California State University, Bakersfield
Title V - Developing Hispanic-Serving Institutions Program

Increasing the Productivity of the Engineering Degree Pipeline in the High Needs Southern San Joaquin Valley: A Sound Cooperative Arrangement Project with Bakersfield College

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	California State University, Bakersfield (CSUB)	**Bakersfield College (BC)**
Mission	California State University, Bakersfield is a comprehensive public university committed to offering excellent undergraduate and graduate programs that advance the intellectual and personal development of its students. An emphasis on student learning is enhanced by a commitment to scholarship, diversity, service, global awareness and life-long learning.	With its heritage as a foundation and an eye toward the future, Bakersfield College provides the high quality education necessary for our socially and ethnically diverse students--whether they be vocational, transfer-oriented, developmental, or some combination of these--to thrive in a rapidly changing world. We are committed to student learning and success.
Control/ Type	CSUB opened in September 1970 as the 19th member of the 23-campus public California State University system.	BC was founded in 1913 and is one of the nation's oldest continually-operating public community colleges.
Location	CSUB and BC are both located in Bakersfield, California (Kern County) at the southern end of California's Central San Joaquin Valley.	
Accred.	WASC (Western Association of Schools and Colleges)	ACCJC (Accrediting Commission for Community and Junior Colleges)
Programs	**CSUB offers Bachelor's degrees in 39 areas of specialization, 19 Master's degrees, one Doctorate program and six credential programs.**	BC offers over 70 AA/AS degrees and more than 40 certificate programs in 25 general education disciplines and 18 career and technical areas.
Student Body **Fall 2014 Data** *Sources: CSUB & BC Fast Facts Fall 2014*	**Headcount:** Undergraduate: 7,544; Postbaccalaureate/Graduate: 1,176	**Headcount:** Undergraduate: 19,143
	Undergraduate Race/Ethnicity: Hispanic: 53%; White: 22%; Asian/Pacific Islander: 8%; Native American: 1%; African American: 7% Multi-Ethnicity: 2%; Int'l: 3%; Unknown: 5%. Low-income: 59%; First-generation: 76%	**Race/Ethnicity:** Hispanic: 62.4%; White: 23.5%; Asian/Pacific Islander: 4.1%; American Indian/Alaskan Native: <1%; African American: 4.9%; Multi-Ethnicity: 3.3%; Unknown: 1.4%. Low-income: 74%; First-generation: 82%
	Age: Under age 25: 82%; Age 25 and Older: 18%. **Gender:** 61% F; 39% M.	**Age:** Under age 25: 61.8%; Age 25 and Older: 38.2%. **Gender:** 55% F; 45% M.

1. COLLABORATIVE COMPREHENSIVE DEVELOPMENT PLAN

California State University, Bakersfield (CSUB), the lead institution in this cooperative arrangement project, enrolls over 7,500 undergraduates, **53% of whom are Hispanic**. CSUB is the only public university campus within a 100-mile radius, serving a vast Central San Joaquin Valley region encompassing Kern, Tulare, Inyo, and Mono counties, and parts of Los Angeles and Kings counties. This service area has one of the fastest growing and most economically depressed Hispanic populations in California. The main CSUB campus is located on a 375-acre

site donated by the Kern County Land Company to the State of California for the university, a remarkable demonstration of the community's commitment to and support for a local CSU campus. Bakersfield College (BC), the partner college, is one of California's oldest community colleges and enrolls over 19,000 students, **66% of whom are Hispanic**. BC, located just 10 miles from CSUB, shares the socio-economic and demographic challenges of the region and is CSUB's main feeder community college. BC has very deep roots in the community and strong support.

Justification for Cooperative Arrangement: CSUB and BC have many challenges in common. College completion is at the top of America's education agenda today. Increasing completion is also a top service area priority and a daunting challenge for both CSUB and BC. There are severe local workforce shortages in sectors critical to the regional and state economy.[1] Bakersfield is now California's 9th largest city and one of the fastest growing metropolitan areas in the western United States. Though workforce demands are increasing, few local adults are qualified for the area's well-paid jobs. The industries that produces these jobs increasingly need workers with college degrees to enable them to continue their contribution to the area economy, and workforce shortages also reflect a huge waste of human capital and lost opportunity for many individuals.

Providing degree programs to meet local industry demand absolutely requires that CSUB and BC join forces. They must join forces in order to make the cost affordable because so much change is required at both underfunded HSIs. Engineering programs are expensive. They must join forces because BC is the only accessible entrance point to college for the highest

[1] *Closing the Gap: Meeting California's Need for College Graduates* is one in a series of reports issued by PPIC as part of the California Workforce: Planning for a Better Future Project. (January, 2011.)

need local Hispanic students, and CSUB is the only accessible degree-granting public university for these students and many others who need to join the local workforce.

Both CSUB and BC face enormous challenges in providing equitable degree opportunity in a state public education system struggling to meet overwhelming needs with severely limited resources. **But California's new reality requires intersegmental solutions so that its higher education system can once again serve as a pipeline, rather than a funnel that fails to meet workforce demands.** CSUB and BC have extensive experience already in cooperating to meet local demands. While some financial recovery occurred due to the passing of Prop 30 in November 2012, the current level of state funding for the CSUs is still inadequate to meet the burgeoning need. It is well documented that the CSU System, the largest public university system in the county, is now having to serve many more students with severely restricted funding. The CCCs have been hit even harder, with unprecedented cuts of $1.5 billion from 2007-2013 and drastic, unpredictable fluctuations in annual funding. CSU and CCC campuses have cut student support, classes and instruction, and college participation rates in both systems are at their lowest in twenty years. Both CSUB and BC have been warned to increase "productivity" and reduce costs at the same time. Intersegmental collaboration is highly recommended by both CSU and CCC Systems as a way to increase efficiency and effectiveness in terms of student success.

Local industry will support BC and CSUB's efforts to develop programs that address local workforce needs, but that support is limited and depends on quick results. By working together instead of competing for local industry support, the partnering HSIs have found they can save time and effort and even increase the amount of industry support. The new engineering pathway is specifically designed to increase industry support.

The collaboratively planned intersegmental pathway will not only improve access to high-demand engineering degrees, it will build on student success initiatives at each partnering HSI. The project is planned to build on each partner's strengths and focuses on areas where collaboration has the most potential to increase impact in both institutions on better serving Hispanic and low-income students. The project meets all Title V 2015 priorities at both CSUB and BC and is designed to use cooperative effort as one key strategy to produce more local Hispanic engineers.

Table Summarizing Strengths of CSUB/BC Collaboration

Geographically Sound:

- CSUB and BC are just ten miles apart; both are located in the city of Bakersfield, California.
- Faculty and staff at both partnering institutions travel back and forth routinely between the campuses/are accustomed to collaborative effort.

Economically Sound:

- Both agree it is more cost effective to add a Power/Energy Engineering track to the intersegmental engineering pathway rather than just adding a more specialized engineering degree in petroleum engineering at CSUB. The service area would like CSUB to develop a petroleum engineering degree. Petroleum engineering degree programs are the most expensive to develop and maintain, however. If the Power/Energy Engineering track is a success in all the ways planned and implemented through this project, then CSUB can afford to consider additional engineering options and will have increased industry support to do so.
- The new Industrial Automation degree pathway at BC, starting in Fall 2015, will provide an additional seamless pathway towards engineering degrees at CSUB, eliminating course duplication, reducing time to transfer and time to completion, thus realizing significant cost savings for both HSIs in producing more local engineers.
- CSUB recognizes that the National Academy of Engineering (NAE) is projecting that the world of engineering is on the cusp of revolution, significantly affecting engineering education. This project will also help both BC and CSUB to modernize their engineering education models cost-effectively and develop pedagogy and practices that have been proven effective in improving retention and learning in engineering.
- The cost of the project is significantly reduced by partnering collaboratively with Project Lead the Way (PLTW), a high school engineering readiness program. Chevron has already helped fund PLTW projects in the region. BC and CSUB work cooperatively now to prepare PLTW students for the new engineering pathway through BC or for direct enrollment in CSUB. Cooperating with PLTW reduces the cost of engineering outreach for both HSIs and encourages Chevron to continue contributions, both to PLTW and to the engineering programs at BC and CSUB. Chevron critically needs a local engineering degree pipeline.
- The cost of providing student success services will be reduced by building on recent service improvements at both CSUB and BC and using technology already in place at CSUB to make services scalable.

Analysis of Challenges in Common

High Need Students. The rapid growth and changing demographics in the region they both serve are critical forces impacting the future of both CSUB and BC. The underpreparedness of Hispanics, the fastest growing segment of the population in the service area, for higher education is a significant challenge for both institutions in building a more productive engineering pipeline. Most students at both HSIs come from Kern County, which includes 47 public school districts with 273 school sites (K-12), and has the largest K-8 elementary school (Bakersfield City) and the largest high school district (Kern High) in the state. Kern County School District enrollment is now 62.5% Hispanic. Numerous California reports have documented the decline in K-12 learning outcomes overall, particularly among Hispanics. California Standards Tests (CST) to assess state-adopted content standards in grades 2-11 reveal that Hispanic students in the CSUB/BC service area are much less likely than White (non-Hispanic) students to be proficient in all of the areas tested. **CSUB and BC are challenged to serve a Hispanic population that is among the most underprepared for college, but it is mission critical for both Hispanic-serving institutions to provide a responsive education opportunity for these students**.

Kern County Demographic and Economic Characteristics Informing CDP
• The county's population has increased significantly since 2000 (26.9% growth, compared to approximately 10% in California and 9.7% in the United States). • The percentage of Hispanics now residing in Kern County (50.3%) is much higher than California as a whole (38.2%) and the U.S. (16.9%). • Per capita income in the area is among the lowest in California, at just $22,360 – more than 50 percent below the state average of $44,980 (2012 figures). • Percentage of persons living below poverty levels (22.5%) is higher than the average for California (15.3%) and the country as a whole (14.9%). • Bachelor's degree attainment is also lowest in the CSUB service area (14.9%) compared to

California (30.5%) and the U.S. (28.5%). **Bakersfield ranks last out of 100 metropolitan areas in terms of college degree attainment**.[2] Less than 11% of California Hispanics age 25 and older hold a degree, compared to 39% of Whites.

- The county's unemployment rate (12.1%) is much higher than the state's (7.3%) and the nation's (6.1%) (January 2015). The unemployment rate for young Hispanics aged 18-24 is at least 7% higher compared to Whites.
- California has one of the highest proportions (4.3%) of STEM positions in the nation, and the county exceeds the state average (STEM jobs represent 5% of Kern County's total workforce).
- Forbes recognized Bakersfield as a city with a large ***capacity*** for innovation based on the large number of engineering jobs in the region. While it ranked #32 nationwide in job growth, it ranked #197 in education. So, while CSUB's service area is steeped in industries needing qualified, local graduates, less than 1% of the residents have related STEM degrees. Industries cannot grow without educated local workforce, and growth is needed for economic recovery.

High Need Industries. The regional economy of the five-county area served by CSUB – equivalent in size to Vermont, New Hampshire, Connecticut and Rhode Island combined –was traditionally agriculture based. However, agriculture faces serious environmental challenges, and land devoted to agriculture is steadily shrinking in the Valley. The region has experienced the loss of more than 20,000 acres of prime farmland over the last six years, resulting in the loss of traditional agricultural jobs. While agriculture provides more than ten percent of the jobs in the area, that number is down from 20 percent just five years ago. The current water shortage crisis is projected to reduce agriculture jobs even faster. Significant job loss in the agricultural industry has forced many to seek higher education and degrees that offer stable employment in the area. Given the decline in agriculture, the regional economy is now more heavily dependent on the oil and energy industries.

CSUB is not producing the type of engineers most needed by the area "power" and "energy" industries. Kern County is one of the nation's largest crude oil producers and is the center of the California oil industry, producing 75% of the state's supply. If the county were a state, it would rank fourth in oil and gas production in America. Kern's future in oil is assured: it

[2] The Brookings Institute, *The State of Metropolitan America: Educational Attainment*.

is estimated that 80% of California's remaining oil waits to be tapped from this county's soil. But the future holds promise for new and clean energy in the area. Industries traditionally devoted to oil production are now developing innovative solar, wind and other energy technologies. The growth of new types of "power" and "energy" also has major implications for the future of agriculture. Known as "America's food basket" the San Joaquin Valley's agricultural products feed the nation and world. Agriculture is now heavily dependent on sustainable energy and technology as evidenced by Kern County's Paramount Farms, the world's largest vertically integrated agriculture products supplier, which is fully powered by a 1.1-megawatt solar plant. Kern County is thus experiencing an unprecedented boom in these new industries and is a national hub for clean energy job growth. Together these employers need local power/energy engineers committed to staying in the area, and the existing engineering pipeline at CSUB and BC is not meeting their need. The pipeline is beginning to produce local engineers but not with the skills and knowledge these employers need.

"Kern County is quickly becoming the renewable energy center for California," said County Supervisor Zack Scrivner in early 2014, discussing the urgent need for local, engineers to meet workforce demands.

