory experiences are provided at the Lancaster University Center (LUC) by instructors on-site. Laboratory equipment has been specified by the main campus and procured in accordance with the requirements of the College of Engineering in order to provide students with the same laboratory experience that their main campus counterparts receive. The City of Lancaster has provided a building which houses a mechanical engineering laboratory capable of providing students with product development, fluid mechanics, heat transfer, and thermodynamics laboratory experiences.

The LUC hosts an electrical engineering laboratory equipped to provide students with essential laboratory experiences required to graduate. Progress is being made to expand laboratory capabilities to address Edwards AFB Flight Test needs (primarily instrumentation) as well. The mechanical engineering laboratory includes both a subsonic and a supersonic wind tunnel. Experiment equipment is modular and mobile (except for machining equipment) to allow easy laboratory reconfiguration for the various laboratory classes offered.

The foundation of the Lancaster program for this model is based on the traditional lecture style, laboratories, and project based classes. There has been no effort made at the main campus or in Lancaster to conduct asynchronous classes, or move to an on-line delivery mode, and there has been no effort to either modify curriculum or to adjust teaching style to accommodate the technology. Lectures are simply broadcast live and the technology allows interaction between the main campus class room and the distant class room. Lecturers at the distance location use the same syllabi and laboratory manuals as the main campus instructors. There is recognition, however, that additional

preparation and forethought is required in the transmission of homework, quizzes, and tests, as well as material distributed during class. Contingencies for failures of the technology must also be predetermined[19] and include recording and posting lectures where distance students can access missed material using a PC.

The evolution of the model is not yet complete. There are many factors, such as customer needs, the technology employed, current economic conditions, processes, procedures, and instructional methods that require focused attention before the model can be fully matured.

Evaluation and Results

The Antelope Valley Engineering Program was initially hampered by the lack of engineering laboratories making student recruitment and degree objective completion difficult. Shortly after the dedication of the mechanical engineering laboratory in 2007, the first two Bachelor of Science degrees were awarded to students enrolled in the current effort. Since that milestone event a total of 9 BS and 12 MS degrees have been awarded. By the end of the spring semester in 2011 the number of BS degrees awarded will have increased three fold. This adds to the several hundred MS degrees awarded over the 34 year history of the engineering program in the Antelope Valley.

Seven of the nine individuals that have received their bachelor's degree are working in the region in either federal civil service or with major aerospace corporations. One individual receiving a BSEE, did so specifically to achieve a life-long ambition, and has no intent to work. One individual just graduated as a BSME and is exploring career opportunities. One third of the graduates did so with honors. All of the individuals graduating with master's degrees were working adults from industry or in federal service, both civil and uniformed, within the region.

Enrollment growth only really began with the opening of the laboratories and has been adversely impacted by recent events. At the beginning of the spring 2007 semester there were only 19 undergraduate and graduate students. In only two semesters enrollment for matriculating students more than doubled. The initiation of an outreach class for high school juniors and seniors, as well as Open University participants added significantly to the population of students involved in the AVEP as well. The current student population is relatively diverse with 53% Caucasian male, 26% female, 13 % Hispanic, 4% African American, and 4% Middle Eastern. Students that are employed full time in engineering positions, in cooperative education programs, stay-in-school-programs, or that have internships account for 56% of the enrolled students.

Evaluation of the success of this model is on-going and revolves around feedback from customers (employers) regarding their perceived quality of the product (students). Currently feedback is obtained in discussion with an active and engaged advisory board led by an industry partner. At this particular point in time, a Northrop Grumman program manager is the chair. The local division of Northrop Grumman, located at Air Force Plant 42 in Palmdale, is the primary benefactor of the local engineering program. Northrop Grumman has hired graduates and has several full time employees enrolled in the local program. Feedback regarding hired graduates, from the management, is positive and the feedback illuminates the importance placed on retention.

The employees that we have hired from the Fresno State LUC engineering are top notch; their level of preparedness, willingness to be in the Antelope Valley and understanding of our industry far surpass those of any group we recruit from[20].

The importance of rapid integration into the workforce is also a focus of industry concern. There is a critical need for rapid knowledge transfer due to the large segment of the workforce that is preparing to retire. The Advisory Board Chair reports that,

The LUC Engineering Program is turning out some top notch engineers. The engineers that we have hired have hit the ground running and have proved to be far more productive much sooner than those of the other schools we have recruited from[20].

Industry is also concerned about employee professional development. With respect to existing employees industry leadership has reported that,

The LUC Engineering Program is a very positive [impact] for the Antelope Valley. The program has allowed many of our employees to further their higher education close to home, and in a much less disruptive manner than we normally experience. The students/employees, working with the LUC and industry partners gain valuable insight learning close to home and industry. The program has been a great success[20]!

