Pepperdine University

Graduate School of Education and Psychology

DEVELOPING A REGIONAL LEARNING CENTER FOR ENGINEERING

A dissertation submitted in partial satisfaction

of the requirements for the degree of

Doctor of Education in Organizational Leadership

by

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Diana Hiatt-Michael, Ed.D. – Dissertation Chairperson

This dissertation, written by

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under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

June 9, 2008

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DEDICATION

This dissertation is dedicated to my wife, Astrid, and my son, Kenneth Knut, without whose love, patience, understanding, and support, this effort would never have been completed. This dissertation is also dedicated to my deceased father, Rico, a tradesman whose mantra for me was; “Work with your head, not with your hands”, and to my mother, Nancy Beth, who always advised me to aim for the stars.

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PROFESSIONAL EXPERIENCE

California State University, Fresno, Lancaster, California (2007 – Present)
Director, Antelope Valley Engineering Programs
Provide direction for the development and operation of the College of Engineering regional learning center for engineering in the Antelope Valley.

Hamilton Sundstrand Rocketdyne, Canoga Park, California (1980 – 2007)
Retired
Member of the Technical Staff/Manager/Director

- Directed International Space Station (ISS), Electric Power System (EPS), Orbital Replaceable Units (ORU) manufacturing and testing through contract delivery completion.
- Directed ISS, EPS, ORU design and development as the Deputy Product Area Manager. The EPS, ORUs are critical components in the distributed power system onboard the International Space Station and are a major segment of the $3 billion+ Rocketdyne ISS contract.
- Represented the Rocketdyne ISS program at the Johnson Space Center, Houston, Texas. Provided interfaces between Rocketdyne, ISS Vice President and Program Manager and the Boeing and NASA ISS program managers.
- Directed the design, assembly, and test of ISS program support equipment with a budgeted value of approximately $170 million.
- Directed the design and development of the Photovoltaic Power Modules for the ISS. Major subcontractors to this effort included Lockheed Martin and Hamilton Sundstrand.
- Managed design, development, and system integration for the ISS Solar Dynamic

Power Module. This project required coordinating the efforts of Rocketdyne and several major subcontractors.
- Managed advanced valve and control design and development for liquid rocket engine applications.
- Assigned various engineering duties ranging from conduct Failure Mode and Effects Analyses to providing Product Engineering support on major subcontracts. Program assignments include the Peacekeeper, Stage IV, Reentry Vehicle Kinetic Interceptor programs, liquid rocket engine system programs such as the Space Shuttle Main Engine, the Atlas Launch Vehicle MA-5 engines, the Delta Launch Vehicle RS-27 engine, and various advanced program development activities.

ITT General Controls, Burbank, California (1975 – 1980)
Product Engineer
Provided customer support for valves and controls used in the Nuclear and fossil fueled power plant industry and in the process and pipeline industries. International support was required for customers in Japan and Canada as well as throughout the United States.

Military and Government Service

National Oceanic and Atmospheric Administration Commissioned Officer Corps (1975)
Assigned to the NOAA Ship *Pierce* as a ship's officer. The *Pierce* was assigned to conduct hydrographic studies along the east coast of the United States.

United States Air Force (1966-1970)
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Professional Mechanical Engineer, California State License Number M23911
Boeing Leadership Excellence Award (2000)
NASA Space Flight Awareness Team Awards (1998, 2000, 2001)
NASA Appreciation Awards for support provided to Space Shuttle, the Russian *Zarya* module, and ISS Assembly missions.
Rocketdyne Outstanding Achievement awards for various program support activities.
Member of the American Institute of Aeronautics and Astronautics (AIAA)
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ABSTRACT

Antelope Valley is a burgeoning distant suburb of Los Angeles that is demanding new services from colleges and universities. This study investigated industry and community needs for engineering curriculum in order to inform the state university's planning and decision-making.

The study employed mixed methods as part of an action-research approach by the newly state-appointed Director of Engineering Programs in three consecutive phases, January through June 2008. Phase I included mailed surveys to 156 active engineering-related organizations; Phase II assessed selected senior personnel's perceptions through long, semi-structured interviews; Phase III integrated an analysis of the state university's local learning center plan, meeting minutes of the business advisory board, and researcher's field notes for June 2007- June 2008.

Major findings from the survey, with 51 organizations responding, revealed that the area would annually require 200-300 newly graduated engineers and substantiated the area's demand for a state university center. Uniformly, the organizations have expressed a preference to hire locally-educated personnel as they would be a better retention investment; new hires from other areas remain only two-three years. The three most prominent majors are mechanical, electrical, and aerospace engineering.

From the 13 interviews, in order to sustain university life, specialty courses and certificate programs, such as composite materials and reliability and maintainability, should be developed. Interviews recommended construction management as an emerging major. Respondents expressed that the desired quality of engineering graduates, in rank order, was communication, teamwork, and presentation skills. Interviews and the

advisory board support the development of engineering management graduate program and systems engineering as viable new programs.

Every organization, from the surveys and interviews, will support student internships and other work-experience opportunities for engineering students. The advisory board will financially assist the hiring of a fulltime faculty member and encourage skilled personnel to serve in adjunct faculty positions. Board members stated that the state university hiring a respected engineering doctorate as local representative to direct the engineering programs was essential to university expansion into this area.

Direct targeted contact was the most effective means to market engineering programs. The personnel contacted throughout this study are key to this marketing strategy.

Chapter 1: Problem and Purpose

Background

Congresswoman Grace Napolitano, representing the 38th Congressional District of California, asked industry to define for academia what was needed to prepare students for industry employment. Congresswoman Napolitano made her request at a Congressional Field Hearing hosted by the Competitiveness Crisis Council at California State Polytechnic University, Pomona (Napolitano, public comment, September 21, 2007). Chancellor Charles Reed indicated, in conversation subsequent to his testimony, that he believed that the schools need the help of industry to improve the ratio of high school graduates prepared to attend university (Reed, personal communication, September 21, 2007). Mr. Adam Chavarria, Executive Director of the White House Initiative on Educational Excellence for Hispanic Americans reported, in his key note address to the Council, that the need for engineers will increase by 24% within the next two years (Chavarria, public address, September 21, 2007). Mr. Ronald Smith, Vice President of Corporate Competitive Excellence for the Northrop Grumman Corporation described an aging work force with an average age of 54. He noted that 50% of the Northrop Grumman employees will be eligible for retirement within the next 5 years. Mr. Smith reported that Northrop Grumman would be hiring 17,000 to 25,000 employees each year and that 50% of the new hires would be engineers or high technology professionals (Smith, public address, September 21, 2007).

This congressional field hearing and the subsequent panels, roundtable discussions, breakout sessions, and workshops that occurred at the Competitiveness Crisis Council Summit are the result of *the gathering storm* (Committee on Science,

Engineering, and Public Policy, 2006) in science, engineering, and technology discussed by the National Science Foundation. The gathering storm is the result of the aging baby boom generation, low retention rates in engineering at universities, and low interest in math, science, engineering, and technology among elementary, middle school, and high school students. This gathering storm is of serious concern in the Antelope Valley of California.

The Antelope Valley of California

The Greater Antelope Valley of Southern California, USA, is frequently referred to as Aerospace Valley. It includes the cities of Palmdale, Lancaster, Rosamond, Mojave, California City, Ridgecrest, and Inyokern and it is home to Edwards Air Force Base where Chuck Yeager broke the sound barrier in the Bell X-1 and where the Space Shuttle was assembled and occasionally still returns from orbit. Palmdale hosted assembly facilities and production flight testing for the Lockheed L-1011, the North American Aviation XB-70, the Rockwell B-1, and the Northrop B-2 Stealth Bomber. Many altitude records were set by North American Aviation's X-15 during the years that it was launched from Edwards Air Force Base. Mojave airport (just to the north of Edwards Air Force Base), has been home to Burt Rutan's company, Scaled Composites, for many years and most recently was the site where Rutan's *Space Ship One* was carried aloft by the *White Knight* to win the $20 million X-Prize for carrying a human being more than 62 miles above the Earth's surface and into space.

The Aerospace Industry is heavily dominated by the engineering disciplines yet there has been no four year university program in the Antelope Valley for training engineers until the establishment of a program at the Lancaster University Center in

Lancaster, California by a California State University located in the Central Valley. The program is currently in its infancy but in June of 2007 the first two students to complete the bachelor's degree program graduated. One graduated in Mechanical Engineering and has secured employment locally with the Northrop Grumman Corporation and the other graduated in Electrical Engineering and is already employed (Skeen, 2007). The spring semester of 2008 will see 5 undergraduate and 3 graduate students receive their degrees.

For the last two and a half years, a campus of the California State University system has been offering nontraditional upper division and graduate level engineering instruction at the Lancaster University Center (LUC). This program is the result of a consortium of state educational institutions that have a presence in the Antelope Valley. The program's establishment in the Antelope Valley has occurred at the request of the local communities, government agencies, and industry. The program offered at the Lancaster University Center is intended to provide high quality baccalaureate degree programs in mechanical, computer, and electrical engineering (Uhazy, Alameldin, Nunna, & Shelley, 2004). Graduate programs leading to a Master of Science degree in mechanical, computer, and electrical engineering are offered as well. Currently there are approximately 20 – 25 students enrolled in the undergraduate and graduate programs.

The programs at the Lancaster University Center are being supported by the Air Force Research Laboratories, the Air Force Flight Test Center, NASA Dryden Flight Research Center, and the China Lake Naval Weapons Center. The Air Force Research Laboratory is, in fact, providing funding and support that amounts to a million dollars. The City of Lancaster has provided the facilities amounting to a $4.5 million investment, leased to the comprehensive state university, and has recently completed a new building

designed to house the mechanical engineering laboratories. The Antelope Valley section of the American Institute of Aeronautics and Astronautics recently announced that a California State Polytechnic University began offering a Master of Science in Engineering with an emphasis in Aerospace Engineering at the Lancaster University Center starting with the fall quarter of 2007 as well (Ratnayake, e-mail, June 2, 2007).

Because the Lancaster University Center is in a remote location 200 miles from the brick and mortar institution at the host campus, and because of the small number of students currently enrolled, a combination of distance learning and teleconferencing technologies are used to bring the classroom resources at Cal State to the students matriculating at LUC. The laboratory experience, essential to quality engineering education (Asimopoulos, Nathanail, & Mpatzakis, 2005; Esche, 2006) has been significantly improved through the completion of the mechanical engineering laboratory facility, in April of 2007, thus allowing the opportunity for mixed learning (Fernandez & Casals, 2005).

The effort to offer undergraduate and graduate engineering programs in the Antelope Valley; by the local, state, and federal governments is very generous but there is a perceived absence of industry participation that raises concerns about the sustainability of the LUC engineering programs. A graduate level Aerospace Engineering offering at the Lancaster University Center by a California State Polytechnic University adds a new dimension to the engineering offering at the LUC; however, a concern does exist that there may not be enough graduate level engineering students in the Antelope Valley to support both the Polytechnic and the and the LUC graduate programs. Additionally, Cal State and the Polytechnic program curriculums contain significant overlap requiring

modification of one program or the other. Enrollment in the Mechanical Engineering Master's program offered by Cal State has been suspended as a result.

The Problem and the Purpose of the Study

The problem that this study addresses is that there is a lack of affiliation with and information from industry and the communities related to the Cal State Antelope Valley engineering programs. The purpose of this study is to investigate industry and community needs for engineering education in the Antelope Valley in order to inform the university's planning and decision making.

Research Questions

Tyler's (1949) seminal work in curriculum development provides the basis for developing the research questions for this exploratory study. The issues surrounding affiliation and the ability to set goals and accomplish informed decision making can best be accomplished within the framework of Tyler's 4 questions and Dewey's description of the fundamental sources of educational objectives as related by Tanner and Tanner (2007). The research questions for this study are:

1. What is the demographic information provided by regional organizations that would support an engineering program at a State University remote location?
2. What are the available resources to support development of a regional learning center for engineering?
3. What curricular offerings in engineering should be delivered?
4. What are the marketing strategies and tools that may be effective in student recruitment?
5. How should the success of the regional learning center be assessed?

Theoretical Basis

This study is framed by Tyler's (1949) seminal work on curriculum development. In his work Tyler poses four questions which are: (a) "What educational purposes should the school seek to attain?" (p. 3); (b) "How can learning experiences be selected which are likely to be useful in attaining these objectives?" (p. 63); (c) "How can learning experiences be organized for effective instruction?" (p. 83); and (d) "How can the effectiveness of learning experiences be evaluated?" (p. 104). In this, answering the research questions will resupt in data that addresses Tyler's first and second question from the perspective of industry needs which will result in conclusions and recommendations that address the his third and forth questions which relate to the interventions and evaluation methods that may result. Bearing in mind Tyler's questions, this study may be further framed by considering and adapting Dewey's description of the fundamental sources of educational objectives. These sources are the learners and program participants, the society/institutions/communities that are involved, and the content or skills to be acquired and subject matter knowledge (Tanner & Tanner, 2007).

The needs assessment for these sources results in the ability to conduct a gap analysis that compares what is with what should be (Tyler, 1949). These sources are further characterized based on their reference to either the LUC undergraduate programs or to the graduate programs. This characterization results from the source of students entering the undergraduate and graduate programs. The LUC undergraduate program obtains students that have completed their lower division requirements at the local community college and other such institutions while the graduate programs obtain students who are working adults with an interest in continuing their educations.

Significance of the Study

Tyler (1949) focused on developing the educational purposes that a school should seek to attain and on selecting learning experiences for educational programs. Dewey (Tanner & Tanner, 2007) provided an understanding of the fundamental sources of educational objectives. The objectives of the LUC need to be determined consistent with learner and, for the purposes of this study, with industry objectives. The gap between what is and what should be (Tyler) will be determined through comparison of the current engineering curriculum offered at the LUC with the industry requirements that are determined by this study. Developing an understanding the gap can aid in setting specific educational objectives and can help to determine whether adjustment to the curriculum is required.

The results from this study will inform planning and decision making by the staff and faculty of the Cal State engineering programs offered at the LUC and by the Engineering Department at Cal State main campus. It will also provide useful information in developing industry support for the LUC engineering programs. The results will also inform the business plan, for the Antelope Valley programs, which is a living document.

Definition of Terms

Definitions of terms relevant to this study include:

ABET. ABET, Inc. is formerly the Accreditation Board for Engineering and Technology and is widely recognized as the accreditor for applied science, computing, engineering, and technology programs for colleges and universities.

Advisory Board. The Advisory Board is a board composed of senior industry managers that is intended to advise the Cal State Antelope Valley Engineering Programs and the community college and State University partners defined by existing or developing Memorandums of Understanding. The Board is intended to be self-managing, engaged, and empowered to address issues facing the developing program.

Antelope Valley Board of Trade. This board was established in 1957 to promote business and industry, to develop a strong infrastructure, and to provide a strong legislative voice for its membership and for the Greater Antelope Valley (Antelope Valley Board of Trade, 2007).

Comprehensive state university. A designated California State University Center in the Antelope Valley operated by a nearby main campus that does not have an engineering program.

Content or skills to be acquired. The expectations for the engineering program set by the customers.

Core engineering competencies. Engineering disciplines that address particular company core business objectives.

Customer. The recipients of the products and services provided by the Cal State College of Engineering at the Lancaster University Center. For the purposes of this study the products are the engineering students and the engineers that the University graduates and the recipients are the employers of engineers in the Antelope Valley.

Full Time Equivalent Student (FTES). FTES is used to allocate budget and is based on 15 enrolled semester units per FTES for undergraduate students and 12 enrolled semester units per FTES for graduate students.

Greater Antelope Valley. The triangular area in the high desert of Southern California bounded by Gorman, California to the west, Ridgecrest, California to the north, and Lake Los Angeles, California to the East.

Industry. Except when specifically discussed, this term is meant to include commercial and municipal, county, state, and federal government enterprises that employ degreed engineers.

Lancaster University Center (LUC). The facility in Lancaster, California maintained by the City of Lancaster for the use of Universities in offering degree objective programs to the Antelope Valley.

Learning Center. A geographically remote (separated by more than 200 miles) extension of the Cal State main campus College of Engineering.

Society/institutions/communities. The companies, corporations, government organizations that are the recipients of the educational product, namely engineering graduates.

Subject matter knowledge. This is the knowledge provided by the faculty and staff of Cal State in developing curricula that meet customer expectations.

Training. Courses delivered by Cal State that do not carry credit that can be applied to a degree objective.

Assumptions

The assumptions of this study were as follows:

1. Respondents to the survey questionnaire and interview subjects answered questions honestly, candidly, and to the best of their ability.

2. Mixing quantitative and qualitative methods provides the researcher with a better understanding of the stated problem for this study than would using either quantitative methods or qualitative methods alone (Creswell & Clark, 2007).

3. The personnel who responded to the survey questionnaire or who were interview participants had sufficient knowledge to accurately represent the needs of their respective organizations.

4. The researcher possesses prior experience and technical skills to conduct this study as a participant researcher.

Delimitations

This study was initiated in January of 2008, after organizations that shut down for the Christmas and New Year holidays returned to work, and it was completed in June of 2008. Data was collected only from organizations identified in the membership listings of Chambers of Commerce for communities in the Antelope Valley region of the California high desert.

Chapter 2: Review of Related Literature and Research

Background

Universities have traditionally prepared engineering students for careers in the manufacturing and construction industries and although this may be changing in the post-industrial society (Wei, 2005), the outlook for engineering employment in 2007 is improving. The requirement for mechanical engineering graduates is reported to be increasing by 17.4% over the industrial requirement for 2006. In fact, 4 of the top 10 Bachelor's degrees in demand are electrical, mechanical, computer, and civil engineering. Engineering related degrees in demand among the top ten are computer science and information technology and systems and raise the total of engineering and engineering related degrees to 6 of the top ten degrees being sought by industry. The shortage of qualified graduates is being reflected by the fact that starting salaries for graduates with engineering and related degrees are among the highest being offered (Job outlook strong for 2007 ME grads, 2007).

The Aerospace Industry in the Greater Antelope Valley

According to the Greater Antelope Valley Economic Alliance (2007) the largest employer of engineers in the Greater Antelope Valley is the United States Government. Personnel working at Edwards Air Force Base, the Air Force Research Laboratory, the NASA Dryden Flight Research Center, Air Force Plant 42, and NavAir WD account for approximately 21,000 persons in government employ. The next largest segment of the Valley's industry is composed of the major aerospace contractors. Lockheed Martin Co. is the largest contractor employer followed by Northrop Grumman and Boeing. These three companies employ approximately 7,000 persons. The Antelope Valley Board of

Trade (2008) has reported that, for the combined government and commercial sector, the number of engineering jobs in the Antelope Valley is approximately 4300.

Mr. Bob Johnstone of the Antelope Valley Board of Trade has identified an issue for companies and Government agencies that employ engineers in the high desert. The issue is that companies hire engineering graduates and then move them and their families into the areas, near their places of employment, in the high desert. This occurs at a significant expense to the hiring company. Companies have found it difficult to retain these personnel because their families, being unused to desert living find the adjustment too hard to accomplish successfully. The employees, therefore, frequently leave in only one or two years. Mr. Johnstone also reported that companies complain that employees have spent considerable amounts of time while at work using their company's resources to do internet searches for alternate employment (Johnstone, personal communication, February 12, 2007). Engineering employee retention is not just a problem among the newly hired individuals. This retention issue was also identified in the *High Desert Master Plan for Higher Education* (Antelope Valley Board of Trade, 2008). This plan suggested that the solution is to educate engineers locally.

To illustrate the magnitude of the problem faced by the aerospace industry in the Greater Antelope Valley, the Antelope Valley Board of Trade's Mel Layne stated that, "One employment sector that faces challenges is engineering. The average age of engineers in the aerospace field today is 54, and many choose to retire at 55. The future opportunities for young educated workers are huge" (2008, p. 4). As discussed below, there is a "perfect storm" of even greater magnitude that effects the entire aerospace

industry and most likely, other organizations that are heavily invested in engineering as a product or in support of advanced technologies.

A "Perfect Storm" Developing

The National Academy of Science has reported that 60% of those personnel who are federally employed in science and engineering are over 45 years old (Committee on Science, Engineering, and Public Policy, 2006). This statistic portends the approaching retirement wave that will sweep through the aerospace industry as the baby boomers reach retirement age. During a meeting with Mr. Eric Thoemmes, Chair of the American Institute of Aeronautics and Astronautics Public Policy Committee and Vice President of Space Systems and Operations for Lockheed Martin Washington Operations offered the opinion that the quality of engineering graduates in the U.S. is dropping. He attributed this to significantly reduced research and development funding by the Department of Defense and due to increased competition from overseas for the best qualified students (Seat, 2006). One of the top policy issues, identified by AIAA for 2006, questions whether our students will be able to meet this nation's technical needs. In the policy statement the AIAA indicated that industry is struggling each year to find adequately qualified candidates with the educational background to fill highly technical positions.

Mr. Thommes believes that the U.S. is headed for a "Perfect Storm" as an estimated 27% of U.S. aerospace workers become eligible for retirement by 2008 (Seat, 2006). There are some organizations that suggest that as many as half of the aerospace workforce may be eligible to retire soon (Tuttle, 2005). Baby boomers born in 1946 will reach early retirement age (62) in 2008.

Retirement trends for workers aged 55 to 64 have remained relatively stable since 1985 in spite of eroding retirement benefits; however, by 2025 the population in the 25 to 54 age bracket will only rise by 3.8% while the population in the age bracket from 55 to 64 will increase by 36% (Patrick, 2006). Additionally, many retirement decisions are already being made by baby boomers and the current impact on the existing work force is undetermined. The cost of replacing these employees will be high but it will be doubly so if companies have difficulty retaining replacement personnel. Although the size of the Antelope Valley aerospace work force has been declining, attrition will outstrip the foreseen reductions as only a modest decline in the future is predicted (Kemp, 2005). Direct replacement costs have been estimated at $25,000 to $ 30,000 per employee (Jennifer, 2005). Intangible costs that include lost productivity, morale issues, and on-the-job-training indicate that the cost of replacing employees can be from one times the employee's annual salary (Hillmer, Hillmer, & McRoberts, 2004) to as much as one and a half times the employee's annual salary (Waters, 2003). With engineering starting salaries exceeding $50,000 per year (Job outlook strong for 2007 ME grads, 2007) replacing a single individual after only one or two years could cost an organization more than $75,000. Obviously there is an economic argument to suggest that an investment in education, to locally train engineers, that would improve the probability of retention, makes good sense, thereby reducing the cost of replacing retiring employees.

One study that was done in Alberta, Canada, seems to contradict or at least it adds a possible element that complicates the conclusions of the preponderance of literature which suggests that the attrition rates for mature engineers will be severe as the baby boomers approach retirement age (Kennedy, 2006). This study attempted to survey 270

engineers that had graduated from the University of Alberta in electrical, civil, and mechanical engineering during 1967, 1972, and 1978. The conclusions drawn by the researcher were that there are a much lower proportion of mature engineers in large corporations than has been assumed based on baby boomer population demographics, that more engineers leave engineering by the time they are 50 years old than has been assumed, and that a large number of engineers over 50 years old work in areas unrelated to engineering. The significance of these findings may not be generalizable to the situation found in the Antelope Valley as the industry in the Alberta study area was largely petroleum based; however, it does suggest that care must be taken to understand the age demographic of the engineering population and retirement and retention trends for any engineering population under study.

Engineering Student Retention in Universities

The National Academy of Sciences (NAS) in *Rising Above the Gathering Storm* (Committee on Science, Engineering, and Public Policy, 2006) indicates that undergraduate retention in the sciences and engineering is the lowest of any of the schools in universities. The NAS also indicates that it is among the brightest students that depart for other educational objectives. Estimates indicate that only 40% to 60% of the students who enter engineering programs complete their degree objectives and that many very good students, especially female students, left their programs even after having achieved good grades. There is a consensus that student difficulties with mathematics, in the freshman year, is the single largest factor in engineering students decisions to leave engineering programs (Bernold, Spurlin, & Anson, 2007). It should also be noted that

students that have acceptable grades in mathematics also leave engineering programs in significant enough numbers to be of concern.

> In spite of considerable research about the poor retention rate of undergraduate engineering students, we still have an inadequate understanding of the factors that affect student's decisions to remain in engineering programs and their ability to perform well enough to be retained (Bernold, Spurlin, & Anson, 2007, p. 263).

Interest in math, science, and engineering among first year undergraduate students declined from 11.5% in 1966 to 5.8% in 1988 (Daempfle, 2003). Some indicators show that there have been some recent significant gains; however, interest in math, science, and engineering remains cyclical (Suresh, 2006). In spite of the fact that there has been a great deal of study directed towards student retention over the last 40 years, there has been very little progress in effecting significant gains (Tinto, 2006). Declining enrollments resulting, in part, from low interest in science, math, and engineering coupled with lower retention rates in these programs suggests that there are too few undergraduates to meet the nation's needs.

Impact in the Antelope Valley

The storm that Mr. Thoemmes described as a "perfect storm" and that the National Academy of Sciences described as a gathering storm is being keenly felt in the high desert of California. The combination of poor employee retention, significant experience loss through retirement, declining enrollment and poor retention of the brightest students in engineering programs must be addressed by local industry in order to remain competitive. The alternative is to move the enterprise to another location or to discontinue doing business. The establishment of a sustainable institution to locally train

engineers would encourage and may even inspire local students to study engineering and assist in alleviating a severe pending shortage of trained professionals.

Underserved by Higher Education for Engineering Education

Students from the Antelope Valley entering the study of engineering have had to leave the Valley in order to do so. According to the Antelope Valley Board of Trade (2008), students that leave the Antelope Valley to obtain a degree in engineering seldom return because they receive employment from other areas.

Figure 1 summarizes data from the U.S. Census Bureau for the cities of Lancaster and Palmdale. As seen in the figure, there is a reduction of more than 30% of 20 to 24 year old individuals. Population trends for Ridgecrest in the northern part of the Antelope Valley, Barstow, and Victorville on the extreme eastern edge as well as all of the communities in the Greater Antelope Valley Region show trends very similar to those of Palmdale and Lancaster (see Figure 2.). Even the smallest of the communities show census data which is consistent with the general trend in the 20 to 24 year old population group. The data is based on census data taken in 2000. Since then a building boom and significant population growth has occurred in the region.

One conclusion drawn by the Antelope Valley Board of Trade (2008) is that the High Desert has been underserved by the State University systems. According to Mr. Johnstone (personal communication, February 12, 2007), many students commute to universities for their engineering educations.

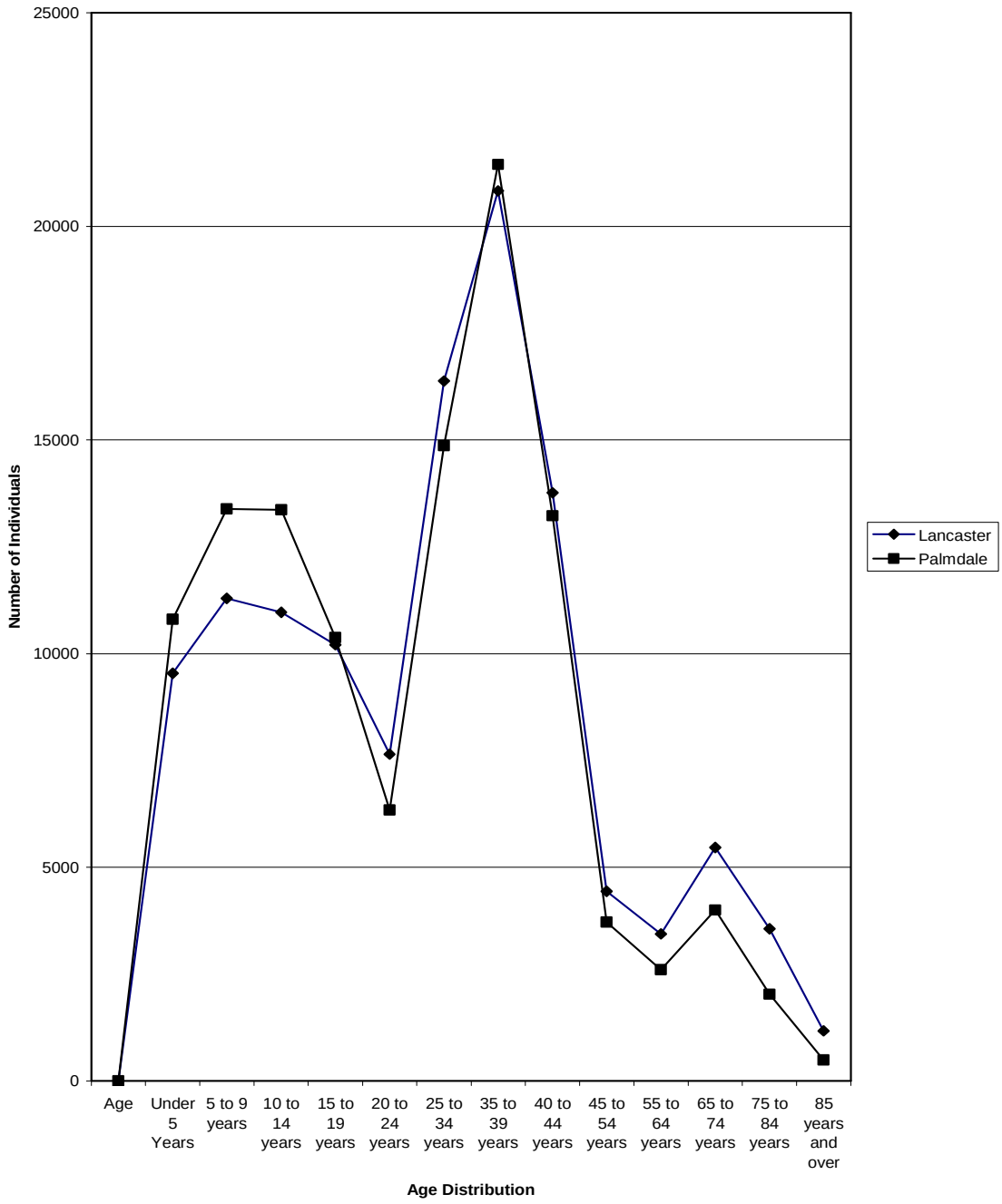

Figure 1: Population distributions by age for Lancaster and Palmdale are very similar and show a reduction in 20 to 24 year olds.

Note. The data in Figure 1 are from "Discovering the Opportunities: Labor, Lifestyles, Los Angeles All Within Reach!" by Greater Antelope Valley Economic Alliance, 2007.

Although the state university in the San Fernando Valley is the closest institution with a four year engineering degree program it is still 50 to 60 miles away and is served from the north by a freeway system that is becoming increasingly congested. Antelope Valley students also find difficulty with universities not accepting many credits from the Local community college thus forcing students to retake subjects. This situation results in long commute times for engineering students that can typically be up to 3 hours one way. The establishment of the Lancaster University Center (LUC) and the initiation of classes should act to both stimulate enrollment in engineering classes at the Local community college, which feeds students to LUC, and encourage those interested in engineering to pursue their studies locally.

An Interim Measure and a Long Range Plan

The Lancaster University Center is viewed by the Antelope Valley Board of Trade as an interim measure to produce locally trained engineers. The Board of Trade has produced a plan for the establishment of a polytechnic university in the high desert. According to Lisa Schencker, a staff writer for the Bakersfield Californian, Kern County could become the site of a California State Polytechnic University in the next 10 to 20 years. She indicates that there are three possible sites that have been identified. One is on Edwards Air Force Base, another is comprised of several patches of land from the Bureau of Land Management that are scattered between Ridgecrest and California City and the third is a 640 acre site near the Mojave airport that is being donated by a San Diego developer.

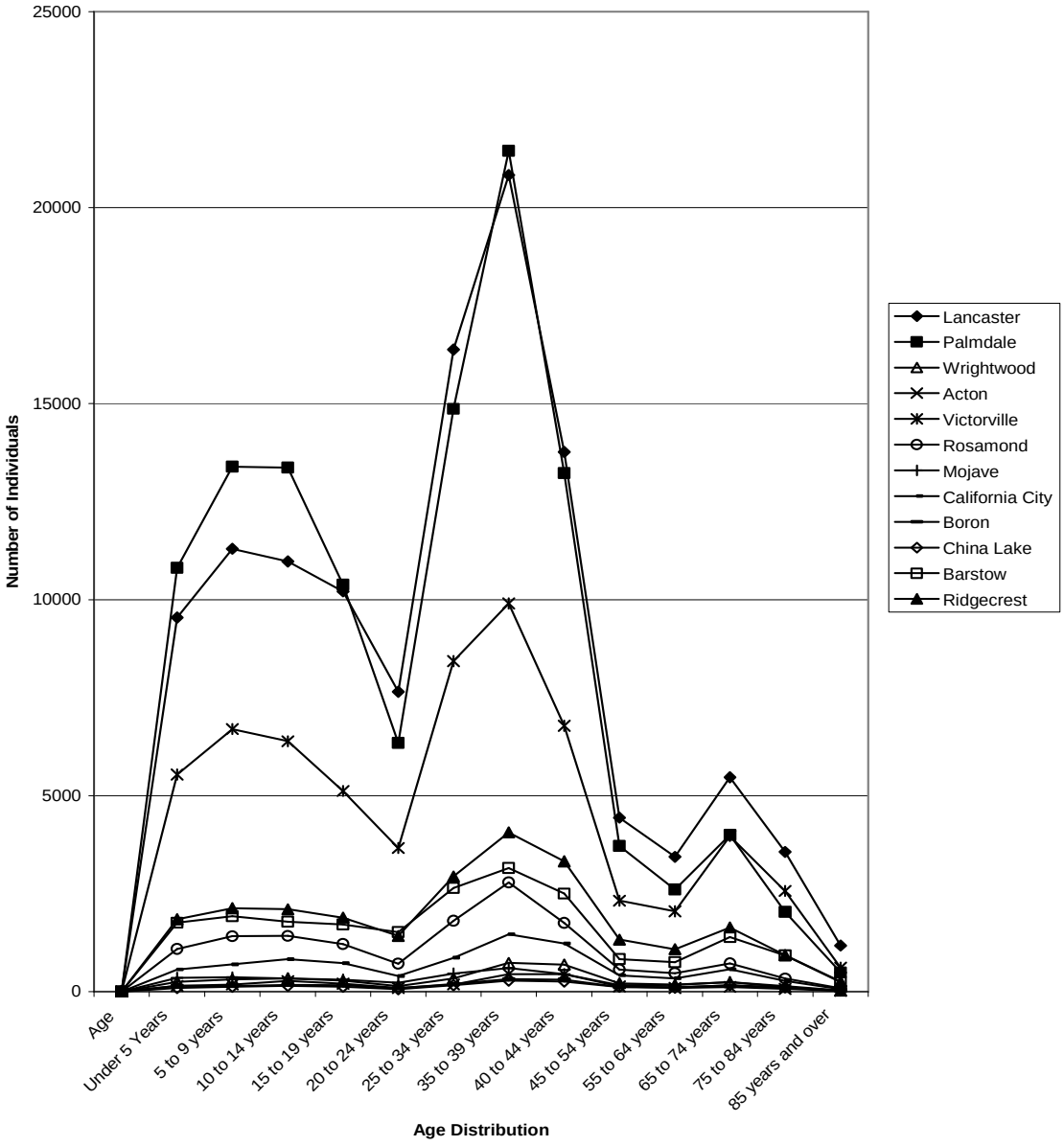

Figure 2: All of the communities in the Greater Antelope Valley region show consistent population trends.