The National and Local Boom in Clean Energy Technologies: The Harbinger for Kern County's Local Power and Energy Engineering Pathway

- The U.S. Energy Information Administration predicts a doubling of workforce needs in the wind industry between 2010 and 2035. A National Renewable Energy Laboratory study projects 290,000 jobs will be created in solar energy by 2030.
- The region has cultivated multibillion investments from wind and solar companies, creating local industries needing a workforce with advanced skill sets and engineering degrees.
- With 300-plus days of sunlight a year, four of six of Google's recent solar photovoltaic fields have been built in Kern County, creating over 500 jobs in the construction phase alone.
- Kern's wind energy projects are now assessed at $7.5 billion, creating 3,000 new jobs in 2013.
- Hydrogen Energy International (HEI), a joint venture between British Petroleum and Rio Tinto Mining Company (and a $2 billion capital investment), has selected Kern County for a new hydrogen-powered electricity generating facility that will capture and store most of its carbon-related emissions, rather than releasing CO_2 into the highly polluted Central Valley. This clean energy project (HECA) employs technology that will reduce national dependence on foreign oil and will revive west Kern County oil fields. Using innovative Carbon Capture, Use and

Sequestration (CCUS) techniques, the plant will generate low-carbon electricity while capturing 90% of the CO_2 normally emitted. A local oil company will take that CO_2 and inject it deep into underground sandstone reserves to assist in recovering oil that would otherwise be inaccessible – while storing the CO_2 within the oil field, keeping it from the atmosphere.

- The National Research Council recently indicated that a combination of such Enhanced Oil Recovery (EOR) with CCUS would conservatively generate up to 36,000 jobs; more accelerated models suggest up to 100,000 workers may be needed. However, the NRC warns that without increased recruitment, development of these technologies will be severely limited.

Source: *Emerging Workforce Trends in the U.S. Energy and Mining Industries: A Call to Action,* National Research Council, National Academies Press, 2013.

CSUB is not unique in facing the challenge of producing more engineers. California became a world leader in science and technology thanks to its highly skilled technology and engineering workforce. There are, however, clear signs of trouble on the horizon in the state as a whole. As documented in a number of reports in recent years, California's ability to continue to marshal a vital and globally competitive STEM workforce is threatened by a variety of long-term trends. This situation is exponentially more urgent in the bellwether region served by CSUB and BC, a region where the majority of high school graduates are already Hispanic, severely underprepared for college, and effectively denied access to STEM degree opportunity.

Summary of California Reports Warning of Statewide STEM Problem

Center for Excellence in Science and Mathematics Education (CESaME) - In a 2009 report titled *The California STEM Education Crisis*, CESaME reported the following worrying facts:

- The state's science and engineering workers are mature – nearly 40 percent are age 45 or older. And, they are preponderantly white (55 percent) or foreign-born (36 percent).
- Only 10 percent of California's science and engineering workers are Hispanic.

Milken Institute: California's Position in Technology and Science: A Comparative Benchmarking Assessment - This 2008 report points to a worrying decline in science and technology-related human capital development in California:

- "The main threat to California's status as a top-tier performer in technology and science can be seen in the severe deterioration of its measures of human capital.
- The state faces serious challenges due to its growing undereducated and unskilled labor force, a struggling K-12 system, and the rising cost of doing business."

National Assessment of Educational Progress:

- California lags behind a number of other states in the number of years of math and science instruction it requires for both high school graduation and admission to its public universities
- Year after year, California's students perform much worse in math and science compared to other states; California's 4th graders assessed LOWEST in the nation in science knowledge.

Public Policy Institute of California:

- California's high school graduates have some of the lowest university enrollment rates in America. With poor college enrollment and degree attainment, by 2025, California will fall 1 million workers short of its demand for degreed workers.
- In 2025, 41% of jobs will require a college degree but only 35% of workers will have one. An additional 60,000 graduates will be needed each year (40% above current levels).

National Center for Higher Education Management Systems:

- California ranks in the bottom five states for college continuation rates and 8% below national "chance for college" rates (high school graduation x college continuation rates).
- California will see a $2,475 decline in per capita income by 2020 unless rates of educational achievement improve.

California Department of Labor:

- Although the state has a high unemployment in general, the needs for STEM workers will reach about 250,000 by 2020.
- At the current rate of production of engineering graduates, California is expected to fill only about 40% of that need by 2015.
- Hispanics must provide the engineering workforce California needs because of demographic changes, particularly in highest growth areas like the San Joaquin Valley. The Hispanic populations aged 18-24 and 25-44 will each grow 67% by 2025; White population growth will only be 5-11% for these age groups.

From national reports on STEM pathways such as *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, to California-specific reports on STEM participation, to Kern County's Economic Development Plan, the message is clear: increasing the number of Hispanic STEM graduates is vital for America's future socioeconomic health. Since 2000, underrepresented minorities' involvement in engineering majors has been flat, representing the second-lowest sector of STEM Bachelor's attainment.[3] Hispanic representation in STEM fields, particularly engineering, remains dangerously low.

The first phase of the BC/CSUB engineering degree pipeline, a Computer Engineering Pathway, was developed to build on existing resources in order to provide increased opportunity for Hispanics to complete engineering degrees. In 2012 the CSUB School of Natural Sciences, Mathematics, and Engineering (NSME) was recognized as a national "Example of Excelencia" honoree as the result of its successful collaboration with Bakersfield College to start the

[3] *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013 Report,* National Center for Science and Engineering Statistics, National Science Foundation.

engineering degree pathway – the first in their shared service area.[4] The priority goal of NSME today is to increase the number of students earning STEM degrees, with a specific focus on increasing the enrollment and success of underrepresented minority, and particularly Hispanic, students. The first engineering pathway was clearly a step in the right direction.

Outcomes of first BC/CSUB Engineering Pathway that Led to Award

- In 2013-2014, only its third year of operation, the Computer Engineering pathway developed through the CSUB-BC Title V cooperative arrangement grant enrolled 203 students (well ahead of the expected 114, a 78% increase), an outcome that validates the engineering needs assessment survey results. Of those, 85 were Hispanic (42% of enrollment).
- Much if this increase is due to transfer and articulation efforts with Bakersfield College. In 2007, only 27 BC students transferred in STEM majors. In 2013-14, the total number increased to 118 students. In 2006, only 22% of all transfer students enrolling in STEM were Hispanic – by 2011, 50% were Hispanic.
- Recent data shows that Hispanics now make up 55.1% of first-time, full-time students declaring a STEM major at CSUB (Fall 2013); this is compared to only 38.4% in Fall 2006.
- Enrollment rates in undergraduate STEM majors at CSUB have increased 42% from 2008-09 (N=704) to 2012-13 (N=1215).
- Student support services are integrated into the fully-scaffolded STEM degree pathways and the new academic programs NSME has developed, including new engineering programs.
- The first-year retention rate for Hispanic STEM students grew from 72% in 2006 to 83% in Fall 2012.
- 2012 data shows the 6-year graduation rate for first-time, full-time Hispanics was 42.3% compared to their White counterparts at 37.5%. CSUB and BC efforts to increase Hispanic student degree completion rates in STEM majors has resulted not only in closing the equity gap, but since 2010 Hispanics have outpaced White students in the 6-year graduation rate.

CSUB's partner in this collaborative effort, Bakersfield College (BC), is the only gateway to postsecondary education for thousands of service area Hispanic and low-income students each year. Bakersfield College faces daunting challenges, even compared to other California public community colleges, in providing an open door to students who are even more underprepared than CSUB students. BC is struggling with a comprehensive CCC mission, severely reduced funding and overwhelming student need for basic skills education, 21st Century

[4] Excelencia in Education is the most respected, premier independent research group studying Hispanic education issues and solutions.

job training and transfer opportunity. Almost all BC students are local and qualify as "high need".

Indicators of the Student Success Challenges Facing Bakersfield College
• **Students enter BC underprepared**: Over 84% of BC students enter college in need of at least one basic skills course; over 90%% of these students need developmental math. • **Basic skills students fail math, English, and ESL at unacceptable rates:** Between 2010 and 2014, failure rates in basic skills math ranged from 28 to 67%; in English from 18 to 43%, and in ESL from 19 to 43%. • **Hispanics are particularly at risk of failing:** Between 2010 and 2014 the failure rates among Hispanic students in their first math class at BC was approximately 56%. • **The majority of students who do enter the basic skills math sequence do not persist:** Over a four-year period (20010-14), only 48% of the students in prealgebra enrolled in the next level, beginning algebra; 33% of students in beginning algebra enrolled in the next level, intermediate algebra. • **Very few students make it to college-level math:** Less than 19% of the students who begin college in prealgebra (Level 1) will make it through the 3-level math sequence (2008-2011). Only 12% will make it to a college-level math class. • The **six-year completion rate for underprepared Hispanic students** is 30.3%; for underprepared students overall it is 34.8%; and overall for all students it is 39.9% • Currently, over 1400 BC students declare a STEM major; however, **only 156 transferred to a CSUB STEM degree program during 2013-2014.**

Both CSUB and BC have undertaken many student success initiatives as enrollment of underprepared students has increased and student outcomes have declined. Both still face serious student success challenges. BC has taken advantage of many CCC system-wide opportunities and initiatives to improve student success and transfer, but BC students who succeed in transferring to CSUB remain at risk until degree completion. With a high enrollment of at-risk and high need students, CSUB is also below the state average in retention and completion.

Indicators of Student Success Challenges at BC		
Comparison of Graduation and Retention Rates	**BC**	**Systemwide**
Percentage of degree, certificate and/or transfer-seeking students who completed a degree, certificate or transfer within 6 years (**overall**)	40.8%	46.8%
Percentage of degree, certificate and/or transfer-seeking students who completed a degree, certificate or transfer within 6 years (**Hispanic**)	34.2%	38.4%
Source: CCCCO, Student Success Scorecard (2008-2009 cohorts)		

Indicators of Student Success Challenges at CSUB		
Comparison of Graduation and Retention Rates	**CSUB**	**Systemwide**
First-time, Full-time Freshman (FTFTF) that graduated within 6 years (overall)	41.2%	54.0%
FTFTF that graduated within 6 years (Hispanic)	46.8%	48.3%
FTFTF declaring STEM majors that graduated within 6 years (overall)	38.2%	49.3%
FTFTF declaring STEM majors that graduated within 6 years (Hispanic)	33.3%	36.6%
2 Year Retention Rate for FTFTF declaring STEM majors (overall)	67.5%	77.3%
2 Year Retention Rate for FTFTF declaring STEM majors (Hispanic)	69.2%	72.5%
Community college transfers graduating within 4 years (overall)	60.1%	69.2%
Community college transfers graduating within 4 years (Hispanic)	64.8%	67.1%
1 Year Retention Rate for community college transfers (overall)	77.0%	86.3%
1 Year Retention Rate for community college transfers (Hispanic)	78.1%	86.4%
Source: CSU Office of Analytic Studies (2008 to 2012 cohorts)		

To produce more engineers, CSUB must implement a new approach to engineering education that addresses the needs of underrepresented students at risk of failure. CSUB will use a "liberal engineering" approach that emphasizes active learning pedagogy and modern engineering principles while also creating a new degree track in the highest demand local engineering career area: Power and Energy Engineering. Developing this approach will require capacity building, intense faculty development, and redesign of student services (including the development of online and hybrid modes of delivery). Liberal engineering is highly recommended as a way to reform traditional engineering education which has emphasized disciplinary learning not 21st Century cross discipline workplace preparation.

American engineering is in trouble: while demand for the profession continues to grow, the percentage of U.S. undergraduates attracted to engineering remains low. CSUB is certainly not the only institution struggling to reinvent engineering education and to grow enrollment. Engineering education has been the subject of numerous studies as its relevance and applicability is constantly tested by changes in industry. According to the National Academy of Engineering

(NAE), engineering education, traditionally divided into discrete disciplinary focus areas, is culpable in large part for declining participation and student success.[5] In particular, NAE notes that **entrenched disciplinary siloes and a "failure culture" in established engineering programs undermine the success of underrepresented students**, and discourage enrollments.

William Wulf, recent president of NAE, calls it a "disgrace" that only 60 to 65% of the students who enter engineering programs complete them. This is even true in highly selective engineering programs. Transformation of engineering education has, however, finally begun in earnest. The Accrediting Board for Engineering and Technology (ABET) fully supports the engineering education reform championed by NSF and NAE, both of which recommend major reform. ABET voted for engineering reform in establishing "Criteria 2000," a revised rubric for the accreditation of engineering education programs. These criteria encapsulate modern workforce demands that have made traditional engineering education obsolete.