This evolving model appears to be effective in providing students with the fundamentals required to be successful in their chosen engineering disciplines. Distant location faculty members report that transfer students from the local community college are very well prepared to enter the upper division program. Employers indicate that they are very satisfied with the graduates that they have hired[20]. Employers also report that graduates are integrating rapidly into the work force. Anecdotal evidence suggests that communication skill development is a natural outfall of being a distant student due to the need to communicate accurately with peers and instructors from a distance.

Instructor and student satisfaction measures[21] are also important means of measuring continuous process improvement as are grade comparisons between students at the distant location and at the main campus. Such an evaluation has been under way by Shelley[22] who has reported that in Dynamics Concept Inventory results and student's grades there is no strong influence evident between the direct-contact and broadcast student populations. Shelley also reports that, even though there is no strong influence in learning outcomes, there is significant dissatisfaction identified by students due to feelings of isolation and a lack of instructor and fellow student interactions[22]. This finding is consistent with the research conducted by Salisbury et al[21].

Vision for Future Evolution

The vision for the evolution of the model is to continue to develop a geographically distributed alternative to the traditional brick and mortar and on-line engineering education program to satisfy our customer's needs.

This evolution will be accomplished by:

- Maintaining the junior-level transfer approach to program admission

- Expanding the community college partnerships to increase the transfer student population base
- Establishing program articulation with community college partners (articulation is currently accomplished course-by-course)
- Establishing joint facility use agreements to deliver courses via live televised broadcast
- Maintaining and expanding the regional laboratories to include joint facility use agreements at community colleges
- Employing continuous process improvement to advance model evolution
- Facilitating innovation and experimentation in delivering engineering education
- Taking advantage of the highly skilled and talented workforce to provide qualified part-time adjunct professors
- Establishing and maintaining data driven decision making processes
- Establishing and maintaining well documented operating procedures, based on best practices, that are consistent between partners
- Maintaining an engaged and structured industry/community advisory board to assure that customer needs are being addressed, that the effort is receiving needed regional support, and to provide feedback for evaluation

It is the considered opinion of the local staff that there are many opportunities for innovation for the institution implementing this vision in the Greater Antelope Valley. Research into changing the existing paradigm regarding engineering education at the undergraduate level, opportunities for technical research with organizations within the region, and the development of an extension offering tenure track faculty opportunities are areas of program development that can be addressed and that will facilitate the evolution of the model. It should be noted as well that this vision has been evolving as a result of a necessary effort that has developed from a grass roots regional initiative launched in 2002. This grass roots effort was led by Mr. Robert Johnstone and Mr. Bill Lawrence, both volunteers who are retirees from Edwards AFB. Their efforts resulted in the establishment of the regional Math, Science, Engineering, and Technology Consortium (MSET). It should also be noted that the evolving model and the resulting vision is consistent with opinions expressed by the National Academy of Engineering (NAE), Center for Advancement of Scholarship on Engineering Education CASEE)[23].

Current Events Effecting Model Evolution

The existing degree granting institution has determined, after considerable evaluation, to phase out involvement in the Antelope Valley Engineering Program. The economic conditions that currently exist in the nation and, particularly in California, are a significant factor that is adversely effecting the continued development of the model. The California State University system has responded to the fiscal crisis by reducing system wide enrollment by 40,000 students for the first time in its history. The CSU campuses have also implemented enrollment caps and penalties for departments exceeding their caps. Therefore, Full Time Equivalent Student enrollment is no longer an incentive for growth. No applications for admission to the spring 2010 semester have been processed system wide. These actions have had the effect of reducing AVEP enrollment by one third. Sustainability is a key issue that must be addressed through sources external to the public university system which dictates an engaged, innovative, and committed advisory board activity. In spite of the challenges, two public universities have expressed interest in offering engineering education programs at the Lancaster University Center. One of the universities is seriously evaluating the opportunity and may

be at a decision point sometime during the first quarter of calendar year 2010. A positive decision is critical to the continued evolution of the model and the region is taking every available step to insure that such a decision is rendered.

Conclusions

The evolving model is effective in delivering a high quality engineering education to students. The model does not rely on asynchronous content delivery. The model does rely exclusively on community college partnerships for lower division course content delivery and the partnerships forged to date are collaborative and the relationships are strong. The customer focus is yielding good industry interaction via an engaged and committed advisory board and industry/community support for the effort is strong. The model has been developed as a result of local needs independent and ignorant of but in alignment with the opinions and activities of organizations such as NAE/CASEE. The continued success of this model has significant potential for changing paradigms regarding undergraduate engineering education.

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