Note. The data in Figure 2 are from "Discovering the Opportunities: Labor, Lifestyles, Los Angeles All Within Reach!" by Greater Antelope Valley Economic Alliance, 2007.

The East Kern Airport District board of directors has recently voted to offer their support to this project (Schencker, 2007). Additionally, adequate access to the property, proximity to transportation, airports, the aesthetics of the location, and whether an area's population was growing are also important factors used in determining a new campus location (Schencker).

According to the Antelope Valley Board of Trade (2008), the primary site would be donated to the State of California by Strata Equity Group and is located 4 miles southeast of the Highway 14/Highway 58 interchange and 2 miles north of Highway 58 at Exit 172. This places the university site within approximately 40 miles of the Palmdale Airport where United Airlines operates daily scheduled flights to San Francisco. Train service is available to Los Angeles from Lancaster, 25 miles to the south. Strata Equity Group has pledged to provide 640 acres for the development of a polytechnic university and a research center as well as an additional 60 acres adjacent to the university site for a community college. In addition to the property donation, Strata Equity Group has pledged $10,000,000 for the first phase of the physical infrastructure development and $5,000,000 for High Desert University Foundation use. Strata Equity Group has experience with university developments having been a partner in the development of California State University, San Marcos (High Desert University Foundation, 2008). The region's population is expected to increase 83% by 2030 (Antelope Valley Board of Trade, 2008).

According to Mr. Johnstone, the developer who plans to donate the land, to the State of California, near Mojave has planned to provide 320 acres to the state for the purpose of building a polytechnic university. The developer also plans to establish a research center on the other 320 acres adjacent to the university property. As already

mentioned, an additional 60 acres will be provided for development of a community college. The plan for the university, research center, and community college are integrated to provide revenue streams to the university and to minimize cost through joint facility use. The university is also integrated with a community developed around the university (High Desert University Foundation, 2008). Again, the Strata Equity Group plans to develop 3,000 additional acres that surround the university site, to create a university town with housing and businesses that will serve the needs of students, faculty, staff and others associated with the university (Gatlin, 2007).

According to the National Science Foundation, the criteria that multinational organizations use when determining where to locate their facilities are as follows: cost of labor (professional and general workforce), availability and cost of capital, availability and quality of research and innovative talent, availability of qualified workforce, taxation environment, indirect costs (litigation, employee benefits such as healthcare, pensions, vacations), quality of research universities, convenience of transportation and communication (including language), fraction of national research and development supported by government, legal-judicial system (business integrity, property rights, contract sanctity, patent protection), current and potential growth of domestic market, attractiveness as a place to live for employees, and effectiveness of national economic system (Committee on Science, Engineering, and Public Policy, 2006, p. ES-2). The establishment of a university in the Antelope Valley would tend to address several of the criteria, reported by the NSF, that concern availability of a qualified work force, innovative talent, and availability of research capabilities thus affording marketability in

acquiring new industry development for the region's Boards of Trade and Chambers of Commerce.

The Lancaster University Center

Skeen (2007), a staff writer for the Daily News has reported that LUC has had its first two engineering graduates. One individual graduated with a degree in mechanical engineering and one with a degree in electrical engineering. The degrees were awarded by a California State University in the Central Valley. This is a major milestone as these individuals are the first two engineering students to graduate from a local engineering program in the Antelope Valley. One of the graduating students will be starting a career at the local Northrop Grumman facility in Palmdale. Skeen also reported that,

> The Lancaster University Center is the product of more than seven years of effort to address the region's need for engineers. In addition to Cal State, the partners in the effort are Lancaster city government, the Air Force Research Laboratory Propulsion Directorate, Antelope Valley College, California State University, Bakersfield, and NASA's Dryden Flight Research Center (p. 3).

Skeen went on to describe the structure of the program explaining that the program is designed so that students take their freshman and sophomore classes at the Local community college and then complete their core engineering courses and the balance of their upper division courses at the center which is located at the site of the old Antelope Valley Fairgrounds.

Dr. Jeigh Shelley, an adjunct professor of mechanical engineering at the center, has stated that there were 21 engineering students enrolled in the LUC engineering programs in April, 2007. There are 5 mechanical engineering and 8 electrical engineering

undergraduate students and 5 mechanical engineering and 3 electrical engineering graduate students (J. Shelley, personal communication, April, 9 2007). Skeen reported that Dr. Shelley stated that the LUC staff has worked hard to make sure that the program at the Center is academically the same as at the Cal State main campus (Skeen, 2007). A final note regarding the Lancaster University Center is that it is basically a facility developed through the generosity of the City.

The program offered at LUC consists of undergraduate mechanical and electrical engineering and a single graduate program, at the Master of Science level in electrical engineering. A mechanical engineering graduate program has been in operation but enrollments have been suspended in order to avoid competition for students with a California State Polytechnic University aerospace engineering program, also being offered at the LUC. The Cal State main campus offers undergraduates the opportunity to study Civil Engineering, Construction Management, Electrical and Computer Engineering, Geomatics Engineering, and Mechanical Engineering. At the graduate level, a Master of Science in Civil Engineering and a Master of Science in Engineering with an option in either Mechanical or Electrical Engineering is offered as well. Industrial Engineering was offered but was eliminated after the 2005-2006 academic year (California State University, Fresno, 2007).

The Impact of a University in the Antelope Valley

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 (Edwards Community Alliance, 2006, p. 1).

The impetus to establish a 4 year university engineering program in the Antelope Valley began with the realization that recruitment and retention of engineers from outside the High Desert region would not meet the Air Force workforce requirements. Edwards Air Force Base is the single largest employer in the region with over 12,000 military and Civil Service personnel working in a very technical environment that is geographically uniquely suited to high performance aircraft flight test. However, the benefit, to the Antelope Valley communities, of establishing a sustainable 4 year institution of higher education goes far beyond meeting the Edwards Air Force Base workforce demand.

A University Exists But is Not Yet Recognized

Based of the information gathered and the literature reviewed at this point, it is the researcher's opinion that the first step in understanding the community benefits that can accrue from the establishment of a sustainable 4 year university, to serve the high desert region, is to recognize that a 4 year university has already been established in the Antelope Valley through the cooperation of the local community college, Cal State, another comprehensive state university, and most recently, a California State Polytechnic University. These 4 institutions provide a collaborative educational entity that is the *University* in the High Desert. The Local community college is the largest of several community colleges in the region with an enrollment that will exceed 14,000 students in the 2007 – 2008 academic year. Through dual enrollment and guaranteed transfer agreements, the local community college provides lower division curriculum for LUC and for the comprehensive state university. Applicable credits earned at the local

community college transfer seamlessly as students begin their upper division work at either university extension. Additionally, the comprehensive state university provides the courses required to satisfy upper division general education requirements for LUC engineering students. Neither university offers lower division classes in the Antelope Valley.

As has been previously mentioned, the California State Polytechnic University is currently focused on providing a Master of Science degree program in Aerospace Engineering. LUC offers Bachelor of Science Degrees in Mechanical and Electrical Engineering as well as a Master of Science degree program in Electrical Engineering at the LUC. The comprehensive state university focuses principally on liberal arts and provides Bachelor of Arts and Bachelor of Science degrees in Business, Communications, Criminal Justice, Economics, English, Environmental Resource Management, Liberal Studies, Nursing, Psychology, and Sociology. Certificate programs are offered in Drug and Alcohol Studies, Elementary Education, Special Education, and Secondary Education Program. Master of Arts and Master of Science degrees are offered in Educational Administration, Educational Curriculum and Instruction, English, and Social Work (Skeen, 2007).

The unique institutional collaboration to create a University in the Antelope Valley needs to be extended through dual enrollment and guaranteed transfer agreements with other regional community colleges. Such an effort would, in this researcher's opinion, extend higher education opportunities to geographically remote areas and, in particular to potential first generation university students, that may not otherwise have an opportunity to pursue a 4 year degree objective. Since LUC provides the only

undergraduate pathway to an accredited engineering degree in the region such collaborative agreements are especially important for students seeking a career in engineering. Other community colleges in/or adjacent to the region, or that a regional university may serve, include community colleges in Bakersfield, Barstow, Santa Clarita, Ridgecrest, Taft, and Victorville (College of Engineering, Antelope Valley Engineering Programs, 2007). Demographic changes and population growth are beginning to significantly affect the region's approach to higher education. These factors dictate the need to understand regional needs and make the adjustments necessary to meet those needs.

Potential Benefits to the Regional Community

The mission of the modern American university began with the medieval European university teaching mission and moved, in America, to the democratization mission which emphasized service to the individual. At the same time the German university began to promote the research mission of the university. In the 20th Century American universities extended the service mission to the public. In the postmodern society an internationalization mission is developing (Scott, 2006). The end of the Cold War, dramatically illustrated by the destruction of the Berlin Wall, and the introduction and availability of the technologies of the information age are flattening the world (Friedman, 2005) and the development of the university mission to include teaching, research, public service, and now moving towards internationalization is consistent with the notion of a world that is flat. The role of the university in the Greater Antelope Valley is impacted by the changing regional demographics which indicate the need to focus on

the service mission in order to successfully address the needs of the community through collaboration and advance the establishment of a sustainable university.

> Therefore, thinking about how we stimulate positive imaginations is of the utmost importance. As Irving Wladawsky-Berger, the IBM computer scientist, put it to me; We need to think more seriously than ever about how we encourage people to focus on productive outcomes that advance and unite civilization – peaceful imaginations that seek to "minimize alienation and celebrate interdependence rather than self-sufficiency, inclusion rather than exclusion," openness, opportunity, and hope rather than limits, suspicion, and grievance (Friedman, 2005, p. 443).

It is the message of hope rather than limits that the university in collaboration with the community needs to advance in the student population of the Antelope Valley.

The demographics of the student population in the Antelope Valley have changed radically over the last ten years as housing has tended to be and continue to remain much more affordable than housing in the San Fernando Valley or in other parts of Los Angeles or Orange Counties. According to the 2007 Economic Roundtable Report, (Greater Antelope Valley Economic Alliance, 2007), median housing prices in the Antelope Valley range from approximately 31% to 61% of the cost of median housing prices in other parts of Los Angeles County. The median home price for all homes in Orange County is $640,000 (Orange County home sale activity for home sales recorded in July 2007, 2007) while in Palmdale the median price is approximately $300,000 less (Greater Antelope Valley Economic Alliance, 2007). Figure 3, based on data from the California Department of Education (2007) shows the demographic change that has occurred over

the last 10 years in the Antelope Valley Union High School District. The data clearly indicates that there has been a significant shift in the student population distributions towards a predominantly minority ethnic makeup. This shift has occurred concurrently with a reduction in the median household income of between 0.4% and 0.8% in the Lancaster – Palmdale area, from 2005 to 2006, as first time home buyers and low wage earner families move into the region (Greater Antelope Valley Economic Alliance, 2007). The opportunity to affect a positive change in the low wage earning segment of the population by attracting first generation university students appears to be significant. Based on the assumption that positive change can be generated, a realistic pathway for the first generation students needs to be developed.

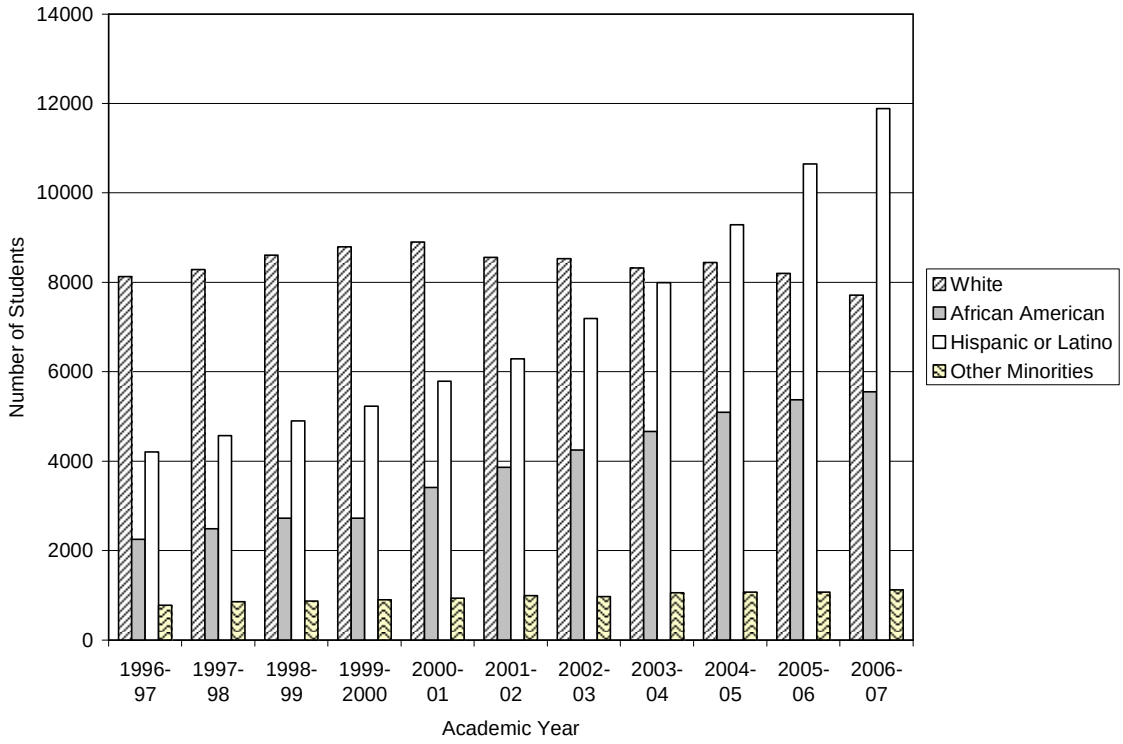

Figure 3: Demographic ethnicity trend in the Antelope Valley Union High School District, 1997 to 2007.

Note. The data in Figure 3 are from "Discovering the Opportunities: Labor, Lifestyles, Los Angeles All Within Reach!" by Greater Antelope Valley Economic Alliance, 2007.

In the researcher's opinion, the university cooperative effort that has been established in the Antelope Valley, between the community colleges and the state university system, is well suited to the establishment of pathways to higher education. A pipeline metaphor is in preferred use in discussing the preparation of students for entering a University and is used most frequently in the Antelope Valley. Filling the pipeline creates an image of students poured in one end of a continuous progression of preparation and then flowing out the other end into the university (Jones, Yonezawa, & Ballesteros, 2002). Discussing pathways; however, opens the way for understanding the variety of routes that students, especially first generation university students and under-represented minorities, take or need to take to enter a university. The University of California, San Diego (UCSD) has established an elementary school/secondary school/university collaborative partnership that they have named CREATE (Jones et al., 2002). CREATE was developed in response to the need to develop a diverse student body at UCSD without affirmative action. This program is focused on underrepresented minority schools and is built around valuing authentic collaboration for school reform. This program provides a model that can be applied in the Antelope Valley.

According to Jones et al (2002), the entry into the partnership required providing teacher requested technical assistance to partner schools in the form of in-class assistance, teacher-driven professional development, or after school academic programs. Examples of such efforts included tutoring programs, after school computer clubs, professional development opportunities, and college counseling. Once trust was

established between the partner schools and the university, the partnership moved to a new level as schools began to reshape their focus towards academic preparation for college. Although the absolute number of poor and underrepresented students eligible to enter the University of California/California State University system is small, increases on the order of 35% have been noted in a single year. Other indicators show schools adding sections of algebra as a result of significantly increased student demand. Two partnership schools have even totally eliminated all non-qualifying math and science classes. The poor and the underrepresented minority first generation students provide a major segment of the market for the local university. The ability to expand the university and to develop sustainability in the Antelope Valley depends on more attention, focused on such a partnership, to aid in opening pathways to a university education for poor and underrepresented minority students. The benefits to the community that accrue from improved pathways to higher education seem obvious. Some of the underrepresented minority and the children of low wage earning families will take advantage of the availability of an education. Success will lead them to improved socioeconomic status and they will become role models for others to follow.

The LUC extension and the comprehensive state university are being considered an interim effort; however, the selection process and the decision to establish a new CSU campus are probably 10 to 20 years in the future (Schencker, 2007). The City of Lancaster has developed and is providing the Lancaster University Center for use by universities at a very low cost. The City has developed the LUC as a center piece of their eastside redevelopment project. Room for expansion is limited but is available. As the student population grows expansion, of necessity, will occur and reshape the complexion

of the adjacent businesses as opportunities for economic benefit are recognized. At least this is the assumed rationale for the investment that the city has made in the Lancaster University Center.

Potential Benefits to Business

The most obvious benefit and the objective of the Aerospace government organizations and commercial industries in the Antelope Valley is to train engineers locally to replace their aging work force with professionals that will be more inclined to remain in the regional work force (Schencker, 2007). According to Scott (2006), a new type of partnership between universities and corporations developed in the 1970s to supplement the government relationship, which evolved during World War II, for funding research. The most notable example occurred in the Silicon Valley with the computer industry. The Strata Equity Group plan for university development in the Antelope Valley includes a research capability.

> The company proposes 320 acres for the university itself, with the remaining 320 acres to be used for a university-owned research park, which would provide a revenue stream to the school and create a symbiotic relationship for high tech research with the university and industry (Gatlin, 2007, p. A4).

Such a successful research facility development, as envisioned by the Strata Equity Group, would have a significant impact on the economy of the region. A successful research facility would draw additional industry into the area to provide the necessary support for both the university in its teaching mission and to provide infrastructure to support the research community and the university's research mission. Construction and

subsequent operations of the university and its associated research community would create many new jobs and would attract students.

Scott (2006) has indicated that the government, corporations, and universities have been working, during the 1980s and the 1990s, to shift research investments away from the military to address civilian technological and scientific needs. Similar situations and redirections have been described in a European context (Valimaa, 2004).

> In Finland, nationalization of higher education has created a cultural understanding of higher education institutions as important factors in the competition with other nations. As for localization, it refers to processes where, on the one hand, higher education institutions support their local communities and provinces to gain social and economic benefits and, on the other hand, local communities and provinces support their higher education institutions in the hope of benefiting from the scientific capital held and generated by these (p. 51).

Valimaa (2004) goes on to state that,

> Finally, economic globalization creates new dynamics within higher education institutions not only through strategic alliances between higher education and commercial enterprises but also through the emergence of alternative new funding sources in this area at a time when the public funding of national higher education systems is steadily ebbing away (p. 51).

The shift from military to civilian needs centered research, Scott (2006) indicated, is not without criticism. He reported that critics are concerned that commercial pressures will compromise the traditional university missions and will threaten institutional autonomy. In the same article, Scott discussed a growing opinion that universities need to

adopt a public service mission that is global as well as national and local in nature and that this mission should then be supported by the missions of teaching, learning, and with new research discoveries. The effort by LUC, comprehensive state university, and the California State Polytechnic University has the potential to embody much of the public service mission discussed by Scott.

The Challenge of Achieving a Sustainable Enterprise

The university in the Antelope Valley, established through the cooperative efforts of the several State University and Community College organizations currently engaged, faces the challenge of achieving sufficient support to become self sustaining and advance the cause of placing a CSU campus in the region within the context of the California State University System. This effort is not without precedent and it does not lack a successful model to emulate. A situation that was 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 system (de Give & Olswang, 1999).

According to de Give and Olswang (1999), the conditions prior to the establishment of the branch campus system were not too dissimilar from what appear to this researcher to be those that currently exist in the Antelope Valley today. The authors de Give and Olswang 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 and the aerospace industry in the Antelope Valley are unmistakable. Both of these areas were and still are heavily influenced by the whims of congressional funding. 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 Oswang (1999) 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 interim university solution in parallel with the coalition building required to achieve the strategic objective of securing a California State Polytechnic University.

Establishing a Distance Learning Center

The Distance Learning Center for the Cal State and the comprehensive state university programs at the LUC has been established and it is in its third year of operation. Two fully equipped, state-of-the-art, distance learning class rooms have been in use for receiving live instruction from the main campus in Fresno and for providing live instruction to students at the main campus. They have also been used to provide upper division General Education classes from the comprehensive state university main campus. Course delivery for LUC engineering via distance learning typically occurs with students in class at both the delivering and the receiving locations. Acceptance of and participation in the distance learning program by the faculty at the College of Engineering in Fresno has not been uniform and some tenured members of the faculty have simply refused to participate. Low enrollment at the distance learning center has disturbed some faculty as they resent adjusting their course delivery for just a few students.

As compared with resident course delivery, preparation for course delivery using distance learning technology requires more time in the design phase and equal time in delivery (Childers & Berner, 2000).

> By nature, a distance education course forces an instructor to face pedagogical and technological issues and problems he might not face in a typical course. What we learned is that the solutions we developed can be used just as effectively in any classroom and will enhance any instruction (p. 64).

The results of the case study by Childers and Berner revealed that good practices in preparing for a resident class still apply to a class offered via distance learning.

Interaction between students and the instructor remains important, but design and support are more time consuming.

Students surveyed, during the course of a class offered by distance learning, wanted to see their instructor's face on their monitor more frequently. They also would have enjoyed and expressed their desire for more interaction with the instructor (Childers & Berner, 2000). In response to an AT&T grant, faculty at Penn State, Lincoln, and Cheyney Universities developed 5 categories of guiding principles and practices (Ragan, 2000). The first category discusses the learning goals and the presentation of the course content. Once the goals have been defined, they need to be communicated then content, delivery, evaluation, and support should all be directed to support the established learning goals. The second category defined the need for interactions among the learners both socially and academically. The need for access to academic support services and resources was also identified. Category III applied to assessment and measurement. Beyond the traditional needs for student progress and feedback, the need to accommodate and evaluate the instructional design within the distance learning context was identified. In the fourth category, the faculty team defined the need to make sure that the instructional media and tools were specifically designed for the technology used to deliver instruction. This category also identified the need for a contingency plan to be implemented during delivery in the event that technology related interruptions occur. The last category addressed learner support systems and services and championed 24/7 access for faculty and learners.

Research at Penn State has identified the need for student orientation at the beginning of a distance learning class (Lesniak & Hodes, 2000). This study also

determined that students with previous distance learning experiences are better able to establish contact with their instructor and develop relationships. Lesniak and Hodes also concluded that more detailed planning is required of the instructor and significantly more detailed instructions for assignments may be required.

The primary difficulty with distance learning using interactive compressed video technology seems to be the perception of impersonal student to instructor and student to student interactions imposed by the technology itself (Salisbury, Pearson, Miller, & Marett, 2002). Differences in expectancy and behaviors existed between the local class and distance class. Some animosity resulted among local class students as a result of distance students buzzing-in to interact during class discussions. Some students reported discomfort at being on camera. Generally, the local students had a great deal of sympathy for the distant students but students all would prefer a live instructor over a distance learning course delivery mode. Salisbury, et al. also brought up the concern that teaching methods and class size have a significant effect on student critical thinking development, the acquisition of problem solving skills, and on motivation to continue learning after the class has been completed. They also report that learning and factual knowledge retention are only minimally effected by class size and teaching methods but that small highly interactive classes that stimulate high amounts of discussion are the most effective in stimulating critical thinking, developing problem solving skill, and in motivating students to continue learning.

It appears from the studies conducted on distance learning, and reported herein, that there is nothing counter-intuitive about the issues revolving around providing high quality instruction and student learning experiences through distance learning. Issues that

need to be addressed in establishing a distance learning center on careful planning, student orientation, instructor training, strong support, and facilitating student – instructor and student – student social interaction and dialog.

Online and Distance Learning Potential

"In India, the distance learning university – Indira Gandhi – has about 1.5 million students and delivers some of it programmes by its own satellite to 17 different countries. Is there any other university in the world that has its own satellite" (Is the future for lifelong learning distance? Dancing with the devil!, 2006, p. 103). The example cited is an extreme example but it dramatically illustrates the potential for distance learning. Of note; however, is the fact that not even the Indira Gandhi National Open University offers undergraduate engineering education through distance learning. In the Antelope Valley which occupies approximately 9,000 square miles, cities and towns are distributed and the population is geographically disbursed. Cal State and the comprehensive university have established distance learning centers at their main campuses and at the Lancaster University Center. The community college in Ridgecrest has 5 learning centers between Mammoth Lakes North of the Owens Valley and Edwards AFB in the Antelope Valley serving 65,000 residents distributed over 18,000 square miles. By developing partnerships with the community colleges in Victorville, Barstow, and Bakersfield and by expanding the relationship with comprehensive state university, higher education could be offered to California residents not only in the Greater Antelope Valley, but in the Lucerne, Victor, Apple, and Owens Valleys as well using expansions and modifications to existing educational facilities. Mining such potential would certainly establish a leadership role for Cal State in offering engineering education at the undergraduate level

using the distance learning delivery being developed along with investment in strategically distributed laboratory facilities.

Topics such as the unbundling of faculty roles and the use of technologically skilled para-professional staff to support instructional development (Paulson, 2002) would lend themselves to the development of such a distributed university. Such a vision; however, must be reserved as the subject of future studies.

Alternate Program Delivery Modes

A distinct subject for this study is the potential need for alternate delivery modes and schedules. The LUC undergraduate engineering program is currently delivered during the normal working day and the graduate programs are delivered in the evening to accommodate working adults seeking to advance their education through a graduate degree objective. Evening classes to deliver the undergraduate curriculum would serve working adults who choose to study engineering. The need for such a program schedule extension needs to be explored during the course of this study.

The limitations placed on learning due to time and distance can now be reduced through the use of technology. Access to instructors, learning, student interaction, and discussion can be extended far beyond the classroom (Brown, 2004).

> Technology has the potential for changing the way teachers teach and students learn (Thompson, Schmidt, & Davis, 2003). Jonassen (2003) suggests using technology for interactive learning because problems encountered in everyday practice are typically emergent and not well defined. Because students represent problems in one way, typically quantitatively, Jonassen suggests using multiple representations to help learners transfer their skills when problem-solving. These

> representations include structural knowledge, procedural knowledge, reflective knowledge, images and metaphors of the system of strategic, social/relational, conversational/discursive and artifactual knowledge. Courseware with capabilities for posting discussions, data displays and threaded conversations support using cognitive tools to introduce and solve problems (Brown, 2004, p. 37).

This, according to Brown (2004), deviates from the practice of simply using technology to broadcast traditional lectures to a distant audience but technology can itself become a tool for learning that meets today's needs and student expectations. It does require; however, a significant paradigm shift requirement for faculty. In a case study of an internationally conducted Master's program in adult learning, it was found that command of the language, participation, and responsiveness were elements that effected student performance and the performance of the cohort in which the students had enrolled. The factors at issue were mistake anxiety for those less proficient in the instruction language and access, at a reasonable cost, to the internet (Dahlgren, Larsson, & Walters, 2006). Such factors must be considered in looking towards alternate delivery methods for an engineering curriculum even within a less geographically disbursed region, such as the antelope valley. Creating an interactive on-line delivery for technical course content may pose unique challenges both due to the nature of the material being learned and due to the personalities of the learners.

The Master's program case study illustrates the nature of what may be a move towards a different future for higher education (Hiltz & Turoff, 2005).

> From**:** face-to-face courses using objectivist, teacher-centered pedagogy and offered by tens of thousands of local, regional, and national universities;

> To**:** online and hybrid courses using digital technologies to support constructivist, collaborative, student-centered pedagogy, offered by a few hundred "mega-universities" that operate on a global scale (Hiltz & Turoff, 2005, p. 60).

This vision is a substitution process that is underway that may significantly change higher education as the technical sophistication and capability continues to increase and improve. Mega-universities already exist and the shake-out that would lead to domination by mega-universities in higher education is not inconsistent with the result of mergers and acquisitions in industry and globalization that has occurred.

An interesting addition to alternate delivery modes is class room augmentation through the use of texts on CD-ROM presented by virtual instructors (Houser, Cowan, & West, 2007). Such an augmentation may develop to a level where lectures can be offered and students can participate as their schedules permit by viewing the lecture and using asynchronous methods of communication to continue class participation with the instructor and with other students.

The *distance learning* conceptualization may be replaced by the less restrictive concept of *distributed learning* (Stella & Gnanam, 2004).

> Distributed learning can occur either on or off campus, providing students with greater flexibility and eliminating time as a barrier to learning. Regardless of whether students are on campus or on-line, by integration of technology into education, learning becomes distributed (p. 145).

This distributed learning model is appealing from the perspective of the course delivery mode required by circumstance for the Antelope Valley engineering program; however, as the move towards distributed learning progresses, the quality of instruction must be

maintained or even improved. In India, distance learning is evaluated using basically the same criteria as live instruction (Stella & Gnanam, 2004). The need for monitoring and improving program quality must be recognized and institutional self-evaluation and improvement initiatives implemented. These actions will ensure that the product of higher education, the student, continues to receive high quality academic programs.

The Customer and the Product

The basic mission of the College of Engineering at LUC in the Antelope Valley is to provide high-quality academic programs in engineering that support the infrastructure and growth of the region (Staff, 2007). Mission statements can be found in the catalogs and on the web sites of most colleges and universities but few have defined themselves in terms of those that they serve (Maguad, 2007). “In campuses that do admit they have customers, there is usually a general agreement that businesses, government agencies, and the society at large are customers” (p. 333). “In order to understand customer needs, an organization must first identify who its customers are” (p. 334).

Customers

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 must be determined. Thus, who the customer is becomes the crucial first step in understanding the customer’s needs (Drucker, 2001).

Higher education is the 13th largest industry in the United States and like many other American industries higher education is facing increased competition and reduced budgets. In order to meet these challenges higher education institutions are faced with the

need to provide higher quality services with fewer resources. This situation requires that customers be accurately identified and that customer needs be well understood (Mustafa & Chiang, 2006). The higher education industry tends to avoid the word *customer* in favor of euphemisms that have the same meaning. Maguad (2007) has stated that, in higher education, the notion of having customers is very foreign to many administrators and faculty members. In fact he indicates that the term *customer* evokes emotional responses, particularly with reference to considering students to be customers.

> In higher education, the notion of having customers is foreign to many campuses. Even the suggestion of the term can arouse many emotions, preconceptions, and misconceptions (Canic and McCarthy, 2000). Faculty and administrators alike are reluctant to call a student or anyone else a customer (Teeter and Lozier, 1993). They find the commercial flavor distracting and difficult to translate to education (p. 333).

Relevance or industry relevance are commonly used terms in evaluating curriculum to determine if customer needs are being satisfied in engineering schools (Munukutla, McHenry, Darveaox, & Tamizhmani, 2005; Wei, 2005). The quality of the education being provided by engineering schools is being discussed in terms industry, community, student, and faculty input (Wolverton, 1996). A simple approach to identifying the customers for particular higher education programs, such as the engineering programs offered by LUC in the Antelope Valley, allows the development of highly focused assessments of customer needs. “The future success of colleges and universities will increasingly be determined by how they satisfy their various customers. The successful ones will be those which very clearly identify their mission and the customers they serve”

(Maguad, 2007, p. 333). A realistic model of higher education has been proposed in which employers are viewed as customers and the product of higher education is the student with the rewards for the student accruing after graduation, namely through employment (Bailey & Bennett, 1996). The implications of adopting this model for the LUC engineering programs in the Antelope Valley become immediately obvious. The customers for the engineering undergraduate and graduate programs are the employers as represented in Appendix A and Appendix B.

Products

The products of higher education are the students (Bailey & Bennett, 1996) which are the units of production and which can be described as academic output (Laband & Lentz, 2003). The methods of production are the undergraduate and graduate programs of instruction that lead to the successful student completions of their degree objectives. The majority of the literature offers the student as the primary customer for or consumer of higher education (Gutman, & Miaoulis, 2003; Maguad, 2007; Mustafa & Chiang, 2006; Paul, 2005). The concept of the higher education product described by Laband and Lentz (2003); however, focuses not on the needs of the student as a consumer of higher education but on industry as a consumer of a completed ready-to-use product. The reason for this product bias is that engineering is a professional discipline and, very much like medicine and law, the vast majority of graduates are consumed by industry and government to practice in their specific area of applied science. Engineering is exceptional though because there are no internships or graduate requirements for entering the work force after only the basic 4 year study program that leads to a Bachelor of Science degree (Wei, 2005).

> Engineering education is the major exception, where the students go straight from high school to an engineering school for a BSE, and then he/she is declared both broad enough to be an enlightened citizen and expert enough to practice engineering, all in 4 years of education (Wei, 2005, p. 129).

It is also of interest that Wei (2005) notes that over half of the engineering graduates in the U.S. are now employed in service rather than manufacturing industries. This may affect the nature of engineering education in the future and the phenomenon, which is the need for engineers in the service industry, should be noted as an area to be studied.