ABET Criteria for Engineers for 21st Century
• The ability to apply knowledge of math, science and engineering. • The ability to design and conduct experiments, and analyze and interpret data. • The ability to design a system, component or process to solve a real problem. • The ability to function on multidisciplinary teams. • The ability to identify, formulate and solve engineering problems. • An understanding of ethical and professional responsibility. • The ability to communicate effectively. • The broad education to understand to impact of engineering solutions in a societal content. • A recognition of the need for, and the ability to engage in lifelong learning. • A knowledge of contemporary issues. • The ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Efforts to reform engineering education did not have much impact until the twenty-first century. There was no unifying vision for reform. With the active engagement of experts in a

[5] *Educating the Engineer of 2020: Adapting Engineering Education to the New Century,* National Academy of Engineering of the National Academies, National Academies Press, Washington, D.C., 2005. **Note that this seminal NAE report is the main external source for CDP analysis of CSUB/BC engineering project.**

wide range of fields including Humanities and Business as well as all types of engineering, NAE came up with a new vision in *Educating the Engineer of 2020*: **a well-designed engineering degree had the potential to become the "liberal arts degree for the twenty-first century"** (p. 9). This vision is fully consistent with ABET 21st century engineering criteria, and it provides a framework for building a Power/Energy Engineering track to meet these criteria. A "liberal" approach to engineering education is not an entirely new idea. Liberal engineering is an idea whose time has come because of the major changes technology has brought to old industries and the new industries it has created. Power and energy industries are undergoing major change and they need engineers that meet ABET criteria. There is unlimited opportunity for growth and creation of jobs in these industries. Their engineering workforce needs have changed in all the ways reflected in the ABET accreditation standards. Employers need engineers who can analyze and solve problems, find new technology applications, and work on teams. Traditional engineering education does not adequately develop these capabilities.

> "Across the country undergraduates are being ushered through an outdated and compartmentalized system in which the education has not kept up with scientific advances . . . Under this paradigm, graduates do not leave with a comprehensive understanding of energy, and this traditional model retards progress in an increasingly globalized world."
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> Webber & Kirshenbaum, "It's Time to Shine the Spotlight on Energy Education," *The Chronicle of Higher Education,* (January 22, 2012).

Eric Walker, the dean of engineering at Penn State in the late 1940s (and later president of Penn), made the highly controversial argument that the technology revolution made it imperative for engineering to become a "liberal arts degree." Demographic shifts, together with the engineering shortage crisis, have finally led to wide embracing of this vision by all top engineering education experts and NSF. The very best engineering schools are leading the way. Today's advocates for engineering reform are also the first generation to take seriously the need

and current opportunity to create a "wider portal for engineering," recognizing America's future depends on attracting underrepresented groups to engineering and other STEM fields. Since it demands a more responsive teaching and learning-centered approach than traditional engineering education, **liberal engineering offers a wider portal to STEM for underrepresented students, including women, according to NAE.**[6]

According to the National Academy of Engineers (NAE), liberal engineering is the "optimum launch pad to challenging and rewarding professions for today's college students." It is a fully integrated, holistic approach to highly technical education which focuses on solving complex problems that require interdisciplinary knowledge and engineering thinking foremost. Most importantly, liberal engineering increases student learning in all the very areas most needed in the high tech workplace. It incorporates the established principles of active learning and student engagement.[7] **Design and work experience are key features of liberal engineering,** and the arts and humanities have as important a role as math, science and business in producing 21st century engineers. Liberal engineering fits CSUB well and is the key to developing a broader engineering degree pathway that is accessible to high needs students.

Identification of Problem in Common and New Opportunity for Collaboration to Increase Student Success and Engineering Degree Productivity. The partners in this cooperative arrangement project recognize that the first engineering pathway is not sufficient and area needs are becoming more urgent. Both recognize they need to make the new engineering degree pathway more productive and responsive to student and regional needs, and NAE

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[6] *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*, National Academy of Sciences, National Academy of Engineering and Institute of Medicine, The National Academies Press, Washington, D.C., 2010.

[7] There is now a large body of research and literature about what works to increase student learning and engagement. (See more information and sources in Implementation Rationale section and Priority 1 narrative.)

research has created new opportunity to do so. Acknowledging the opportunity to design a new, innovative engineering power and energy track, CSUB and BC will follow NAE recommendations for a "liberal engineering" educational approach. The CSUB and BC partnership began with the assumption that their collective impact on the human capital and economic development of the area is greater than the sum of their parts. This assumption led the development of the first BC/CSUB engineering pathway in Computer Engineering, a program that is now showing positive results. This inter-segmental effort laid the foundation for the proposed project which is intended to further expand Hispanic and low-income access and degree opportunity in engineering by following the recommendations of the most respected national engineering education experts.

Summary of Related CSUB/BC Collaboration

- In 1990, CSUB and BC English Departments began working together to align curriculum and ease transfer. The cooperative effort built trust between the two institutions and laid the groundwork for future collaborative endeavors.
- In 2005, BC and CSUB broadened efforts to ease transfer between BC and CSUB with the establishment of the CSUB Satellite Transfer Center, located on the BC campus and staffed by CSUB graduates who themselves transferred from BC.
- Working to better prepare students for STEM transfer, BC developed their first dedicated MESA Center (with mentoring and tutoring) in 2004. This center was developed with CSUB assistance, and a CSUB transfer counselor is available at BC with responsibility for STEM-related transfer advising.
- CSUB and BC began working together intensely on STEM transfer and articulation during the 2008-2009 academic year in an effort funded by a collaborative CCRAA grant. This collaboration has been productive and mutually beneficial, establishing a framework and foundation for extensive STEM articulation between CSUB and BC.
- In Fall 2011, CSUB signed a memorandum of understanding with BC to establish a more seamless pathway to STEM degree completion. The MOU guarantees a four-year plan for transferring students: 2 years at BC + 2 years at CSUB = a STEM degree. CSUB and BC are developing a dual admission policy, by which BC students are admitted to CSUB two years after they begin their studies at the community college.
- At the same time, CSUB began a new Computer Engineering degree program, the first in the region, and asked BC to collaborate to create a seamless transfer pathway from BC's engineering technology program to CSUB's new Computer Engineering programs.
- In January of 2015, the California Community College Chancellor's Office awarded BC the right to develop a 4-year baccalaureate degree in Industrial Automation. Working with CSUB, BC plans to offer two pathways (Industrial Technology and Manufacturing

Technology) that will lead directly to CSUB's proposed Power/Energy Engineering degree, offering an additional option for area students.

CSUB and BC are proud of the fact that their engineering pathway is working well to attract more Hispanics to engineering and help them succeed, but much work remains. The pipeline is not productive enough and it leaks in ways that undermine its productivity and indicate that it is still woefully inadequate.

The two partners have a long history of cooperation to meet the local education and workforce needs, but the challenges they face in meeting local engineering needs require raising this collaboration to a higher level. This project is an opportunity, however, to strengthen the partnership between BC and CSUB. The proposed collaboration will expand opportunities and incentives for BC's many Hispanic students to complete degrees at CSUB. It will strengthen CSUB's capability to provide degrees that are directly responsive to current needs of service area industries. It will strengthen BC's capability to transfer more students. In addition, this project will make the developing BC/CSUB engineering pathway much more responsive to Hispanic student needs by implementing best practices for improving student success in STEM education now identified by the National Academy of Engineering (NAE). The project has clear potential because of the high degree of readiness and collaborative planning already in place at both partnering institutions, and their remarkable achievement so far from working together.

Analysis of Relevant Partner Strengths and Weaknesses

The project is well planned to address daunting challenges facing CSUB and BC. Many institutional weaknesses at both impede Hispanic students from becoming the educated engineering workforce the region so critically needs. However, both CSUB and BC have complementary strengths to contribute to this collaborative project. Following is a summary of a

comprehensive analysis of the partner institutions' academic programs, institutional management and fiscal stability as they relate to the Collaborative Comprehensive Development Plan.

Strengths and Weaknesses in Common Relevant to Proposed Cooperative Project	
Strengths/Opportunities in Common	**Impeding Weaknesses in Common**
Academic Programs	
Award winning engineering pathway. The current cooperative effort between CSUB and BC to improve STEM transfer and degree completion is showing early signs of success; the BC/CSUB engineering pathway has been recognized for excellence in attracting and retaining Hispanic engineering students	Together CSUB and BC now serve over 26,000 students. The current computer engineering pathway still attracts too few BC transfer students (only 22 out of 118 transfers in 2014). The existing engineering pipeline is too narrow and leaky to provide the well-qualified engineers local industries need.
Improved articulation. BC offers all of the courses required for the first two full years of engineering education. Completion of these courses, called the "engineering core" prepares students for transfer at the junior level to CSUB's Computer Engineering and Engineering Sciences tracks. BC has been continuously involved with CSUB to align their engineering core with these new tracks.	New CSUB engineering tracks and approach require modification of BC core and stronger advising and support at BC and CSUB to fully scaffold the success of Hispanic students. Articulation is still inadequate to ensure that BC students do not have to repeat engineering courses at CSUB or that they are prepared for CSUB higher engineering education standards.
Locally-responsive programs. CSUB and BC perform community needs assessments and offer most programs in highest demand locally while also offering all programs mandated by their state systems. CSUB and BC faculty work with program advisory boards, are sensitive to community-based issues, and engage in the community.	The challenge of providing degree programs to meet local needs has increased exponentially as the region has grown and become increasingly dependent on a 21st Century STEM workforce. The economic and social future of the service area depends more than ever on expensive engineering degree programs that are highly productive/meet highest standards.
Responsiveness to new industry needs. The new "Energy Center" at CSUB (inaugurated in Fall 2014) brings industry, faculty and students together to address technical, economic and public policy issues associated with energy production. It is one of many steps CSUB is taking to help address the challenges and opportunities now facing service area industries. The new Industrial Automation baccalaureate at BC, which will enroll the first cohort in fall 2015, will address a specific need of the local energy industries.	The Energy Center has strong community support, but it comes with an expectation that CSUB will produce more engineers who can help local power and energy industries grow and develop to take advantage of new technologies. There is no academic program now at CSUB to fully utilize this Center to help meet local energy industry workforce needs. BC's new degree program only addresses one local workforce need; the greatest local need is for engineers with industry-relevant degrees.
Improved readiness for modern engineering. The new Chevron-funded "Fab	Many local industries have increased support for the BC/CSUB engineering pathway, and

Lab" at CSUB will allow students to do original design-build projects. These initiatives will provide students with applied research opportunities to use their discipline knowledge to investigate local industry issues. Fab Labs, an MIT initiative, enable community, K12 and undergraduates to experience an authentic engineering design process from original conception to final product. It is an opportunity to help young kids think of engineering as a career option from an early age, and it is an opportunity to build stronger links between the community, K12, BC and CSUB. It opened its doors in Fall 2014.	the new "fab lab" has clear potential to attract more local students and improve their engineering education. Continued support from local industry depends on increasing the number of engineering degrees produced by CSUB in areas that relate to their needs. At the same time that CSUB is developing an engineering program for the first time, engineering education is undergoing major reform. The fab lab is a step in the right direction, but the entire pathway must be built to continue the type of engagement in students that fab labs spark. Liberal engineering requires a redesign of the way engineering is taught in every course.
Improved student preparation for engineering. In 2008, the local high school district developed the first Project Lead the Way (PLTW) in the Central San Joaquin Valley. Now there are PLTW programs in almost all local schools. PLTW is the most successful high school pre-engineering curriculum in the nation. Chevron has contributed significantly to funding for local PLTW programs. Many more students enroll now at BC and CSUB with interest in engineering.	While Project Lead the Way is attracting and better preparing many more local students for engineering, BC and CSUB are not ready to meet this demand. More engineering options are needed, and engineering education has to be made more accessible to students who will still be underprepared and high need when they arrive at BC and CSUB. These students need more than access; they need full support until degree completion.
Model of equitable STEM access. CSUB was listed by the Center for Urban Education (CUE) in 2011 as **one of the 25 top institutions as potential exemplars of effective practice in providing equitable STEM education for Hispanics**. The gap in the achievement of STEM students in the CSUB College of Natural Sciences and Math was below average in 2011, and the gap is now even smaller.	As CSUB adds new STEM pathways, its high enrollment of Hispanic and at risk students clearly presents a student success challenge, and increasing the number of Hispanic transfer students will increase the need to improve services. BC and CSUB must work harder, find new resources to develop a new model of engineering education that has well-documented potential to improve the learning and success of underrepresented students.
Institutional Management	
Responsiveness to community needs. Leaders at both CSUB and BC have long recognized the need for and support outreach for early college awareness and preparation because of low achievement in local schools and lack of a college-going culture in the area. Leaders at both have made STEM outreach and early identification/readiness a budget priority.	CSUB/BC are providing only a small fraction of the service area population needing college access with any real opportunity to complete a college degree and a good local career. **The San Joaquin Valley is bleeding local talent.** When engineering students leave the area to go to a university with more engineering offerings, they seldom return to