Support from Industry

The California State University budget is based on the practice of incremental budgeting and is driven by enrollment (Office of the Chancellor, 2006). This produces a difficult situation for an extension organization that is in a start-up mode. Student enrollment is currently low in the Antelope Valley engineering programs. This results in a situation where the Full Time Equivalent Student (FTES) contribution to the parent California State University in Fresno is very small. The involvement of the community and industry, in both tangible and intangible support, is therefore required in order to develop a sustainable enterprise.

The need for community and industry support not only sustains the local higher education effort, it also provides the ability to create graduates that meet the needs of their potential employers. Support structures provide the ability for engineering education to develop graduates that have what they need to know to minimize the gap between what is learned in class and what practicing engineers need to become effective in the work force (Kovacs, 1993). Methods of support identified by Kovacs are through industry open

houses directed at students and faculty, funded student projects of mutual interest, internships, cooperative agreements, support to an endowed chair, and involvement in the class room through the presentation of case studies by subject matter experts. Direct support to a foundation account to support operations is also necessary.

The researcher is a 27 year veteran from the aerospace industry and has over 36 years of engineering and government service experience. This industry experience, coupled with a doctorate in education, allows the researcher the ability to obtain the trust of engineering managers, executives, and community leaders because of the extensive experienced gained and the common vocabulary and industry insights which years of engineering management experience have developed. According to Kouzes and Posner (2002),

> Relevant experience is a dimension of competence and one that is different from technical expertise. Experience is about active participation in situational, functional, and industry events and activities and the accumulation of knowledge derived from participation. Experience correlates with success, and the broader your experience, the more likely you are to be successful across organizations and industries (p. 30).

Kouzes and Posner also state that,

> A leader must have the ability to bring out the best in others-to *enable* [emphasis added] others to act. In fact, new research is revealing that the ability to enable others to act has become the critical differentiator between success and failure in the executive ranks. We think it applies equally at all organizational levels, as well as to leaders in all settings (p. 30).

The ability to enlist the support of industry and the community and then to enable supporters to act is critical to successfully sustaining LUC.

Marketing

The effort undertaken to bring engineering education to the Antelope Valley is a start-up endeavor, only in its third year of operation. As an organization in startup, LUC also requires entrepreneurial leadership. The staff at LUC is limited and there is essentially no budget for advertising and marketing. The effort, therefore must be focused around personal selling and direct marketing. According to Ali and Seiders (2004),

> Personal selling is an important activity for entrepreneurs on an informal personal level-through professional networking. Leveraging personal and industry connections is a key success factor, especially in the startup or early growth stage of the venture (p. 98).

The authors go on to explain that personal selling is very time-consuming and often very laborious process that is often neglected and seldom optimized.

Direct marketing is another approach that can be successfully used. The methods for direct marketing include direct mail, telemarketing, infomercials, and email. The effectiveness of these approaches is easily measured as they lend themselves to the use of databases that be analyzed. Ali and Seiders (2004) go on to say,

> With the increased use of technology and databases in marketing, and the growth of the Internet channel, the practice of one-on-one marketing has become pervasive. This type of marketing is interactive and has qualities similar to personal selling: A company can address a customer on an individual-level,

> factoring in that customer's previous purchasing behavior and other kinds of information, and then respond accordingly (Ali & Seiders, 2004, p. 98-99).

Ali and Seiders also discuss Guerrilla Marketing which, based on its explained use, has an appeal for application at LUC. This marketing effort is used to get the customer's attention and build awareness of the enterprise through nontraditional methods that appeal at a grassroots level to captivate. It generates awareness through word-of-mouth in the market and makes a unique impact. Braddock and Sawyer (1985) offer the following advice, "Small companies have neither the funds nor expertise to undertake complex scientific market research. Such studies may not only be costly but also unnecessary" (p. 335). They go on to suggest that conducting informal interviews, reviewing books, magazines, and existing surveys can be used to conduct market research. The authors also recommend attending meetings where customers meet to discuss their needs.

Needs Assessment

In order to develop the community and industry support to sustain the infant 4 year university and, in particular, the Cal State College of Engineering effort in the Antelope Valley, it is necessary to align that which is offered by the College of Engineering with that which is needed by the local communities and industries. "Most experts agree that human learning, training, and performance-improvement initiatives should begin with a needs assessment" (Gupta, Sleezer, & Russ-Eft, 2007, p. 13). The effort to bring an undergraduate engineering curriculum to the Antelope Valley was reported to have been stimulated by the desire for such programs on the part of the region's communities and industry. This is evidenced by the recent meeting of the California State University Chancellor with regional leaders in Mojave, California to

discuss the establishment of a new California State University campus in the Antelope Valley (Gatlin, 2007). Based on the assumption that undergraduate engineering education is needed in the region, a needs assessment is required in order to address dissatisfaction with the lack of a local program and to satisfy the desire for change (Gupta et al., 2007). According to Gupta et al, "Needs Assessment is a diagnostic process that relies on data collection, collaboration, and negotiation to identify and understand gaps in learning and performance and to determine future actions" (p. 15).

The theoretical basis for this needs assessment will rely on the seminal works, in curriculum development, of John Dewey and Ralph W. Tyler. According to Tanner & Tanner (2007) the leading curricularists of the twentieth century restated Dewey's phases of scientific inquiry in their efforts to promote systematic approaches to curriculum development. Dewey's work is still pertinent and visionary even in today's age of distance learning and the advent of the mega-university. His work is still regarded as exhibiting a deep understanding of educational processes and as championing a democracy of abundance (Boyte, 2004). Even in this new century Dewey's philosophy of education is relevant and applicable to education (Carver & Enfield, 2006). Ralph Tyler's four questions that relate to purpose, experiences, organization, and evaluation are therefore equally valid and relevant in today's world.

John Dewey began his work early in the last century and even in his early works he related education to society in suggesting that there is a relationship between experience gained outside the class room and the application of learning to the environment outside the class room (Dewey, 2001). Much has been written recently about Dewey's philosophies. Comparisons have been made describing the convergence

of his works with those of Karl Marx (Harris, 2006), similarities between his philosophy and that of the Buddha (Chinn, 2006), as well as a comparison with the Zen masters (Zigler, 2007). John Dewey's work has been recently used to argue for a more useful theory of knowing that fosters class room practices that lead to inquiry (Boyles, 2006). His efforts have been used to define contemporary citizenship in a democracy (Boyte, 2004). Dewey's work, began a century ago, seems as contemporary today as it was when written. His contributions used in framing this needs assessment are equally contemporary and relevant.

The theoretical basis for his study dates to 1902 in John Dewey's *The Child and the Curriculum*. In his short discussion the argument Dewey presented can be used to set the organization of thinking with which a needs assessment, relating to higher education, can be approached. "The fundamental factors in the educative process are an immature, underdeveloped being: and certain social aims, meanings, values incarnate in the matured experiences of the adult" (Dewey, 2001, p. 104). As related by Tanner & Tanner (2007) the fundamental factors (sources) described by Dewey resolve to learners, society, and organized subject matter. Dewey (2001) also provides the observation that the three sources are most often viewed independently and that educators tend favor one source to the exclusion of the others. He goes on to suggest that the three sources need to be viewed within the context of a single reality. Dewey's observation and suggestion were largely confirmed by the Progressive Education Association's Eight-Year Study conducted between 1933 and 1941. In this study, three approaches to sources were identified. They were the social demands approach, the adolescent needs approach, and

the specialized subject matter approach which coincide with Dewey's three sources (Tanner & Tanner, 2007).

Ralph W. Tyler (1949), basically building from Dewey's work, posed four questions which are: (a) "What educational purposes should the school seek to attain?" (p. 3); (b) "How can learning experiences be selected which are likely to be useful in attaining these objectives?" (p. 63); (c) "How can learning experiences be organized for effective instruction?" (p. 83); and (d) "How can the effectiveness of learning experiences be evaluated?" (p. 104). Bearing in mind Tyler's questions, this study may be further framed by considering and adapting Dewey's description of the fundamental sources of educational objectives. The three frames are the learners and program participants, the society/institutions/communities that are involved, and the content or skills to be acquired and subject matter knowledge (Tanner & Tanner, 2007).

Ralph W. Tyler's work has not been the recent subject of attention as that of Dewey's work; however, Tyler (1949) did discuss the analysis of the gap between what is and what should be, which he described as the need, which has direct application for this study. Tyler suggested that the systematic and intelligent study of educational programs requires a clear understanding of the objectives to be achieved and those studies which identify the gaps between what is and what should be provide the basis for defining needs and selecting objectives. Tyler offered these ideas within the context of studying the learner as a source of objectives; however, the ideas are equally useful in considering the customers of higher education as a source of educational objectives.

Others who have made contributions to curriculum development include Inglis, Rugg, Bode, Giles, McCutchen, Zecheil, and Taba. Inglis was a leading member of the

commission on Reorganization of Secondary Education in 1918. Rugg was the chair of the Committee on Curriculum Making in 1927. Giles, McCutchen, and Zechiel were on the staff of the Eight Year Study and published the results in a curriculum report in 1942 after the study concluded. According to Tanner & Tanner (2007), the curricularists of the twentieth century restated Dewey's ideas "… in their efforts to promote systematic approaches to curriculum development…" (p. 130). Benjamin Bloom, for whom Ralph Tyler was a mentor (Sarangapani, 2006), recognized the complexion of the cognitive process in Bloom's Taxonomy which has been revised and extended (Tanner & Tanner, 2007). Howard Gardner developed his theory of multiple intelligences (Brualdi, 1998); however, within the context of a needs assessment Dewey's discussion of fundamental factors (Dewey, 2001) and Tyler's (1949) questions still provides the simple and straight forward framework for research organization.

Research Methods

The methods available for designing a needs assessment have been grouped into basic needs assessment methods, survey-based methods, and performance assessment methods (Queeney, 1996) in order to address continuing professional education. Performance assessment methods are appropriate for investigating needs in continuing education; however, products of performance, performance simulations and observations, and assessment centers are not appropriate tools for determining industry needs for degree granting programs. These tools are best applied to the continuing education area where skills enhancement and training are being investigated. Basic needs assessment methods include self-reports, focus groups, nominal group process, delphi method, use of key informants, and supervisor evaluations. Again, of this group, focus groups and delphi

methods have general application while the other methods provide application for future work that will be directed at specific continuing education initiatives. Survey-based methods include written on-site, mail, media questionnaires, and oral personal and telephone interviews (Queeney, 1996). Seven methods of investigating the gap between what is and what should be have been identified for continuing medical education (Lockyer, 1998). Lockyer lists the seven methods as questionnaires, focus groups, interviews, chart audit, standardized patients, environmental scan, and clinical recall interviews. Of these seven methods, three appear to be uniquely suited to research needs for medical education. In another article, that discussed continuing medical education, the same methods listed by Lockyer are discussed except that brainstorming, clientele analysis, advisory groups, and planning committees are added (DeSilets, 2007). There is a good deal of research in the literature relating to needs assessments that have been conducted, by various medical industry researchers, to address either improved patient care or continuing medical education. Literature that applies needs assessment as a tool for establishing engineering higher education curriculum appears to be very limited.

Mixed methods are discussed by Lockyer (1998) as a method of triangulation. Lockyer used the term *multiple methods* in describing the strategies of mixing methods in data collection and then continued to discuss the method combinations.

> Focus groups have been combined with questionnaires before the questionnaire to guide its design or after to validate information found from the survey.[1] Similarly, interviews have effectively been combined with chart audits, participant observation, and questionnaires.[3] As Hatch and Pearson[6] note, environmental

> scanning activities regularly use several data sources to create a complete picture of professional practice and the needs practitioners have (Lockyer, 1998, p. 191).

Of relevance to the planning for this study is the combination of questionnaires and interviews.

A discussion of mixing methods should start with understanding the researcher's world view. There are two world view positions taken by mixed methods advocates, the pragmatic and the dialectic. The pragmatic view calls for using methods that work for a particular study. The dialectic position is that mixing methods allows a fuller understanding of the human phenomena (Rocco, Bliss, Gallagher, & Perez-Prado, 2003). Creswell and Clark (2007) offers that there are four worldviews which are relevant in research. They are postpositivism, constructivism, advocacy and participatory, and pragmatism. In brief terms, the postpositivist is focused on theory verification, the constructivist on theory generation, those who subscribe to advocacy and participation are change oriented and political, and the pragmatist is problem centered and real-world oriented. This study will be influenced by the pragmatic position. The problem being researched is industry's needs for higher engineering education in a specific geographical setting. The results will be used to adjust curriculum at an institution of higher education. The adjustment will match the service the institution is providing to industry with industry needs and, as a result, to obtain tangible and intangible industry support. This purpose of this study does not address any of the primary focuses for a position other than pragmatism.

Rocco, et al (2003) describes 5 purposes for mixing methods in research. They describe *triangulation* as being directed towards corroboration or convergence,

complementarity to increase a study's validity and interpretability, *development* as using the results from one method to help develop or to inform another method, *initiation* attempts to develop new insights, and *expansion* attempts to increase the breadth and the range of a study. The authors also went on to discuss 8 types of mixed method designs based on the work of Tashakkori and Teddlie in 1998. Creswell and Clark (2007) describe 4 types of mixed methods designs. They are triangulation, embedded, explanatory, and exploratory. According to Creswell, Triangulation Design is the most common and well known and is used to compare, contrast, validate, or expand results obtained using quantitative and qualitative methods. Creswell describes Embedded Design as a design that uses one research method in support of another and in which a qualitative questions may be embedded in a quantitative design. The Explanatory Design is a mixed method design conducted in two phases. The first phase is the quantitative phase followed by the second or qualitative phase. This design, according to Creswell, lends itself well to using the quantitative results to form groups or to do purposeful sampling. The Exploratory Design is also a two phase design that starts with a qualitative method that informs the next quantitative phase. This design is used when exploration is needed as, in Creswell's view; it is best suited to exploring a phenomenon. The Explanatory mixed method design appears to provide the design best suited to conducting this needs assessment. The quantitative phase allows the collection and reduction of demographic and opinion data that then informs the qualitative phase and allows sampling that the researcher will use to more fully understand specific issues and specific industry segments.

Summary

Across the United States and even in Western Europe the demand for engineers is increasing and is outstripping the supply of students graduating with degrees in the engineering disciplines. This is largely the result of the aging baby boomer population, born from 1946 to 1954, that is approaching full retirement age. This issue is especially problematic in the Antelope Valley due to the heavy influence of the aerospace industry in the region. The Antelope Valley is in the high desert of California and the retention of engineers hired from others regions is a problem as families frequently have difficulty adjusting to the desert environment. A failure to retain employees can be very expensive as studies indicate replacement costs at one to one and a half times the employee's annual salary.

One solution to the employee retention problem is to train students from the Antelope Valley in the Antelope Valley where they can be hired by local industry. The hypothesis being that students from the desert that are trained locally will have a higher probability of retention once hired. This solution; however, does not address the basic lack of student interest in math and science at the high school level or the issues of student retention in engineering degree programs. The National Science Foundation (Committee on Science, Engineering, and Public Policy, 2006) has reported that the best and the brightest are opting to change their majors to non-engineering disciplines prior to graduating.

Until recently there has not been an ABET accredited, degree granting institution for training engineers in the Antelope Valley. The Cal State Antelope Valley Engineering Program at the Lancaster University Center is in its infancy and requires industry support

to become self sustaining. The establishment of a sustainable institution of higher education to locally train engineers may have the effect, within the communities served, of inspiring local students to study engineering. It may also serve to inspire students to seek a university education, even outside of engineering, who otherwise might choose to end their educational advancement after high school.

The LUC effort is considered an interim measure for bringing higher education to the Antelope Valley and Adjacent regions by the Antelope Valley Board of Trade which is leading a regional effort to bring a California State Polytechnic University campus to the region. Three sites are under consideration and others are being sought. Chancellor Reed of the California State University System met with regional leaders and a prominent Real Estate developer at Mojave, California in August, 2007 to discuss the possibility of establishing a CSU campus and to offer advice to the region regarding what is required for success. In the interim; however, the cooperative college and university effort is bringing higher education to the Antelope Valley. In terms of undergraduate engineering education the delivery, using a combination of community colleges, universities, and distance learning interactive television technology is unique and provides a leadership opportunity for Cal State in innovative engineering education. Even with a brick and mortar university established in the region, the model being developed now will be useful as the region being addressed extends from the California-Nevada boarder in the north, to the Lucerne and Apple valleys in the east, as far south as Valencia, California, and west to Bakersfield. This is a huge geographic area serving the residents in more than 25,000 square miles.

As stated previously, it is the message of hope rather than of limits that the university in collaboration with the community and industry needs to advance in the student population of the Antelope Valley and adjacent regions. The university will aid in opening pathways to a university education for poor and underrepresented minority students. The benefits to the community that accrue from improved pathways to higher education seem obvious. Some of the underrepresented minority and the children of low wage earning families will take advantage of the availability of an education. Success will lead them to improved socioeconomic status and they will become role models for others to follow. Other benefits that derive from the presence of the university included redevelopment, the ability to hire and retain skilled workers, as well as improving the possibility for the brick and mortar campus currently under consideration.

A necessary concern for the LUC engineering programs is being able to achieve sustainability. A model for coalition building was developed to support the establishment of a branch campus system in Washington State that may prove useful in developing the regional support necessary to become self sufficient. Such a model is also a model for the development of a regional coalition to establish a new State University campus.

The literature reviewed is consistent in concluding that hands-on laboratory experiences are essential to training engineers. The solution, for the Antelope Valley Programs, has been to establish laboratories at the LUC to serve students in the region. Distance Learning and laboratories at learning centers are equal partners in the Cal State effort. The distance learning capability has been put in place at the Lancaster University Center, at Cal State, and at comprehensive state university main campus. This distance learning capability has been functioning to deliver lectures for over two years. Research

into the delivery of courses via distance learning technology has not revealed any counter intuitive issues. Issues that need to be addressed in establishing a distance learning center on careful planning, student orientation, instructor training, strong support, and facilitating student/instructor and student/student social interaction and dialog. Distance learning holds a great potential for serving the geographically disbursed population of the Antelope Valley and the adjacent regions; however, institutional self-evaluation and improvement initiatives need to be implemented to insure that instruction meets the same criteria as live instruction.

The basic mission of the College of Engineering at LUC in the Antelope Valley is to provide high-quality academic programs in engineering that support the infrastructure and growth of the region. Implementation of effort to meet this mission requires an understanding of the customers, their needs, and the products being delivered. A simple, yet practical model, views the employers of engineers as the customer and the students that graduate from the engineering program as the products. Students are the units of production and can be described as the academic output of the university.

The California State University budget process is incremental and is driven by enrollment. This makes it very difficult for an enterprise in start-up, as is the case with the AV Engineering Programs and direct support of industry and the community is required to support operations and growth. Understanding and meeting customer needs is critical to the process of acquiring support and sustaining the effort. John Dewey and Ralph Tyler have provided, in their seminal works, the theoretical basis for a needs assessment. The fundamental factors in the education process described by Dewey (2001) and Ralph Tyler's (1949) questions regarding curriculum development provide a simple

and straight forward framework for research organization. Within this framework, a pragmatic philosophy, will serve to focus methods that work for the particular problem at hand. Based on the literature reviewed, the study design selected for this needs assessment is an exploratory mixed-methods study that will use explanatory-sequential research methods conducted in two phases. This mixed-method approach will provide both quantitative and qualitative data to address the gap between what is and what should be for the AV Engineering Programs. This will then facilitate the development of recommendations for curriculum development designed to close the gap and satisfy customer needs.

Chapter 3: Methodology

Overview of the Study's Design

The focus of this study was the development of a regional learning center for engineering. The method used to understand the development requirements was to assess customer needs for undergraduate and graduate engineering programs offered by LUC in the Antelope Valley. The customers that were included in this study were the businesses; local, state and federal government agencies, in the region, that employ engineers and that are expert in understanding the region's industry.

The study employed mixed methods and consisted of three sequential phases. The three phases provided data to assess the customers' perceptions of what is in terms of the existing programs. Each phase informed the following phase of research activity thus allowing a degree of triangulation (Creswell, 2003). The first phase consisted of a cross-sectional survey questionnaire, directed at Human Resource Directors or senior managers, from industry and government organizations, designed to obtain applicable characteristic data and to assess current customer perceptions that relate to the stated problem. This phase was used to target specific organizations for the second phase where selected senior personnel were interviewed. Three critical cases were defined for the selection of interview subjects. Critical Case A was defined as aerospace, professional, and other industrial organizations. Critical Case B were federal and state district directors of elected officials, Critical Case C was the Building Industry. Interview questions for this second phase were developed focused by the results of the survey data from the first phase, tailored for each Critical Case (see Appendix C). The Phase III analysis of the Phase II interview content, the review of field notes (records that were collected by the

participant researcher throughout the year), and minutes from appropriate meetings, such as advisory board meetings, were integrated to synthesize, through the use of force-field analyses, the view of what should be thus allowing use of a gap analyses (see Figure 4.) that allowed conclusions to be drawn and recommendations to be developed.

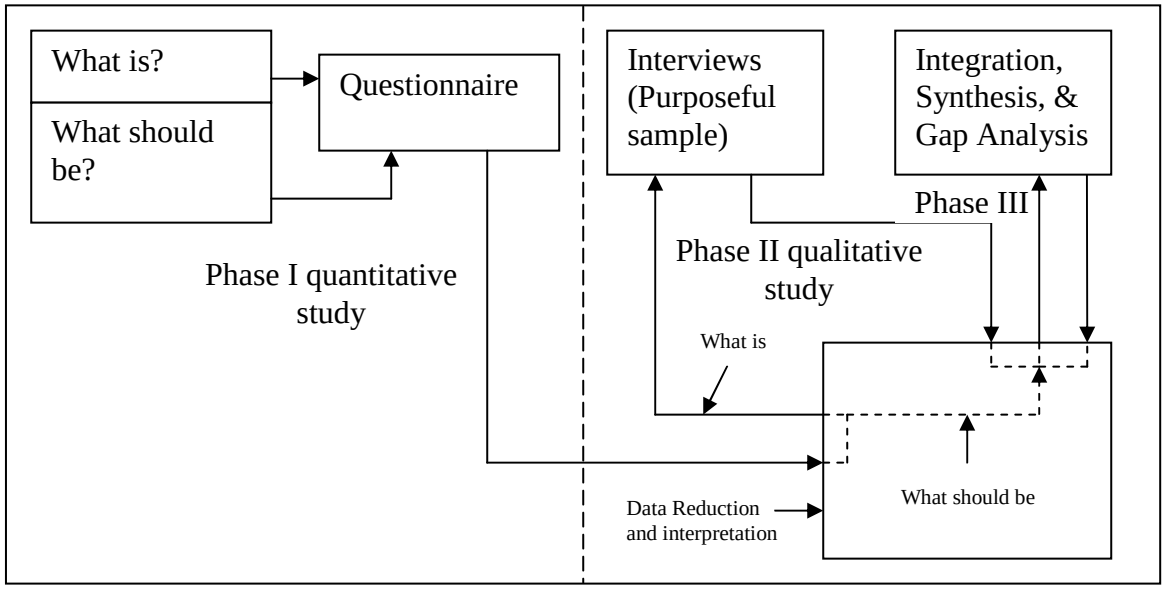

Figure 4: Mixed-method sequential-explanatory study design implementation.

Research Philosophy and Framework

The philosophical underpinning for this research is pragmatism since this study is intended to develop an understanding of a specific problem (Creswell, 2003). The problem, in this case, is the perceived lack of industry support and the complication, for the LUC, presented by having another California State institution at the same site offering an overlapping curriculum. Pragmatism is a method of thinking that does not focus on the attainment of truth. It allows the researcher to focus on distinguishing between those hypotheses which are legitimate and those that are not (Friedman, 2003). A pragmatic

approach to research design allows the researcher to focus on the problem of interest and it allows for maximization of the flexibility that the researcher has available to develop a research design employing mixed methods. “Thus, for the mixed methods researcher, pragmatism opens the door to multiple methods, different worldviews, and different assumptions, as well as to different forms of data collection and analysis in the mixed methods study” (Creswell, 2003, p. 12).

This research is exploratory in nature as no presumptive hypotheses have been established regarding the nature of the stated problem (Rocco et al., 2003). The strategy selected to guide this research implementation is sequential and explanatory as described by Creswell (2003). Sequential – explanatory research is typically conducted in two phases. The first phase is the collection and analysis of quantitative data followed by the collection and analysis of qualitative data. The first phase (Phase I) quantitative data was analyzed and the results used in purposefully selecting participants for entry into the second phase (Phase II). Creswell and Clark (2007) identify this methodology as the explanatory design –participant selection model. This study used two distinct methods for gathering qualitative data in the second phase. These two methods were conducted sequentially as well. The first method in this second phase was the targeted interviews directed at the purposefully selected participants. These interviews were used to refine and explain the general understanding obtained during Phase I of this study. The second method focused on extracting specific content from the interviews, integrated with field notes, to synthesize a view of what should be. A final analysis that evaluated the gap between what customer’s desire and what is currently being provided was conducted to establish the need. This second method has been identified as Phase III.

Another feature typical of sequential – explanatory research is that priority is typically, but not necessarily, placed on the first phase of research. The main issue with sequential – explanatory research is the time required to collect data. The data collection time requirement issue is also exacerbated when equal priority is given to both phases (Creswell, 2003) as was the case for this study. Equal emphasis on both phases of sequential-explanatory research is consistent with the pragmatic worldview (Creswell & Clark, 2007).

Sequential – explanatory research is well suited to research where it is desirable to use the results from the quantitative data analysis to identify participant characteristics for purposeful sampling in the qualitative phase. It is also well suited to research that is designed to use the quantitative data results to follow-up with groups (Creswell & Clark, 2007). This study is designed to take advantage of both survey questionnaire responses and one-on-one interviews. The pragmatic philosophical underpinning coupled with the exploratory, sequential – explanatory mixed method framework produced rich findings of greater utility in understanding the stated problem than would be the case using either quantitative or qualitative methods alone.

Description of Population

The population for this study consisted of the industry, the local, county, state, and federal government organizations that employ degreed engineers, in the Greater Antelope Valley of Southern California, that graduate from ABET accredited schools. The Greater Antelope Valley is a large triangular region in the high desert of California that, historically, has been home to flight test and aircraft manufacturing industry and government organizations. Recent reductions in government research and development

expenditures, a government inspired migration of aerospace industry to regions in the United States that have a lower cost of living and consequently a lower labor rate, and the demographic changes in Los Angeles County that have resulted from the Antelope Valley's lower housing costs have diluted the traditional aerospace industry's dominant position in Antelope Valley communities. Therefore, this study is intended to consider the total population of engineering employers.

The sample population was initially developed for the quantitative phase of the study. The analysis units consisted of industries and government organizations resident in the region that were identified by the researcher as being likely to employ engineers as defined by the population under study. The researcher is a 27 year veteran from the aerospace industry and has over 36 years of engineering and government service experience. To ease the burden of identification, companies and agencies listed in the region's various chambers of commerce provided the information for making the sample selection and are categorized and listed in Appendix A and Appendix B (see Appendix D for the chambers of commerce listing). The analysis results of the quantitative phase of the study informed the sample selections for the qualitative phase of the study. Interviews were conducted based on the availability of selected participants.

Baseline Engineering Education Program

The baseline which this study will ultimately influence is the existing program offered by Cal State at LUC. The existing LUC program consists of undergraduate mechanical and electrical engineering and a single graduate program, at the Master of Science level in electrical engineering. A mechanical engineering graduate program has been in operation but enrollments have been suspended in order to avoid competition for

students with a California State Polytechnic University aerospace engineering program, also being offered at the LUC.

The LUC program is accomplished in cooperation with the local community college where students complete their lower division element of the program and with another comprehensive State University Center in the Antelope Valley where students obtain their upper division general education requirements. Upper division engineering lectures and laboratories are presented at the Lancaster University Center.

Lectures are presented through the use of state-of-the-art distance learning class rooms and by instructor led laboratory classes at the LUC. Undergraduate classes are offered only during the day and graduate courses are offered only in the evening.

The results from this study will significantly influence or affirm the vision and mission under which the LUC Antelope Valley engineering programs are being administered. The results will establish the direction or redirection and the prioritization of program development and staff and faculty growth required to adjust the existing business plan to satisfy industry needs and to correct any revealed misperceptions. The results will also allow a general customer focused approach to growth that has been lacking in the past.

Study Design

Phase I Study

The study was accomplished initially using a survey instrument in a passive-descriptive study validated first using a panel of experts (see Appendix E). The panel of experts provided guidance regarding question clarity and identified several issues such as double barreled statements which required adjustment. Specific recommendations were

provided, by the panel, with respect to specific word changes in a number of questions on the questionnaire. They also advised where specific methods of questioning, such as the use of a Likert scale, were or were not appropriate. Questions were asked by the panel to clarify issues that needed to be addressed within the questionnaire. The panel did confirm that the questionnaire addressed the study research questions and was appropriate for the population under study.

A small pilot study followed, completion of the questionnaire with the panel of experts, using representative company and government resources in Los Angeles and Orange Counties. This allowed the opportunity to adjust the questionnaire to eliminate problems in the data collected, although an adjustment was not required. The pilot study also allowed the data reduction process using an EXCEL spreadsheet and NCSS (Hintze, 2003) to be practiced and fully developed. The use of a panel of experts and the small pilot study resulted in a questionnaire which consisted of 25 questions specifically directed towards characterizing the responding organizations (see Appendix F). The questions were distributed to address all of the research questions with the exception of research question 5. Research question 5 was reserved for exploration during the qualitative phase of the study. There were two attitudinal questions and for these questions a standard Likert scale was used for the respondents to record their responses. A combination of interval/ratio, and/or ordinal questions was used to collect demographic and characteristic information. The nature of this study did not require a finer differentiation of attitude than the standard Likert scale provides. Asking open-ended questions to record numerical demographic data allows the calculation of mean values and affords the researcher the ability to recode the data in ordinal form for analysis

(Nardi, 2003); however, this study does not require the open ended questions because the responses would require categorizing after the fact any way. According to Nardi the correct way to end a difficult questionnaire is to place all the demographic questions at the end so that respondents only need to check boxes to finish. This questionnaire did not require answers that are difficult to generate and it was designed using Likert, interval/ratio and ordinal items to check, therefore the question ordering has not been considered an issue.

Phase I Procedure for Data Collection

For both the pilot study followed by the study itself, the survey was directed to the Director of Human Resources or to a senior manager or executive such as a site manager or a Vice President. Where a name of a specific individual was able to be determined, the survey was so directed. The pilot study was directed at companies that are similar to those in this study. The survey was directed towards those companies listed in Appendix A and Appendix B. This placed the survey with the individuals most likely to have access to the data that was being requested and who are most aware of the educational needs of the organization and learning desires of the employees. The survey was accompanied by a description of this study; a statement of confidentiality, an agreement to participate, and an e-mail address for requesting project status and research results. Additionally, a feature was provided to opt-out and return the survey if the recipient deemed their organization to be inconsistent with the stated description of the study. This was accomplished in the first two questions. This allowed an estimate to be made of the recipient selection accuracy and the size of the sample population. The survey was implemented in and distributed using a Survey Monkey account established by the

researcher. A response rate of 60% was anticipated. If a low response rate (less than 25%) was realized, a mailing was planned. If the response rate remained low (less than 25%) then personal delivery of the surveys, where practical, was planned. The initial survey response was less than 9%. Mailings, personal survey delivery, as well as phone requests to complete the survey were used resulting in a final response rate of 33%.

Phase I Analysis

The questionnaire used is shown in Appendix F. Frequency counting was employed to reduce data. Responses were accumulated and loaded, via spread sheet, into Number Cruncher Statistical System (NCSS), (Hintze, 2003) where appropriate. The data was evaluated through the application of the descriptive statistics function of the software. The attributes of size in terms of the number of employees and the business segment addressed by the organization's responses to the core disciplines sought were evaluated to determine size relevance for the Phase II efforts. The returned opt-out surveys were evaluated to assess the accuracy of selection and estimate the actual sample size. The analysis completed in this phase was used to identify critical cases and to purposefully select participants from within the sample surveyed. This purposeful selection was used for the Phase II interview component (see Figure 4.).

The 25 question phase I survey questionnaire was delivered to 171 organizations in the region that were thought to employ degreed engineers. This was accomplished through the use of e-mails that provided a link to Survey Monkey and via hardcopy mailings. The initial mailings occurred because a number of organizations registered with the Chambers of Commerce or listed in the Boards of Trade directories failed to provide an e-mail contact. A total of 94 organizations were initially contacted via e-mail and 68

organizations were provided hardcopy survey questionnaires, with stamped self-addressed envelopes, via mail resulting in 162 organizations initially surveyed. Nine surveys were additionally hand delivered to organizations bringing the total sample to 171. A total of 15 organizations that were listed in the registrations and directories had gone out of business. This was determined by the returned mailings stamped with no forwarding address. The out-of-business component reduced the sample to 156 active organizations.

Repeated follow-up by mail, e-mail, by telephone, and by personal delivery of hardcopy questionnaires was required to achieve a 33% response. Thirty five recipients identified their organization as having 100 or more employees. This represents 60% of this important segment of the sample and is sufficient to generalize within the region for organizations employing engineers that have 100 or more employees. Twenty one responses were received from organizations having fewer than 100 employees. The nonresponse bias for the smaller organizations was 78.6%. Two questions were provided to opt-out of the survey, one for organizations that did not employ engineers and one for respondents who did not desire to participate (see Appendix F). There were seven responses to the first question and five to the second.

Not all of the questions were answered by all of the respondents. The cover letter for the questionnaire instructed respondents to skip questions that they felt they could not answer. Four questions received responses from 100% of the respondents. Two questions, one for the undergraduate and one for the graduate program, were write-in questions and asked if there were any engineering disciplines not identified in a previous question that were core-engineering disciplines sought by the respondent's organization. Twenty eight

percent of the respondents wrote in additional disciplines for the undergraduate program such as avionics, loads and dynamics, structural, materials, explosives, manufacturing, composite manufacturing, flight test, and electronic warfare engineering. For the graduate program approximately 13% of the respondents wrote in desired disciplines such as aeronautical, flight test, structural, materials, and manufacturing engineering. Forty four percent of the respondents answered question 10 (see Appendix F) which gave the respondent 8 choices for support that their organization would likely provide to the local engineering education program. Fifty four percent of the respondents answered question 14 which named the Cal State Antelope Valley engineering education program and added choices such as providing topics for design projects, participating in design team activities, and providing financial aid to student projects.

Phase II Study

Entry into Phase II of this study was predicated on completion of the data analysis conducted in phase I. The analysis was used to purposefully select participants to interview from the sample. In order to conduct the selection, the analysis data was used to identify critical cases. The critical cases are those that the analysis indicates are most important to the success of the engineering programs in the Antelope Valley.

> The selection of *critical cases* aims at those cases in which the relations to be studied become especially clear – for example in the opinion of experts in the field – or which are particularly important for the functioning of a programme to be evaluated (Flick, 2002, p. 68).

A total of 13 interviews were conducted with senior executives and directors from various commercial and government organizations. The interview sample was drawn

from a general category of aerospace, professional, and other industrial organizations (Critical Case A), federal and state District Directors of elected officials (Critical Case B), and from the building (construction) industry (Critical Case C). This last critical case was composed of renewable energy, construction and building, and local municipal public works organizations. The critical cases were determined based on the predominant distribution of industry in the Antelope Valley.

The federal and state District Directors were included because of the significant overview that they could provide due to there strong personal relationships with the region's industry. Participants were purposefully selected to represent a cross section of each of the three interview categories. As an example, for category A, individuals were invited to interview from major aerospace firms, a government research organization, an aircraft modification company, a major mining enterprise, and from the wind energy industry. There were seven Critical Case A interview subjects, two Critical Case B subjects, and four Critical Case C subjects. The ratio of subjects was based on the estimated sizes of the work forces employed in the economic segments represented by Critical Cases A and C based on GAVEA statistics (Greater Antelope Valley Economic Alliance, 2008). Questions were prepared for each critical case using the results of the quantitative Phase I effort to provide a data driven focus that also informed the selection of the three critical cases for qualitative study. These interviews were accomplished in order to investigate and clarify results from the first phase of the study. Interviews were semi structured and allowed to proceed as determined by the flow of ideas. Interviews were both recorded live or over the phone and transcribed as soon as they could

practically be downloaded and sent to the transcriber. Transcriptions were provided to the participants for review to accomplish subject verification.

This study focused primarily on organizations and on the opinions of individuals who represent organizations. This results in a situation where information may be distributed across several departments. Willis (2005), in discussing cognitive interviewing, suggests that there are several unique features associated with surveying establishments that need to be considered. The organization as an entity or a system, emphasis on the organization and the location of information, difficulty in identifying and recruiting the correct interviewee, interviewing on-the-road, and unwillingness or inability of interviewees to retrieve information in real time are all issues that need to be considered in planning and implementing this mixed-methods study.

Appendix A identifies large and medium sized companies in the Antelope Valley. Appendix B identifies the small companies. Two criteria were used to categorize companies. The first was by the number of employees and the second criterion used was the likelihood that a particular company would employ engineers as a significant portion of their population. In this case "significant" is a subjective measure based on the researcher's judgment and the categorization within the Chambers of Commerce listings. A numerical priority of one, two, three, or four for interview selection has been assigned with one being the highest priority.

Phase II Procedure for Data Collection

Potential interview subjects were contacted via phone to determine interest in participating in the interview process. Once interest was established, the prepared questions and the informed consent agreement (see Appendix F) were forwarded to the

potential participant. A date and time for the interview were established. Most interviews were conducted at the Lancaster University Center but several were conducted over the phone.

The interviews were initiated by reviewing the informed consent agreement and obtaining consent. The forms were signed and, in the case of the phone interviews, either faxed or scanned and provided to the researcher as an attachment to an email. In each interview all of the prepared questions were addressed but the subject was allowed to deviate and address those thoughts that they felt important for the researcher to understand. Additional questions were used to clarify and penetrate specific issues being raised by the subjects. All interviews were recorded using a digital voice recorder for later transcription.

Phase II Analysis

Qualitative content analysis based on Strauss and Corbin's (1997) grounded theory was used to reduce the material derived from the Phase II element of this study. Creswell (2003) has summarized grounded theory as that,

> In which the researcher attempts to derive a general, abstract theory of a process, action, or interaction grounded in the views of participants in a study. This process involves using multiple stages of data collection and the refinement and interrelationship of categories of information (Strauss & Corbin, 1990, 1998). Two primary characteristics of this design are the constant comparison of data with emerging categories and theoretical sampling of different groups to maximize the similarities and the differences of information (p. 14).

Flick (2002) has explained the method for summarizing content analysis as being comprised of two data reduction activities.

> In *summarizing content analysis*, the material is paraphrased, which means that less relevant passages and paraphrases with the same meanings are skipped (first reduction) and similar paraphrases are bundled and summarized (second reduction), (p. 191).

After the data was first paraphrased and then bundled by the researcher, intra-rater reliability was addressed through repeating the reductions and bundling and then by comparing the results. Multiple coders were used to address inter-rater reliability. Coders were carefully selected to provide for high quality in the coding effort. Coders were engineers that had become skilled in coding through previous experience and/or training and that were knowledgeable in the study of Organizational Leadership as evidenced by the fact that coders had either received a doctorate or had been advanced to doctoral candidate status. Transcripts were provided to interview participants for review and comment/correction to establish subject verification for the Phase II interviews.

For some items, there were field notes and observations that were made during the data collection process. In these cases a thick description was prepared based on the Criticism and Connoisseurship approach. Stufflebeam (2001) has explained that this approach grew out of the methods used in art criticism. He goes on to explain that this approach was pioneered in education by Elliot Eisner and that it is very dependent on an expert's qualifications and an audience's willingness to accept the expert's report. He goes on to explain that,

> The main advantage of the criticism and connoisseur-based study is that it exploits the particular expertise and finely developed insights of persons who have devoted much time and effort to the study of a precise area. Such individuals can provide an array of detailed information that an audience can then use to form a more insightful analysis than otherwise might be possible (Stufflebeam, 2001, p. 36).

Stufflebeam also provided that the main disadvantage to this approach is that it leaves room for subjectivity because it relies on the expertise and qualifications of the individual doing the evaluation. Direct pertinent quotations from interviewees and thick descriptions from field notes and observations were used to support the analysis. Eisner (1998), in discussing connoisseurship and criticism, suggested that discursive language is our most powerful tool for classification and that through thick descriptions an account of an event can be provided for the reader followed by accounting for the event through interpretation..

Phase II of this study resulted from the Phase I quantitative survey to develop critical cases and to inform the selection of interview participants. This selection was a purposeful selection accomplished to prepare for expert interviews. Interviews were recorded and verbatim transcriptions were prepared. Data was paraphrased and bundled by the researcher and by multiple coders. The results of this effort were then used in then used to draw conclusions and were used in the Phase III study effort.

Phase III Study

Phase III of this study was conducted using field notes accumulated by the researcher over the course of the study, minutes from meetings, briefings offered, and the

Phase I and Phase II analysis results. The results from force-field analyses used to establish what the customers of higher education, in the Antelope Valley, believe should exist in terms of curriculum, were used to develop gap analyses (see Appendix G). The force-field analyses integrated the information used in Phase III to synthesize driving and restraining forces. The results of the gap analyses were used to draw conclusions and to develop recommendations.

Key to the accomplishment of this third phase of research was the University Partners Advisory Board meetings held on April 10, 2008 and May 5, 2008 during which notes were taken by two individuals and subsequently compiled into minutes distributed to participants. In many respects these meetings emulated focus group interviews although they were guided by the Board members themselves. The focus group interview is a very efficient method of collecting qualitative data that is low cost, rich in data, and that can lead beyond the answers that a single interviewee might provide (Flick, 2002).

Limitations

The sample was not planned to be randomly selected. The sample was limited to that which could be derived from several registers (see Appendix D), in a reasonable amount of time, based on the effort of a single researcher. The bias of the researcher in the selection of engineering companies and the resulting accuracy or inaccuracy that may have impacted the sample was minimized by using the business categories provided by the various registers. Examples of register business categories are *Aerospace* and *Consultants*. The target population was limited to engineering dominated organizations and does not address other occupation dominant organizations and therefore the results cannot be generalized throughout all organizations in the Antelope Valley. Generalization

to all engineering companies is difficult as there was a large no-response among companies with fewer than 100 employees.

Researcher bias must also be considered as the researcher in this study is also the director, of the programs for Cal State in the Antelope Valley for which this study is being conducted. Such bias may impact the interpretation of the data collected, particularly in Phase II of the study. Bias is also possible in Phase I, particularly during the questionnaire development where bias could be introduced. The use of mixed-methods accomplished in three phases, the use of a panel of experts, small pilot studies, and multiple coders should all combine to mitigate the effect of researcher bias.

Protection of Human Subjects

This mixed methods study was conducted in three phases. Phase I was a quantitative study. Data collected during Phase I was done so through the use of a questionnaire distributed and received through a third party on-line survey service. Use of an on-line service assured that the responses received by the researcher were anonymous. The questionnaires distributed were accompanied by a description of the research being performed and a consent-to-participate agreement. Phase II was composed of individual long interviews. Individuals have been afforded the opportunity to opt-out at any time during the study at which time any data collected relative to a specific individual will be destroyed or deleted. Individuals have been given the opportunity to review transcripts for accuracy and to make additions, deletions, or modifications that they deem appropriate. Participants were assured that confidentiality would be maintained. There was no physical risk, emotional risk was minimal, and there was no use of deception. An

application for exemption per 45 CFR 46.101 (b) was prepared and submitted for Internal Review Board review and was approved (see Appendix H).

Chapter 4: Analysis of Results and Findings

Introduction

This chapter presents the data analysis and results according to the three phases of this, mixed-method, exploratory study. Responses from the Phase I survey questionnaire (see Appendix F) are organized according to the first four of the study's five research questions. The Phase II interviews (see Appendix C) are similarly organized, according to last four research questions. The Phase III integration/synthesis/gap analyses complete the study through the use of force-field analyses to integrate and synthesize analysis results from Phases I and II.

Phase I Quantitative Data Analysis

There were 23 questions designed to obtain pertinent data on the survey questionnaire. Of the 23 questions, the responses for 16 questions were coded and loaded into an EXCEL spreadsheet to facilitate data sorting and descriptive statistical analysis. Data logs were also created to record responses for five of the questions that asked for multiple responses. The remaining two questions were write-in questions and these responses are recorded verbatim in the results for Research Question 4 in this chapter. Research Question 5 was not addressed by the survey questionnaire but is dealt with during the second phase of the study. The primary tool used was descriptive statistical analysis which allowed tabulations of percentages, bar charts that provide graphical data comparison, and descriptive statistical analysis using NCSS (Hintze, 2003). The tabulations record the percentages of responses for each of the various ranges offered as answer choices for participants. The percentages of responses for organizations having more than 100 employees are also presented for comparison. The smaller organization

responses are omitted since they can be easily calculated from the data presented. The questions that allowed multiple responses by participants are presented in the form of bar charts. Attitudinal questions are tabulated providing descriptive statistical analysis of means, standard deviations, standard error, confidence limits, and sample size.

Findings

Research Question 1: What is the demographic information from regional organizations that would support an engineering program at a State University remote location?

A total of 51 responses were received and 39 respondents completed the survey questionnaire. As stated in Chapter 3, the respondent organizations are estimated to represent one quarter to one third of the total regional engineering employed work force.

There were 13 questions on the Phase I survey Questionnaire that were used to obtain the demographic data for the organizations' present and near future engineering employment. The data addresses a range of demographic information relating to engineering workforce size and age, retention, hiring, and continuing education. As shown in Table 1, 55.3% of the respondents represented organizations with over 100 employees. Of these organizations 31.6% reported having over 501 employees. This first data set was drawn from the response to question 5 of the survey questionnaire.

Table 1

Percentage of Organizations Reporting Number of Employees

Number of Employees	%	*n*
1 to 10	15.8	6
11 to 30	15.8	6

(*table continues)*

Number of Employees	%	*n*
31 to 60	10.5	4
61 to 100	2.6	1
101 to 500	23.7	9
501 or more	31.6	12
Total	100.0	38

The data in Table 2, drawn from survey question six, provides the percentage of an organization's employed work force that are degreed engineers and the percentage of the organizations reporting in each percentage range. This data indicates that only 5% of the responding organizations had no degreed engineers in their employee populations. All or the responding organizations that have more than 100 employees have degreed engineers among their employees. Sixty two point five percent of all responding organizations have degreed engineers comprising more than 35% of their employees. Among the organizations having more than 100 employees, degreed engineers account for more than 35 % of the employees.

Table 2

Percentage of Organizations Reporting Employees that are Degreed Engineers

	Responses	
% Engineers	% of all organizations reporting	% having > 100 Employees
None	5.0	0.0

(*table continues*)

	Responses	
% Engineers	% of all organizations reporting	% having > 100 Employees
1% to 5%	12.5	7.5
6% to 15%	12.5	7.5
16% to 35%	7.5	2.5
36% to 50 %	27.5	15.0
51% or more	35.0	20.0
Total	100.0	52.5

Table 3 summarizes the responses to survey questionnaire question seven which asked the average age range of the degreed engineering work force. Eighty one point eight percent of the respondents have indicated that their engineers are 36 years old or older. In fact 24.2% indicated that the average age of their engineers is 45 years or older. Of the 52.5 % of the organizations reporting that they had over 100 employees, only 47.3% reported their employee age ranges. Of these larger organizations, 23.7% of the respondents indicated that their work force average age was 36 to 45 years old, 10.5% reported their employees to be between 46 and 55 years old and 2.6 % reported that the average age of their engineering work force was 56 years or older.

Survey questions 8, 11, and 15 requested information regarding hiring and employee replacement. Responses from organizations indicated that predominantly the numbers of open positions are between 1 and 10 (48.6 % of all responses) followed by 11 to 20. Approximately 11% of the respondents indicated that they have 61 or more open positions.

Table 3

Percentage of Organizations Reporting Engineering Employee Average Age

	Responses	
Average Age	% of all organizations reporting	% having > 100 Employees
18 to 25	0.0	0.0
26 to 35	18.2	10.5
36 to 45	57.6	23.7
46 to 55	21.2	10.5
56 or older	3.0	2.6
Total	100.0	47.3

Organizations that have 11 or more open positions are all organizations with more than 100 employees and account 37.8 % of all respondents (see Table 4).

Table 4

Percentage of Organizations Reporting Number of Open Positions

	Responses	
Number of Open Positions	% of all organizations reporting	% having > 100 Employees
None	13.5	2.7
1 to 10	48.6	16.2
11 to 20	16.2	16.2
21 to 30	5.4	5.4

(*table continues*)

Number of Open Positions	Responses: % of all organizations reporting	Responses: % having > 100 Employees
31 to 60	5.4	5.4
61 or more	10.8	10.8
Total	100.0	56.7

The number of open positions for new graduates was developed based on question 11 of the survey questionnaire and is reported in Table 5. The responses indicate that 41.7% of the reporting organizations are planning to hire between 1 and 5 new graduates annually. 25% of the organizations in total are planning to hire 21 or more new graduates annually, all of which are organizations with more than 100 employees. The data also indicates that 11.1% of all companies are not planning to hire any new graduates; only 5.6% of those are organizations with more than 100 employees.

Table 5

Percentage of Organizations Planning to Hire New Graduates

Number of Planned Positions	Responses: % of all organizations reporting	Responses: % having > 100 Employees
None	11.1	5.6
1 to 5	41.7	8.3
6 to 10	16.7	11.1

(*table continues*)

	Responses	
Number of Planned Positions	% of all organizations reporting	% having > 100 Employees
11 to 15	5.6	5.6
16 to 20	0.0	0.0
21 or more	25.0	25.0
Total	100.0	55.6

Table 6 summarizes survey question 15 which collected data regarding the number of employees that must be replaced annually. The data indicates that 35.1% of the responding organizations, which are also those with more than 100 employees, replace 13 or more employees annually. 10.8 % of the larger organizations also indicate that they replace between 10 and 12 employees annually. Only 5.4% of the responses indicated that there was no annual employee replacements required by their organization.

Table 6

Percentage of Organizations Reporting Number of Employees Replaced Annually

	Responses	
Number of Replacements	% of all organizations reporting	% having > 100 Employees
None	5.4	0.0
Fewer than 1 per year	10.8	2.7
1 to 3	21.6	0.0

(*table continues*)

	Responses	
Number of Replacements	% of all organizations reporting	% having > 100 Employees
4 to 6	16.3	8.1
7 to 9	0.0	0.0
10 to 12	10.8	10.8
13 or more	35.1	35.1
Total	100.0	56.7

Survey question 9 was concerned with the annual cost of replacing employees who leave the organization (see Table 7). The data from respondents indicates that 41.4 % of the reporting organizations spend less than $50,000 annually; however 24% of the reporting organizations spend over $151,000 annually replacing employees who leave. 10.3 % of the organizations spend over $450,000 annually replacing employees.

Survey question 12 began the collection of data regarding the continuing education of the responding organization's employees. This question asked specifically about the financial level of educational reimbursement offered to employees. Of the organizations responding, that some level of reimbursement was offered, 43.3 % were organizations having more than 100 employees.

Table 7

Percentage of Organizations Reporting Annual Cost of Employee Replacement

	Responses	
Annual Cost of Replacement	% of all organizations reporting	% having > 100 Employees
None	10.3	3.4
Less than $50 k	41.4	13.8
$50 k to $150 k	24.1	10.3
$151 k to $300 k	10.3	10.3
$301 k to $450 k	3.4	3.4
Over $450 k	10.3	10.3
Total	100.0	51.5

Twenty six point seven percent of the respondents indicated that no educational reimbursement was offered which included 3.3 % of the larger (more than 100 employees) organizations (see Table 8). 36.7 % of all respondents reported that their organizations provide 100 % reimbursement for fees and books to their employees.

Table 8

Percentage of Organizations Reporting Educational Reimbursement for Employees

	Responses	
Reimbursement	% of all organizations reporting	% having > 100 Employees
None	26.7	3.3

(*table continues*)

	Responses	
Reimbursement	% of all organizations reporting	% having > 100 Employees
Up to $2500/year	16.7	10.0
Up to $5000/year	16.7	13.3
Up to $10,000/year	3.3	3.3
100% of fees and books	36.7	16.7
Total	100.0	46.6

Table 9 summarizes the demographic data which pertains to the current employee enrollments in higher education engineering programs leading to Bachelor or Master of Science degrees or programs that enhance the skills of employees. 51.6 % of the organizations reporting have between 1 and 10 employees seeking Bachelor or Master of Science degrees, 22.6% of which are the larger organizations. Organizations that report having no degree seeking employees account for 25.8% of the respondents. Fully 50 % of the organizations reporting have employees currently enrolled in skills enhancement programs. Twenty eight point one percent of the organizations reporting have no employees enrolled.

Table 10 summarizes the balance of the demographic data pertaining to how many employees respondents believe would enroll in locally offered Bachelor and Master Degree programs in engineering and in skills enhancement classes. Organizations predominantly indicate the between 1 and 10 employees would enroll in locally offered degree programs or skills enhancement classes.

Table 9

Percentage of Organizations Reporting Current Employee Participation in Higher Education Programs for Engineering

Bachelor and Master Degree Programs

	Responses	
Number of Employees	% of all organizations reporting	% having > 100 Employees
None	25.8	6.5
1 to 10	51.6	22.6
11 to 20	12.9	9.7
21 to 30	3.2	3.2
31 to 60	6.5	6.5
61 or more	0.0	0.0
Total	100.0	48.5

Skills Enhancement Programs

	Responses	
Number of Employees	% of all organizations reporting	% having > 100 Employees
None	28.1	15.6
1 to 10	50.0	15.6
11 to 20	3.1	3.1
21 to 30	9.4	6.3

(*table continues*)

	Responses	
Number of Employees	% of all organizations reporting	% having > 100 Employees
31 to 60	6.3	6.3
61 or more	3.1	3.1
Total	100.0	56.9

At the Bachelor of Science level 54.8 % of the respondents indicated that between 1 and 10 employees would enroll. At the Master of Science level, 58.8 % of the respondents replied that between 1 and 10 employees would enroll. Within the same range, 58.3 % of the reporting organizations indicated employees would enroll in skills enhancement programs. Thirty five point five percent of the reporting organizations indicated that none of their employees would seek a Bachelor of Science Degree, 23.5 % indicated that none of their employees would seek a Master of Science Degree, but only 2.8 % reported that none of their employees would enroll in a locally provided skills enhancement class.

Research Question 2: What are the available resources to support development of a regional learning center for engineering?

Three survey questions were used in the quantitative first phase of this study. They were survey questions 10, 13, and 14. Question 10 inquired about respondent preferences for methods of support for any State University while question 14 made a similar inquiry with respect to the Cal State Antelope Valley Engineering Programs specifically.

Table 10

Percentage of Organizations Reporting Potential Employee Participation in Higher Education Programs for Engineering

Bachelor of Science Degree Program

	Responses	
Number of Employees	% of all organizations reporting	% having > 100 Employees
None	35.5	12.9
1 to 10	54.8	29.0
11 to 20	6.5	3.2
21 to 30	0.0	0.0
31 to 60	3.2	3.2
61 or more	0.0	0.0
Total	100.0	48.3

Master of Science Degree Program

	Responses	
Number of Employees	% of all organizations reporting	% having > 100 Employees
None	23.5	2.9
1 to 10	58.8	32.4
11 to 20	11.8	11.8
21 to 30	2.9	2.9

(*table continues*)

	Responses	
Number of Employees	% of all organizations reporting	% having > 100 Employees
31 to 60	2.9	2.9
61 or more	0.0	0.0
Total	100.0	52.9

Skills Enhancement Classes

	Responses	
Number of Employees	% of all organizations reporting	% having > 100 Employees
None	2.8	2.8
1 to 10	58.3	16.7
11 to 20	13.9	13.9
21 to 30	16.7	13.9
31 to 60	8.3	8.3
61 or more	0.0	0.0
Total	100.0	55.6

The response options for design team and design project support were added to the Cal State question but not to the State University question. The data is reported in Figure 5. Organizations exhibit a strong preference for providing topics for design teams and for participation with design teams by more than 2 to 1. Offering faculty endowments received no responses

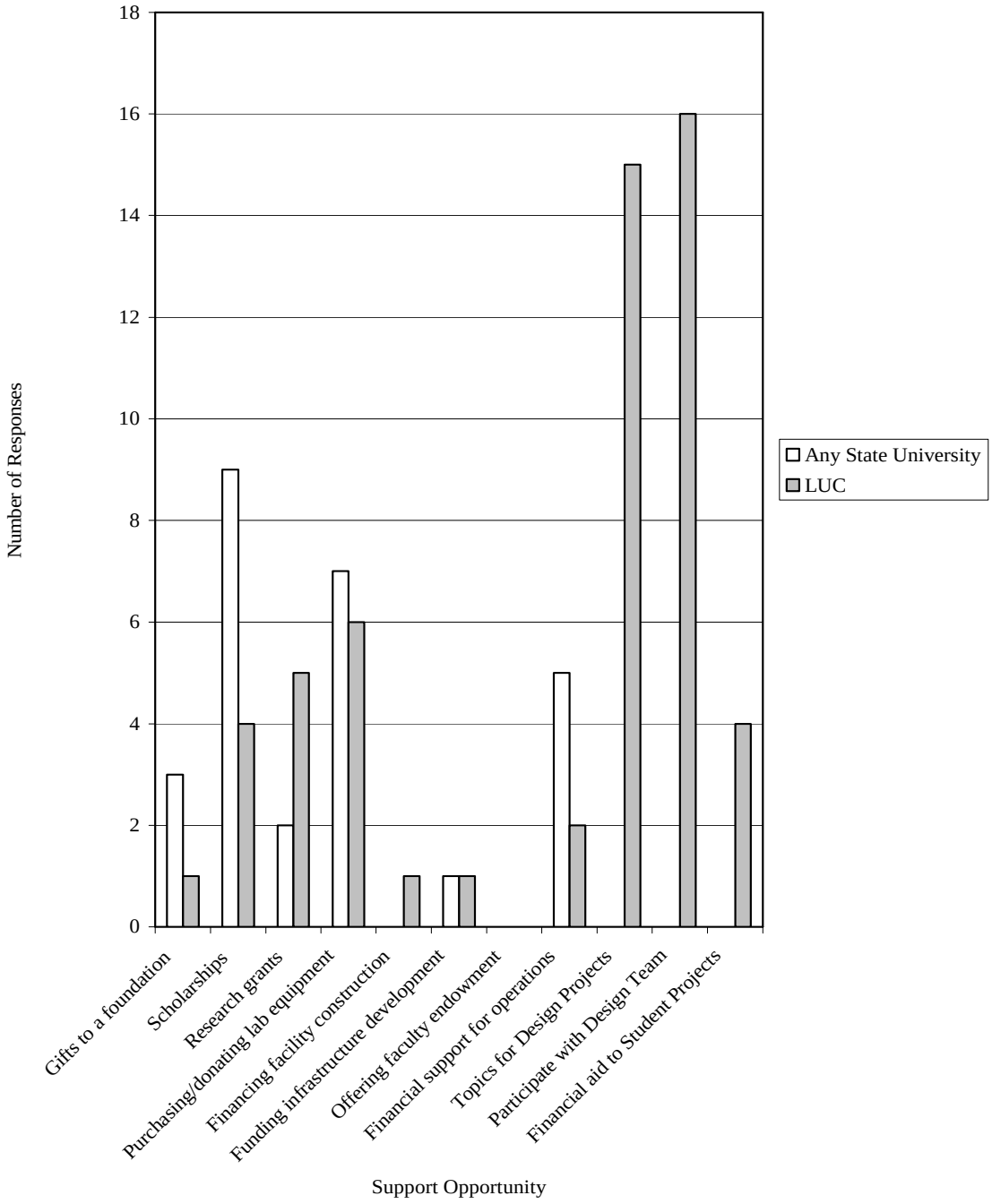

Figure 5: Survey responses indicated limited industry interest in providing tangible support.

The third survey question was used to determine what interest respondents had in supporting student work experience. Survey results are summarized in Figure 6.

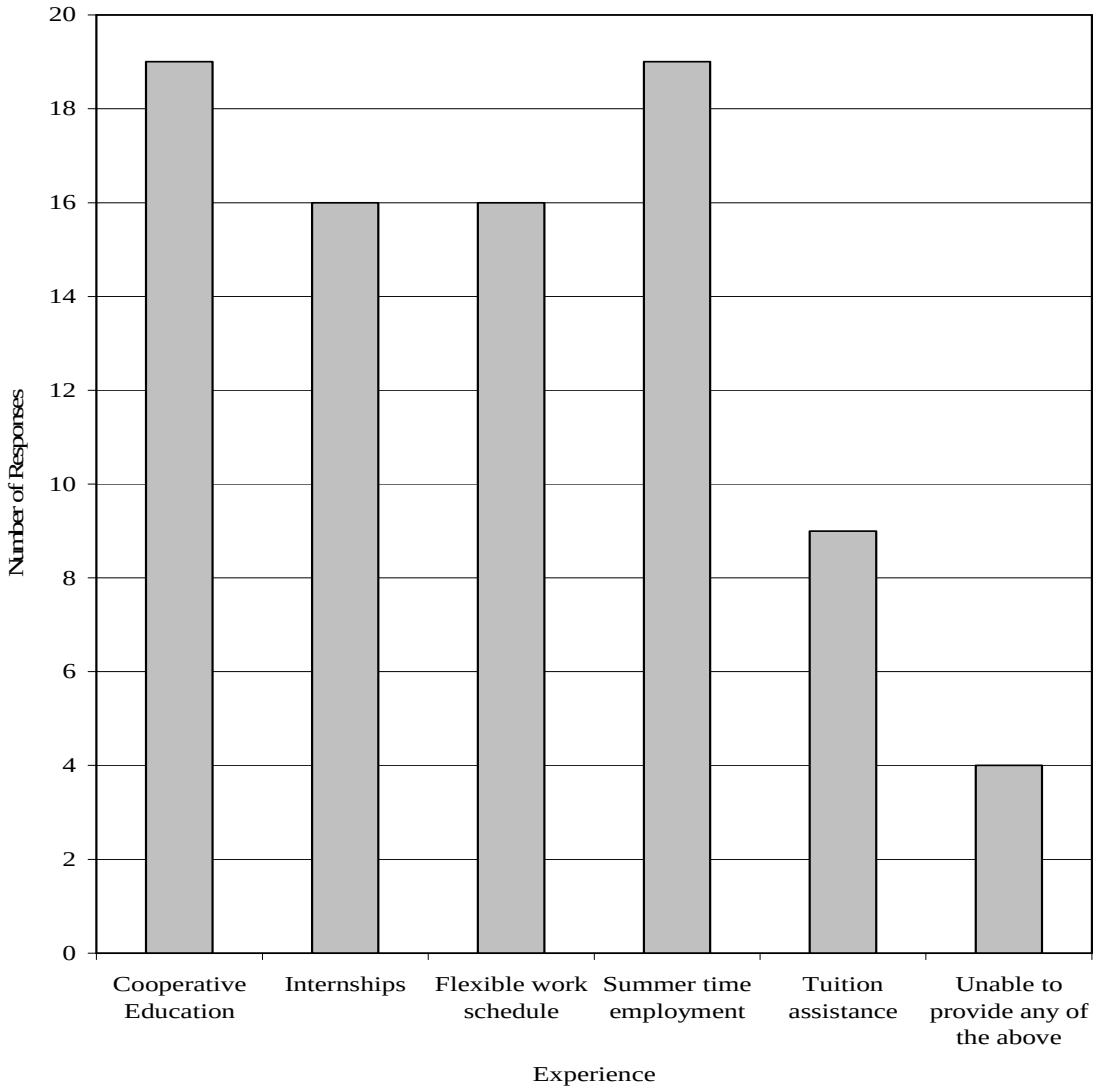

Figure 6: Employers are willing to provide work experience for students.

The organizational support, exhibited by respondents, for providing opportunities for student work experience is reasonably uniform between the various work opportunity programs with 65% of the respondents answering this question.

There were 4 survey questions that addressed curriculum devoted to research question 4. Survey Question 22 requested respondents to identify the core engineering disciplines sought by their organizations in hiring engineers with a Bachelor of Science degree. Survey question 24 asked about the core disciplines sought by organizations in hiring engineers with a Master of Science degree.

Research Question 3: What curricular offerings in engineering should be delivered?

Figure 7 displays the data for industry requirements for both baccalaureate and graduate degrees in various core engineering disciplines. Mechanical Engineering, Electrical Engineering, Aerospace Engineering, and Computer Science attracted the most response in the order stated for both the bachelor and Master of Science Degrees.

At the Bachelor degree level Chemical Engineering is close to Computer Science in the number of respondents selecting Chemical Engineering as a desired core discipline to be offered. Systems Engineering was a fifth choice at the Master's level. A total of 36 respondents answered the question for the Bachelor level degrees and 34 respondents answered the Master degree requirement question.

There were two additional questions that requested respondents to write in any disciplines that were needed but not already represented. Eleven respondents wrote in additional disciplines requiring a BS degree that are reported verbatim as follows:

1. Avionics, Software, Loads and Dynamics (variation of above)
2. Structural Engineer
3. Manufacturing Engineering
4. Materials Engineering
5. Materials Engineering

6. Explosives Engineering
7. Material/metallurgical
8. Composite Manufacturing
9. Flight Test Engineering
10. EW Engineering
11. Mathematician

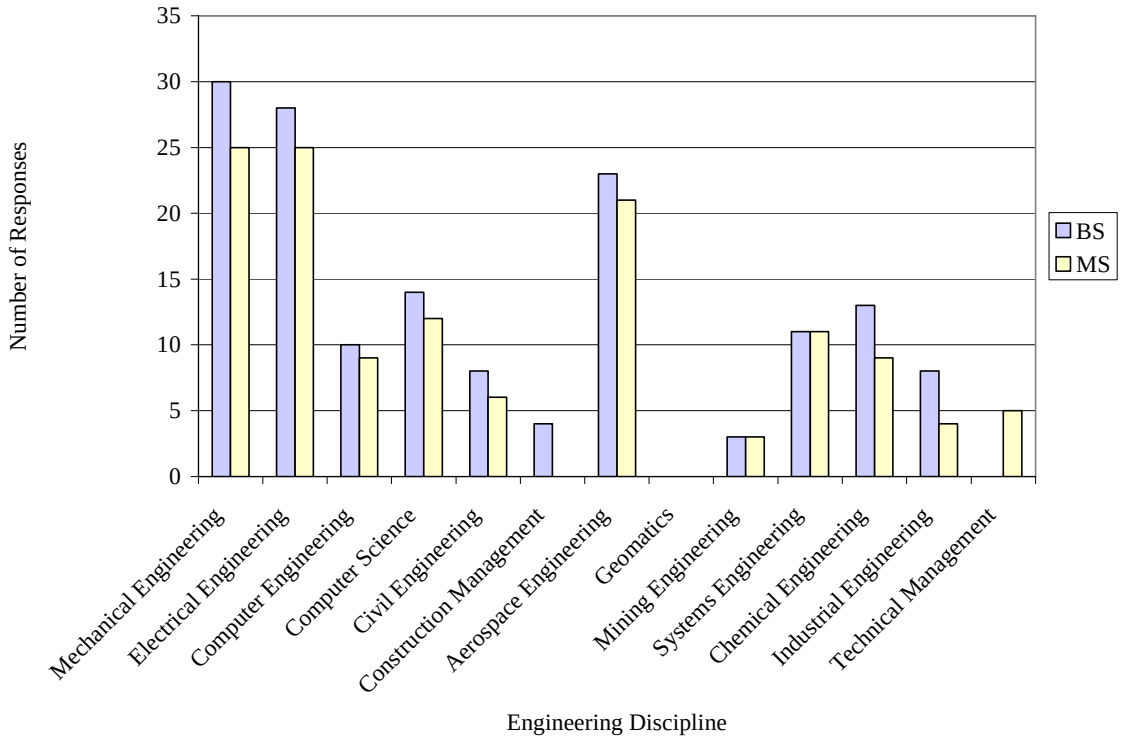

Figure 7: Industry needs greatest for mechanical, electrical, and aerospace engineers

Many of the write in responses do not pertain to core engineering disciplines but refer instead to highly specialized areas of emphasis typically learned once employed. Examples are Explosives and EW (Electronic Warfare) Engineering.