They have strengthened ties with local industries, and Hispanic communities.	work in the valley. CSUB's current Computer Engineering program is not adequate.
New leadership. The CSUB School of Natural Sciences, Mathematics and Engineering has a new dean with a strong background in STEM pedagogy. Dr. Julio Blanco, who initiated CSUB's engineering program planning and development, retired from CSUB in 2013. The new dean, Dr. Anne Houtman strongly supports this project to further develop the new engineering pathway as a model of accessible engineering education framed by "liberal engineering" principles. BC President, Dr. Sonya Christian is determined to improve student career options and success, and strongly supports this collaborative project.	The challenges facing leaders at CSUB and BC are formidable. There are many urgent priorities at both HSIs. Both are struggling to improve programs that help students improve their basic skills, particularly math. While new leaders at CSUB and BC have participated actively in planning this collaborative project because they both recognize its potential to move both institutions forward in addressing urgent priorities at an opportune time, neither HSI has the resources to address even the most urgent needs. Both are struggling to address serious institutional challenges, many of which are mission critical.
High ranking HSIs in degree completion. CSUB and BC have had major campus diversity initiatives for many years which have not only increased enrollment of under-represented students, making both HSIs, but have focused resources on promoting the success of and providing support for these students. The result is their ranking this year among the top 25 for CSUB and top 100 colleges for BC in awarding the most undergraduate and graduate (CSUB) degrees to Hispanics. (HSIs are ranked each year in *Hispanic Outlook Magazine.)*	Both CSUB and BC are below state averages in transfer and degree completion, and the state averages are way too low in both public systems to meet California's needs. Both CSUB and BC are mandated in effect to increase the numbers of degrees they produce by the systems on which they are almost dependent for funding. They can only do so by adding expensive new programs and finding innovative ways to increase the success of students who are underrepresented in degree completion nationwide particularly in STEM and engineering.
Fully Accredited. Both CSUB and BC are fully accredited by WASC and ACCJC respectively. The accrediting bodies confirmed that the two partners have the necessary policies and procedures in place and that educational and fiscal planning is adequate. No major findings were reported by either body.	Accreditation compliance does not ensure effectiveness or efficiency in attracting, preparing, retaining, and graduating students. Both CSUB and BC have weaknesses that impede them in these critical areas. Faculty at both partnering HSIs have been slow to adapt their methods and use technology to improve student success.
Fiscal Stability	
Cooperative effort to increase productivity in terms of student success. CSUB and BC have cooperated to seek essential outside funds to support needed development. Both are taking full advantage of HSI and other funding available to become more effective and efficient through cooperative efforts.	Both the CSU and CCC systems have issued reports and recommendations that make very clear that funding will be severely restricted for the foreseeable future and that performance-based funding is inevitable. Both CSUB and BC are scoring too low on statewide measures of institutional

Both have faced funding cuts, and have done their best to preserve access and maintain quality while maintaining a balanced budget.	effectiveness that are increasingly focused on degree progression. Funding is increasingly tied to student success metrics.
Budget linked to planning. CSUB and BC have reorganized and are now placing more emphasis on planning to maintain a balanced budget while addressing issues requiring institutional change. Planners must consider cost and sustainability.	Both campuses operate on fixed budgets with little private support. The only way to get more operational funding is through increased enrollment. The only way to develop new programs is with external funds. All programs must be efficient as well as productive.
Room to grow for more cost-effective operation. CSUB is one of the five campuses in the 23- campus CSU system that is allowed to grow enrollment, and has room to develop a new engineering program.	Lack of a fully scaffolded HS/BC/CSUB pathway towards an Engineering degree will limit CSUB efforts to retain new students to degree completion in engineering. Much more engineering infrastructure is needed.
Development costs for engineering covered by grants. CSUB has been aggressive and successful in obtaining grant funding and industry support for essential infrastructure, including two new engineering buildings.	Maintenance of high quality new engineering instruction and support services is a major challenge for both partnering institutions even with external start-up funds. CSUB still needs to add more engineering tracks and services to produce more engineers.

Collaborative Planning Process

CSUB's Computer Engineering pathway with BC has laid a strong foundation for development of a new Power/Energy Engineering pathway using liberal engineering pedagogy and evidence-based methods to increase access and success of underrepresented students. Building on this foundation has distinct advantages related to the objectives of this project: it reduces the time required to achieve desired results and reduces costs significantly. CSUB is well qualified to launch the new pathway because of the well-established alliance with BC and resources in place already. CSUB has planned collaboratively with BC for many years, and both partnering institutions have well-established planning operations that contributed to CDP planning.

Table Summarizing Main Planning Steps Leading to the CDP	
CSUB (Lead HSI) Planning Steps	**Role in CDP Process**
Defining CSUB for the Future Through Partnerships for	Of the numerous objectives listed in the CSUB Strategic Plan, the following four are most closely related to the CDP.

Excellence CSU Bakersfield Strategic Plan: 2008-2015: The plan is updated every two years with input from all university constituent groups as well as community. The plan identifies a simple but rigorous academic strategy: Continual review of existing academic pathways in order to determine new tracks that should be added to meet changing regional needs.	(1) Develop new academic programs that respond to regional, state, and national needs and student demand. (2) Provide academic facilities, and instructional and technology resources that support teaching, learning, research and creative activities. (3) Reduce existing achievement gaps in first –year retention, and baccalaureate degree completion. (4) Collaborate with partners in K-12 education, community colleges, community based organizations, and employers to advance the educational attainment within the region, and respond to regional needs for graduates with advanced technological knowledge.
"Walking the Talk": The Achievement of Student Learning and Community Engagement through University Alignment and Campus Culture, Prepared for WASC Accrediting Commission for Senior Colleges and Universities: 2007-2012.	This self study, prepared for the most recent accreditation visit, identified Student Learning Outcomes (SLO) development and assessment as the one of the "gold" goals for the future of CSUB. The study shows the commitment of faculty, staff, and administration to achieving a high standard of responsive pedagogy, total student experience, and data-driven decision-making. It also showed the need to continue BC faculty development in learning assessment.
Engineering Marketing Assessment Study 2010: An external consultant surveyed 19 employers, over 7,500 high school students, 222 BC students, and 119 CSUB students about their interests and attitudes towards Engineering.	There was clearly high demand for better prepared local engineers. Eleven employers mentioned that it was highly likely that they would hire CSUB Power/Energy Engineering graduates when available. 16 employers mentioned that they would work with CSUB to develop this pathway. Collectively the local employers anticipate 55 engineering hires in the next year. Long term hiring and industry health depends on local workforce qualifications according to these employers.
Bakersfield College Planning Steps	**Role in CDP Process**
California Community College System Strategic Plan. The plan provides a roadmap for CCCs to improve access and success for all students and promote diversity and equal opportunity. The CCC system is now requiring colleges to increase STEM transfer and degree completion rates.	The CCC System Strategic Plan has made clear that the primary goal for CCCs is to provide both an open door to college and opportunity for transfer to complete a four-year degree. Recent reports from highly respected policy groups and the CCC Research Organization, the Center for Student Success (CSS) have provided strong evidence that CCCs are not doing a good enough job in providing transfer success and degree completion, particularly in STEM, which will have severe implications for the future of California. BC is now in effect mandated to improve transfer rates. Improvement in career technical education is identified as the primary goal for the state of California in order to support the needs of the high tech, energy, and aerospace industries. The governor's plan for the revitalization of the state's economy calls for community colleges to lead the charge for economic development in most technical areas.

Data-based Planning for Student Success. Planning operations at BC have intensified under the leadership of an energetic new president who has moved the college decisively toward planning for improved student success.	President Christian led the final stages of the development of the Bakersfield College 2012-2015 Strategic Plan though a collaborative process that engaged campus constituents and community members in discussion about the college's future in light of extensive information from data collection and analysis. The process helped the college and the community to understand the importance of BC's role in the service area future and the challenges and opportunities confronting BC today/riveted attention on student success.
Acting on Plans. The strategic planning process led to an accelerated development process spurred by joining Achieving the Dream (ATD) and becoming data-driven.	The extensive data collection and analysis process required both by ATD and new CCC Scorecard revealed weaknesses and led to initiatives on many fronts. The ATD college wide experience was essential to clarify highest priority institutional development goals/to clarify the need to cooperate more fully with CSUB.
New Industrial Automation Baccalaureate: BC is one of only 15 community colleges in CA to be awarded permission to establish a 4-year baccalaureate degree.	Environmental scans revealed severe need for more applied college degrees. BC worked with CSUB and consulted extensively with local government and industry to develop a 4-year applied baccalaureate to address industry needs for highly skilled workers in the Energy/Agriculture sectors. BC will develop two pathways that lead directly to CSUB's Energy/Power Engineering track for students that desire an engineering degree from CSUB.
Collaborative Planning	**Role in the CDP Process**
The Future of Engineering at San Joaquin Valley, February 2010: A day-long symposium held at the CSUB school of Natural Science and Mathematics in order to discuss future steps for advancement of STEM education and review the Engineering Marketing Survey commissioned by CSUB. There were many follow-up BC/CSUB meetings.	This symposium was the landmark event that led to the development of CSUB's first engineering program. Participants included CSUB and BC faculty and administrators, representatives from the local high school district and local industries. Additional planning meetings were held between the project partners, including CSUB, BC and feeder high schools. Participants included representatives from the high school Project Lead the Way project, BC MESA Program, CSUB/BC STEM pathway leaders and affected departments at CSUB. It was already clear in 2010 that the first engineering pathway would not be sufficient to meet local needs.
National Academy of Engineering (NAE), 2005 *Educating the Engineer of 2020: Adapting Engineering Education to the New Century.*	This is a landmark report that provides recommendations for the restructuring of engineering education in the US. The strategies to increase the productivity of the BC/CSUB engineering pathway were highly recommended in this report as best practices to improve learning and success in students underrepresented in engineering.

The following table presents individuals and groups who played important roles in the development of the CDP, but is not all-inclusive. There are many stakeholders in this project.

Title V Collaborative Planning Team		
Constituency	**Representatives**	**Role/Expertise**
CSUB	Dr. Horace Mitchell	President of CSUB
CSUB	Dr. Anne Houtman	Dean of Natural Sciences, Mathematics and Engineering; and Team Leader for Title V Planning
CSUB	Dr. Jorge Talamantes	Department Chair of Engineering and Physics, CSUB Faculty Lead for Title V Planning
CSUB	Dr. Melissa Danforth	Chair, Computer Science, Co-Head for Planning
CSUB	Dr. Charles Lam	Interim Associate Dean-School of NSME
CSUB	Dr. Jacqueline Mimms	Associate Vice President of Enrollment Management
CSUB	Dr. Arif Wani	Professor, Computer Science
CSUB	Dr. Wei Li	Associate Professor, Computer Science/Engineering
BC	Dr. Sonya Christian	President (former Math faculty and STEM Dean)
BC	Liz Rozell	Dean-Science, Technology, Engineering and Mathematics
BC	Consuelo Gonzalez	Project Director, MESA
Antelope Valley College	Christos Valiotis	Associate Professor, Math, Science & Engineering, Title V Engineering Pathway Project Director
Kern High School District	John Meyers	Director of Career Technical Education
Kern High School District	Connie Sack	Director of Instructional Services
AERA Energy	Lorraine Franco	HR Specialist
AERA Energy	Keith Lobo	Engineering Manager
Chevron Corp.	Sam Chow	Resource Advisor
Chevron Corp.	Noel Shotts	Petroleum Refinery Manager
Occidental of Elk Hills	Theresa Bush	HR Manager
Congressional Office	Vince Fong	Field Representative for Congressman Kevin McCarthy
Marketing Consultant	Jacquelyn Jans, M.B.A.	Marketing & Corporate Image Consultant
Marketing Consultant	Talita Pruett	Research Assistant, Marketing & Corporate Image Consultant
CSUB, BC, & High School students	CSUB and BC student senates, High School student groups	Focus groups conducted by a marketing consultant, bi-lingual counselors, and the Center for Community Engagement & Career Education at CSUB.

Planning Based on Solid Evidence: an engineering needs assessment was conducted by a reputable, objective consulting agency in 2010, and a comprehensive report was developed by that agency. This report provided BC and CSUB with data to be used in their current and future engineering planning efforts. Specifically, the consultant agency gathered and analyzed information regarding the current interest among local high school students, BC community

college students, and those students already attending CSUB in a new engineering program at CSUB; and their willingness to enroll at CSUB if such a program was offered as a degree major. Further, it gathered information from local employers regarding their views of the program and interest in joining a collaborative effort by working with students in the proposed program as part of a design team approach. This needs assessment was conducted with the understanding that CSUB would use the data to determine whether there was sufficient demand to start an engineering program. Over 7,653 High School, 222 Community College (Bakersfield College), and 111 CSUB students were surveyed, as well as 19 local employers. Student Surveys were given to students in relevant classes of applicable subject matter. The survey clearly indicated there was strong community and student support and need for CSUB to develop an engineering program – many programs in fact.

Table Summarizing the Conclusions of the Engineering Needs Assessment Study

Student Survey:

- 63% of the total number of students surveyed indicated to be interested in a potential engineering major. Further, even in those cases where the students did not express an interest in the proposed programs at this time, many of them still are interested in individual courses which could comprise the major; thus, in the future they may reconsider their decision and become candidates for the proposed programs.
- **Almost one third of the responders chose Energy/Power engineering as a career of choice if it were available.**
- Over one-third of the targeted students surveyed (37.7%) said they have taken (or are currently taking) a calculus course. And over 36% have taken (or are currently taking) a pre-calculus course. These findings; therefore, suggest that many of these students are not only interested in the proposed programs but are in fact actively pursuing the mathematics prerequisite for entry into the proposed CSUB programs.
- The most significant result was identified on student interviews after they completed the survey. **45% of Hispanic students interested in engineering admitted that they are more likely to pursue another major rather than moving far away from family and home to pursue an engineering degree.**

Employer Survey:

Overall, how would you rate the merit of CSUB starting Engineering Program(s)?