For the disciplines requiring an MS degree only 5 recipients of the survey questionnaire responded by writing in additional requirements. The written comments are reported below verbatim.

1. Aeronautical Engineering and Flight Test
2. Structural
3. Materials Eng.
4. Manufacturing Engineering
5. Materials Engineering

These write-in responses do pertain to specializations at the Master's level, however, only Materials Engineering was repeated and that only be one other respondent.

Research Question 4: What are the marketing strategies and tools that may be effective in student recruitment?

There were three survey questions that addressed research question 4. The first was survey question 3 which asked respondents if they were aware of the engineering programs currently being offered by Cal State at the Lancaster University Center. The requested response was yes or no. Of the 39 respondents answering this question exactly two thirds of the respondents answered yes and one third answered no. Survey questions 4 and 16 were attitudinal questions that used a Likert scale to allow respondents to record their opinions. These questions presented statement regarding retaining personnel and new employee and family adaptability to the high desert region. The analysis is presented in Table 11. Mean values indicate that respondents in general were neutral regarding problems with adaptability and retention resulting from the region's desert environment, however, the ranges are large as are the standard deviations.

Table 11

Attitudinal Question Response Descriptive Statistics

Question	Mean	Standard Deviation	Standard Error	Range
Employee Retention Problem	3.128	1.105	0.177	4
Employee and family adaptability Problem	3.135	0.787	0.129	3

Preparation for Phase II

Review of the data collected during Phase I indicates that there exists two major customer segments of concern. The first is the general category that includes aerospace, professional and other industrial organizations. This segment is dominated by aerospace and large firms which, for the purpose of this study, are those with over 100 employees. This segment was defined as Critical Case A in preparation for Phase II of this study. The Building industry forms the other major customer segment and the survey responses showed a very low level of need for engineers in comparison to the Critical Case A customer segment. The district offices of elected officials were designated Critical Case B. The district offices of elected officials were selected to provide a broad view of the regional industrial perspective due to the unique visibility that legislative members maintain within their districts (Davidson & Oleszek, 2006). Critical Case C identified the second largest segment of organizations employing engineers which is the Building Industry.

Phase II Interview Data Analysis

Qualitative content analysis of the transcripts based on Strauss and Corbin's (1997) grounded theory was conducted. Two coders were chosen. One was experienced. Both coders had trained in the protection of human subjects. Instructions (see Appendix I) were provided to each coder along with the themes for coding (see Appendix J) and were reviewed with each coder. Paraphrased and bundled transcripts were coded by the researcher on multiple occasions until the final themes had developed and intra-rater validity was achieved. Inter-rater agreement was similarly achieved through multiple coding passes until themes were matured and inter-coder agreement was reached on the matured themes. Theme maturation was accomplished by first coding with the experienced coder. Agreement was reached on the initial coding pass. Themes were then reviewed by the experienced coder and the researcher and revised were confusion had been observed. The coding was then mapped to the matured themes and agreement was reached on the mapping. Coding then proceeded with the inexperienced coder using the matured themes. Agreement was reached through an iterative process of coding and recording agreements. In the event of a coding impasse, consensus between the coders for the correct theme was developed. Eleven themes were identified and the relationship between the themes and the research questions is shown in Table 12.

Findings

Research Question 2: What are the available resources to support development of a regional learning center?

This research question was addressed during the second phase of this study by two themes that were developed from interviews.

Table 12

Relationship of Themes Developed from Interviews to Research Questions

Theme	Research Question
1. Opportunities for cooperation between industry and the University	Available resources
2. Support to endowments and the University Foundation	Available resources
3. Curriculum	Curricular offering
4. Student/graduate communication/presentation skills	Curricular offering
5. Cost of employee replacement	Marketing strategies & tools
6. Employee educational reimbursement	Marketing strategies & tools
7. Employee recruiting and retention	Marketing strategies & tools
	(*table continues)*
8. Market environment and opportunities	Marketing strategies & tools
9. Outreach	Marketing strategies & tools
10. Student Coop, Internship, and Summer Hire programs	Marketing strategies & tools
11. The opinion of industry regarding the support received from higher education	Success Assessment

Opportunities for cooperation between industry and the University. The Critical Case A respondents provided their perceptions of the support that they have received, specifically relating to higher education, and they offered a variety of opinions regarding

possible opportunities for cooperation that were, in most cases, generic, but some comments were very specific to their particular product or service.

In all cases the question used to initiate the interview asked the subject for their organization's view of the support provided by higher education. A Deputy Director of a major research facility indicated that,

> The higher education, it's here, it's available. Not only here through [Cal State] and [another State University], but also at the Aero Institute in Palmdale where we've got Purdue, USC, Cal Poly Pomona, Pepperdine, and some additional schools that are available (Respondent A-4, personal communication, April 10, 2008).

One respondent summed up the situation, with respect to engineering education, from the perspective of a major aerospace corporation. "The higher education piece in the valley is a very positive thing and we are definitely in support of it" (Respondent A-2, personal communication, March 13, 2008). Respondent A-2 went on to add, "So, it's better than it was when I arrived in the valley 18 to 20 years ago. But, we still have a long ways to go, but it's definitely leaps ahead of where it was" (March 13, 2008). These respondents were familiar with the Cal State program as a result of either hiring our graduates from the baccalaureate engineering program (Skeen, 2007) or because they have students currently enrolled in the Cal State graduate engineering programs. Other respondents with less direct contact with the existing LUC program offered that they had not received any help. One site director stated, "This is difficult for me to answer because I've only been here for four months, but generally, I see no evidence that anything in the Antelope Valley is helping us at all" (respondent A-3, personal communication, March 24, 2008). This site director' response was consistent with the balance of the Critical Case A respondent's

opinions of the level of support received relative to engineering education, from higher education in the Antelope Valley.

In continuing the semi-structured interviews all of the respondents were optimistic about the potential that the LUC engineering programs brings to the region and offered a variety of ideas for cooperation between industry and the University. Generally, in the opportunities for cooperation theme, the respondent's suggestions fell into 5 topics. The topics were training, specialized classes, educational needs, special projects, and active outreach. An example of the type of training industry needs was provided by Respondent A-1. This respondent indicated that training for their engineering employees in electronics instrumentation control would be very useful. He also indicated that an important aspect of such training would be to offer training classes in the evening (personal communication, March 11, 2008). There were a large variety of specialized classes suggested by the interview subjects. The suggestions ranged from simply having advanced classes available for employees to expand their understanding of their chosen engineering disciplines (Respondent A-1, personal communication, March 11, 2008) to very specific classes that would correct deficiencies in the local industry skill sets for the engineering staffs. Examples of specialized classes included several suggestions relating to Reliability Engineering. Reliability is a very specialized multi-disciplinary branch of engineering. Respondent A-2 stated that,

> We have reliability engineers over there, but as you're probably well aware, there's a lot of the specialty engineering that hasn't had a great influx of younger folks in recent years, so they're all getting more senior in years. Retirement

> eligibility is looming for many. But, even as a general knowledge builder for the rest of the staff, it would be great (personal communication, March 13, 2008).

Another respondent offered that, "It's an area that we're not very strong in, and it [strength in Reliability Engineering] has to be there if we're going to be a major player" (Respondent A-3, personal communication, March 24, 2008). This same respondent suggested that Composite design, manufacturing, and testing was another area that would be an appropriate area for cooperation. He indicated that the availability of qualified personnel was a problem because of the competition for such personnel. He also suggested training for specific design software products (personal communication, March 24, 2008). Other areas suggested for specialized classes were in engineering team building, engineering program management, and systems engineering (Respondent A-6, personal communication, April 10, 2008).

In the category of educational needs, one respondent indicated the need for advanced degrees because employers are looking for engineers with advanced degrees, this respondent also indicated that it is important to have a local engineering education capability available, "… makes it easier for those that have jobs and families who want to pursue a quest for higher education. It would be very difficult for these individuals if they had to commute to Los Angeles, Bakersfield, or Fresno and they most likely wouldn't advance their education" (Respondent A-4, personal communication, April 10, 2008). Another respondent discussed the need for graduates with a solid foundation in fundamentals but that are capable of bridging several different disciplines so that industry can broaden their skills (Respondent A-5, personal communication, April 10, 2008).

Cooperation in the form of special projects was also suggested. Examples discussed were undertaking joint efforts in factory automaton, to develop special tooling, and working to improve systems (Respondent A-5, personal communication, April 10, 2008). The possibility of establishing cooperative efforts in research and development was also touched (Respondent A-6, personal communication, April 10, 2008).

The final category of suggested cooperation is in the area of active outreach. Respondent A-6 was concerned with the availability of engineers entering the aerospace engineering field and indicated that the field is reducing in size that active cooperative outreach activities to attract students to the field is required to support industry in the near future (personal communication, April 10, 2008).

The Critical Case B respondents had a broad insight into industry due to the political nature of their positions and the need for a wide range of affiliations and relationships required to serve their elected representatives at the state and federal levels. When asked if industry was, generally, even aware of the LUC engineering programs, his response was, “Yes, yes, there is an awareness. And, the comments that I’ve heard about the program you have are very positive” (Respondent B-2, personal communication, April 21, 2008). Respondent B-1 indicated that he believed that companies were very upfront in their support of the LUC program. He summarized his opinion by stating, “And so I feel that they [companies] are willing participants. They have resources that they can bring to bear” (personal communication, March 20, 2008). In addressing suggestions for cooperation Respondent B-1 suggested that cooperation between the University and the city was simply a matter of going to city hall and just telling them what is needed. He said that he believes the city has the capability to deliver what is

requested. They just need to know what is needed (Respondent B-1, personal communication, March 20, 2008).

The building industry, Critical Case C, respondents uniformly echoed the fact that their industry has not received any benefit from higher education with respect to engineering education. Respondent C-2 (personal communication, April 15, 2008) reported that he was even unable to establish a cooperative effort when one was available. This respondent is an experienced adjunct professor having taught lower division and some upper division land surveying classes at various institutions. He recounted an event that happened during, the last building boom in the Antelope Valley that occurred approximately three years ago. He was able to interest 23 students in taking basic land surveying classes but he reported being unable to obtain sufficient support to offer classes, from the existing post secondary education institutions then operating in the region. Another interview subject offered his opinion from the perspective of the local government organization which has invested in providing the Lancaster University Center for the use of higher education institutions.

> So, I believe the city's view on the support is that it's not there yet. [The local community college] is a wonderful institution. It's a large community college. But their success at transferring students into these types of programs and having those students come back into the Antelope Valley hasn't been all that successful (Respondent C-3, personal communication, April 18, 2008).

The suggestions for cooperation offered by the Critical Case C respondents are very similar to the suggestions made by the Critical Case A respondents. Training and specialized classes were also suggested as were special projects. Training revolved

around such specific technologies as wind and photovoltaic power, however, a cautionary note was sounded due to heavy work loads and limited time availability. As Respondent C-1 stated the situation resulting from a major wind power initiative,

> So, right now the attitude is having to put up or shut up. We've all advocated and have all gone out there to beat the drums that, yes, we can meet these needs, and we need to move forward as diligently as we possibly can to develop the 4500 mega-watts. Because, we've got to put our money where our mouth is now. So, I'm sure we can get some folks to help you with different programs or different things, but it's going to be hit or miss right now (Respondent C-1, personal communication, April 9, 2008).

This respondent went on to suggest that what the industry could provide was help in formulating a program to get graduates into the industry.

The Building Industry deals largely with property so the specialty classes suggested dealt largely with the legal aspects of the work done by engineers. Writing and interpreting legal descriptions and dealing with boundary were specific suggestions (Respondent C-2, personal communication, April 15, 2008). All of the respondents in this critical case emphasized the boom or bust nature of their business and suggested that engineering education needed to focus on preparing students to enter the work force to meet industry needs when the next boom developed.

Support to endowments and the university foundation. The second theme that addresses the research question of the available resources to support development of a regional learning center is directed at the financial resources that can be made available to provide faculty and the necessary capital to conduct operations. The theme is support to

endowments and the University Foundation. The motivation to visit the question of gift giving and endowments resulted from the total lack of response to endowments and foundation for supporting the University, as a respondent choice, on the Phase I survey questionnaire.

The question that was asked of interview subjects was directed at obtaining their opinion as to why organizations are reluctant to provide gifts to the University Foundation to support operations and to endow faculty. There were a variety of opinions from the respondents regarding this theme. Respondent A-2 reported that, "… there is a lot of reluctance to do that" (personal communication, March 13, 2008) in his organization and he concluded by stating, "But, you know, I don't have a good answer for why there's a lot of resistance for the endowments, both faculty and facility" (March 13, 2008). Respondent A-3 shared that it is easy to obtain money for laboratory equipment but it is much more difficult to justify money for faculty development (personal communication, March 24, 2008). Respondent A-5 explained that there are many well known universities in California and that organizations spend money because they obtain access to research and other things that are going on at a particular university. This respondent went on to suggest that LUC in the Antelope Valley is not in the well enough established to interest most organizations for funding endowments and for giving to a foundation (personal communication, April 10, 2008). Respondent C-2 suggested that the general attitude toward supporting faculty development and operations was the job of the government (personal communication, April 15, 2008). Respondent C-4 explained that the problem is that the Antelope Valley is not very large and that the same pool of resources is being tapped over and over again. This respondent stated that, "…

the running joke is [that] it's the same twelve people that are on every board of directors. It's the same fifteen companies that get to write a check" (personal communication, April 21, 2008). One respondent, B-1, even suggested that organizations are spending their money for the wrong things and that they are not taking care of the future (personal communication, March 20, 2008).

All of the respondents tended to agree that supporting the University through giving to endow faculty and to the University Foundation was not impossible. Such giving is just difficult to justify and requires that requests be specific. Respondent C-4 added that it is necessary to compete with many long established charitable organizations that have developed strong relationships throughout the Antelope Valley (personal communication, April 21, 2008).

Research Question 3: What curricular offerings in engineering should be delivered?

Two themes emerged as applying to this research question. They were curriculum and student/graduate communication/presentation skills.

Curriculum. The curricular findings, in the first theme, result from the core engineering discipline requirements expressed by the interview subjects. The core engineering disciplines depend heavily on the industry segment expressing a need. As one interview subject stated, "And our Valley up here is heavily dependent on two industries still; the aerospace industry and the construction industry" (Respondent C-4, personal communication, April 21, 2008).

Critical Case A respondents provided information which supports the results of the quantitative phase of this study and which expand the understanding of specific industry needs. Respondent A-1 explained that in the local large mining operation, the

traditional disciplines of Civil, Mechanical, and Electrical Engineering form the majority of the organization's requirements. The reason that this respondent gave for the emphasis on the traditional disciplines is that the mining operation is heavily process oriented. He also indicated that the core of their engineering operations is engineers with Bachelor of Science degrees. Mining engineers are in extremely short supply because of the world wide demand and due to the fact that many schools have dropped their mining engineering programs. A Master of Science Degree program was also something that this respondent thought would interest his organization. Respondent A-1 explained that his organization has a problem that develops when top scientists and engineers are assigned to manage a department. The problem is that the assigned scientists and engineers don't know how to maintain schedules or how to correspond with management (personal communication, March 11, 2008).

Respondent A-2 (personal communication, March 13, 2008) focused on Systems Engineering as an area of great importance. Respondent A-2 explained that his organization had created, within the last two years, a Systems Engineering department and that a director for the department had been hired. Since this department is new within the organization, respondent A-2 indicated that training in Systems Engineering is lacking. This respondent also indicated that sending employees to LUC for the Master of Science degree in Technical Management would be a way that he could obtain additional personnel training using a different resource pool. Chemical engineering was also discussed during this interview. The need for chemical engineering was verified by respondent A-2; however, the application was very specific to the materials and processes

used in production. In describing the situation within the organization relative to Chemical Engineers, respondent A-2 said,

> We brought in a core group of those folks, probably eight or nine years ago. Many have left. But, there are still two or three of them. And, then you've got a dozen senior folks, that all are going to be retirement eligible in the next five or six years or less (March 13, 2008).

The focus for respondent A-3's organization is aircraft modification. As such Mechanical Engineering, Aerospace Engineering, and Systems Engineering form the principle core discipline interests for respondent A-3's organization. An additional area that respondent A-3 discussed was Composites Engineering. This is a specialty area allied with the core Chemical Engineering discipline (personal communication, March 24, 2008).

Respondent A-4 (personal communication, April 10, 2008) identified Electrical, Mechanical, and Facilities Engineering. In describing Facilities Engineering, this respondent discussed the facility construction programs that were underway implying that what was meant was Construction Management.

Electrical Engineers having some software development capability were the principle requirement for respondent A-5's organization. Respondent A-5 shared that his organization also used Chemical Engineers, as a specialized side of the business, primarily for process development (Personal Communication, April 10, 2008).

Respondents A-6 (personal communication, April 10, 2008) and respondent A-7 (personal communication, April 11, 2008) both discussed the specialized Composite Engineering relating to their industry segments. Respondent A-6 defined Composite

Engineering as drawing heavily from Chemical Engineering but that the specific industry segment need was in the area polymer materials. This respondent stated that, "Aircraft are increasing the amount of composites used in structural components and the associated lay up and [that] resin chemical properties are proprietary and constantly changing" (April 10, 2008). Respondent A-7 explained that his view was that Composite Engineering not only requires additional strength in Chemical Engineering, but that it should be most closely aligned with Mechanical Engineering due to the needed fundamentals of Statics, Dynamics, and Strength of Materials. He suggested that an understanding of electrical properties may be required as well because advanced battery technologies are moving away from lithium ion to lithium polymer type batteries. Grounding electrical systems on composite aircraft also produces unique challenges. Respondent A-7, as an aside, also provided me with 13 articles from the University of Texas regarding Developing Machine Intelligence which appears to be an emerging technology related to, but moving well beyond Mechatronics. Respondent A-7 summed up his organization's core needs by stating,

> We cover mechanical, electrical, aerospace, systems and the associated software and chemical fields. From an electrical standpoint I tend to rank electrical and systems higher. But, you know, aerospace and mechanical structures [a specialty] comes in a very close second (April 11, 2007).

Respondent A-7 also provided his perspectives about Computer Engineering and Computer Science. This individual indicated that he had earned a Master of Science degree in Computer Engineering and that there was a great deal of confusion through out industry about the difference between the two disciplines. He explained that,

> There are several trends in industry that reinforce the need for more Computer Engineers and less Computer Science type graduates. For example, the trend to auto-code generate requires a much higher understanding of the control theories and architectures of embedded computer systems design than ever before. Large standing armies of computer programmers are a thing of the past. Real-time secure operating systems are much more rigid design applications that require Computer Engineers who can certify their work rather than knowing just the fundamentals of computer science. The next technical revolution is not the microcomputer or its associated software development but rather the rapid proliferation of intelligent mechanical actuation systems and micro-machines (Respondent A-7, personal communication, April 11, 2008).

Respondent A-7 went on to explain that Software Engineering (Computer Science form an engineering perspective) and Systems Engineering both should be graduate level programs with students drawn from the traditional engineering disciplines after they have had several years of experience. Respondent B-1 (personal communication, March 20, 2008) agreed with the comments from the Critical Case A respondents by indicating his understanding that composites were the wave of the future because stronger and lighter than steel.

All of the Critical Case C respondents offered very similar opinions regarding the core engineering disciplines for the Building Industry. Basically, they identified Civil, Mechanical, and Electrical Engineering as required by employers. They also identified Land Surveying (Geomatics), Project Management, and Construction Management as being required. Specialty engineering areas specifically mentioned were Environmental

and Traffic Engineering. Respondent C-4 (personal communication, April 21, 2008) offered that LUC in the Antelope Valley may want to partner with a community college in Valencia, CA because they already had a Associate of Arts degree that is offered in Construction Management.

Student/graduate communication/presentation skills. The second theme that addressed this research question was student/graduate communication/presentation skills. These are skill sets identified by the respondents as being typically deficient in new engineering graduates both at the baccalaureate and graduate levels. Specific references were unique enough to identify as they are very revealing and note worthy, particularly since communication and presentation skills, or their lack, continues to become manifest in many anecdotal situations.

Respondent A-1 (personal communication, March 11, 2008) indicated that project engineers or project managers needed assistance in working with people, time, and money. These are all areas that require good communication and presentation skills to do successfully. This respondent also offered an interesting but directly applicable observation, “Just teaching smart people how to write is a challenge”. Respondent A-7 observed that teams can be autonomous but, they are really only as good as their communication within the team (personal communication, April 11, 2008).

Research Question 4: What are the marketing strategies and tools that may be effective in student recruitment?

The interview coding process revealed six themes that apply to this research question. The six themes are:

1. Cost of employee replacement

2. Employee educational reimbursement
3. Employee recruiting and retention
4. Market environment and opportunities
5. Outreach
6. Student Coops, Internships, and Summer Hire Programs

Cost of employee replacement. Only one respondent offered a response regarding the cost of employee replacement. It is important because it is consistent with the literature on the subject. Respondent A-2 offered that the cost of replacing employees is high and stated, "But the general number is $100,000. And that's for the entry level folks. Now, if you're out recruiting for some of the more mid level to senior positions, you're looking at about $150,000 or more" (personal communication, March 13, 2008).

Employee educational reimbursement. Two respondents addressed employee educational reimbursement. Respondent A-3 made the following statement regarding the corporate attitude toward employee education.

> Let's take continuing education first. That is a big one. We have a lot of people who have basic degrees. Some have associate's degrees. And the company is very willing to sponsor people to go and get further education so that again, that helps with retention, because we have a career path of people to move into. So from that point of view, we're very interested in further education (personal communication, March 24, 2008).

Another respondent offered a more general opinion regarding employee educational reimbursement programs in the aerospace industry. This respondent, A-4, stated that,

"Those who work in these areas have the opportunity available to them to pursue higher education to help them further their careers" (personal communication, April 10, 2008).

Employee recruiting and retention. The third theme that addresses the research question of marketing strategies and tools for recruiting students is employee recruiting and retention. Scrutiny of the data has revealed three topical areas that respondents repeatedly discussed. In addition to the thematic areas of recruiting and retention, the topics are; the cost of living in California, the Antelope Valley environment, and a specific subset of retention which is the subset of retaining employees longer than two years.

A major consideration that is adversely impacting recruiting for the organizations in the high desert region is the cost of living in California. Moving employees to California is an expensive process and it is often difficult to keep up with sufficient salary incentives or differentials on housing (Respondent A-1, personal communication, March 11, 2008). Respondent C-4 (personal communication, April 21, 2008) suggested that attracting business to move into the California economy is as challenging as is recruiting employees from other locations due to the high cost of living.

There is opportunity, however, for recruiting employees from other areas, particularly Southern California, of the State. The cost of housing in the Greater Antelope Valley is much lower than in many other parts of Los Angeles County, Orange County, San Diego County, and the Inland Empire in San Bernardino County. Respondent B-2 offered that, "On the other hand, we have lower priced housing, more affordable, and that's a plus" (personal communication, April 21, 2008). Respondent A-2 in describing employee recruiting efforts explained,

> Well, you know, we try to emphasize that as a benefit for them. Because most of them can't or don't see themselves ever being able to afford a house in California, especially in the San Diego and LA areas. So that's one of the reasons folks get attracted to here – lower cost of housing (Respondent A-2, personal communication, March 13, 2008).

The Antelope Valley environment, however, tends to offset the lower price of housing for young people considering positions in the Antelope Valley. The environment is both the physical environment of the high desert region and the social environment provided by the communities in the region and it is considered a detractor by employers attempting to recruit degreed engineering personnel. The specific environment that exists in the Greater Antelope Valley, on the other hand, is why there has been and continues to be so much aerospace activity in the region. As one respondent, representing a major national aerospace research organization explained, "The natural landscape is not one of the big attractions; however, the landscape provides the aerospace business with the ability to do what you can't do anywhere else in the world" (Respondent A-4, personal communication, April 10, 2008). In spite of the ideal conditions for aerospace research that the Greater Antelope Valley provides to the government and to industry, the local environment remains a significant detractor in recruiting. Respondent B-1, who interfaces with employers, explained,

> Well, we are in the desert. Engineers are in demand worldwide and what companies have found, what we've been told is that young engineers coming out of university, ready to go to work, [are] going to get offers from places that have

> beaches with oceans nearby. And then how do we compete with that physical environment? (Respondent B-1, personal communication, March 20, 2008)

Respondent B-2 shared his view that,

> Our area itself, in the high desert, is a negative for us. Obviously, we don't have an ocean to stare at. And we've got windy days, cold winters, and hot summers. We may not have the most ideal climate for some of these young people that are coming out of school (personal communications, April 21, 2008).

Another respondent offered the responses that he has received from job candidates that come for job interviews.

> Then they come out here and see the area and state, 'You've got to be kidding me!' especially if you're from the East Coast. 'I'm coming out here from all this green and trees and I'm coming out to this? And it is hot out here. You've got to be kidding!' (Respondent A-5, personal communication, April 10, 2008).

A seemingly important aspect of the environment in the Antelope Valley is the social environment. An important part of the social environment for young people, entering the work force, is the availability, quality, and variety of entertainment in the community. Respondent A-2 reported that, "For the younger folks, there's not a lot of night life and the things that you find like in the South Bay or San Diego. That's probably the single biggest issue we have up here as far as the newly hired folks" (personal communication, March 13, 2008). For those contemplating a family or those that are bringing a family to the region, the communities can be a disadvantage as well. Respondent B-2 offered his opinion by stating,

> It really is. I mean, they get that from the paper in the morning. They read about gang problems and people moving up from Los Angeles. They're gang kids and all this kind of stuff. And if they're youngsters and if they're thinking about a family down the road, this may not be the area they want to stay in. And I feel bad about that, because it's my home. But there's a lot of negatives that pop up in that newspaper every day that might drive people away and think elsewhere. So I think our area is our biggest problem, and the people that I talk to pretty much agree with that. That's the one thing that we really need to overcome (personal communication, April 21, 2008).

Concerns of new people to the area result from the physical environment and the social environment and are substantiated by the third topical area discussed by respondents,.

The inability to retain new employees beyond two years tends to substantiate the environmental issues raised by respondents. Respondent A-2 (personal communication, March 13, 2008) indicated that it is difficult to get engineering personnel to even consider taking a position in the Antelope Valley and that it is the more adventurous ones who accept a job. The newly graduated engineers are typically being recruited from universities such as Southern Florida, Georgia Tech, Ohio State, and Purdue. The problem then becomes that it is difficult to retain new employees for more than two years. Respondent A-2 went on to add that, "Even if we bring them out two or three times and they finally say yes. We typically have the 2 year attrition problem. Not all of them, but a pretty high percentage of them" (personal communication, March 13, 2008). Respondent A-5 also discussed the issue of having recruited newly graduated engineers from out of the region who came on board and did a tremendous job but after a couple of

years they left the organization and returned to where they had come from (personal communication, April 10, 2008). The particular retention problem of retaining employees new to the region seems to be largely resident with the Critical Case A industry and government organizations that are largely aerospace oriented. Respondent C-2 expressed experience from the Critical Case C building industry stating that,

> I don't know if there's so much a problem with the retention as with the economy. When the economy or the boom goes down or dies then people suffer. They hired on when things were booming, when there was a lot of development and construction. They were working over-time. But then, when that slows down, all of a sudden, they were working 5 days a week and then they're working 4 days a week, and things continue to decline and they're down to working 3 days a week. So it gets to a point where they just can't support themselves or their families on part-time work. So they immediately go to another area, maybe one that's booming, maybe even a different part of the country. The sad part is, you've trained this person to do it the way you want it done, and then, because of the economy, you just can't afford to pay them full time because you just don't have that much work (personal communication, April 15, 2008).

One respondent represents an industry that does not have a retention problem with their personnel, but the employees are highly mobile between companies because the industry is composed of a large number of small companies (Respondent C-1, personal communication, April 9, 2008). The retention issues provide insight into the recruiting problems that the industry in the region is facing.

The respondents have reported that the costs of recruiting engineers from outside the region are rising. For the Critical Case A industrial segment, the rising costs manifest in the form of salary incentives, generous moving packages, and housing differentials. Respondent A-3 indicates that his organization is having some good success at recruiting engineers because the company has a good reputation for being an exciting place to work; however, they are also paying for their success with high salaries and good relocation packages (personal communication, March 24, 2008). According to respondent A-7, "It's something that we've got to be aware of and HR is going to have to adapt to it. And I know it's getting expensive in some cases too. Relocation packages are always seeming to grow" (personal communication, April 11, 2008). The Critical Case A government organizations and the Building Industry in the region are finding the recruiting issues particularly difficult to manage. In the case of the government organizations, respondent A-4 explained that an issue for the government research organizations, that employee engineers, is the salary that they are able to offer prospective employees. The non-government industry, responds much quicker to competitive pressure so their salary offers can remain competitive. Government employers must comply with congressional mandates that place limitations on salary offers (personal communication, April 10, 2008). Respondent C-3 summarized the Critical Case C industry recruiting issues by explaining that,

> It's actually difficult to find any engineers, quite honestly, and we advertise for engineers, and finding someone with the knowledge of what we're looking for has been difficult. We've gone through interview processes where quite honestly

> we've eliminated all the candidates or we haven't had very many candidates (Respondent C-3, personal communication, April 18, 2008).

Employers represented by the individuals who have participated as interview subjects for this study have a number of requirements for newly graduated engineers that effect their recruiting. The government organizations, particularly those with a research mission, have strict guidelines for hiring from accredited universities and for engineering graduates with high grade point averages (Respondent A-4, personal communication, April 10, 2008). Aerospace firms are looking for graduates with good fundamental skills that, "… can hit the ground running ready to apply a hands-on approach to actively apply their basic skills" (Respondent A-6, personal communication, April 10, 2008). The organizations in the Antelope Valley are all also looking for good retention investments in the engineers that they hire. They are looking for engineers educated locally and they use the term *Homegrown* (Skeen, 2007). Respondent A-2, speaking on behalf of his organization said, "We're just glad that you're here and that the school has taken an interest in putting a satellite here" (personal communication, March 13, 2008). He, A-2, went on to explain that his organization really struggles to get personnel that want to be in the Antelope Valley and that have the requisite skills to do the necessary jobs. Respondent A-2 also made the statement that, "I don't know any people that have left once we've gotten them from here or they've gone to school here" (March 13, 2008). Respondent B-1 made the observation that, "… because if people grow up here, go through the local school system and get their degrees here, their engineering degrees, they're more inclined to stay than somebody who's coming from another place" (personal communication, March 20, 2008). Respondent C-3 said that his organization would love

it if they could stop advertising in other places and just pull engineers from an available local pool (personal communication, April 18, 2008).

Market environment and opportunities. The next theme that addresses the research question regarding marketing strategies and tools that may be effective in recruiting students is the market environment and opportunities. The two major industrial components of the market, as has already been noted, are the Aerospace Industry and the Building Industry. Supporting aerospace and other business segments of the national economy are Manufacturing, Mining, and Renewable Energy Sources such as wind and solar power generation, all of which employee engineers. Each of these industrial segments has a unique market environment. According to respondent A-2, the wind energy market is being served by many little operating companies and, therefore, they have difficulty perpetuating themselves over time (personal, communication, March 13, 2008). This view of the local wind energy industry was echoed by respondent C-1 (personal communication, April 9, 2008) who indicated that there are large companies and small companies in the market. The many small companies; however, range from professional, shirt and tie operations to the ones that operate in a t-shirt and jeans environment. The Wind Power Industry; however, is gearing up for a major power production increase, at the Tehachapi Wind Farm, resulting from a Southern California Edison announcement for development of an additional 4500 mega-watts of capacity. The State of California has prepared mandates and legislation that increase the amount of the State's energy produced by wind to 30% by 2010. The future looks like the capability for even more power produced by wind will be developed. According to respondent C-1, "Well, the CEC has designated the Tehachapi-Mojave Wind Resource area as supplying

at least 42% of the RPS goals which is significant" (personal communication, April 9, 2008).

The manufacturing segment in the Antelope Valley is represented in this study by respondent A-5 who has indicated that his organization is growing and expanding to address new opportunities. Right now it is very process oriented, therefore, process improvement, tool design, and test equipment design and manufacture are the principle areas of focus. With growth; however, an increase in the engineering staff and a move towards engineering services as a larger segment of the business will occur (personal communication, April 10, 2008).

The Aerospace Industry in the Antelope Valley is comprised of two segments. The laboratories and flight test facilities operated by the United States Air Force and the National Aeronautics and Astronautics Administration form the first segment. Commercial companies such as The Boeing Company, Northrop Grumman, Lockheed Martin, ATK, and Aerojet make up the second segment.

Contracting with the government has always been regulated but now, the government is shifting more risk to the commercial sector, asking industry to accept larger percentages of firm-fixed-price contract components and minimize, or even eliminate altogether, the cost-plus-fee contract vehicles (Respondent A-7, personal communication, April 11, 2008). Another relatively new aspect of the government organizations is their ability to compete for commercial contracts. According to respondent B-2 (personal communication, April 21, 2008), the National Aeronautics and Space Administration in the Antelope Valley, just three years ago Dryden Flight Research Center had no commercial contracts. As of last year 35% of Dryden's work was

private contract work. Respondent B-2 also indicates that the Air Force Flight Test organizations at Edwards Air Force Base are also doing private testing and contract work.

The Building industry benefits from the government contract work that is underway as well. Respondent C-2 commented that,

> The other factor is when the aerospace gets the contracts, big contracts, then, all of a sudden, they're needing engineers and expanding. With the base consolidation, when they close down bases in some areas, and bring people to Edwards Air Force Base that creates more demand for housing and utilities and everything because they're increasing their personnel out there. And up at China Lake too, up in the Ridgecrest area as well (personal communication, April 15, 2008).

The increase in contracts being executed by the local government organizations coupled with the local cities' efforts to catch up with the last boom in terms of infrastructure development and active commercial construction tends to level somewhat the regional demand for engineers (Respondent C-2, personal communication, April 15, 2008). Respondent C-4 offered the opinion that a lot of the problems currently faced by the Building Industry are created by the media. The Building Industry crisis is really being driven by certain counties in California, Florida, and to some extent Texas. The rest of the country is reasonably stable (personal communication, April 21, 2008).

Respondents B-1 and B-2 offered direct insights and advice into effective marketing tools and strategies for the Greater Antelope Valley. Respondent B-1 (personal communication, March 20, 2008) advised that marketing must be targeted. Mass media does not work in the region because there is too much fragmentation with some people

watching television, some listen to the radio, and a few still read newspapers of which there are several. As a matter of fact, Respondent B-1 indicated that no one has a 50% market share any more. Market shares are all below 50%. Respondent B-1; however, did suggest obtaining Public Service Announcements from the local radio stations. Public Service Announcements are offered at no charge. Respondent B-2 shared that,

> Well, we've been hearing now for several years that there is a major shortage, that there is a graying of the profession of engineers, and in particular in aerospace, because that's our biggest employer of engineers here in the Antelope Valley. I think that one employer out at Edwards Air Force Base told me that the average age of an engineer working at Edwards has grown in the last 20 years from the mid-30s to the low 50s (personal communication, April 21, 2008).

B-2 also shared that the information he was receiving indicated that young graduating engineers aren't interested in joining the Aerospace Industry anymore. They would rather work in Silicone Valley because the money is better and the work environment is more exciting. This is producing a shortage of engineers for the local Aerospace Industry; however, all of the major companies have programs underway to attract engineers.

Respondent B-2 offered the opinion that competition for engineers right now is fierce because there are so many new areas where engineers can work. An example is from the entertainment industry. Movie production is now heavily dependent on computer driven animation. As a result, the movie industry is hiring fewer artists and more engineers. There are a lot more employers from a much larger cross-section of industries drawing from our pool of engineers (personal communication, April 21, 2008).

> I think you need a marketing department. I think you need someone to go out and talk to employers. Just off the top of my head, if I were doing this, I would have a marketing department who would go out and be in contact with Lockheed, Boeing and Edwards Air Force Base. All of these other employers. We're talking about the big lab over here. What's it's called? Senior Systems Technology? All of these private industry employers. And I'd try to get them all under your wing as possible employers for students coming in and making sure that they know what kind of pool of engineers you have available in any given time coming up. Because then they can become proactive in recruiting some of these people (Respondent B-2, personal communication, April 21, 2008).

Respondent B-2 also suggested that a news letter, distributed via e-mail, be offered on a monthly basis to industry and the community colleges in the region. He suggested that the main campus news letter could also be an avenue to explore for the Antelope Valley engineering programs. As a last element of advice, respondent B-2 offered that LUC must work hard to get the word out about what is being offered in the Antelope Valley and that the staff needs to be very proactive with industry in attempting to meet industry needs for engineers (personal communication, April 21, 2008). Respondent B-2 stated,

> I think you guys are doing a great job. I just think you guys just need to market better. A little more concentration on marketing and being proactive that way because you've got to bet the word out. People need to know you're there and what you have available (personal communication, April 21, 2008).

Outreach. The fifth theme that responds to the research question regarding the marketing strategies and tools that may be effective in student recruitment is outreach.

Outreach, in the context used by the Cal State Antelope Valley Engineering Program, is specific to elementary school children, to middle school students, to high school students, and to the community (College of Engineering, Antelope Valley Engineering Programs, 2007).

Respondent C-4 (personal communication, April 21, 2008) discussed elementary school enrollment in a term called student generation. Student generation is declining, meaning that the numbers of new students entering elementary schools are declining. Respondent C-4 indicated that this is true across the state and is a factor that must be considered in planning. This respondent also offered concern about reading levels and math skills being below acceptable performance levels and suggested that it was absolutely necessary to inspire elementary school children to study math and science and to become proficient readers as early as possible. Respondent C-4 stated, "If they aren't ready, thinking college, when they start a high school program, they're done. Right there, that 4 years is not going to make it up for them" (personal communication, April 21, 2008). Respondent A-3 offered a similar concern to that expressed by Respondent C-4. Respondent A-3 stated that,

> My main concern is getting good quality graduates in, and I think this goes back to junior high school and high school as we discussed earlier on. It is raising the awareness of what engineering is all about and developing the enthusiasm and showing them it's a good career path (personal communication, March 24, 2008).

Student coops, internships, and summer hire programs. The last theme that is relevant to the question of marketing strategies and tools that may be effective in student recruitment is student coops, internships, and summer hire programs. Respondents tended

to agree that the programs that allow students to obtain work experience while they are in school are beneficial to both the students and to employers. Respondent A-4, in fact, stated that these programs are where his organization captures their employees. Respondent A-4 stated,

> Our coop program is where we get the majority of our new employees, because of the experience, knowledge, and the type of work. They experienced first hand the type of work we are involved with, and if they have an interest, they have a genuine interest in returning as a full time employee (personal communication, April 10, 2008).

Respondent A-1 explained that his company had summer hire programs from time to time depending on the availability of budget ; however, he provided that his company has an excellent program for a career mentoring program and obtaining a summer position provides an excellent opportunity to enter such a program (personal communication, March 11, 2008). Respondent A-5 explained,

> I like the idea of a summer program, because a really good friend of mine was a co-op student when I first joined IBM. And that was a really super idea. I mean, he ended up with a really good feeling of what the industry needed before he graduated. And I've often thought that I should have done the same thing... Because I got into, I went into the engineering side when looking for a job and I really had no idea what the job was going to entail. And he got a completely different version of it because he got to live through it for a couple of years. And by the time he came on board, the transition was 'I'm just back.' You know. 'I'm back with some more school,' and that's it. So I think those kinds of things

> are good. And it also gives the employer a chance to kind of kick the tires a little bit (Respondent A-5, personal communication, April 10, 2008).

Respondent A-7 (personal communication, April 11, 2008) suggested that from a training perspective and in terms of getting through an undergraduate program, the cooperative programs really pay off. Respondent A-7 also stated that his organization reserved certain jobs and tasks for the summer hire students.

The Critical Case C respondents report having more difficulty employing students, on a part time bases, for a variety of reasons. In most cases the reason is simply that a close working relationship with universities has never been developed (Respondent C-3, personal communication, April 18, 2008). Respondent C-2 offered a personal experience and reported that,

> I'm not aware of any program right at the moment. I know when I worked for the county, the County of Los Angeles; we used to have students on our survey crews in the summer time and things like that. We try to get more of our work done in the summer with the good weather compared to the winter when it's raining (personal communication, April 15, 2008).

Respondent C-1 suggested that the programs for engineering students could be looked at (personal communication, April 9, 2008). Respondent C-3 saw the potential for having students in direct support of his organization's operations, both for the student and for the organization. He also expressed his understanding of the benefit to the local LUC engineering program when he postulated what a student might say,

> Yeah, it would be like 'wow, I can go to Lancaster University Center, take on some really interesting projects. I heard this guy worked on the modeling of the

> sanitation system or the water treatment work that's going on'. Well, let's say they work with us figure out solutions. When it comes time to find another engineer, I know the perfect guy or gal (Respondent C-3, personal communication, April 15, 2008).

Other respondents in this critical case also saw the benefit of the types of programs that allow students to obtain job experience while going to school: however, respondent C-1 suggested that the University to present possible program suggestions to the local companies (personal communication, April 9, 2008).

Research Question 5

How should the success of the regional learning center be assessed? The theme from the Phase II interview responses that provides some insight for this research question is, the opinion of industry regarding the support received from higher education.

With only three exceptions, the respondents indicated that they have not noted any significant support received to date. Respondent A-1 observed that,

> I think the support would be almost nil. … as far as a professional sort of background – a four year type degree – there is nothing really that we look to in the Antelope Valley at this time – we have to go somewhere else (personal communication, March 11, 2008).

Respondent A-3 observed that he found no evidence of support for his organization further reporting that recruiting was done out of the area for newly graduated engineers (personal communication, March 24, 2008). Although the positive responses only represent 23% of the total interview responses, they did provide insight into what is required to generate a positive industry opinion. Respondent A-2 provided such insight

with respect to the LUC students currently in his organization as he related an interface with the executive staff of his company.

> I‘ve introduced them to Rebecca and some of the other bright young kids we brought in from [Cal State], and from here [LUC], and they’re very, very impressed (personal communication, March 13, 2008).

Phase III Integration, Synthesis, and Gap Analysis

Phase III of this study integrates and synthesizes a number of artifacts in the form of meeting minutes, documents, field notes, and observations; influenced by experiences accumulated over the period of this study to develop a vision of what the Cal State Antelope Valley Engineering Program should look like in order to meet the needs of the industry in the region that includes the Antelope Valley. Meeting minutes include participation in in such regional organizations as the Math, Science, Engineering, and Technology Consortium, the Antelope Valley Board of Trade Education Committee, attendance at various economic outlook conferences, and at the Competitive Crisis Council. This phase culminates with a gap analysis that determines the difference between what is and what should be in order to draw conclusions and develop recommendations to guide planning and decision making.

Findings

The ultimate vision for the region is described in the Antelope Valley Board of Trade master plan for a comprehensive polytechnic university (Antelope Valley Board of Trade, 2008). The High Desert Master Plan defines a plan for a university development in Eastern Kern County near the city of Mojave. This vision; however, is beyond the scope of this study. The success of the learning center under development by Cal State that is

being addressed by this study will be one key to successfully implement the Antelope Valley Board of Trade's plan. This finding is inferred from comments made by California State University Chancellor Reed at the Competitive Crisis Council (personal communication, September 21, 2007) regarding the need to demonstrate the ability to enroll a sufficient student population.

Central to the integration and synthesis effort has been the development of a Business plan for the Antelope Valley Engineering Programs that has been approved for implementation by the Dean of the Cal State College of Engineering and by the Provost (see Appendix K). The business plan defines a five year effort to develop the learning center and is meant to be a living document updated annually with the assistance and guidance of a University Partners Advisory Board that has been recently convened. The board has met twice, the first meeting was April 10, 2008 and the latest meeting was held on May 5, 2008. The board member inputs have been critical to completing the vision of a mature learning center meeting the needs of the region's industry. Another aspect that bears directly on this phase of the study was a requirement issued by a key benefactor to understand when a self-sustaining condition would be achieved (Santarelli, 2008).

Development of the business plan required establishment of student enrollment growth goals. This was accomplished by first defining the baseline student population. This was done in July of 2007 and was simply accomplished by determining the student enrollment, at both the graduate and the undergraduate levels, for the fall semester that began in August. The baseline established was 19 students (Steele, personal communication, July 2007). A reasonable rate of growth was then projected based on archived data from surveys administered to the local community college students enrolled

in bell weather classes by the Cal State Antelope Valley Engineering Programs Administrative Coordinator. The community college bell weather classes are the Calculus series, Physics, Electric Circuits, Statics, and Differential Equations. These classes are all required in order to transfer into upper division engineering. The Administrative Coordinator surveyed a total of 151 students. She reported that 100 students expressed an interest in Engineering and 58 of those indicated that may transfer to the local upper division engineering program offered at the LUC.

Table 13 displays the enrollment plan that forecasts student enrollment. Note that, as has been previously mentioned, the enrollment for Master of Science in Mechanical Engineering (MSME) students drops to zero in 2009 as a result of the suspension of enrollment until the MSME program is restructured. Enrollments are planned to reopen for the fall semester of 2009.

Table 13

Learning Center Enrollment Plan Projected for Five Years

	Degree Program						
Year	BSME	BSEE	BSComE*	MSME	MSEE	New Programs	Total
2007	5	3	1	3	7	0	19
2008	10	10	7	1	9	0	37
2009	15	16	9	0	10	6	56
2010	20	21	14	6	11	8	80
2011	26	26	18	8	12	12	102

* BSComE = Bachelor of Science in Computer Engineering

The key benefactor and supporter of the Cal State Antelope Valley Engineering Program requested an evaluation of when self sustaining would be achieved. This evaluation was conducted in January of 2008 and assumed that there would be no outside tangible support directed to accelerate student enrollment or for faculty development. The results were presented on February 1, 2008 and are summarized in Table 14. This was also a topic of interest to the last Advisory Board meeting as the Board was interested in the level of support required and for how long it must be sustained.

The State University System allocates budget on the basis of Full Time Equivalent Students (FTES). FTES are calculated based on the number of enrolled class units. One FTES for undergraduate students is 15 units and one FTES for graduates is 12 units. The assumption for a self-sustaining level was $500,000 annually. The allocation per FTES was assumed to be $5000/FTES annually (R. Nunna, personal communication, January 28, 2008). The data for the allocation was based on a realization factor of 63% per student for each FTES based on current enrollments. As can be seen from Table 14, self-sustaining is achieved during the 2013/2014 academic years provided the enrollment plan is achieved and a linear growth rate is maintained beyond the business plan five year duration.

Table 14

Self-Sustaining Projection Based on Student Enrollment

	Year							
Enrollment	2007	2008	2009	2010	2011	2012	2013	2014
Total Enrollment	19	37	56	80	102	124	146	168

(*table continues*)

	Year							
Enrollment	2007	2008	2009	2010	2011	2012	2013	2014
FTES	12	23	35	50	64	78	92	106
Allocation	$60k	$115k	$175k	$250k	$320k	$390k	$460k	$530k

The business plan features which facilitate achievement of the student enrollment growth rate are; increasing the community college base from which transfer students can be drawn, increasing the enrollment in engineering at the community college level through outreach, and by expanding the engineering programs offered by Cal State at the Lancaster University Center.

The current community college base, from which transfer students are drawn, has been centered at the local community college. The enrollment for the last term recoded (fall 2007) was 14,038 students (California Community Colleges System Office: Chancellor's office data mart, 2008). Student enrollment in engineering is difficult to assess due to the mobility of students at the community college level (L. Uhazy, personal communication, July 2007). Using the data that the Cal State Antelope Valley Engineering Program Administrative Coordinator collected, only 100 of the 14,038 students enrolled at the local community college were interested in engineering. This low ration of engineering students to total student population indicated the need to increase the total population of students from which transfer students in engineering could be drawn. The ration (less than 1%) also indicated a need to increase interest in engineering through outreach.

The increase in the community college base is being developed by the enrollment of community colleges in Ridgecrest and in Victorville in guaranteed transfer partnerships that require the community colleges to develop lower division engineering curricula that articulates with the Cal State lower division offering at the main campus. The community college in Ridgecrest has completed curricula development and is ready to begin the articulation process. A Guaranteed Transfer Memorandum of Understanding is in a signature cycle between the community college district office and the office of the Cal State President. A handshake has occurred with the community college in Victorville to develop a similar partnership as well. Opportunities to develop partnerships with community colleges in Barstow and Valencia are also under development. Partnerships with the community colleges in Ridgecrest, Victorville, Barstow, and Valencia will add over 38,000 students (California Community Colleges System Office: Chancellor's office data mart, 2008) to the base from which transfer students can be drawn.

The communities and industry in the Greater Antelope Valley have been working to interest students in math, science, engineering, and technology for several years. Programs such as Project Lead the Way have been started at several local high schools. The specific interest development in engineering; however, needed focus. To that end a framework was developed to capture student interest in elementary school, inform students in middle school so that they are able to make appropriate class enrollment decisions when entering high school, and to inspire students to continue their interest in engineering through high school and into college or university (Santarelli, 2007).

A program expansion is described in the business plan but it is not fully defined in curricular terms. In order to meet customer (industry) and student (jobs) needs, an

understanding of the Antelope Valley Engineering Program at maturity is required. This allows an analysis of the difference between what is and what should be in order to establish the needs (Tyler, 1949) to be used in planning and decision making.

The Phase I and Phase II results from this study significantly inform the vision of what should be. Industry and input from the Dean's office into the understanding of what should be were also required. This has been accomplished through the formation of the University Partners Advisory Board. Two meetings of three hours each have been held. The first meeting was held on April 10, 2008 with 17 participants. The second meeting was held on May 2, 2008 with 12 participants. The results reported are from notes compiled in the form of meeting minutes published to the Board participants.

The University expectation based on the direction from the Office of the President is that the Antelope Valley Engineering Program will not place a financial burden on the University. This means that the expectation of the University is that industry and community support will sustain the effort until student enrollment reaches a self-sustaining level (R. Nunna, personal communication, July 2, 2008). The first two years of operation of LUC engineering programs were conducted with only one Administrative Coordinator and two full time faculty members. Development occurred when the Dean of the College of Engineering from the main campus was able to travel to Lancaster and meet with an ad hoc advisory board and the LUC staff and faculty (A.Steele, personal communication, July, 2007). LUC had no full time advocate working to inform industry and the community of the engineering programs and to develop the relationships necessary to obtain the support necessary to sustain the effort per the University's expectation.

Industry, at the Advisory Board meetings tended to focus on the attributes of the graduates and specific individual organizational needs for skill set development. The first meeting was largely a review of the business plan and a status of the Antelope Valley Engineering Program. A Technical Management curriculum was discussed as the Phase I data suggested a low level of industry interest. It appears from the Phase II results and the comments from industry, at this first meeting, that the interest among the employers is much higher than the quantitative study indicated. For example, one major engineering employer discussed, at length, the need for a curriculum strong in program and project management that explicitly emphasizes the need to consider contract closeout at the beginning of a project or program and that the requirements for successfully closing a contract be taught.

The need to retain students in engineering programs was also discussed. The Dean of the College of Engineering explained that, in the past, Engineering Colleges accepted a culling process, particularly in the lower division, that resulted in as much as 50% attrition of students remaining in engineering programs. The goal now is to retain 100% of the students entering engineering without sacrificing the quality of the graduates in order to meet industry needs (M. Jenkins, personal communication, April 10, 2008). Serendipitously, it was a board member request to discuss the industry view of what the University needed to provide industry at the next Board meeting.

The second Board meeting focused on a discussion of industry participants' views and needs for engineering education. All but one participant expressed concern with the aging work force in their organizations or concerns with retention of new graduates hired from other regions of the country. One participant indicated that his organization is facing

a 60% loss of its corporate knowledge of the next five to six years. The single participant that expressed no concern for the aging work force indicated that the problem in his organization was recognized early and that the issue has been addressed now for several years resulting in a good balance between aging and new employees allowing the opportunity for knowledge transfer to occur (Santarelli & Steele, 2008a).

Participants did not discuss concerns for the basic curricula relating to engineering fundamentals but, instead, focused on the attributes of engineering graduates and on deficiencies that were developing in specific skill sets resulting from the retirements occurring in the work force. The participants at this meeting were unanimous that communications and presentation skills were uniformly lacking in graduates, generally from all institutions, across the country. They also agreed that most graduates that they see are well trained and capable engineers, but as one participant explained, new engineers need to be able to express thoughts and ideas to diverse audiences in a clear and concise manner. Another participant, who represented a Department of Defense development center, explained that his organization rotated newly hired engineers, who recently graduated, through four departments during their first year of employment. Each department assigns a project for the new engineers to accomplish and at the end of each rotation the new engineers must produce a written project report and provide a management briefing about their work. This participant additionally reported that the newly hired engineers always have problems with both the written report and the briefing and that it is critical to obtain engineers that can sell a project to a funding authority. One of the other participants, representing a major aircraft modification company, suggested that students be schooled in writing statements of work and in proposal writing. This is

consistent with the opinion of a Chief Executive Officer of an electronics manufacturing company, who offered his opinion that students not only need to have the opportunities to write and present but that they needed to be taught writing and presentation skills as well. The participants agreed unanimously that both written and verbal communication skills were lacking in recently graduated engineers. The Associate Dean of the College of Engineering announced that a technical writing course had been developed at the main campus and that it is currently being implemented. The Board members suggested that the course include presentation and listening skills development as well (Santarelli & Steele, 2008b).

With respect to the skill set deficiencies and specific industry needs, the participants related their individual requirements and suggestions. A participant representing a major defense contractor identified his organizations specific needs to be in avionics design and development, electromagnetic interfaces, and in software engineering. Software Engineering is a field of engineering that integrates the various basic disciplines, depending on application, with Computer Science, Computer Engineering, and System Engineering (Lethbridge, Jr, Sobel, Hillburn, & Diaz- Herrera, 2006). This participant also emphasized shortages developing, in his organization, in the "-ilities". The term ilities is industry slang typically applied to the engineering skill specialties of reliability, maintainability, producability, traceability, and other specialties ending in ility. Frequently, Human Factors and System Safety are included as ilities. Delivering certificate programs offered by Adjunct Professors recruited from industry was suggested.

Automation and Manufacturing skills were priorities for the participant representing an electronics manufacturing company. Topics such as Lean, Six-Sigma, and Design of Experiments were suggested to give students breadth. Program/project management was also suggested as an emphasis.

As the discussion progressed it became apparent that System Engineering was, in fact, another area of emphasis but it was also made clear that System Engineering should be a graduate level program as the participants felt that experience was required to be an effective system engineer. Instrumentation and composite structure design and manufacturing were also discussed as skill sets that industry needed. In the composite material the participant representing the aircraft modification company indicated that he was looking for recent graduates with backgrounds in composite materials. Issues that must be considered are structural and electrical re-qualification after a modification is developed using composite materials. This participant also explained the highly proprietary nature of the design allowables defined during composite material development. The proprietary information bears on the competitive advantage that company investment in material development represents and is, therefore, guarded intellectual property. Course work that included a discussion of intellectual property rights, patents, and export compliance was offered as breadth development area. Finally, the participants advised that graduate programs should broaden students as well as allow specialization in a discipline.

Integration of the data collected in the three phases of this study and the synthesis of the various requirements, which will provide the greatest service to the region's industry, produce a vision for the learning center of what should be. The Phase I survey

questionnaire responses provided a ranking of the engineering core disciplines in terms of the hiring desires of organizations for both Bachelor and Master of Science graduates. The Phase II interviews, however, have provided additional data that have created insights that the questionnaire could not provide. For example, the simple ranking from the quantitative phase of the study (see Figure 7) would place Civil Engineering, Construction Management, and Geomatics at the bottom of the ranking. Geomatics received no responses as a desired discipline but this may have resulted from confusion, as the term is academic in nature, and employers would have recognized the term "Land Surveyor" although this term is not wholly accurate (Respondent C-2, personal communication, April 15, 2008). Ignoring these disciplines which is suggested by the ranking ignores the second largest business segment in the Antelope Valley.

Force-field analysis was used to organize the Phase I, II, and III findings in a comparative manner allowing the curricular issues to be evaluated for the undergraduate, graduate, and the special courses/certificate programs (see Figure 8 and 9). According to Cummings and Worley (2001), force-field analysis is derived from Kurt Lewin's three step change model and organizes qualitative data into driving forces and restraining force. The Phase II and III data analysis results were used to establish the driving and the restraining forces as well as the relative strengths of the forces as indicated by the length of arrows in the analyses. The engineering disciplines were ranked from top to bottom based on the disciplines most needed at the top based on the number of responses received for that discipline on the Phase I survey questionnaire. The use of the force-field also allowed the gap between what is and what should be to be discerned.

The undergraduate curriculum is built around Mechanical and Electrical Engineering programs. These two disciplines are at the core of most engineering projects and industry has indicated that their greatest is need for mechanical and electrical engineers. Aerospace Engineering was identified by industry as a needed discipline but it is not offered by the main campus and its development would be centered with the Antelope Valley Engineering Programs. Computer Science does not capture the interest of industry as the quantitative data might indicate. The principal expressed industry interest is in electrical and computer engineering with some emphasis on software integration. Chemical Engineering holds a level of industry interest that revolves largely around composite material development and application. Industry also recognizes that composite materials might be more appropriately located as a subset of mechanical engineering that focused appropriate chemistry course work to compliment Statics, Dynamics, Strength of Materials, and Stress and Strain and other relevant mechanical engineering course work. The main campus once offered Industrial Engineering but the program has been closed for some time. The industry need does not appear sufficient to reactivate and update the program. There is a small need for mining engineers in the region and the competition for graduates is strong, world wide (Respondent A-1, personal correspondence, March 11, 2008). Mining Engineering: however, is highly specialized and very expensive to establish. Civil Engineering, Construction Management, and Geomatics are disciplines that are offered at the main campus and that should not be ignored. The Building Industry is the second largest economic sector in the region that employs engineers and industry responses indicated the need is to begin now to meet industry needs in two to three years.

The graduate programs, as with the undergraduate programs need to be built around Mechanical and Electrical Engineering as these two disciplines register the strongest industry needs. Aerospace Engineering follows but is currently offered by another university resident at the LUC. Computer Science, at the graduate level, has weak industry interest and is not offered by the College of Engineering. Computer Science is currently offered by the College of Science and Mathematics. Industry respondents and Advisory Board members all agree that a strong background in systems is required; however, experience in practice is required to make a good systems engineer, therefore industry has recommended that Systems Engineering need only be offered at the graduate level. There is a segment of the industry that needs engineers that can integrate hardware and software for modern aerospace and applications such as factory automation using machine intelligence. A program in Computer Engineering, therefore, has a reasonable level of interest. Chemical Engineering, again based on industry input, should be focused on Composite Materials and offered as a graduate level focus within Mechanical Engineering. Relative to Civil Engineering, the Building Industry segment, again, advises beginning now to prepare for the upturn in construction that may develop within the next two to three years. A Technical Management program, defined as Engineering Management (M. Jenkins, personal communication, April10, 2008) is under development at the main campus and, again in spite of the Phase I data that showed a low level of interest, has indicated significant interest in the Phase II interviews and by the Advisory Board. Industrial Engineering and Mining Engineering similar to the undergraduate results show insufficient driving force strength to overcome or reduce the restraining forces.

Industry responses in both Phase II and Phase III have shown significant interest in specialty courses and industry recommendations suggest considering certificate programs as well. The force field analysis indicates driving forces strong enough to produce motion in the direction of implementation.

The gaps resulting between what is and what should be for the learning center begins with the lack of an ECE faculty member, on site, at the learning center. The largest impediment (gap); however, to the continued successful development of the learning center, is funding to sustain the operation. The current FTES allocation (see Table 14) is only half of that which is required to meet the basic expenses which include facility rent, utilities, supplies, and staff salary for one staff member. Threats that could exacerbate this situation exist in the form of loss of support from the Air Force in providing one faculty on personnel loan and a contract with Cal State for the director's position.

The gap analysis (see Appendix G) was further developed to view only those elements of curriculum with sufficient driving force strength to indicate the potential for motion towards implementation. The comparative strengths of the driving forces were then used to prioritize recommendations for the planning of implementations.

Both Computer Engineering and Construction Management are the easiest curriculum expansions to implement and may have the highest student enrollment impact. Both rely on the resolution of faculty availability and the resolution of faculty issues in both areas are being aggressively pursued by the Dean's Office at main campus.

At the graduate level the gap with the greatest immediacy to resolve is that of the Master of Science for Mechanical Engineering. The Mechanical Engineering graduate

program is a complement to the existing baccalaureate program and provides educational continuity for students desiring to advance their education and it serves the industry in the region as Mechanical and Electrical Engineering are the disciplines reported most frequently as being those needed by industry. Based on industry comments, the Technical Management Master of Science program, identified as Engineering Management by the Main Campus (M. Jenkins, personal communication, April 10, 2008), the graduate Computer Engineering program, and the Civil Engineering program are also gaps in the curricula offered at the learning center.

A major gap has also been noted relative to near term industry support through specialty courses and certificate programs that can be developed based of the recommendations and with the support of the Advisory Board. Examples of specialty courses and certificate programs are the opportunities provided by the suggestions made by the various industry interview participants. A specialty materials course focused on composite structure design and manufacture and certificate programs in the ilities represent several of the opportunities implied or suggested directly by industry comments.

How should the success of the regional learning center be assessed is the fifth research question guiding this study. In *Good to Great*, Collins (2001) defines the "Three Circles of the Hedgehog Concept" (p. 96), "A Culture of Discipline" (p. 120) that excludes anything that falls outside of the Hedgehog concept, and "The Flywheel Effect" (p. 175) that builds momentum to achieve breakthrough. Assessing success occurs by first using the Hedgehog Concept to define success by defining what we can do better than anyone else, what we are deeply passionate about, and what drives our economic

engine? The conclusions derived during the course of this study largely accomplish defining success within the context of the Hedgehog Concept. Discipline is be achieved by focusing every effort within our definition of success and by excluding anything that does not fit. The primary assessment tools to be developed will measure the consistency and the direction of the force applied to spin the flywheel.

Tyler (1949) stated that, "The process of evaluation begins with the objectives of the educational program" (p. 110). Tyler's statement can be applied to answering the research question of assessing success by applying this simple statement regarding objectives in the context of the Hedgehog Concept through the application of the definitions for customer and product established for this study. The customers are those organizations, in this region, that employ engineers and the products are the students that graduate and become employed by the customers.

Significant Findings

The major findings are summarized for all three phases by research question.

Research Question 1: What is the demographic information from regional organizations that would support an engineering program at a State University remote location?

Phase I data showed that 41.7 % of the reporting organizations are planning to hire between 1 and 5 new graduates annually, 16.7% are planning between 6 and 10 new graduates, 5.6% are planning on 11 to 15 new graduates, and 25% are planning to hire 21 or more new graduates annually. Conservatively, this data indicates that 200 to 300 newly graduated engineers will be hired annually.

Research Question 2: What are the available resources to support development of a regional learning center for engineering?

Inspection of the Phase I survey data shows that organizations prefer supporting students. Sixteen of 21 respondents to the question of providing support to the LUC indicated that they would participate in design projects while only 1 of 21 respondents indicated that they would finance facility construction or fund infrastructure development. There were no responses to the choice of endowing faculty. Phase II results; however, clarified that organizations believe that tangible support for endowing faculty is more difficult to justify than other forms but it is not impossible. One respondent explained that the reason that it is difficult to obtain tangible support is because of the high demand for philanthropy coupled with a low supply of philanthropists.

Support for providing student work experience is significant with 65 % of the respondents answering this Phase I question. Opportunities to cooperate were identified as training, special topics classes, meeting educational needs, working together on special projects, and participating in active outreach to interest young students in engineering careers. The Building Industry respondents offered that the University had largely ignored their industry.

Research Question 3: What curricular offerings in engineering should be delivered?

The Phase I results show that, at both the undergraduate and the graduate level, Mechanical, Electrical, and Aerospace Engineering are the primary disciplines required by industry. The Phase II data indicates that Computer Engineering, due to the hardware/software integration skills developed by this curriculum is of value to industry.

The loss of corporate knowledge resulting from the aging of the work force precipitates the need for specialized courses and certificate programs needed by both the Critical Case A and Critical Case C industries. Systems engineering was also identified in the Phase II and the Phase III analyses as being of more significance than is deduced from the Phase I data. The Building Industry respondents (Critical Case C) were unanimous in their recommendation to begin preparing now to develop graduates to support the future needs of their industry.

Both the Phase II and the Phase III analyses indicated that industry, uniformly, is concerned about new graduates' abilities for communication across disciplines, flexibility to work in a multidisciplinary environment, and with presentation skills. Project and program management were also addressed by respondents indicating the need for a Technical Management (Engineering Management) graduate program.

Research Question 4: What are the marketing strategies and tools that may be effective in student recruitment?

The Phase I data showed that 13 of 39 respondents were not aware of LUC. Key industry executives interviewed in Phase II indicated that they were unaware of any benefit derived from LUC.

The high cost of living in California was identified as an impediment to recruiting from outside the area as are the environment of the high desert and the lack of social amenities available in the region. These factors also significantly impact employee retention particularly for the larger organizations. For this reason industry is indicating a strong preference for locally educated engineers. The Building Industry additionally suffers from a boom or bust economic environment; however, there is a sufficient level of

sustained business activity resulting from municipal requirements to “catch up” with infrastructure development during the lean times to accommodate locally educated engineers assuming a degree of job mobility.

The market for engineers in the region will remain strong due to the aging work force and the unique physical environment that exists for research and test activities in the Aerospace Industry. Another factor that will sustain the market is the recently acquired ability of the government organizations in the region to compete for commercial contracts.

In terms of marketing the Cal State Antelope Valley Engineering Program to the industry in the region, mass media marketing should be minimal due to the fragmentation that exists in media clientele. Targeted methods such as direct email monthly news letters are recommended by respondents.

Key factors in student recruiting are the ability to provide students with relevant curricula, opportunities for students to obtain industry experience, and a preference for employment for locally educated graduates. Another factor that must be emphasized, not only by the University but by industry as well, is the intrinsic value of the work performed by engineers in the region.

Research Question 5: How should the success of the regional learning center be assessed?

Phase II interview responses indicate that measuring the success of the program must be based on measuring industry satisfaction with the support received from the University and with industry feedback regarding the quality of the key attributes that locally educated graduates poses. The LUC business plan features which facilitate

achievement of the student enrollment growth rate are; increasing the community college base from which transfer students can be drawn, increasing the enrollment in engineering at the community college level through outreach, and by expanding the engineering programs offered at the LUC.

Gap Analysis

The gap analysis, based on a force-field analysis used to evaluate findings revealed that funding to support a full time Electrical and Computer Engineering faculty member assigned to the Antelope Valley Engineering Program is an obvious gap as is the current lack of a graduate Mechanical Engineering program. In terms of expansion of the undergraduate program, Computer Engineering and Construction Management are the easiest curriculum expansions to implement. The Engineering Management curriculum at the graduate level, deploying the revised Mechanical Engineering program, along with specialized courses and certificate programs developed and delivered by qualified industry personnel hired as adjunct professors by the University are activities that industry has indicated will have significant benefit. Other programs requiring more resources and effort, such as Civil Engineering and Geomatics need to be addressed through planning with industry support.