- *Richard Chapman- Kern Economic Development Corporation: "*I think having a strong
- Engineering program is a vital hiring mechanism for traditional and non-traditional industries in the county.
- *Lisa Wong- T.J. Cross Engineers: "*It would be of great benefit to our community if CSUB

offered BS degrees in engineering. Our community is losing talent to other areas because we have difficulty offering educational requirements. We also have difficulty attracting talent outside of Bakersfield.

- *Theresa Bush- Occidental of Elk Hills*: —A Power/Energy Engineering program is an excellent ideal and would prepare students for positions in a variety of industries; making the students more marketable.
- *Donna Carpenter- Sikand Engineering:* —We have a need for educated engineering work force. The new degrees have tremendous merit.

One of the more innovative elements of the CSUB program would be the "design team approach" in which interested companies would team with faculty and several students to work on discrete projects of the company's choice. Does this approach make sense to you?

- *Richard Chapman- Kern Economic Development Corporation: "*Students need the real-life experience that comes from working in teams and with companies. I also believe current student would possibly bring a fresh look to an issue."
- *Steve Knecht- Townsend Design: "*Yes. We have done some of these projects with Cal Poly students. The experience was not a great benefit to us, but the experience to the student was priceless. The benefit to the industry comes when the potential employee comes to work with a fuller education because of the experiences gained."
- *Donna Thompson- San Joaquin Energy Consultants: "*Yes. This is an excellent approach, which would give the students the practical experience of working on an actual project rather than just academic exercises. This also is the approach that allows students with degrees from the Cal Poly schools and many CSU schools to be well-trained and familiar with their future industries, even with an undergraduate degree."
- *Robert A. Luster- Luster National, Inc.: "*Yes, internships do make students employable. The whole experience of working in a real world situation is invaluable."
- *Donna Thompson- San Joaquin Energy Consultants: "*Yes. Absolutely. It would introduce the student as a prospective employee to the companies involved in the design team. This approach has worked well locally between employers in the petroleum industry and the CSUB Geology Department."

CSUB Engineering Assessment Study, Jacquelyn S. Jans, Marketing & Corporate Image Consultant, Final Report, March 2010.

Collaborative CDP Goals and Objectives: After extensive discussion and analysis, CSUB and BC determined the collaborative goals and objectives for joining forces again to broaden engineering access and success for their Hispanic students.

Key Collaborative Goals to Address Identified Problems Related to Title V Project
1. To develop a new CSUB Power/Energy Engineering track that is responsive to student and local industry needs and is designed with a liberal engineering framework using pedagogy and methods known to increase learning. The track will meet all standards essential to full academic accreditation and sustainability.
a. Related Academic Program Goal: To develop the necessary curriculum for the Power/Energy Engineering track; to develop fully equipped state-of-the art laboratories and classroom facilities that are conducive to learning; and to attract highly qualified faculty and

offer professional development opportunities for existing faculty.
b. Related Institutional Management Goal: To ensure that the new track will gain full accreditation status in the shortest amount of time possible by addressing all the accreditation criteria established by WASC, ABET and the CSU system.
c. Related Fiscal Stability Goal: To increase productivity and reduce the duplication of effort and resources needed to develop an effective, responsive engineering track that increases enrollment equitably and supports program operation.
2. To increase postsecondary access and success of local Hispanic and other high need students through intersegmental collaboration and development of an equitable, seamless, and scaffolded degree pathway from high school to completion.
a. Related Academic Program Goal: To establish a dual admission option for seamless transition and remove all other identified institutional obstacles on existing transfer pathway for degree completion from BC through CSUB.
b. Related Institutional Management Goal: To involve committed leaders and practitioners at both CSUB and BC in a cooperative effort to develop a responsive and seamless engineering pathway with a Power/Energy Engineering focus.
c. Related Fiscal Stability Goal: To ensure adequate enrollment by outreaching to high schools; aligning all engineering and related science and mathematics courses, as well as assessments and standards, in order to reduce duplication and time to degree completion.
3**. To increase CSUB degree completion productivity through development of new, well-designed institutional STEM capacity that is responsive to student and service area needs.**
a. Related Academic Program Goal: To increase the numbers of students completing engineering degrees by providing a much needed Power/Energy Engineering track that is designed to respond to underrepresented student and service area needs.
b. Related Institutional Management Goal: To develop a responsive Power and Energy Engineering pathway through an innovative approach that will leverage existing resources, increase productivity, and better address the needs of the community.
c. Related Fiscal Stability Goal: To reach adequate enrollment through transfer and new freshmen students to ensure adequate self-sustainable funding at the end of the 5-year project.
Key Measurable Objectives For Cooperative Effort To Achieve CDP Goals
1. To increase enrollment in CSUB's newly designed engineering pathway by 20 students each grant year and reaching the sustainability-ensuring level of at least 90 FTES by year 5, with Hispanic students equitably represented compared to overall enrollment (first time, full-time and transfer). *Related to Goals #1, 3.*
2. To increase by 2% each year the retention, success, and persistence rates (over 2014 baseline) in the new engineering track by continuously monitoring student achievement of milestones and using data-driven improvements. *Related to Goals #2,3.*
3. To significantly increase the number of BC students who are formally enrolled in a fully-articulated curriculum in engineering with an approved plan to transfer on schedule and increase the number of Hispanic and other underrepresented students who complete all pathway preparation in engineering at BC on schedule. *Related to Goals #2, 3.*
4. To eliminate the gap between CSUB's six-year graduation rate for CC transfers (5.5% gap) and first-time freshman (12% gap) as compared to the statewide average. *Related to Goal #3.*
5. To double the number of Hispanic students, including transfers, who complete CSUB STEM degrees (over 2014 baseline.) *Related to Goals 1, 2, 3.*

Plan for Institutionalizing Practices and Improvements: This Title V Cooperative arrangement project is carefully designed to increase the capacity of each partner institution and result in self-sufficiency at both in maintaining the practices and improvements developed through this project. When the grant ends, CSUB will have a productive Power/Energy Engineering tract in its new engineering degree program that will attract enough new students to generate the necessary FTES for sustainability. The tables below show a cost-revenue analysis for a five-year period starting Fall 2015. The retention rates used are very conservative and are assumed as follows: Freshman to Sophomore, 70%; Freshman to Junior, 60%; and Freshman to Senior, 55%. These rates are the national averages published in reports by the National Science Board, and the National Science Foundation. The CDP planning team is fully aware that these rates are significantly low and that one of the results of this cooperative effort will be to significantly increase them. The conversion factor of 0.77 Full Time Equivalent (FTE) per student was calculated by adding all the units taken by full time and part time students and dividing by 12 (per CSU guidelines).

Power/Energy Engineering Enrollments, Attrition, and FTES by Year					
Calendar Year	2015/16	2016/17	2017/18	2018/19	2019/20
Grant Year	Year 1	Year 2	Year 3	Year 4	Year 5
New Students					
Freshman	15	20	25	31	38
Sophomore		8	12	16	20
Junior			7	10	14
Senior				7	10
Transfer Students from BC					
Junior	5	7	10	13	16
Senior		4	10	15	20
Total Enrollment (TE)	20	39	64	92	118
Estimated FTES (TE*.77 FTE per student)	16	30	49	71	91
Estimated Revenue (FTES*$4,000)	**$64,000**	**$120,000**	**$196,000**	**$284,000**	**$364,000**

Estimated Equipment, Supplies, Personnel Costs for Grant Period					
	2014/15	2015/16	2016/17	2017/18	2018/19
Labs (Equipment, Supplies)	$205,000	$214,000	$ 62,000	$ -	$ -
Personnel (Faculty, Support Staff)	$175,000	$215,000	$215,000	$245,000	$345,000
ABET Consultants	$ 10,000	$ 10,000			
Other	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Total Costs	**$ 410,000**	**$ 459,000**	**$ 297,000**	**$265,000**	**$365,000**

As can be deduced from the table above, even in the most conservative scenario, the program will be self-sustainable by the fifth year of the grant and continue to generate enough income after that to ensure that CSUB can maintain the program. Increased FTE will enable CSUB to expand the program in the future by offering more sections and hiring additional personnel. Community needs assessment shows a high demand for the new engineering track.

Only three CSUB positions will need to be institutionalized at the end of year five with institutional funds generated by projected program FTE (planned through regular budget process): the Engineering Student Support Services Specialist, the Liberal Engineering Curriculum Specialist and the Engineering Transfer and Articulation Developer. Bakersfield College has already pledged its commitment to institutionalize the Engineering Liaison position requested in this proposal. This position will eventually be covered by the increased enrollment in BC's new Industrial Automation applied baccalaureate degree. Faculty at CSUB will be trained to teach the new Power/Energy Engineering courses, and thirteen already have industry-relevant research backgrounds that qualify them to teach courses in the new engineering track with additional training. The Student Support Services position will be phased into the CSUB budget during the grant period and will be sustainable because of the expected cost-savings from developing online services which use new CSUB information technology (IT) capacity.

Unlike most public universities, CSUB has room to grow enrollment. This will help significantly to institutionalize operating costs if project objectives are met. CSUs that have

reached their enrollment cap do not receive more state funds when they admit more students. The Project Management and Data Analysis Specialist/Researcher positions will not be needed when planned development is complete. Continuing costs for tutors and mentors will be allocated within appropriate department budgets and will be reduced when the new online services are operational. Professional Development will absorb the costs of future faculty/staff development at both CSUB and BC. Chevron and other service area employers will also be tapped to continue and expand Project Lead the Way.

Models for the alignment of curriculum and the development of any new courses and strategies associated with continuous improvement will have been fully developed by the end of the grant. Alignment of curriculum as programs evolve and the development of any new courses and strategies associated with continuous improvement will continue to be supported and funded with institutional resources based on these models. Each partner, through their ongoing instructional programs, will continue all of the new and revised courses that are planned. CSUB and BC have processes for new course approval that will be adhered to, and as new courses are developed, resources will be allocated based on expected student demand for the courses.

CSUB and BC will maintain and institutionalize the intersegmental systems, tools and databases developed as an integral part of this project. The new online student services program, IHeLP, will be cost-effective to develop and institutionalize because CSUB recently invested in new software to aid in the transition from a quarter to a semester system. The cost of upkeep, data entry and hosting will become part of the on-going, operational costs of each campus. The two institutions will maintain continuous improvement of systems for the Power/Energy Engineering pathway through institutional resources with support from each campus IT and research departments.

FIVE-YEAR PLAN TO IMPROVE SERVICES TO HISPANIC AND OTHER LOW-INCOME STUDENTS: The CDP is a five-year collaborative plan to improve the effectiveness of CSUB and BC as Hispanic-serving institutions. The recent regional engineering needs assessment found that many Hispanic students in the service area were interested in engineering, but were more likely to pursue another major at BC or CSUB than move away from home. Few who indicated an engineering interest had a clear idea of what type of engineering they wanted to study, but they repeatedly said they wanted to prepare for well-paid local careers. CSUB is not providing broad enough access to regional careers for the rapidly growing number of Hispanics with interest in engineering, interest that has grown because of Project Lead the Way programs in local high schools.

Local potential Hispanic engineers are the most underserved by CSUB's limited engineering offerings. They are missing opportunity because of the inadequate response of CSUB and BC to meeting their learning needs. Local Hispanics are most likely to enroll in BC first, and the path to a degree at CSUB is long and hard even if they manage to transfer. Most do not. Local engineering students critically need more engineering degree options, but traditional engineering education does not work for them. Its culture of failure affects them the most. The proposed new "liberal engineering" approach for the next BC/CSUB engineering track is a decisive next step toward improving to Hispanic student access and success at both Hispanic-serving institutions.

The Liberal Engineering approach was chosen after careful review of many successful engineering programs and multiple visits at the Olin College of Engineering in Massachusetts. The Olin model emerged as the best candidate for adaptation because of its built-in flexibility for

adaptation, and because it was designed form the ground up to be student centered rather than teacher centered.