Chapter 5: Summary, Conclusions, and Recommendations

This chapter provides a summary of this mixed-method, exploratory study into the development of a regional learning center for engineering. Conclusions are drawn based on force-field and gap analyses that will provide a framework for planning and decision making for the Antelope Valley Engineering Program and the College of Engineering and include methods for assessing the success of the program where appropriate. Recommendations are offered for further research as well.

Statement of Problem and Purpose

There is a lack of affiliation with and information from industry and the communities related to the Cal State Antelope Valley engineering programs. The purpose of this exploratory study was to investigate industry and community needs for engineering education in the Antelope Valley in order to inform the university's planning and decision making.

Methodology

This study employed mixed-methods to conduct a needs assessment and was exploratory as no presumptive hypotheses were established regarding the nature of the stated problem (Rocco et al., 2003). The research consisted of three consecutive phases conducted between January and May of 2008. Both quantitative and qualitative data were collected to characterize the organizations in the region that employ engineers and to determine their higher education needs at both the baccalaureate and graduate levels. The study was restricted to the businesses; and to the local, state, and federal organizations that employ engineers and that are expert in understanding the region's industry.

Quantitative data was collected during Phase I from Human Resource directors or senior managers. The sample population for this phase was developed using categorized business listings from Chambers of Commerce and Boards of Trade in the region. A cross-sectional survey instrument with 25 questions was developed and distributed by mail and email. Fifty one responses were received from 156 active organizations contacted.

The initial response rate to the Phase I survey was unsatisfactory (<10%) and the researcher offered repeated reminders and the researcher finally drew upon personal relationships and direct contact to achieve an acceptable response (33%). The data was reviewed and used to define three critical cases (Flick, 2002) and to develop questions for interview participates organized by critical case.

During Phase II, 13 interviews were completed with purposefully selected senior personnel from organizations with 100 or more employees or from state and federal offices of elected officials. Interviews were conducted either at the LUC or over the phone. Participants were sent an Informed Consent Form and a set of questions prior to the interview scheduled date and time. Long, semi-structured interviews were conducted and were recorded using an audio digital recorder. Interviews were transcribed and provided to participants to obtain subject validity prior to conducting content analysis.

The researcher integrated data in Phase III from Phases I and II and from the minutes of two advisory board meetings, one key meeting presentation, the LUC Business Plan and field notes accumulated between July 2007 and June 2008. The data was synthesized using force-field analyses, based on Lewin's action-research model

(Tanner and Tanner, 2007). Gap analyses were conducted to compare what is currently offered at the LUC with the results resolved by the force-field analyses.

Significant Findings

The major findings are summarized for all three phases by research question.

Research Question 1: What is the demographic information from regional organizations that would support an engineering program at a State University remote location?

Phase I data showed that 41.7 % of the reporting organizations are planning to hire between 1 and 5 new graduates annually, 16.7% are planning between 6 and 10 new graduates, 5.6% are planning on 11 to 15 new graduates, and 25% are planning to hire 21 or more new graduates annually. Conservatively, this data indicates that 200 to 300 newly graduated engineers will be hired annually.

Research Question 2: What are the available resources to support development of a regional learning center for engineering?

Inspection of the Phase I survey data shows that organizations prefer supporting students. Sixteen of 21 respondents to the question of providing support to the LUC indicated that they would participate in design projects while only 1 of 21 respondents indicated that they would finance facility construction or fund infrastructure development. There were no responses to the choice of endowing faculty. Phase II results; however, clarified that organizations believe that tangible support for endowing faculty is more difficult to justify than other forms but it is not impossible. One respondent explained that the reason that it is difficult to obtain tangible support is because of the high demand for philanthropy coupled with a low supply of philanthropists.

Support for providing student work experience is significant with 65 % of the respondents answering this Phase I question. Opportunities to cooperate were identified as training, special topics classes, meeting educational needs, working together on special projects, and participating in active outreach to interest young students in engineering careers. The Building Industry respondents offered that the University had largely ignored their industry.

Research Question 3: What curricular offerings in engineering should be delivered?

The Phase I results show that, at both the undergraduate and the graduate level, Mechanical, Electrical, and Aerospace Engineering are the primary disciplines required by industry. The Phase II data indicates that Computer Engineering, due to the hardware/software integration skills developed by this curriculum is of value to industry. The loss of corporate knowledge resulting from the aging of the work force precipitates the need for specialized courses and certificate programs needed by both the Critical Case A and Critical Case C industries. Systems engineering was also identified in the Phase II and the Phase III analyses as being of more significance than is deduced from the Phase I data. The Building Industry respondents (Critical Case C) were unanimous in their recommendation to begin preparing now to develop graduates to support the future needs of their industry.

Both the Phase II and the Phase III analyses indicated that industry, uniformly, is concerned about new graduates' abilities for communication across disciplines, flexibility to work in a multidisciplinary environment, and with presentation skills. Project and program management were also addressed by respondents indicating the need for a Technical Management (Engineering Management) graduate program.

Research Question 4: What are the marketing strategies and tools that may be effective in student recruitment?

The Phase I data showed that 13 of 39 respondents were not aware of LUC. Key industry executives interviewed in Phase II indicated that they were unaware of any benefit derived from LUC.

The high cost of living in California was identified as an impediment to recruiting from outside the area as are the environment of the high desert and the lack of social amenities available in the region. These factors also significantly impact employee retention particularly for the larger organizations. For this reason industry is indicating a strong preference for locally educated engineers. The Building Industry additionally suffers from a boom or bust economic environment; however, there is a sufficient level of sustained business activity resulting from municipal requirements to "catch up" with infrastructure development during the lean times to accommodate locally educated engineers assuming a degree of job mobility.

The market for engineers in the region will remain strong due to the aging work force and the unique physical environment that exists for research and test activities in the Aerospace Industry. Another factor that will sustain the market is the recently acquired ability of the government organizations in the region to compete for commercial contracts.

In terms of marketing the Cal State Antelope Valley Engineering Program to the industry in the region, mass media marketing should be minimal due to the fragmentation that exists in media clientele. Targeted methods such as direct email monthly news letters are recommended by respondents.

Key factors in student recruiting are the ability to provide students with relevant curricula, opportunities for students to obtain industry experience, and a preference for employment for locally educated graduates. Another factor that must be emphasized, not only by the University but by industry as well, is the intrinsic value of the work performed by engineers in the region.

Research Question 5: How should the success of the regional learning center be assessed?

Phase II interview responses indicate that measuring the success of the program must be based on measuring industry satisfaction with the support received from the University and with industry feedback regarding the quality of the key attributes that locally educated graduates poses. The LUC business plan features which facilitate achievement of the student enrollment growth rate are; increasing the community college base from which transfer students can be drawn, increasing the enrollment in engineering at the community college level through outreach, and by expanding the engineering programs offered at the LUC.

Gap Analysis

The gap analysis, based on a force-field analysis used to evaluate findings revealed that funding to support a full time Electrical and Computer Engineering faculty member assigned to the Antelope Valley Engineering Program is an obvious gap as is the current lack of a graduate Mechanical Engineering program. In terms of expansion of the undergraduate program, Computer Engineering and Construction Management are the easiest curriculum expansions to implement. The Engineering Management curriculum at the graduate level, deploying the revised Mechanical Engineering program, along with

specialized courses and certificate programs developed and delivered by qualified industry personnel hired as adjunct professors by the University are activities that industry has indicated will have significant benefit. Other programs requiring more resources and effort, such as Civil Engineering and Geomatics need to be addressed through planning with industry support.

Conclusions

The following conclusions have been drawn from these findings:

Many key elements of the industry and the community were unaware of the existence of LUC for the two years prior to the researcher's appointment.

The industry responses to the Phase I survey question that asked if their organization was aware of the engineering degree programs offered by LUC indicated that one third of the 39 respondents were not aware that the programs were being offered. This was confirmed and clarified by the Phase II interview subjects. Regardless of whether interview subjects were aware of LUC engineering programs or not, all but three of the subjects observed that they have not received any significant support from LUC to date. Respondents observed that new graduate recruiting, for their organizations, was done out of the area. The Building Industry respondents unanimously agreed that their industry has been ignored.

The University expectation based on the direction from the Office of the President is that the Antelope Valley Engineering Program will not place a financial burden on the University. This means that the expectation of the University is that industry and community support will sustain the effort until student enrollment reaches a self-sustaining level (R. Nunna, personal communication, July 2, 2008). The first two years of

operation of LUC engineering programs were conducted with only one Administrative Coordinator and two full time faculty members. Development occurred when the Dean of the College of Engineering from the main campus, 202 miles distant, was able to travel to Lancaster and meet with an ad hoc advisory board and the LUC staff and faculty (A.Steele, personal communication, July, 2007). LUC had no full time advocate working to inform industry and the community of the engineering programs and to develop the relationships necessary to obtain the support necessary to sustain the effort per the University's expectation.

The Antelope Valley has been underserved by higher education. Students from the Antelope Valley entering the study of engineering have had to leave the Valley in order to do so. As a matter of fact, it is quite possible that significant portions of the young people leave the Antelope Valley and then return after they complete their education and acquire some experience. This is evidenced by the demographics which show a significant reduction in the population of college age individuals followed by a significant increase in the number of individuals in the 25 to 34 year old age range. This is also evidence that industry has been conditioned to recruit outside the region due to the lack of locally educated individuals.

The essential elements to sustain LUC are present

The high cost of living in California was identified as an impediment to recruiting from outside the area as are the environment of the high desert and the lack of social amenities available in the region. These factors also significantly impact employee retention particularly for the larger organizations. The Building Industry additionally suffers from a boom or bust economic environment; however, there is a sufficient level of

sustained business activity resulting from municipal requirements to “catch up” with infrastructure development during the lean times to accommodate locally educated engineers assuming a degree of job mobility.

The regional job market for newly graduated engineers is sufficient to sustain the regional learning center for engineering in terms of being able to absorb any foreseeable graduation rate within the local job market. Industry, in the region, is expressing a strong preference to hire locally trained engineers because they are better retention investment than engineers hired from outside the region. Phase I data showed that 41.7 % of the reporting organizations are planning to hire between 1 and 5 new graduates annually, 16.7% are planning between 6 and 10 new graduates, 5.6% are planning on 11 to 15 new graduates, and 25% are planning to hire 21 or more new graduates annually. Conservatively, this data indicates that 200 to 300 newly graduated engineers will be hired annually.

The market for engineers will remain strong due to the aging work force and the geography featuring clear skies around the year, the large dry lake beds suitable for aerospace vehicle research, and the proximity (approximately 70 miles) to a large city (Los Angeles). Another factor that will sustain the market is the recently acquired ability of the government organizations in the region to compete for commercial contracts.

Self-sustaining for LUC will be achieved with an enrollment of approximately168 students. Since LUC is an upper division campus, the maximum number of graduates annually would be half the enrollment. The local job market for engineering graduates will easily absorb LUC’s graduating engineers well beyond the level at which self-sustaining occurs.

The ability for participation by industry in offering student design projects and in participating with design teams is significant based on the responses to the survey. Offering scholarships and providing or buying laboratory equipment is also an available avenue to exploit in producing growth in student enrollment as the diversity of laboratory experience is important in addressing industry needs and in providing students a diversity of experience.

Sixty five percent of respondents indicated that they will provide Cooperative Education, Internship, and Summer Hire programs. Respondents also indicated that they provide flexible work schedules for students advancing their education. This is an important aspect for attracting new students to the Antelope Valley engineering programs as well. Not only do the students receive industry experience, they are generally paid, and they acquire industry contacts through these processes.

The ability to receive direct financial aid, from industry and the community, for endowing faculty and subsidizing operating costs is difficult but possible. Respondents have reported that it is far easier to provide financial subsidies to scholarship and to purchase or provide laboratory equipment. One key industry respondent, who is also an advisory board member, offered that progress toward achieving the goal of endowing faculty and subsidizing operations is progressing within his organization. The key factor is showing industry benefactors the return on investment that they will receive.

There were a large variety of specialized courses and certificate opportunity programs suggested by industry respondents. The Antelope Valley aerospace work force is highly skilled and educated. A pool of capable and willing adjunct faculty is available and can be effectively used with the help of the advisory board.

An effort is already underway to develop partnerships with two community colleges in addition to the local community college partnership that already exists. The partnership requires community colleges to establish lower division engineering curricula that will articulate with the Cal State main campus lower division programs. A third community college has recently expressed interest in a partnership as well. The local community college enrolls 14,000 students annually. The developing partnerships with other community colleges will double and may even triple the community college student population from which LUC draws transfer students.

The Antelope Valley Board of Trade has identified an issue for companies and Government agencies that employ engineers in the high desert. The issue is that companies hire engineering graduates and then move them and their families into the areas, near their places of employment, in the high desert. This occurs at a significant expense to the hiring company. Companies have found it difficult to retain these personnel because their families, being unused to desert living find the adjustment too hard to accomplish successfully. The employees, therefore, frequently leave in only one or two years.

> *Higher potential* businesses can identify a market niche for a product or service that meets an important customer need and provides high value-added or value created benefits to the customer (Timmons, 1999, p. 50).

Customers will actively work to facilitate the growth of the Antelope Valley engineering program. The need for community and industry support not only sustains the local higher education effort, it also provides the ability to create graduates that meet the needs of their potential employers. Support structures provide the ability for engineering

education to develop graduates that have what they need to know to minimize the gap between what is learned in class and what practicing engineers need to become effective in the work force (Kovacs, 1993). Methods of support identified by Kovacs are through industry open houses directed at students and faculty, funded student projects of mutual interest, internships, cooperative agreements, support to an endowed chair, and involvement in the class room through the presentation of case studies by subject matter experts. Direct support to a foundation account to support operations is also necessary. *The hiring of a full time director of LUC with strong engineering background and a doctorate degree provided a visible LUC champion.*

The researcher is a 27 year veteran from the aerospace industry and has over 36 years of engineering and government service experience. This industry experience, coupled with a doctorate in education, allows the researcher the ability to obtain the trust of engineering managers, executives and community leaders because of the extensive experienced gained and the common vocabulary and industry insights which years of engineering management experience have developed. Kouzes and Posner (2002) explain that relevant experience correlates with success and that the broader the experience the more likely the success that a leader will achieve across organizations and industries. Another key factor that is relevant to the success of LUC is the ability to enable others to act. Kouzes and Posner identify the ability to enable others to act as being critical to success. The particular ability is required because of the meager staff at LUC. Industry, through the advisory board must be engaged and enabled to act to support LUC efforts to become self-sustaining and meet the needs of the region's industry.

The needs-assessment of the engineering-related organizations within the area provided current and future curricular needs.

The Phase I results show that, at both the undergraduate and the graduate level, Mechanical, Electrical, and Aerospace Engineering are the primary disciplines required by industry. For the baccalaureate programs 83% of the respondents reported needing Mechanical Engineering, 78% need Electrical, and 64% need Aerospace Engineering. The Phase II data indicates that Computer Engineering, due to the hardware/software integration skills developed by this curriculum is of value to industry. The loss of corporate knowledge resulting from the aging of the work force precipitates the need for specialized courses and certificate programs needed by both the Critical Case A and Critical Case C industries. Systems engineering was also identified in the Phase II and the Phase III analyses as being of more significance than is deduced from the Phase I data. The Building Industry respondents (Critical Case C) were unanimous in their recommendation to begin preparing now to develop graduates to support the future needs of their industry.

The force-field analyses provide the simplest and most efficient method of summarizing findings that reveal basis for the conclusion that current and future curricular needs have been provided. Figure 8 presents the analysis of the needs for the undergraduate engineering program. The length of the arrows representing the driving and restraining forces represent the relative strength of the forces, not only between driving and restraining forces but between disciplines as well. The undergraduate force-field analysis shows that strong driving forces are coupled with relatively weak restraining forces for Mechanical, Electrical, and Computer Engineering and for

Construction Management. Mining Engineering, Computer Science, Systems, Industrial, and Chemical Engineering have the strongest restraining and weakest driving forces.

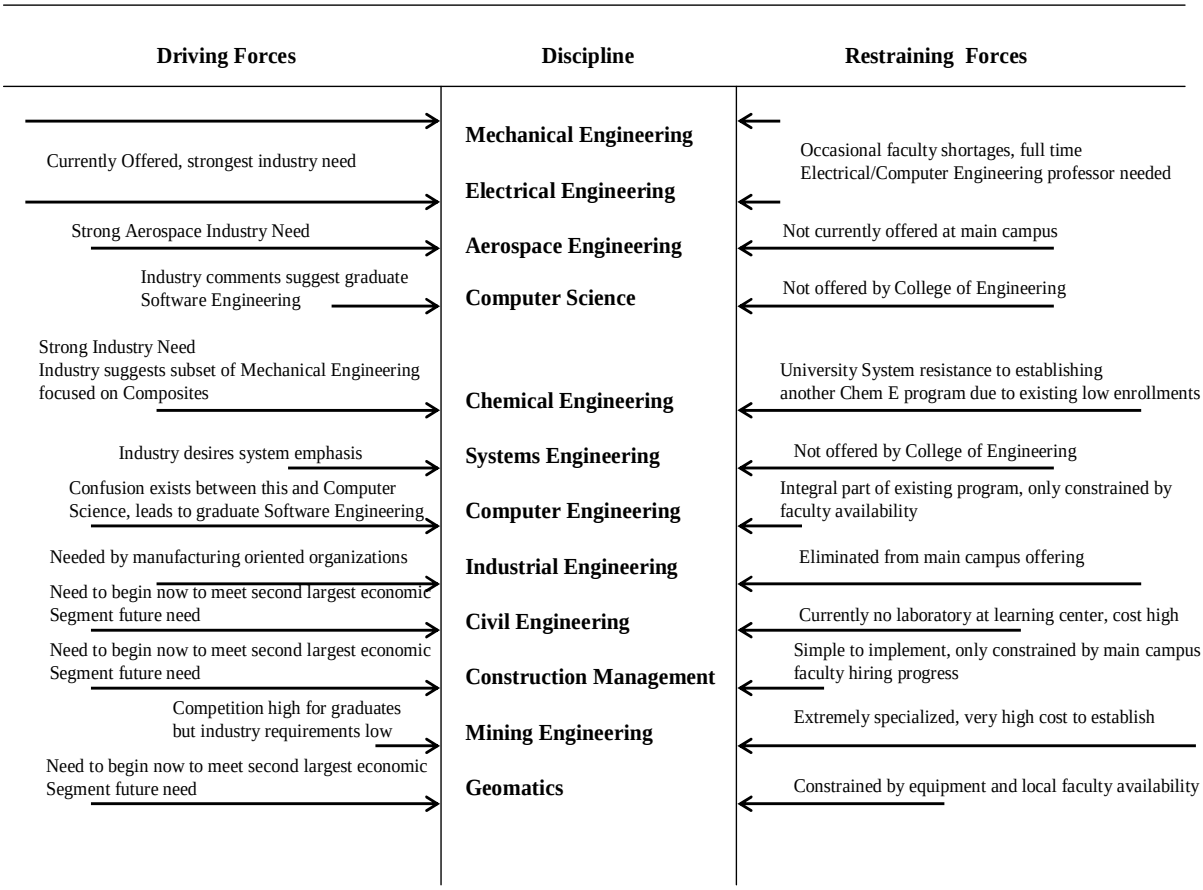

Figure 8: The force-field analysis for the undergraduate curriculum identifies the industry needs and provides a means of prioritization.

The graduate program force-field analysis (see Figure 9) shows that the strongest driving forces, in order, exist for Mechanical, Electrical, and Aerospace Engineering followed by Systems Engineering, Chemical Engineering, Civil Engineering, Technical Management, and Computer Engineering. The strongest restraining forces are associated with Mining,

Industrial, Aerospace, and Systems Engineering. Computer Science, after Mining Engineering shows the largest Restraining to Driving force differential.

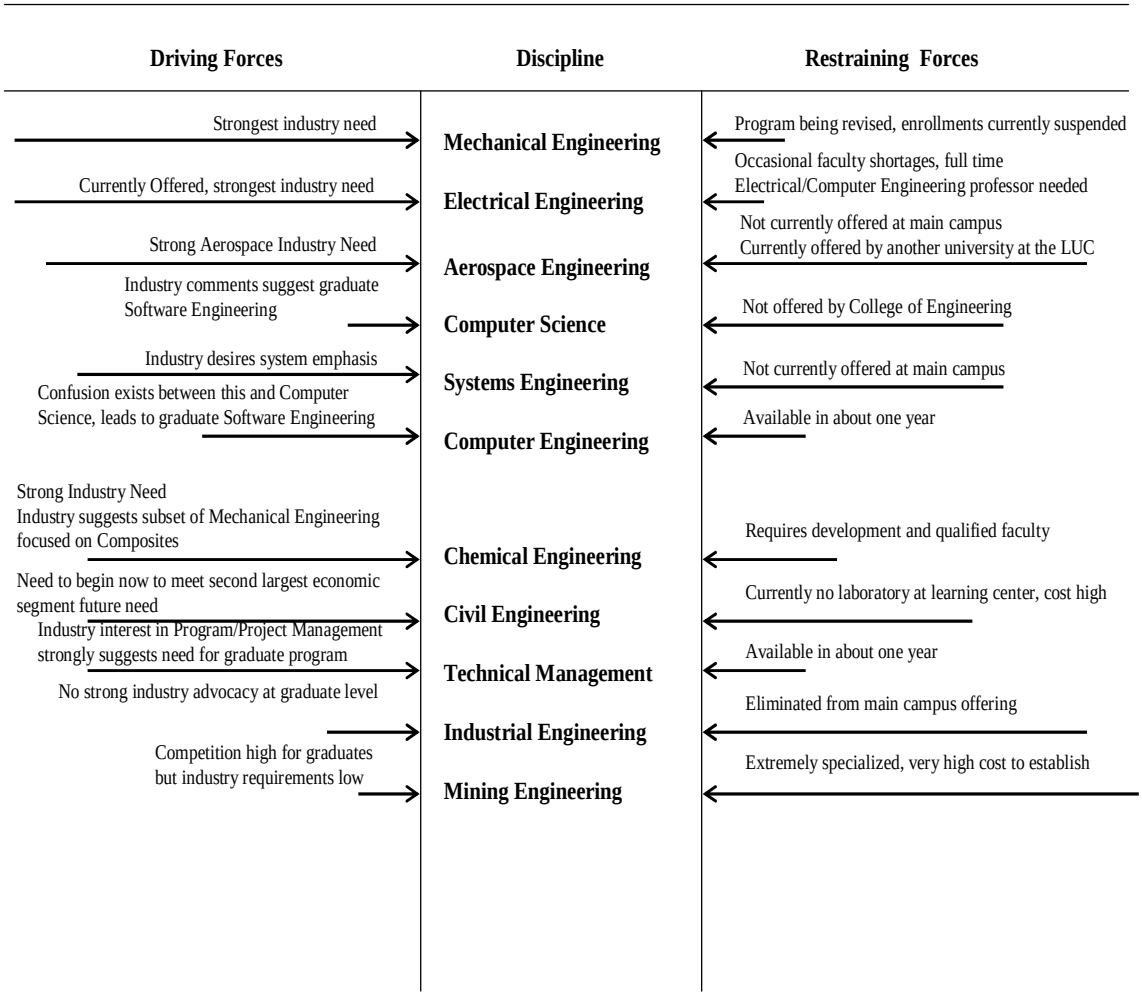

Figure 9: The force-field analysis for the graduate curriculum identifies the industry needs and provides a means of prioritization.

Both Mechanical and Electrical Engineering needs, at the graduate level, were registered by 74% of the respondents. Aerospace Engineering was required by 62% of the respondents.

There are significant opportunities for cooperation between the University and industry in the form of specialty courses that provide the ability to address specific industry needs directly, in a timely manner, and with reasonable effort. Specialty courses are those that are specifically identified by industry that address specific skill development and knowledge transfer issues that are of direct interest.

Both the Phase II and the Phase III analyses indicated that industry, uniformly, is concerned about new graduates' abilities for communication across disciplines, flexibility to work in a multidisciplinary environment, and with presentation skills. Project and program management were also addressed by respondents indicating the need for a Technical Management (Engineering Management) graduate program.

Relevance or industry relevance are commonly used terms in evaluating curriculum to determine if customer needs are being satisfied in engineering schools (Munukutla et al., 2005; Wei, 2005). The quality of the education being provided by engineering schools is being discussed in terms industry, community, student, and faculty input (Wolverton, 1996). A simple approach to identifying the customers for particular higher education programs, such as the engineering programs offered by Cal State in the Antelope Valley, allows the development of highly focused assessments of customer needs. "The future success of colleges and universities will increasingly be determined by how they satisfy their various customers. The successful ones will be those which very clearly identify their mission and the customers they serve" (Maguad, 2007, p. 333).

Based on the assumption that undergraduate and graduate engineering education is needed in the region, a needs assessment was required in order to address dissatisfaction with the lack of a local program and to satisfy the desire for change (Gupta

et al., 2007). According to Gupta et al, "Needs Assessment is a diagnostic process that relies on data collection, collaboration, and negotiation to identify and understand gaps in learning and performance and to determine future actions" (p. 15). The results of the three phases of this exploratory study have been resolved into the aforementioned conclusion drawn within the context of Tyler's second question which relates to how learning experiences are selected to obtain objectives.

The current undergraduate enrollment pool has not been adequately marketed.

The first two years of operation of LUC engineering programs were conducted with only one Administrative Coordinator and two full time faculty members. Additionally, there were no laboratories available locally and students had to travel to the main campus 202 miles distant to obtain their laboratory experience. A single administrative coordinator was an insufficient resource for marketing to the transfer student pool and without engineering laboratories, the marketing effort lacked complete programs to attract students. An additional complication is the low number of students found to be enrolled in engineering majors at the local community college based on data from surveys administered to the local community college students enrolled in bell weather classes by the LUC Administrative Coordinator. The community college bell weather classes are the Calculus series, Physics, Electric Circuits, Statics, and Differential Equations. These classes are all required in order to transfer into upper division engineering. The Administrative Coordinator surveyed a total of 151 students and reported that 100 students expressed an interest in Engineering and 58 of those indicated that may transfer to the local upper division engineering program offered by LUC. Recalling that the local community college has enrolled 14,000 students, 100

students, interested in engineering, is less than 1% of the student population. It is encouraging: however, that 58% of the interested students indicated that they are considering transferring to LUC.

The current community college engineering interest data is consistent with US Census Bureau data that shows a 30% to 40% drop in the population in the 20 to 24 year old range followed by an increase of more than double in the 25 to 34 year old individuals. One conclusion that can be drawn from these statistics is that students transfer to universities out of the area to complete their educations.

The low percentage of students indicating an interest in engineering is also consistent with the fact that interest in math, science, and engineering among first year undergraduate students declined from 11.5% in 1966 to 5.8% in 1988. This low percentage of student interest in engineering is further compounded by student retention in engineering majors. The National Academy of Sciences has indicated that undergraduate retention in the sciences and engineering is the lowest of any of the schools in universities. The NAS also indicates that it is among the brightest students that depart for other educational objectives. Estimates indicate that only 40% to 60% of the students who enter engineering programs complete their degree objectives and that many very good students, especially female students, left their programs even after having achieved good grades. There is a consensus that student difficulty with mathematics, in the freshman year, is the single largest factor in engineering student decisions to leave engineering programs. It should also be noted that students that have acceptable grades in mathematics also leave engineering programs in significant enough numbers to be of concern.

The recently established Advisory Board has quickly become a highly supportive group to implement future curriculum development and to sustain the center.

The recently established Advisory Board has met twice since April and has a third meeting already scheduled in early June. The Board members have been extremely engaged in understanding the current status of LUC from a business and curricular perspective. The first meeting was devoted to a review of the Business Plan and status of the progress in meeting the plan. The second meeting focused on industry needs at the request of one of the Board members. The Board members discussed attributes of the new graduates that the hire in terms of the need for better communication, teamwork, and presentation skills.

The Board Members related their concerns about their aging work force. One member indicated that his organization is facing a 60% loss of its corporate knowledge of the next five to six years. The Board members also discussed skill set deficiencies resulting from retirements as well as recruiting adjunct professors from industry and providing tangible support to acquiring a full time Electrical and Computer Engineering professor.

A situation that was 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. According to de Give and Oswang (1999) the model used was one of coalition building that started with a grass roots effort by community elites with entrepreneurial skills.

Targeted direct contact marketing seems to be the most effective means to market new engineering programs.

One respondent advised that marketing must be targeted. Mass media does not work in the region because there is too much fragmentation with some people watching television, some listen to the radio, and a few still read newspapers of which there are several. As a matter of fact, this respondent indicated that no one has a 50% market share any more. Market shares are all below 50%. The respondent did suggest; however, to obtain Public Service Announcements from the local radio stations. Public Service Announcements are offered at no charge.

Another respondent suggested that a news letter, distributed via e-mail, be offered on a monthly basis to industry and the community colleges in the region. He suggested that the main campus news letter could also be an avenue to explore for the Antelope Valley engineering programs. The need for personal and direct contact was also heavily emphasized. As a last element of advice, this respondent offered that LUC must work hard to get the word out about what is being offered in the Antelope Valley and that the staff needs to be very proactive with industry in attempting to meet industry needs for engineers.

The marketing advice provided by respondents is consistent with the advice and suggestions offered by Ali and Seiders (2004), “Personal selling is an important activity for entrepreneurs on an informal personal level-through professional networking. Leveraging personal and industry connections is a key success factor, especially in the startup or early growth stage of the venture” (p. 98). They go on to suggest that conducting informal interviews, reviewing books, magazines, and existing surveys can be

used to conduct market research. The authors also recommend attending meetings where customers meet to discuss their needs.

Recommendations

Continue to Engage and Empower the Advisory Board

The development of the learning center is a huge effort that transcends the ability of the meager staff (one director and one administrative coordinator) to accomplish without significant assistance. Continue development of the recently established University Partners Advisory Board to establish grass root support from community/industry elites to build a coalition that can secure the strategic objective of producing a self sustaining regional learning center (de Give and Oswang, 1999). Through the proper development of a self directed, engaged, and empowered advisory board the ability to address the many issues facing development of the regional learning center and to implement the recommendations contained herein will be magnified many times over through the offices of the board members.

Maintain Disciplined Use of the Business Plan to Guide Operations

Use the Business Plan for the Cal State Antelope Valley Engineering Programs to legitimize and institutionalize the recommendations presented herein. The Business Plan has been developed as a living document, reviewed and revised annually at a minimum, which addresses a five year rolling planning window. Seek guidance and council from the Advisory Board in revising the business plan, during the summer breaks, to appropriately install the recommendations offered. The purpose of including the Advisory Board is to obtain their buy-in for support of the efforts required for implementation. Legitimization and institutionalization will occur through the review by and approval of the College of

Engineering and the Office of the Provost at Cal State. The Consultative Body of the College of Engineering will be requested to review and comment on the Business Plan as part of the review process.

Apply the Hedgehog and Flywheel Concept (Collins, 2001) to focus the Advisory Board to help define what we can do better than anyone else, what we are deeply passionate about, and what drives our economic engine. Employ the Advisory Board to build the momentum required to achieve a breakthrough through establishing a culture of discipline. Resolve with the Advisory Board that if it is not in the Business Plan, then don't do it.

Plan and Implement Prioritized Program Expansion

The conclusions derived from the findings of this study provide the guidance required to prioritize the effort required to successfully continue development of the regional learning center. The recommended priorities are as follows:

1. Obtain a Professor of Electrical and Computer Engineering.
2. Develop and deliver composite materials special topics course.
3. Begin enrollment for Master of Science with Mechanical Engineering Emphasis.
4. Develop a certificate course consistent with industry needs.
5. Add Construction Management to the baccalaureate offering.
6. Add Engineering Management to the graduate offering.
7. Plan for the next steps in curriculum development which will include an undergraduate Aerospace Engineering program.

Obtaining a Professor of Electrical and Computer Engineering (ECE) is the first priority because of the benefit to the students and to the development of the learning

center. A full time ECE Professor on-site provides the students the opportunity to directly interface with a faculty member to obtain advisement, resolve academic issues, and obtain assistance with course work. The full time faculty member will provide instruction for laboratories and can assist in laboratory expansion. Filling this vacancy will also allow enrollments in Computer Engineering to resume. The ECE Professor will also supervise graduates in Electrical and in Computer Engineering. Fulfilling this priority requires sufficient funding to implement. The Advisory Board has already been made aware of this issue and is considering solutions.

The development of the special topics course in priority 2 will begin to address industry registered needs in a timely manner and help to increase student enrollment. A draft syllabus has already been prepared and comments have been received from industry. A second draft is in preparation.

It is also important to begin enrollment in the revised Master of Science with an emphasis in Mechanical Engineering. This program was identified by industry as being one of the most needed disciplines at the graduate level and it is a complement to the existing baccalaureate program. The Mechanical Engineering Department has been working to revise the graduate program and enrollments should begin in the fall of 2008.

A specific certificate program should be selected for development based on the advice of the Advisory Board. A qualified individual willing to develop and deliver the program will need to be found and a sufficient number of students identified to justify development and delivery. Certificate programs will be designed to address specific skill and knowledge retention issues faced by industry.

Offering Construction Management will begin to rectify the lack of support from the University currently being experienced by the Building Industry. A prerequisite to being able to offer this program in the Antelope Valley; however, is completion of the faculty acquisition effort currently being pursued by the College of Engineering at the main campus.

The addition of Engineering Management at the graduate level will address industry concerns for technical management training that has been inferred from this study. It will also provide a rigorous technically oriented MBA style curriculum for those who desire maintaining the technical focus and rigorous mathematics in a management program.

The balance of the curriculum development efforts need significant and careful planning and include the development of a graduate Systems Engineering curriculum, a baccalaureate level Aerospace Engineering curriculum, addition of Geomatics, and Civil Engineering. Geomatics and Civil Engineering involve expensive laboratory development, equipment acquisition, and qualified instructor identification.

Rely on Direct Targeted Marketing

The concept for marketing the program will be addressed in the Business Plan. The concept should rely most heavily on direct targeted marketing approaches. One approach that will be applied is to develop a monthly news letter issued directly to targeted industry, association, government, and community college partners via email. Additionally, provide news worthy articles and announcements on the LUC and the College of Engineering web sites. Minimize mass media advertising. Place the emphasis in messages on opportunities for Cooperative Education, Internship, Summer Hire, and

for job placement assistance. The practice of speaking to community service clubs such as Rotary and Kiwanis in an effort to stimulate word-of-mouth information dissemination and to create a buzz in the community.