Why the Proposed Project is Responsive to the Needs of Hispanic and Other Underrepresented Students in the BC and CSUB Service Area	
Needs of Potential Hispanic Engineers	**How Liberal Engineering Addresses Needs**
A Better Start toward Degree Completion. Almost half of underprepared Hispanic freshmen who are admitted and enroll in CSUB fall out of the degree pipeline in the first year. These students met most CSU admission requirements and would not have been admitted unless they had demonstrated academic strengths and potential. Most first year gateway courses are also high risk for these students. BC students are not better served even though BC's mission gives priority to basic skills programs and transfer. BC Hispanic students are even less prepared than those who enroll as freshmen at CSUB.	Like top engineering schools that attract the best prepared and motivated engineering students, CSUB's liberal engineering model will **be designed to include an improved first-year engineering (FYEE) experience tailored to CSUB Hispanic student needs.** It will have many features recommended by ABET (design emphasis, integration, hybrid and online learning, project-based learning and faculty mentoring). BC faculty will be included in CSUB professional development activities to integrate and contextualize the first year experience for engineering students and help them overcome their underpreparedness.
Degree pathways leading to local job and career opportunity. Most CSUB's Hispanic students are low-income and tend to be placebound. Often their families suffer when they go to college. Research has found that clearly-possible, local career opportunity is the best incentive for going to college both for parents and students. Hispanic students need learning opportunities in college which connect their career aspirations to academic requirements, and they need degree opportunity which is meaningful to them, their family and local community.	Liberal engineering (LE) is a responsive strategy to increasing degree completion of underrepresented students and is heavily supported by the most innovative industries because it is based on ABET criteria that reflect real engineering practice today. One of the signature methodologies of LE is connecting the academy to the workplace. A Power/Energy engineering track will be developed to address identified high-need areas in San Joaquin Valley and senior projects will be connected to local research needs connected to local industry.
Degree pathways that can be completed before financial aid runs out. Hispanic students need to complete degrees in no more than six years (the average degree completion time according to national research), even though they need more remediation and also need to work while attending school.	Project design includes streamlining the curriculum at BC and CSUB while adding the "essence of modern engineering"; curriculum will be aligned, guided by learning outcomes determined by faculty, so BC students do not have to repeat courses upon transfer to CSUB.
An educational environment that engages and promotes learning rather than requiring students to sit and listen to professors, work alone and digest knowledge provided by many confusing academic disciplines. Hispanic	Liberal engineering is not a specialized engineering discipline; it is an approach to engineering education created to reform the way engineering has been taught – a way that in effect excluded students who needed more

students are not alone in needing a learning environment that is active and engaging, but it is absolutely critical to their success in completing engineering degrees. **Hispanics and women are among the biggest victims of poor STEM pedagogy**. The NAE and NSF agree that poor teaching is one of the two biggest reasons for drop out and failure in STEM programs. Traditional STEM teaching is even less appropriate and effective for nontraditional students. NAE and NSF have defined "effective teaching" in STEM for Hispanics (signature pedagogies). Minorities and women face the greatest challenges in trying to become engineers, and they benefit the most from reforms such as hands-on learning, a design team approach and research opportunity with faculty and internships/ experience tied to academic requirements ("liberal engineering" approaches) that are fully endorsed by the National Academy of Engineers.	than the traditional, dry and passive academic environment to learn up to their potential. Engineering colleges that have been the most successful in **producing well-qualified minority and women engineers** use the liberal engineering approach.[8] CSUB will develop curriculum, facilities (learning spaces) and pedagogy that will transform the learning environment in ways recommended by NSF and NAE. **Developing a much needed Power/Energy engineering pathway, using a liberal engineering approach, is in itself a faculty development process for universities like CSUB which need to better serve under-prepared Hispanic students**. This faculty developmental process, though not easy, can have a transformational impact in terms of reorienting an institution around learning and student success.[9]
Undergraduate research (UR) project opportunity, and opportunity to work with faculty on meaningful hands-on projects that hook them on STEM learning. The HSIs ranked highest in STEM equity by CUE had strong, integrated UR programs.	UR is one of the top rated innovations for increasing Hispanic interest in STEM. Liberal engineering integrates UR and project-based learning across the curriculum. This is a high priority in project design for developing the new engineering tracks.
Education that gives them knowledge and tools to help their community rather than expecting them to accept academic values that seem unrelated to their lives and future. Hispanic parents want their children to succeed, to go to college, but Hispanics tend to be community-centered according to extensive research. Hispanics in college are more likely to be interested in academic projects which address problems that are meaningful to them and their community.	Liberal engineering is characterized by problem-based learning. The best programs, which CSUB will use as models, involve students in projects from the beginning of their college experience to graduation – projects which address local problems, that engage them in working with faculty and the community, that create learning community among students and faculty, that engage students until graduation and that prepare them for today's STEM career opportunities. BC students will be invited to participate in these

[8] Olin College in Massachusetts is second in the country in the percentage of women graduating in engineering. Olin's exemplary liberal engineering approach is a significant project model.
[9] *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*, NAE, 2005.

	experiences, recognizing that early exposure leads to future transfer and career success.
Integrated support services (learning assistance, accessible advising, study groups, and strong peer support) rather than a maze of different, disconnected types of service programs that are extra work to use and minimally helpful. Hispanic engineering students have been consistently found to do best with integrated services and services tailored to their needs.	Liberal engineering (LE) is envisioned as a holistic engineering education approach that will reduce the need for separate services because instruction and practices are coordinated to produce a more effective and active learning environment overall. The Integrated-Holistic E-Learning Program (IHeLP) will be designed to achieve this integrated vision as much as possible. It will include: e-Advising; online supplemental instruction sessions (e-SI); adaptive feedback online homework; and Just in Time Teaching[10] online video-modules that will be a critical component of the overall hybrid teaching and learning approach.

In developing a collaborative plan to provide more engineering degree opportunity and success to local, underprepared Hispanic students, both CSUB and BC were "equity-minded" as defined by *America's Unmet Promise: The Imperative for Equity in Higher Education.*[11] This recent report concluded that there were finally signs of improvement in the completion rates of Hispanic college students. CSUB and BC are committed to joining those HSIs that are making a difference in closing the equity gap.

[10] See more information and research sources in the Implementation Rationale and Priority narratives
[11] Keith Witham, Lindsey E. Malcom-Piqueux, Alicia C. Dowd and Estela Mara Bensimon. *America's Unmet Promise: The Imperative for Equity in Higher Education,* Association of American Colleges & Universities, January 21, 2015.

Relationship of the CDP Goals/Objectives to Better Serving Hispanic and Other Low-Income Students	
5-Year CDP Goals and Objectives	**Strategies to Better Serve Hispanic Students**
5-Year Goals to improve services to Hispanic/low-income students: **Goal 1:** To develop a new CSUB Power/Energy Engineering track that is responsive to student and local industry needs and is designed with a liberal engineering framework using pedagogy and methods known to increase learning. **Goal 2:** To increase postsecondary access and success of local Hispanic and other high need students through intersegmental collaboration and development of an equitable, seamless, and scaffolded degree pathway from high school to completion. **Goal 3:** To increase CSUB degree completion productivity through development of new, well-designed institutional STEM capacity that is responsive to student and service area needs. **5-Year Objectives to develop a productive engineering pathway:** 1. To increase enrollment in CSUB's newly designed engineering pathway by 20 students each grant year and reaching a sustainable level of at least 90 FTES by year 5, with Hispanic students equitably represented in all categories (first time, full-time and transfer) compared to overall enrollment. 2. To increase by 2% each year the retention, success, and persistence rates (over 2014 baseline) in the new engineering track by continuously monitoring student achievement of milestones and using data-driven improvements. 3. To increase the number of BC students formally enrolled in a fully-articulated curriculum in engineering with an approved plan to transfer on schedule and increase the number of Hispanic students who complete all pathway preparation in engineering at BC on schedule. 4. To eliminate the gap between CSUB's six-year graduation rate for CC transfers (5.5% gap) and first-time freshman (12% gap) as compared to the statewide average. 5. To double the number of Hispanic students, including transfers, who complete CSUB STEM degrees (over 2014 baseline.)	• **Completion pathway** for Hispanic students to prepare for a local engineering career, thus reducing significantly their overall college cost. It will be fully scaffolded for their success/use modern liberal engineering approach. • **High intensity practices.** All features of the completion pathway were selected for their evidence-based potential to keep Hispanic students on track to degree completion. Instructors will use pedagogy known to work with Hispanic engineering students. • **Flexible, fully integrated services with multiple delivery modes** to accommodate students who cannot be on campus all the time due to work and family commitments/ensure that services inescapable. Services will be intentional, integrated and continuous as students progress toward a degree. • **Local workplace experience.** Capstone project as a graduating requirement requiring close collaboration with industry partners for completion. Graduates will have opportunity for real world work experience while in college, thus improving their employability in local industries. • **Reduced time and cost** for students will result from improved articulation, faculty collaboration to align curriculum and improved coordination of support services within and between the two HSIs. • **Better prepared CSUB/BC faculty** to improve learning in Hispanic/low income students due to *collaborative* faculty development at BC/CSUB. There will be college-wide and intersegmental faculty responsibility and capability for the success/degree completion of Hispanic engineering students.

2. ACTIVITY OBJECTIVES

The CDP identified major problems facing CSUB and BC – inadequate and inequitable completion rates and inadequate productions of local engineering workforce to meet industry demand and improve service area socioeconomic conditions. Both problems already have and will continue to have significant negative impact on both HSIs in terms of academic quality, institutional management and fiscal stability. The relationship between Five Year Activity Objectives and the CDP problem, along with defined results, is described below. **Incremental progress** toward each Five Year Activity Objectives **will be achieved annually.**

How Activity Objectives Relate to Goals and Problems Identified in the CDP
Objective 1: To increase enrollment in CSUB's developing engineering pathway by 20 students each grant year and reaching the sustainability-ensuring level of at least 90 FTES by year 5, with Hispanic students equitably represented in all categories (first-time, full-time and transfer) compared to overall enrollment. **Related to Goals 1, 3.** **Relationship to CDP identified problems:** The need for a Power/Energy Engineering pathway for the service area is based on solid evidence. It is essential that the pathway be sustainable beyond the duration of the grant and meet all the academic standards as well as standards of productivity and effectiveness in providing an accessible engineering pathway for underprepared Hispanic and low-income students and a "culture of success" in all pathway courses. **Measurable Outcomes of Objective 1:** The new CSUB Power/Energy Engineering track will be approved by the CSUB academic senate, curriculum committee at CSUB and for CSU system. It will start enrolling students at the end of the first grant year (20 students) and will reach 90 FTE at the end of the fifth year making it sustainable. The project has the potential to graduate close to 100 students by the end of year 5 and continue further growth.
Objective 2: To increase by 2% each year the retention, success, and persistence rates in the new engineering curriculum by continuously monitoring student achievement of milestones and making data-driven improvements. **Related to Goal 2.** **Relationship to CDP identified problem:** In order to increase the number of Hispanics and other underrepresented students earning engineering degrees, learning outcomes must be improved. The partners have collaborated to analyze the reason for the existence of these gaps and will develop student support services within the liberal engineering education approach. The new engineering pathway must have seamless articulation and dual enrollment between BC and CSUB. It must be fully scaffolded to be productive for Hispanic student success, requiring close monitoring of students and intervention whenever they are at risk. **Measurable Outcomes of Objective 2:** Student success and retention rates for Hispanic students varies from 5% to 25% lower for all gateway science and math courses at CSUB. Those gaps will be 100% eliminated by the end of the project improving the chances of Hispanics to successfully complete an Engineering degree. By closing these gaps, CSUB will increase the number of degrees awarded to Hispanics making the educational endeavor more **efficient and productive.**

Objective 3: To significantly increase the number of BC students who are formally enrolled in a fully-articulated curriculum in engineering with an approved plan to transfer on schedule and increase the number of Hispanic and other underrepresented students who complete all pathway preparation in engineering at BC on schedule, including all transfer requirements. **Related to Goals 2, 3.** **Relationship to CDP identified problems:** BC has a serious transfer problem summarized in the CDP. Research indicates Hispanic students are more likely to transfer if they have a clear, meaningful degree goal. Many more BC students have been attracted to engineering with a transfer goal. CSUB will work with BC to provide effective early counseling to identify and help potential Power/Energy Engineering students prepare for CSUB. Faculty and peer advising will be strengthened, and potential students will be tracked, monitored, mentored and advised to formally enroll and stay on track for transfer. Dual admission to BC and CSUB will also help many students stay on track. Dual admission is a top recommendation for improving transfer in both the CCC and CSU systems. It is already in place and will be improved as needed for pathway students. **Measurable Outcomes of Objective 3:** The number and rate of BC students transferring into CSUB's engineering program will increase providing reliable enrollment needed for CSUB to maintain a self-sustaining pathway (specified in Institutionalization Plan).
Objective 4: To eliminate the gap between CSUB's six-year graduation rate for CC transfers (5.5% gap) and first-time freshman (12% gap) as compared to the statewide average. **Related to Goal 4.** **Relationship to CDP identified problems:** CSUB and BC know that students who declare a major are more likely to stay in college. Hispanics and other underprepared students are the most likely to drop out or be dismissed for academic reasons. Declaring an engineering major knowing that there is meaningful employment opportunities after graduation will help focus students towards graduating early. Many high need students never declare a major and do not establish an education plan although there are advisors to help them. The IHeLP program will be developed to centrally coordinate academic efforts and student support services to better serve students and ultimately improve retention and degree completion rates. **Measurable Outcomes of Objective 4:** The graduation gaps will gradually be eliminated as a result of the development of a scaffolded, fully-articulated engineering pathway which is based on best practices and principles of modern engineering education.
Objective 5: To double the number of Hispanic students, including transfers, who complete CSUB STEM degrees (over 2014 baseline.) **Related to Goals 1, 2, and 3.** **Relationship to CDP identified problems:** The number of Hispanic students earning STEM degrees at CSUB is still much too low. This is partly due to the lack of local engineering degree opportunity. The low number of Hispanic STEM degree holders in the area puts local companies at a disadvantage and forces them to recruit employees from outside the area, increasing costs. Workers from outside the area are poor investments for businesses when they do not stay. **Measurable outcome of Objective 5:** The number of Hispanics earning STEM degrees will increase each year until numbers are doubled as the result on increased enrollment and success.

3. IMPLEMENTATION STRATEGY RATIONALE AND TIMETABLE

All Activity strategies were selected after extensive planning informed by internal and external research. Capacity building will include professional development along with carefully planned program and infrastructure improvements. All strategies are designed to work in concert

to increase access to high demand engineering degrees, and to increase degree completion of Hispanic and other high need students through development of a seamless, intersegmental and scaffolded pathway that supports success at every juncture.

Strategies to Achieve Collaborative CDP Goals and Objectives
(1) Curriculum Development: CSUB faculty will develop the curriculum for the new Power/Energy Engineering track following accepted standards followed by all successful similar programs in the nation. Courses will feature design, be interdisciplinary and integrate new labs and existing resources, including the Energy Center. **Related to Objective #1, #3 and #5.** **(2) Infrastructure Development:** Laboratory rooms will be refitted to comply with safety regulations. The latest technology laboratory equipment will be purchased to ensure maximization of the learning experience as well as familiarize students with equipment used in the modern engineering workplace. This will facilitate the production of ready-to-work graduates that will need minimal training when they enter the workplace. **Related to Objective #1.** **(3) Faculty Development:** Inclusive, collaborative training of CSUB and BC STEM faculty to become well-qualified modern engineering teachers who facilitate learning effectively and create a "culture of success" in their classes. **Related to Objective #1.** **(4) High School Outreach:** Collaborate and support Project Lead the Way teachers in order to align pre-engineering curricula with science, mathematics and engineering courses at BC and CSUB. Raise early the awareness of high school students, and especially Hispanics, about accessible engineering opportunities close to home that will meet the needs of families. **Related to Objective #1, #3, and #5.** **(5) Undergraduate Research (UR) Opportunities:** According to the NSF Center for Undergraduate Research, and NAE, undergraduate research is the single most important strategy to increase success and retention in engineering courses of study. In addition, UR is critically important for developing work-related collaborative skills. Both CSUB and BC students will participate. **Related to Objectives #2 through 5.** **(6) Other High Impact Practices:** Liberal engineering is itself a high impact practice for engineering student success according to the National Academy of Engineering. Active learning pedagogy is a key feature. Other pathway practices include Supplemental Instruction, a first year experience gatepost course and learning communities. **(7) Integrated Holistic E-Learning Program (IHeLP):** Essential components of the IHeLP program include: • Online gatepost courses (orientation to college and engineering) • e-Advising/Counseling • Online Peer Mentoring • Just in Time Teaching (JiTT) • Virtual Learning Communities • Online Supplemental Instruction (e-SI) **Related to Objectives # 1 through 5.** **(7) Intersegmental Teamwork** to involve CSUB and BC in all Activity development strategies using best practice collaboration approach and closing the gap identified in research as the greatest obstacle for Hispanic students in degree completion – **the lack of communication between different sectors of the pipeline**. **Related to Objectives #1 through 5**

Both institutions have planned carefully to use the proposed project to move forward quickly while also meeting the highest standards for modern engineering education. Meeting these standards is not an academic exercise; it is an essential strategy for meeting project objectives. The following table summarizes the types of standards the pathway must meet, and also the rationale for the Activity strategies planned to meet these standards.

Developing a New Engineering Pathway that meets Academic and Accreditation Standards	
Description of Standard	**Rationale for Activity Strategies**
CSU Standards for New Programs in 2015	
1. Programs must be developed only if there is of a proven, very strong community need. 2. Programs must be sustainable within the severely limited restraints on California public institutions for the foreseeable future. 3. Programs must be affordable to develop with mostly external funding. 4. Programs must use existing resources to full advantage and avoid duplication.	1. The need has been established in the CSUB Engineering Marketing survey. 2. By 2020 (Year 5) the pathway will generate 91 FTES and will reach the breakeven point (see details in CDP sustainability plan). 3. The new pathway will use existing facilities and will share laboratory resources with other programs ensuring affordability. 4. The existing Computer Engineering program will be used as a foundation; thus there will be no unnecessary duplication or waste.
Standards of WASC and ABET Accreditation (The many standards from each body boil down to 8 general areas) *WASC-Western Association of Schools and Colleges* *ABET – Accreditation Body for Engineering and Technology*	
1. Students- Performance and progress must be continuously evaluated 2. Program Objectives: POs are consistent with the mission, are communicated, and periodically assessed. 3. Program Outcomes: Students will develop content knowledge, problem solving ability, ethics, communication skills, and life-long learning ability. 4. Continuous Improvement: The program must show evidence of actions to improve the program. 5. Curriculum: One year of mathematics, one and half year of sciences, and one and half year of engineering specific studies. 6. Faculty: The number of faculty must be sufficient and highly credentialed.	1. A student database and tracking system will be created for tracking and progress monitoring. 2. The CSUB Strategic Plan already specifies processes for mission alignment and program evaluation. 3. The new curriculum will be informed by existing engineering education research that stresses rigorous content, problem based learning, and collaborative work. 4. Student success, retention and persistence data will be analyzed yearly. Adjustments will be made accordingly. 5. The existing Mathematics and Physics courses will be redesigned to support the needs of the new pathway. Upper division courses will be designed to incorporate best practices in pedagogy. A capstone course will be offered for real work experience. 6. Existing faculty from the Computer Engineering

7. Facilities: Classrooms, laboratories, and equipment must be sufficient to safely accomplish objectives and provide an atmosphere conducive to learning. 8. Support: Institutional support, financial resources, and constructive leadership must be adequate to assure the quality and continuity of the program.	and Engineering Sciences departments will lead the initial phase of the pathway. Two new faculty are needed to develop the new curriculum and improve student support services to students. All faculty have PhDs and extensive experience in engineering education. 7. Existing laboratories will be renovated and all necessary equipment will be purchased. Classrooms will be equipped with the latest technology tools. (See budget detail form for details.) 8. By Year 5 the pathway will be sustainable because of increased enrollment revenue. Training will have moved faculty to the "tipping point" in using new methods and practices.
Standards of Regional Responsiveness	
1. Programs must not be too "academic"; they must use innovative pedagogy and provide learning tied to real local workplace needs in the Valley. 2. Programs must provide internships and project-based learning that tie to workplace, regional needs.	1. The learning outcomes to guide curriculum for all new pathway courses will include workplace experience/local industry related learning and research outcomes. 2. The Advisory Committee will help identify internship, project-learning opportunity in related regional industries.
Standards to Meet CSUB/BC Strategic Goals	
1. Programs must be scaffolded to support the community college and university goals to improve graduation and transfer rates. 2. Programs must identify clear learning outcomes and be effective in producing learning in students even if they are underprepared. 3. Programs must increase productivity by: sharing resources, eliminating gaps in student preparation, and offering seamless transfer opportunities.	1. The services to be provided to pathway students include those now proven most effective with CSUB engineering students, including peer mentoring, tutoring and faculty advising. In addition a new more coordinated and accessible program, IHeLP, will be developed to improve student success. 2. Project will produce a seamless transfer pathway through collaborative intersegmental curriculum alignment, improvement of the dual enrollment system and more coordinated and timely advising.

Strategies to be used to build the proposed pathway have been identified by NAE, *Excelencia*, Lumina, and CSUB research as the most promising ways to remove obstacles for Hispanics and other underrepresented students as they struggle to get through the leaky higher education pipeline from community college to degree completion in engineering. Some of these obstacles are addressed by simply improving articulation practices, but many require substantial

intersegmental cooperation. Both CSUB and BC have mandates to provide transfer students with a seamless transition, but insufficient resources have prevented this from becoming a reality. In order to increase transfer success, CSUB and BC will work together, learn together and follow the best available advice from well-respected experts to develop the pathway their students need.

Every BC student has the potential to be an engineer. Many more would choose this locally available degree and career if they thought they could succeed at CSUB. Hispanic community college students are very poor in math outcomes nationally, and BC's Hispanic students enroll severely underprepared in math and English. BC has a major initiative underway to improve basic skills outcomes, but the needs of underprepared students do not begin and end in basic skills education. The reality is that most underprepared students will continue to need a fully-scaffolded degree pathway to have a chance at degree completion.[12]

There has never been a better time to develop a new engineering program because so much is now known about how to create a "culture of success" for underprepared students. Programs and services that prioritize success are essential to achieve equitable outcomes. Results of a decade long national effort aimed at identifying evidence-based STEM programs designed to support Hispanics and other underrepresented groups was reported in 2003 by an National Science Foundation–funded initiative known as Building Engineering and Science Talent (BEST). The report (*Building Engineering and Science Talent*, 2003) identified nearly 100 programs operating nationally in support of minority-student academic success in higher education. Through a process that examined the results of these programs closely, seven were identified that met a rigorous empirical set of criteria. Looking across these exemplary

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[12] Camille Esch, "Higher Ed's Bermuda Triangle." *Washington Monthly*. September/October 2009. (Esch directs the California Education Program at the new America Foundation.)

programs, NSF identified a set of BEST design principles to serve as a guide to future NSF investments and to the development of interventions to improve minority-student success. NSF's BEST principle are synthesized below (for a more detailed reference to the programs cited below, *see* www.bestworkforce.org). **New pathway development will follow these principles, supported by the BEST evidence.**

Summary of Rationale for Strategies to Achieve an Effective Engineering Pathway for Underprepared Hispanic Students in Shared Service Area	
NSF Recommendations from BEST: Design features for STEM Success	**Rationale for Activity Strategies to Achieve CDP Goals and Objectives**
Institutional leadership. The climate of inclusiveness in which exemplary programs grow requires institutional leadership that supports broad commitment. Such commitment, encompassing the administration and senior faculty, insures that the values, goals, and pathways toward increased participation are central to the campus as a community.	CSUB/BC leaders already support and work to create an inclusive climate on their campuses and have worked to develop exemplary programs that make education opportunity equitable. The project will have strong leadership at CSUB from Dean Anne Houtman, and she will work with the PDs and President Christian at BC to ensure the Activity meets all standards, including continual strong support from CSUB leaders (the P/E Engineering pathway will be offered in her college).
Targeted outreach. Establishing, sustaining, and improving a feeder system—pre–K-12, undergraduate, and graduate—demands an extra measure of institutional investment, extraordinary networking across communities and stakeholders.	Engineering outreach will be much more targeted through Activity implementation. PLTW will be the targeted model to build on achievements of that program that are now recognized in the community. More community stakeholders will be incentivized to help with high school readiness when new engineering programs are a reality.
Engaged faculty. Faculty view student outcomes as critical measures of their performance, and they are rewarded accordingly. Although research productivity is still important, student-centered performance indicators and learning outcomes assessment are essential ingredients of the liberal engineering framework.	Faculty development has a central role in the Activity. Faculty will be provided compensation and release time to learn, try new methods and evaluate them in terms of student outcomes. They will be trained by national leaders in engineering education to develop student talent by providing effective engineering learning opportunity.
Peer support. Model programs enable students of diverse backgrounds and interests to interact routinely and intensively.	Cohorts will be developed and implemented to provide engineering students with peer support from other students with same degree goals. Upperclassmen will be utilized as peer mentors.

Individual needs. The best programs provide hi-touch services to every individual student. Underfunding is no excuse to ignore student needs. Technology can be used to provide many services with a personal touch and also free up personnel so they can provide hi-touch intervention at the first sign of achievement slump.	Faculty will be trained to mentor and provided experiential learning opportunity in the undergraduate research and capstone project models to be developed. Peer mentoring and case management advising will also be developed to intensify personal attention. The IHeLP program will greatly improve the effectiveness and efficiency of services and make it possible to scale them up to meet growing need.
Enriched research opportunities. Standout programs extend research experience beyond classroom hours during the academic year. Summer internships and other research opportunities outside the classroom are regular activities. They connect the student's experiences to the world of work, establish mentoring relationships, and open a window on career options.	CSUB has begun to develop an undergraduate research program and has used this program and new Fab Lab to enrich the current engineering pipeline. Undergraduate research in engineering will be a key component of the strategies to attract and retain Hispanic students. New resources will be available for project-based learning and early research opportunity. Graduate students/upperclassmen will be recruited and trained as Research Apprentices to assist faculty supervising student research projects.
Creating a bridge to the next level. Too few programs recognize that they are part of an education and workforce continuum. Those that do build the institutional relationships that make a pathway possible.	The leadership team will put concerted effort into involving all stakeholders in the entire continuum of the engineering pathway. BC and CSUB will develop even stronger cooperative partnership to remove all the intersegmental obstacles that penalize Hispanic first generation students the most.
Continuous evaluation. Effective programs never stop asking basic questions about process and outcomes. Continuous monitoring, evaluation, and program adjustment are hallmarks of best-in-class.	The evaluation plan reflects NSF recommendations for evaluating engineering pathway effectiveness in attracting/retaining underrepresented students. It answers the most important questions for project stakeholders: will the number of local well-qualified engineers increase?