The unique LUC relationship with industry is creating the ability to offer students work experience opportunities while in school as well as a preference for employment after graduation. This relationship creates differentiating features which must be central to the LUC message delivered to potential students and to the community at large.

Again, the Advisory Board will play a significant role as well. The Board will be encouraged to develop the word-of-mouth dissemination of information through their contacts and personal relationships. Engaging the Board will effectively increase the LUC staff effort many times over.

Continue community college guaranteed transfer partnership development

The development of guaranteed transfer community college partnerships is a key element for increasing LUC undergraduate engineering student enrollment. The partnership effort, to date is meeting with success. In addition to the partnership with the local community college, another community college has developed their lower division engineering curriculum and is in the process of signing a Memorandum of Understanding with the Cal State office of the President. A third community college has agreed to initiate curriculum development, and a fourth community college has expressed interest in creating such a partnership.

Enlist Industry in Organized Outreach

The plans for accomplishing a successful outreach program must also be included in the Business Plan and rely heavily on industry to deploy. An active outreach program

which appeals to the imagination of elementary school children, provides information about preparation for college to middle school children, and inspires high school students to pursue a career in engineering is necessary. Outreach is required to change the poor high school graduate college preparedness statistics and to stimulate interest in math, science, engineering, and technology related studies.

React to Competition

Government organizations and cities attempt, from time to time, to attract institutions to offer engineering education in the region. An example is the situation that exists with the state polytechnic university offering the Master's program in Aerospace Engineering. The state polytechnic university is the primary competition currently active in the region. As has been previously stated, the announcement that the Polytechnic was offering their Aerospace Engineering Master's program precipitated the decision to stop enrollments in the LUC Mechanical Engineering Master's program due to the similarities between the programs and because the potential graduate student population is too small to support competing programs.

The response to this competitive challenge is for the main campus to develop a more traditional Mechanical Engineering Master's program so that enrollments can be reopened. Additionally, since the Polytechnic is active in the Antelope Valley because the LUC's primary benefactor sponsored the effort, it would not be politically astute to overtly resist the Aerospace program's success. Any penetration beyond Aerospace Engineering in the region by the Polytechnic University will; however, be actively resisted through the Office of the Provost and the University President if required.

The competitive environment must be understood through maintaining a continuing awareness and understanding of the strengths and weaknesses of competitors. To date, the competition exists in the form of a variety of private institutions offering engineering technology programs and well known universities offering asynchronous on-line graduate programs. These programs are a distraction but they are not threats in that they attract some students who might otherwise enroll at the LUC; however, they pose little cause to respond. The engineering technology programs limit themselves because graduates of such programs cannot be hired by the government or industry as engineers and the on-line programs are available to anyone with a computer and internet access. On-line degree programs may actually be appropriate for some individuals.

Maintain an Assessment of Program Success

The basic objective of developing the regional learning center is to meet the needs of industry in the high desert. While Tyler (1949) discusses the importance of beginning the process of evaluation with the objectives of the educational program, the same concept holds for assessment. Assessment, as used in this study, applies to obtaining some objective evidence of the success (or lack of success) of the program while evaluation implies a measurement of the quality of an outcome. An assessment section will be developed, in the Business Plan that defines the method of assessing customer satisfaction with the support being provided to industry by the University through the regional learning center. The assessment will be accomplished with the assistance of the advisory board and will include feedback from customers about customer satisfaction with the communication, team work, and presentation skills that our graduates posses. The assessment is to be used to inform the Advisory Board and the University

Partnership so that effective adjustments can be developed and implemented via the Business Plan.

Industry satisfaction with the support provided by the University is the key factor in developing a successful regional learning center engineering program which must not be underestimated in importance. Feedback form customers regarding the attributes possessed by new graduates that are of importance to customers form another key element with which to measure program success. A final element of assessment is the tangible and intangible support that the Antelope Valley Engineering program is receiving from industry and the community. Basically, this would involve the income to the Foundation account and the frequency and duration of interactions with industry.

Disseminate the Study Findings

This study should be presented, a soon as possible, to the Dean, the Associate Dean, and the Department Chairs at the main campus College of Engineering. Additionally a presentation should be provided for the University Provost and, after the fall semester starts, this study should be presented to the College of Engineering Consultative Body. The study should also be presented to the Advisory Board at an appropriately scheduled time.

The researcher should prepare papers, to disseminate the information, from this study, for presentation at the regional and national conferences of the American Society for Engineering Education (ASEE). Articles in professional publications such as ASEE's *Prism* should also be pursued.

Pursue Research Opportunities

This study was focused on the customer. Future research should investigate the product (students) from the perspective of the unique regional learning center program being developed and offered at the LUC. As an example, a proposal to conduct exploratory research into improving Dynamics course delivery in our synchronous interactive television environment has been submitted to the National Science Foundation. An award is expected late in July of 2008. Student satisfaction with the program should be researched to identify potential improvements, and to determine the effectiveness of interventions.

Final Thoughts

The crucial first step in understanding the customer's needs is to define who the customer is (Drucker, 2001). The customers of LUC have been defined as the organizations that employ of engineers in the region. The products of the LUC effort are the students and the engineers that graduate from the Antelope Valley Engineering Program which is consistent with Maguad's (2007) findings. Conclusions have been drawn from this exploratory mixed-methods study within the context of these customer and product definitions. Additionally, throughout this study the sources of educational objectives as defined by Dewey (2001) have been considered as have the 4 questions posed by Tyler (1949). The first two of Tyler's questions, "What educational purposes should the school seek to attain?" (p. 3) and "How can learning experiences be selected which are likely to be useful in attaining objectives?" (p. 63) are answered through the development of an industry needs assessment and the resulting conclusions which are drawn. The educational purpose that the school should seek to attain is summarized in the

simple mission which is to provide high-quality academic programs in engineering that support the infrastructure and growth of the region. This mission has been confirmed by the Phase I, Phase II, and Phase III results from this study. Tyler's third and forth questions, "How can the learning experiences be organized for effective instruction?" (p. 83) and "How can the effectiveness of learning experiences be evaluated?" (p. 104) are the subject of the recommendations that have resulted from the conduct of this study.

Development of a regional learning center within the State University System is a difficult and challenging undertaking for a small staff that is under funded as a result of the budget allocation system based on Full Time Equivalent Student enrollment. To be effective at meeting regional industry needs for engineers entering the work force, the student enrollment must be increased by an order of magnitude. This can only be accomplished through building a coalition of community elites that are engaged and empowered to address the issues facing the learning center. The effectiveness of the newly formed Advisory Board provides a key to accomplishing the required staff *force multiplier* necessary to effect growth and to achieve a self-sustaining regional learning center.

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APPENDIX A

List of businesses that received a survey questionnaire and that have 100 or more employees in the Greater Antelope Valley

1. Aerojet
2. AFC Industries
3. Alliant Tech Systems
4. ATK
5. AVTEL Services
6. BAE Systems/Flight Systems
7. Boeing High Desert Assembly, Integration, and Test (HDAIT) Center
8. Boeing Reusable Space Systems
9. Booz Allen Hamilton
10. Boyle Engineering
11. CACI Dynamic Systems
12. CCL Engineering, Inc.
13. Ch2M Hill, Inc. [Worldwide]
14. Computer Sciences Corporation
15. Computer Technology Associates
16. Crissair, Inc.
17. DCS Corporation
18. Delta Scientific
19. Deluxe Corporation
20. Edwards Air Force Base, Electronic Warfare
21. Edwards Air Force Base, Instrumentation
22. Edwards Air Force Base, Flight Test
23. Edwards Research Site/Air Force Research Laboratories
24. Electronic Warfare Associates, Inc.
25. E Squared Consulting
26. Exquadrum
27. Flight Test Associates
28. FPM Group
29. INCOTEC
30. Interviewing Service of America
31. Jacobs Naval Systems Group, Inc.

32. L-3 Communications
33. L-3 Communications, Government Services, Inc.
34. Lockheed Martin Corporation
35. Michael's Stores, Inc.
36. NASA Dryden Flight Research Center
37. Naval Air Weapons Development Center
38. New Directions Technologies, Inc.
39. Niklor Chemical Mojave
40. Northrop Grumman Corporation
41. Penfield & Smith
42. Portland Cement
43. PPG Aerospace
44. Raytheon Corporation
45. Rite Aid Customer Support Center
46. RND Enterprises
47. SA Tech
48. Scaled Composites
49. Senior Systems Technology
50. Starwood Hotels and Resorts Worldwide, Inc.
51. Sverdrup Corporation
52. Tybrin Corporation – Jtech
53. Tybrin Corporation – Mojave
54. Tybrin Corporation – Ridgecrest
55. Tybrin Corporation - SETA
56. US Borax
57. Wyle Laboratories
58. XCOR Aerospace

APPENDIX B

List of businesses that received a survey questionnaire and that have less than 100 employees in the Greater Antelope Valley

1. A & C Precision Machining
2. Accurate Machine Company
3. Ace Cogeneration Company
4. Ace Engineering, Inc.
5. Adams Metalizing & Grinding
6. Adaptive Optics Associates
7. Adobe Inspections
8. Advanced Clutch Technology
9. Advanced Fuel Systems
10. Aero Bending Company
11. Allan Jaffe Consulting
12. Allrite Precision Grinding
13. American Carriage, Inc.
14. American Institute of Aeronautics and Astronautics
15. Antelecom, Inc.
16. Applied Web Engineering
17. Aries Blasting
18. Armor Powder Coatings and Strength and Fitness
19. Aspen Builders, Inc.
20. Auto Dismantlers
21. AV Anodizing, Inc.
22. AV Engineering
23. Barstow City Engineer
24. Baumann Corporation
25. BC Enterprises
26. BE Precision
27. Bennett Optical Research, Inc.
28. Budco Fabrication
29. Building Industry Association
30. C & T Machining
31. California Connection
32. Caithness Operating Company, LLC
33. CDMC Consulting
34. Ch2M Hill, Inc. [Western US]
35. Chemtool, Inc.
36. China Lake NAS
37. Consolidated Technology

38. Cosner-Neipp Consulting
39. Coso Operating Company
40. Don Ward
41. Earth Systems So. California
42. EDO Technical Services Operation
43. E & S Manufacturing
44. Entron Systems Company
45. Fiberset, Inc.
46. Fielden Engineering Group
47. Firequick Products, Inc.
48. Four Winds Intertribal Council
49. PPL Energy Operating Services
50. GE Energy
51. Hanbali & Associates
52. Hardway Manufacturing
53. Hays Engineers and Scientists, Inc.
54. Henway, Inc.
55. High Desert Machining
56. High Desert Plan Room
57. High Plains Engineering
58. Inland Empire Labor Management
59. International Council on Systems Engineering
60. Interorbital Systems
61. Kennedy Engineered Products
62. Kern Wind Energy Association
63. KV Solar Supply
64. LA/Palmdale Regional Airport
65. Lancaster Alloys
66. Lancaster City Engineer
67. Lancaster Rotary Clubs
68. LandTek, CA, LP
69. Los Angeles County Sanitation District
70. Mojave Air & Space Port
71. National Test Pilot School
72. Netzer Russell Consulting, LLC
73. Oak Creek Energy Systems, Inc.
74. Omidi Enterprises
75. Palmdale City Engineer
76. Palmdale Heat Treating
77. Palmdale Precision

78. Patco Grinding
79. Polaris, Inc.
80. Powerdyne Automotive Products, Inc.
81. QNET
82. Raven Tek
83. Ridgecrest City Engineer
84. SCE Gaskets, Inc.
85. Scott Wray M III PE & Associates
86. Simulation Plus, Inc.
87. Soarcraft, Inc.
88. Society of Flight Test Engineers
89. Space Age Control
90. Taylor Manufacturing
91. Tiger Tech, Inc.
92. TOSS Industrial Services
93. Translunar Research
94. Trona Railway Company
95. Tri-Mar Precision
96. Valencia Automotive Manufacturing Corporation (VAMCO)
97. Victorville City Engineer
98. Words +, Inc.

APPENDIX C

Critical Case Interview Questions

Interview Questions: Critical Case A

1. What is your organization's view the support received from higher education in the Antelope Valley?
2. What issues does your organization face in hiring newly graduated engineers?
3. What opportunities do you see for cooperation with the local Fresno State Engineering Program for developing specialty classes that could be offered to members of your organization?
4. The data that I have collected indicates that employee retention problems may be isolated to several employers rather than being a general problem for employers through out the region. Is this the perception of your organization as well?
5. The data that I have collected indicates that organizations in this region have no desire to provide gifts that support faculty endowments. So that I may understand, why do organizations not wish to offer donations that support faculty endowments to a local program?
6. The data that I have collected indicates that the need for computer engineering is lower than what may have earlier been perceived. Could there have been confusion between computer engineering and computer science?
7. The data that I have collected indicates that the need for chemical engineers is surprisingly strong. Does your organization have requirements for Chem Es? Please explain your need?

Interview Questions: Critical Case B

1. What has your office heard from industry regarding the support received from higher education in the Antelope Valley?
2. What issues has your office heard that industry faces in hiring newly graduated engineers?
3. What opportunities do you see for cooperation with the local Fresno State Engineering Program for developing our higher education in the Antelope Valley?
4. The data that I have collected indicates that employee retention problems may be isolated to several employers rather than being a general problem for employers through out the region. Is this the perception you have as well?

Interview Questions: Critical Case C

1. What is your organization's view the support received from higher education in the Antelope Valley?
2. What issues does your organization face in hiring newly graduated engineers?
3. What opportunities do you see for cooperation with the local Fresno State Engineering Program for developing specialty classes that could be offered to members of your organization?
4. The data that I have collected indicates that employee retention problems may be isolated to several employers rather than being a general problem for employers through out the region. Is this the perception of your organization as well?
5. Do you think that the local employers would have a preference for local Civil Engineering Graduates? Are Land Surveyors needed as well? People with a degree in Construction Management?
6. The data that I have collected indicates that organizations in this region have no desire to provide gifts that support faculty endowments. So that I may understand, why do organizations not wish to offer donations that support faculty endowments to a local program?
7. The data that I have collected indicates that the need for civil engineering is lower than what I expected. Would you provide your perspective on current and future CE demands in the AV and the constraints in the market that are inhibiting growth?

APPENDIX D

Chambers of Commerce in the Greater Antelope Valley

Organization & Web-site

Antelope Valley Chamber of Commerce
http://www.avchambers.com/members.directoriey.php

Apple Valley Chamber of Commerce
http://www.avchamber.org/members

Barstow Area Chamber of Commerce
http://www.barstowchamber.com

Boron Chamber of Commerce
http://www.boronchamber.org

Greater Antelope Valley Economic Alliance
http://www.aveconomy.org

Mojave Chamber of Commerce
http://www.mojave.ca.us/new_site/Mojave_chamber_members.htm

Palmdale Chamber of Commerce
http://www.palmdalechamber.org

Ridgecrest Chamber of Commerce
http://www.onlinemedoffice.net/rcc/business.aspx

Rosamond Chamber of Commerce

http://www.rosamondtowncouncil.org

Tehachapi Chamber of Commerce

http://www.tehachapi.com/chamber/

Victorville Chamber of Commerce
http://www.vvchamber.com/member_directory/

Data was also retrieved from: http://www.yellowbook.com/category/engineers-consulting/California/Book/Antelope_Valley

APPENDIX E

Panel of Experts

1. Dr. Dennis Anderson, Dean of Instruction, Academic Programs, Mount San Jacinto College
2. Dr. John Hultsman, Associate Vice President and Director, California State University, Bakersfield, Antelope Valley Center
3. Dr. Michael Jenkins, Dean of the College of Engineering, California State University, Fresno
4. Dr. Ramakrishna Nunna, Associate Dean of the College of Engineering, California State University, Fresno
5. Dr. Leslie Uhazy, Dean of Math, Science, and Engineering, Antelope Valley College

APPENDIX F

Phase I Questionnaire

Phase I, Industry Needs Assessment

1. Phase I, Industry Needs Assessment

My name is Kenneth W. Santarelli, a graduate student under the direction of Dr. Diana Hiatt-Michael of Pepperdine University. I am conducting research to assess industry needs for undergraduate and graduate engineering programs in the Antelope Valley. The benefit to you for completing this survey is the ability to help provide an understanding of industry needs for higher education in the Antelope Valley as they pertain to the engineering disciplines.

Your participation will involve responding to the survey questions and will require approximately 10 to 20 minutes to complete. Should a question or questions cause any discomfort, please skip the question and continue the survey. Your responses will be confidential and will be stored in a locked file cabinet and destroyed 5 years after the study is completed. Please understand that no information gathered from your study participation will be identified to you and released to others without your permission, unless such a disclosure is required by law.

Your participation is strictly voluntary and you may refuse to participate and/or withdraw your consent and discontinue participation in this project or activity at any time without any penalty or loss of benefits to which you are otherwise entitled.

This project is research being conducted for a dissertation in partial fulfillment of the requirements for the degree of Doctor of Education in Organizational Leadership. This survey questionnaire forms the first phase of a mixed-methods study. The second phase will be comprised of personal interviews followed by one or more focus groups.

I will answer any inquiries you may have concerning this research. Please direct your requests to eefeef@antelecom.net. You may also contact Dr. Hiatt-Michael at Pepperdine University (Diana.michael@pepperdine.edu, 310-568-5644) if you have other questions or concerns about this research. If you have questions about your rights as a research participant, you may contact Dr. Stephanie Woo, Ph.D. of the Institutional Research Board at Pepperdine University, (swoo@pepperdine.edu, 310-568-5753).

Your consent to participate in this study is registered by returning the completed survey questionnaire. Thank you for your participation.

Sincerely,

Kenneth W. Santarelli

Page 1

Phase I, Industry Needs Assessment

2. Default Section

1. Does your organization employ degreed engineers,

◯ If no check here and submit. If yes please proceed to question 2.

2. If you do not wish to continue,

◯ Please check here and submit, otherwise skip to question 3.

3. My organization is aware of the engineering degree programs being offered by Fresno State at the Lancaster University Center on Division Street in Lancaster.

◯ Yes

◯ No

4. My organization has a significant problem retaining engineering personnel hired from outside the high desert region.

◯ Strongly disagree

◯ Disagree

◯ Neither disagree nor agree

◯ Agree

◯ Strongly agree

5. How many employees does your organization have in the Antelope Valley or adjacent regions (Victorville, Barstow, and the Owens Valley)?

◯ 1-10

◯ 11-30

◯ 31-60

◯ 61-100

◯ 101-500

◯ 501 or more

6. How many of your employees are degreed engineers?

◯ None

◯ 1%-5%

◯ 6%-15%

◯ 16%-35%

◯ 36%-50%

◯ 51% or more

Phase I, Industry Needs Assessment

7. What is the average age of your degreed engineering workforce?

- ◯ 18-25
- ◯ 26-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56 or older

8. How many positions in engineering is your organization currently trying to fill?

- ◯ None
- ◯ 1-10
- ◯ 11-20
- ◯ 21-30
- ◯ 31-60
- ◯ 61 or more

9. How much does your organization (in the Antelope Valley or adjacent regions) spend, in total, annually to replace employees who elect to leave?

- ◯ None
- ◯ Less than $50k
- ◯ $50k to $150k
- ◯ $151k to $300k
- ◯ $301k to $450k
- ◯ Over $450k

10. My organization will likely provide support to the local engineering education program offered by the State University System by, Check all that apply.

- ☐ Offering gifts to a foundation
- ☐ Providing scholarships
- ☐ Offering research grants
- ☐ Purchasing or donating laboratory equipment
- ☐ Financing facility construction
- ☐ Funding infrastructure development
- ☐ Offering faculty endowment
- ☐ Providing financial support for operations

Phase I, Industry Needs Assessment

11. On average, how many newly graduated engineers does your organization plan to hire annually?

- ◯ None
- ◯ 1-5
- ◯ 6-10
- ◯ 11-15
- ◯ 16-20
- ◯ 21 or more

12. How much does your organization reimburse employees, attending classes and programs at accredited schools, for fees and books?

- ◯ None
- ◯ Up to $2500/year
- ◯ Up to $5000/year
- ◯ Up to Up to $10,000/year
- ◯ 100% of fees and books

13. My organization is interested in providing work experience for upper division engineering students at our Antelope Valley business locations by offering:

- ☐ Cooperative Education: Students receive college credit and are paid by the employer.
- ☐ Internships: Students receive college credit but are not paid by the employer.
- ☐ Flexible work schedules that allow employees to attend classes during normal business hours (full or part time).
- ☐ Summer hires: Summer time employment only.
- ☐ Tuition assistance for students for any of the above options.
- ☐ Unable to provide any of the above.

Phase I, Industry Needs Assessment

14. My organization is willing to provide support to the Fresno State Antelope Valley engineering education program by, Check all that apply.

- ☐ Making gifts to a foundation
- ☐ Offering scholarships
- ☐ Offering research grants
- ☐ Purchasing or donating laboratory equipment
- ☐ Funding facility construction
- ☐ Investing in infrastructure development
- ☐ Offering faculty endowment
- ☐ Providing financial support for operations
- ☐ Providing topics for design projects
- ☐ Participating in design team activities
- ☐ Providing financial aid to student projects

15. How many employees must your organization replace annually?

- ◯ None
- ◯ Fewer than 1 per year
- ◯ 1-3
- ◯ 4-6
- ◯ 7-9
- ◯ 10-12
- ◯ 13 or more

16. How strongly do you agree with the following? Employees and their families recruited from outside the region have difficulty adapting to the high desert and leave the organization after a short time.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neither disagree nor agree
- ◯ Agree
- ◯ Strongly agree

Phase I, Industry Needs Assessment

17. How many of your employees are currently enrolled in programs leading to a Bachelor's or Master's degree?

- ◯ None
- ◯ 1-10
- ◯ 11-20
- ◯ 21-30
- ◯ 31-60
- ◯ 61 or more

18. How many of your employees are currently enrolled in skills enhancement programs (e.g. engineering skills review and Professional Engineer License examination preparation)?

- ◯ None
- ◯ 1-10
- ◯ 11-20
- ◯ 21-30
- ◯ 31-60
- ◯ 61 or more

19. In your opinion, how many of your employees may be likely to enroll in a locally offered ABET accredited engineering program to complete their Bachelor of Science degree?

- ◯ None
- ◯ 1-10
- ◯ 11-20
- ◯ 21-30
- ◯ 31-60
- ◯ 61 or more

Phase I, Industry Needs Assessment

20. In your opinion, how many of your employees may be likely to enroll to complete a locally offered program leading to a Master of Science degree in an engineering discipline?

- ◯ None
- ◯ 1-10
- ◯ 11-20
- ◯ 21-30
- ◯ 31-60
- ◯ 61 or more

21. In your opinion, how many of your employees may be likely to enroll in locally offered programs to enrich their skills, such as taking a course for a specific computer aided design program or a course in project management?

- ◯ None
- ◯ 1-10
- ◯ 11-20
- ◯ 21-30
- ◯ 31-60
- ◯ 61 or more

22. What are the primary core-engineering disciplines sought by your organization in hiring engineers with a Bachelor of Science degree? Please check all that apply.

- ☐ Mechanical Engineering
- ☐ Electrical engineering
- ☐ Computer Engineering
- ☐ Computer Science
- ☐ Civil Engineering
- ☐ Construction Management
- ☐ Aerospace Engineering
- ☐ Geomatics
- ☐ Mining Engineering
- ☐ Systems Engineering
- ☐ Chemical Engineering
- ☐ Industrial Engineering

Phase I, Industry Needs Assessment

23. Are there any other engineering disciplines that your organization needs that are not represented in question 22? Please write in your response.

24. What are the primary core-engineering disciplines sought by your organization in hiring engineers with a Master of Science degree? Please check all that apply.

- [ ] Mechanical Engineering
- [ ] Electrical Engineering
- [ ] Computer Engineering
- [ ] Computer Science
- [ ] Civil Engineering
- [ ] Chemical Engineering
- [ ] Aerospace Engineering
- [ ] Technical Management
- [ ] Mining Engineering
- [ ] Systems Engineering
- [ ] Industrial Engineering

25. Are there any other engineering disciplines that your organization needs that are not represented in question 24? Please write in your response.

APPENDIX G

Gap Analyses

Discipline	Need	Gap	Effect
Mechanical Engineering	1) Highest industry need 2) One professor in each discipline required full time at the learning center	Enrollments currently suspended pending program revision	1) Industry not served 2) Graduate program missing 3) Loss of student enrollments necessary to achieve self-sustaining
Electrical Engineering	1) Highest industry need 2) One professor in each discipline required full time at the learning center 3) Industry suggests focus in controls and instrumentation	1) No full time Electrical and Computer Engineering (ECE) Professor 2) Laboratory requires expansion	1) Students have no direct support 2) Student satisfaction suffers 3) Classes difficult to schedule when needed 4) Laboratory expansion underway with resources provided by the Flight Test Center
Aerospace Engineering	Industry reported as 3rd highest need	An Aerospace curriculum is not currently offered at either the LUC or at the Main campus	Another university currently offering graduate program at the LUC
Chemical Engineering	The actual reported need for course work is for composite materials	Should be an emphasis area within Mechanical Engineering	Curriculum needs to be developed and special topics classes offered
Computer Engineering	Industry recommending software engineering emphasis at graduate level	Not currently offered at main campus	1) Begin enrolling with the assignment of an ECE professor 2) Support action for advisory board
Civil Engineering	Industry advising to begin preparing for Building Industry upturn within 2 to 3 years	1) No plan currently in place to offer curriculum at the learning center 2) Expensive to implement due to cost associated with laboratory	Second largest industrial segment remains unsupported.
Technical Management	Industry interest in program and in project management stongly suggests the need for a graduate program	1) Curriculum under development at main campus 2) Simple to implement	Should allow increase in graduate student enrollment
Implement Specialty Courses and Certificate Programs	Industry expressing needs in several areas	1) Comprehensive plan required 2) Advisory Board identify opportunities and industry Adjunct	High potential to meet industry needs, develop positive branding, develop graduate programs, and increase enrollment

APPENDIX H

IRB Approval

PEPPERDINE UNIVERSITY

Graduate School of Education and Psychology

December 10th, 2007

Kenneth W. Santarelli
43441 Buena Vista Way
Lancaster, CA 93536

Protocol #: E1107D10
Project Title: ***An Industry Needs Assessment for University Undergraduate and Graduate Engineering Programs in the Antelope Valley of California***

Dear Mr. Santarelli:

Thank you for submitting your application, *An Industry Needs Assessment for University Undergraduate and Graduate Engineering Programs in the Antelope Valley of California*, for exempt review to Pepperdine University's Graduate and Professional Schools Institutional Review Board (GPS IRB). The IRB appreciates the work you and your faculty advisor, Dr. Diana Hiatt-Michael, have done on the proposal. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations (45 CFR 46 - http://www.nihtraining.com/ohsrsite/guidelines/45cfr46.html) that govern the protections of human subjects. Specifically, section 45 CFR 46.101(b) (2) states:

> (b) Unless otherwise required by Department or Agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:
>
> **Category (2) of 45 CFR 46.101**, research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: a) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Based upon review, the GPS IRB has determined that **your proposed study is exempt from further IRB review.** In addition, your application to waive documentation of consent, as indicated in your **Application for Waiver or Alteration of Informed Consent Procedures** form has been **approved**.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit a **Request for Modification Form** to the GPS IRB. Because your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the GPS IRB.

The goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the GPS IRB as soon as possible. If notified, we will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event. Please refer to the protocol number denoted above in all further communication or correspondence related to this approval. Should you have additional questions, please contact me. On behalf of the GPS IRB, I wish you success in this scholarly pursuit.

Sincerely,

Stephanie M. Woo, Ph.D.

Stephanie Woo, Ph.D.
Chair, Graduate and Professional Schools Institutional Review Board
Graduate School of Education and Psychology
6100 Center Drive 5th Floor
Los Angeles, CA 90045
swoo@pepperdine.edu

cc: Dr. Lee Kats, Associate Provost for Research & Assistant Dean of Research, Seaver College
Ms. Ann Kratz, Human Protections Administrator
Dr. Stephanie Woo, Chairperson, Graduate and Professional Schools IRB
Ms. Jean Lee, Manager, Graduate and Professional Schools IRB
Dr. Diana Hiatt-Michael
Ms. Christie Dailo

APPENDIX I

Coding Themes

Themes

1 **Cost of employee replacement** – This is a dollar value assigned to replacement of employees who are not retained after they are recruited.

2 **Curriculum** – This is the set of courses, and their content, offered at a school or university (Wikipedia contributors, 2008). Examples include Aerospace, Chemical, Civil, Computer, Electrical, Mechanical, and Mining, Systems, and Construction management as well as graduate level programs including Technical Management.

3 **Employee educational reimbursement** – Programs offered by employers to subsidize and encourage life long learning by employees. Examples include paying for employees' college costs, tuition-reimbursement programs as an effective way to recruit and retain good workers

4 **Employee recruiting and retention** – Recruiting both from the locally educated workforce and from outside the region. Retention refers to retaining an individual as an employee after recruitment.

5 **Market environment and opportunities** – The economic and political forces that impact industry either positively or negatively. Examples include location of specific industries in the desert that do not appeal to the new grads and thus making retention of these employees after recruitment almost impossible.

6 **Opportunities for cooperation between industry and the university** – Opportunities created as a result of the co-existence of the University and the industry (in the same local region), in reshaping the local economic system and forming a new, market-oriented, competitive and innovative-based local economy. Examples include offering specialized courses to enhance employee skills or to expand skill sets such as courses in Composites, Reliability, or Writing legal descriptions.

7 **Outreach** – The effort by the University and industry to engage and maintain the interest of elementary, middle, and high school students in going to

college and specifically in the engineering disciplines. Examples include offering youth programs to stimulate the interest of younger students in the local community in specific jobs that are or would be in short supply in the local industry.

8 **Student Coop, Internship, and Summer Hire Programs –** Programs offered by the industry to help students in the local community universities gain knowledge and experience by exploring their interests in specific jobs in their local communities. Examples include programs in Civil/Mechanical Engineering coop, internship, and summer hire programs.

9 **Student/Graduate communication/presentation skills –** Programs offered by the universities that are created to complement the technical skills of employees, mostly front-line supervisors, in the industry. Examples include interpersonal skills for effective talking, listening, conflict resolution, and anger management.

10 **Support to endowments and the University Foundation** – Financial Gift Giving in the form of a transfer of money or property donated to an institution, usually with the stipulation that it be invested, and the principal remain intact in perpetuity or for a defined time period (Wikipedia, 2008). Examples include frequently restricted funding to very specific areas of the university.

11 **The opinion of industry regarding the support received from higher education** - Positive or negative views from local industries who are engaged in various sectors of higher education in local universities and who have a clear stake in the outcome of the education of their employees. Examples include discussions with influential employers on issues that educators can learn from which may prove in the long run to be even beneficial to the community.

APPENDIX J

Instructions for Coders

Coding Instructions

1. The coder will receive a set of themes and each theme will be numbered. The coder will receive interview excerpts that are numbered as well. A coder log sheet that corresponds to the interview excerpts will also be provided.
2. The coder will read a paragraph and choose a theme that best represents the idea expressed in the paragraph. The coder will then record the number of the theme adjacent to the paragraph number just coded on the log. Only one theme can be assigned to a paragraph.
3. When the coder finishes recording themes for a given interview excerpt set, the log will be returned to the researcher/coder. The researcher/coder will compare the returned log with a master log. Where the records do not match, a discussion will be initiated by the researcher/coder to determine the best-suited theme for the particular paragraph in question.
4. In the event that the coders cannot come to agreement with the theme chosen by the researcher/coder, the researcher/coder will seek a consensus and modify the master log to conform accordingly.

APPENDIX K

Business Plan Executive Summary

California State University, Fresno
Antelope Valley Engineering Programs
Business Plan

Executive Summary

The College of Engineering at California State University, Fresno (Fresno State) has established a unique approach to provide ABET accredited engineering education for the residents of the Greater Antelope Valley and adjacent regions. The resources of the College of Engineering are made available locally through developing partnerships between Fresno State, California State University, Bakersfield (CSU, Bakersfield), and community colleges in the region. Students matriculate at the community colleges to complete their lower division course requirements and then transfer to Fresno State to accomplish their upper division course of study at the Lancaster University Center where a combination of live instructor lead lectures and laboratories is offered with lectures delivered using state-of-the-art distance learning class rooms. Upper division general education courses are provided by CSU, Bakersfield. At the successful completion of their studies students receive a Bachelor of Science degree, awarded by Fresno State, in their engineering discipline. Master of Science degree programs are also offered.

The program is informed by a vision of growth in student enrollment and through an expansion of the programs offered. Key program features are the ability to address the geographically distributed population through distance leaning, development of partnerships that take advantage of the existing community college system to provide lower division instruction, and a focus on first generation undergraduate students that results from the rapidly changing regional demographics.

The establishment of Mechanical and Electrical Engineering Laboratories is a key factor in attracting students and provides a foundation for enrollment growth and program expansion. The program priorities are student retention, recruiting, and community/industry/government support. A *student first* philosophy addresses retention via personalized attention. Recruiting relies on developing partnerships with community colleges in the region exemplified by the existing relationship between Fresno State and the Antelope Valley College and requires community/industry/government support to develop pathways beginning in elementary school. This is necessitated by the crises in STEM education indicated by the low ratio of students graduating from high school having completed the California A through G UC/CSU admission requirements. Program growth is dependent on faculty development. Significant community, industry, and government tangible and intangible support will be required to assure success. A unique foundation account has been established at Fresno State to receive gifts, donations and

scholarship resources expressly identified to support the Antelope Valley Engineering Programs.

The available Fresno State staff in the Antelope Valley is very small; therefore, reliance on the Advisory Board to facilitate this plan is required. It is necessary for the Advisory Board to align with the priorities established by this plan and work diligently to facilitate success.