Improving Support Services for Pathway Students: Engineering and science faculty at CSUB have been working with staff at the university's student support services area to identify solutions to the problem of providing enough high intensity services to support student completion as the engineering pathway grows. CSUB currently offers traditional drop-in tutoring services augmented by face-to-face Supplemental Instruction. Both services are very weakly utilized by students mainly because the university's schedule does not fit their schedule. NSSE data indicate that CSUB students work considerably more than their peers nationwide. Furthermore, extensive national research by Excelencia in Education and the American Association of Colleges and Universities (AAC&U) has found that at risk Hispanic students need services to be inescapable. They must be fully integrated with

curriculum and instruction.[13] All services to engage pathway students will be fully integrated into the new engineering pathway. New pathway students will be engaged early in engineering specific events such as colloquia and math/science bridge workshops at CSUB. Students will participate in the annual Engineering Day where they will meet industry partners. In partnership with local industry, an internship program will be developed to enable pathway students to participate in year round or summer internships. Every effort will be made to align pathway students' career interests with internship opportunities as recommended by various NSF-supported Centers for Undergraduate Research. Upperclassmen will mentor lowerclassmen in order to offer support, identify problems early, and offer general advice. During the first two years of study, engineering students will be enrolled in a learning community that includes: one physics, one calculus and one engineering course. Many other strategies will be developed to build learning community among pathway faculty and students.

Undergraduate research (UR) is a particularly important pathway strategy because it has been found to be one of the highest impact practices for improving learning in underrepresented students, particularly in science and engineering courses. UR is a way "to connect key concepts and questions with students' early and active involvement in systematic investigation and research."[14] It has been found in research by the American Association of Colleges and Universities (AAC&U) to be highly effective in engaging students in college and keeping them on track.

IHeLP. Further developing the engineering pipeline gave impetus to identifying online methods to deliver more engaging services to engineering students. Both BC and CSUB are struggling to provide all the services needed by the increasing number of underprepared engineering students,

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[13] *Growing Knowledge About What Works for Latino Student Success,* 2014 report from a collaborative initiative between AAC&U and Excelencia to find what are the best practices to support Latino student completion.

[14] George D. Kuh. *High Impact Practices: What They Are, Who Has Access to Them, and Why They Matter.* AAC&U, 2008, p.1.

most of whom are at risk from entry until degree completion. More and more underfunded HSIs are experimenting with methods to use technology more effectively to improve learning. Low income students need to work and have more family responsibilities. Scaling up even the most beneficial services is almost impossible without technology when almost all students are high need. The search to identify methods and practices with the most evidence-based potential resulted in the design of IHeLP (Integrated, Holistic eLearning Program) to increase the effectiveness and efficiency of pathway services.

Rationale for IHeLP Student Success and Learning Support System Features	
Feature	**Rationale**
Face-to-Face IHeLP Orientation. IHeLP is a learning support structure that augments and enhances traditional face-to-face versions of the services it includes, and hence it is provided for students regardless of the modality of instruction. All participating faculty and advisors will be trained to provide face-to-face orientations to ensure students are proficient at using the entire IHeLP platform.	For most students underprepared for college, there is a significant barrier to being able to function and thrive in an online learning environment if not properly acclimated to the online platform. Web resources can provide an important knowledge base on how to use features in an online system, but are often inadequate for the neediest students who need face-to-face guidance and support to get started with a new tool.
e-Advisor. An advising solution that places the information students need in order to make informed decisions about their education at their fingertips right when they need it, and connects them with the people that know how to help. Ideally every high need college student would have a one-on-one relationship with a caring faculty member in his/her field of interest. This is impossible in large underfunded public HSIs.	Technology-supported advising is increasingly common and there is now a large body of evidence about what works.[15] There are several successful models that will be used to guide the development of CSUB's e-Advising program, such as Arizona State University's *eAdvisor*,[16] which has been linked to disproportionately higher improvements in student retention for Hispanic students than white students.
Connection with Existing Systems. The e-Advising system will have direct links to existing advisement systems including course catalog and schedule, student educational plans, and degree check. CSUB has recently upgraded these systems with new software. This will ensure that all information needed for establishing proper connections and context will	Students' abilities to make informed decisions about their educational paths are often hindered by a vast and shifting landscape of options and requirements. E-Advising will provide a "roadmap" to completion along with pointed, timely advice right when it is needed most. It will make this advice available on students' schedules, a major improvement designed to

[15] The advising component of IHeLP will be built on the recommendations of the NACADA's Technology in Advising Commission. This commission is a central resource and clearinghouse for information about innovations and issues in academic advising technology.
[16] Arizona State University, eAdvisor Program, eadvisor.asu.edu

be available immediately to students and advisors.	increase the persistence to a degree.
Online Supplemental Instruction (e-SI). e-SI is a series of out-of-class sessions led by a student who has taken the course e-SI is offered in successfully. The program targets courses, not students. The CSUB e-SI sessions will be conducted synchronously, in real-time via web-based software. Nothing is installed on the student computer and there are capabilities of audio, video, screen-sharing, white board and other tools. The e-SI leader functions as *model student* of the discipline rather than authority figure.	E-SI leaders help students formulate and answer their own questions. This process helps students develop a more sophisticated approach to learning while maintaining the focus on content mastery. (SI) is one of the most respected learning assistance methods, but in its traditional form it fails to sustainably provide adequate access at scale. The development of the e-SI component of IHeLP will be modeled after the highly successful program developed at the University of Wyoming[17].
Just-in-Time Teaching. Just-in-Time Teaching (JiTT) is a teaching and learning strategy based on the interaction between web-based study assignments and an active learning classroom. Students respond electronically to carefully constructed web-based assignments which are due shortly before class. The instructor uses student submissions as crucial feedback *just-in-time* for classes, allowing nuanced adjustments to the classroom lesson to enhance learning.	The heart of JiTT is the *feedback loop* formed by the students' outside-of-class preparation that fundamentally affects what happens during the subsequent in-class time together. There is a substantial and ever-growing body of evidence supporting the efficacy of JiTT, especially among the most underprepared students.[18] [19] Positive results have spurred a large online community of practice[20] focused on JiTT, which will guide faculty development efforts on this strategy.
Note that there is more information about IHeLP services in Priority 2 Narrative.	

CSUB has a Supplemental Instruction (SI) program but it is not effective or efficient enough to meet the needs of the new engineering pathway. SI is a highly recommended, much researched method of delivering learning assistance. It has proven effective at BC and CSUB, but it is expensive to operate following the best practice methods pioneered by the University of Missouri, Kansas City (see the International Center for Supplemental Instruction website for more information). Online SI is not as proven an approach but it is absolutely essential for the proposed pathway, and there are online SI

[17] University of Wyoming, Online Supplemental Instruction, http://www.uwyo.edu/learn/si/.
[18] Rhem, James. Just-in-time teaching: Across the disciplines, across the academy. Eds. Scott Simkins, and Mark Maier. Stylus Publishing, LLC., 2010.
[19] Novak, G. M., Gavrini, A., Christian, W., & Patterson, E. Just-in-time teaching: Blending active learning with web technology, 1999.
[20] A well-respected resource is the Science Education Resource Center at Carleton College, serc.carleton.edu

models to follow that have shown clear potential. (See more information in the Competitive Priority narratives.)

Description of Online SI Component of IHeLP
What is e-SI?: e-SI is a series of out-of-class sessions led by a student who has taken the course e-SI is offered in successfully. The program targets courses, not students. While all students might not take advantage of the voluntary opportunity, it is expected to attract an equal proportion of students from differing ability and cultural groups. E-SI does not segregate students based on prior academic performance or predictions of academic success. In fact, e-SI works best with heterogeneous groupings of students.
The Role of e-SI Leaders: The e-SI leader functions as "model student" of the discipline rather than authority figure. E-SI leaders help students formulate and answer their own questions. This process helps students develop a more sophisticated approach to learning while maintaining the focus on content mastery. The e-SI sessions integrate the review of lecture notes, textbook readings, outside supplemental readings along with appropriate modeling of learning strategies. "How to learn" is embedded into e-SI sessions along with "what to learn." Through practice and mastery of effective learning strategies, students can adopt and transfer these strategies to other subjects and content areas. Collaborative learning strategies are used in e-SI sessions as a means of creating a more active learning environment for student participants.
How e-SI is done online: The CSUB e-SI sessions will be conducted in real-time via a web-conferencing program. Nothing is installed on the student computer and there are capabilities of audio, video, screen-sharing, white board and other tools.

Arizona State's eAdvisor model has been proven effective and has many features that are ideal for the planned pathway and will therefore be included.

Features of Arizona State University eAdvising Model
• Incoming students consult eAdvisor and meet with advisors (who are trained staff members) during orientation to discuss their degree choices. After students have chosen a major, eAdvisor provides a "major map" that outlines required courses and the sequence in which they must be taken. Students must take general education courses early in their academic careers, and must also enroll early in "critical requirements"—courses that diagnose their likelihood of success in the major. Before the advent of eAdvisor, students would often postpone taking the most difficult required courses, especially those with a mathematical focus. Consequently, they would run into trouble late in their degree programs, resulting in delayed graduation or even failure to graduate.
• The eAdvisor system has been particularly effective in improving success for racial and ethnic minority students and those who are the first in their families to attend college. Survey data also suggest that students are highly satisfied with eAdvisor and appreciate that it provides clear information about their progress to a degree, e-mails them messages when they are off track, and offers clear direction on their personal paths to success.
• In addition to improving student success and satisfaction, eAdvisor has saved money for both

the university and its students. Because eAdvisor provides information about how many students are in each major and where they are in their progress toward the degree, ASU can manage course offerings to match need—guaranteeing that seats in required classes are available for all students while teaching fewer classes for each graduate. Ultimately, eAdvisor saves ASU between $6.5 and $6.9 million dollars in instructional costs and about $7.3 million in advising costs each year. Similarly, by leading students to graduate sooner, eAdvisor saves each student an average of $24,500, the equivalent of one year's tuition and fees.

- Finally and most importantly, ASU produces an average of one thousand additional graduates per year as a result of eAdvisor. These graduates, many of whom are members of less advantaged minority groups, are now enjoying the benefits of a college education, including the opportunity to pursue academic majors that best match their talents and interests.

Professional Development to Support All Objectives: CSUB and BC faculty will be trained to work in teams to improve pedagogy and redesign traditional course structures for the Power/Energy Engineering pathway. Professional development is identified as one of the most important factors affecting student success and retention in engineering programs around the nation. The traditional method of teaching involves a dry lecture, an hour of recitation to help student with homework, and three hours of cook-book style laboratory activities. There is little interaction and collaborative engagement among students. Furthermore, students are not given enough opportunities to develop critical thinking skills in order to develop their own metacognitive abilities that are critical for the improvement of problem solving ability. The National Effective Teacher's Institute was developed in 1991 to address that specific issue. **Pathway faculty will be trained through this Institute to become qualified engineering faculty.**

The National Effective Teaching Institute (NETI) conducts an annual three-day workshop prior to the Annual Meeting of the American Society for Engineering Education. It is sponsored by the Educational Research and Methods and the Chemical Engineering Divisions of the ASEE and funded in part by participants' registration fees and in part by industrial contributions. The NETI has a dual purpose. Most obviously, it is intended to give the participants information and

hands-on practice in the elements of effective teaching-- active and cooperative learning, lecturing, course planning, testing and grading, and dealing with a variety of problems that commonly arise in the life of a faculty member. The workshop is also intended to provide new faculty with tips from experienced faculty about instructional materials and methods that they can use in faculty development programs on their own campuses.

The faculty training will be extensive and multifaceted to reflect best practice pedagogy and methods to increase underprepared student success in engineering. The most important report in the history of engineering education in America *(Educating the Engineer of 2020: Adapting Engineering Education to the New Century.* National Academy of Engineering (NAE), 2005) stresses the need to reinvent engineering – starting with pedagogy. Instruction and learning outcomes must prepare the student for industry expectations of engineers in the 21st Century, and faculty must adapt to changes in the engineering workplace. This is even much more important for HSIs because new methods produce more learning and success.

During the past 20 years or so the National Science Foundation (NSF), the National Academies of Science (NAS), and professional societies such as the Accreditation Board for Engineering and Technology (ABET) have expanded their policy focus beyond traditional support for basic and applied research in Science, Technology, Engineering, and Mathematics (STEM) to include improving the quality of undergraduate teaching and student learning in these disciplines.[21] This expanded mission is in part a response to the decline in students choosing to

[21] James Fairweather, *Linking Evidence and Promising Practices in Science, Technology, Engineering, and Mathematics (STEM) Undergraduate Education*: *A Status Report for the National Academies National Research Council Board of Science Education,* 2008.

major in STEM fields, declining percentages of STEM undergraduates continuing to graduate school, and the social and economic consequences of these trends.[22]

Fisher, Zeligman, and Fairweather (2005) found that pedagogical reforms in engineering service courses dramatically improved ABET-derived student learning outcomes, including problem-solving and analysis of complex problems.

There is a substantial literature on effective college teaching and learning (e.g., Pascarella & Terenzini, 2005). Most of this work centers on student engagement either in active and collaborative instruction in the classroom (e.g., Kuh et al., 2005) or in out-of-class learning environments (Brower & Inkelas, 2007). In addition, there is a large literature on faculty professional development specifically in engineering pedagogy. (e.g., Wulf & Austin, 2004). All of these sources informed the Activity Implementation Plan. CSUB and BC faculty will be trained to use technology more effectively to build community, provide group and individual support services to at risk students, to deliver more effective and engaging learning opportunity tied directly student career interest/workplace. Professional development will be collaborative, and CSUB and BC will work together with industry partners to develop meaningful workplace-related projects for students and integrate these into engineering outreach and courses.

Faculty at both partnering institutions will also be trained to become scholars of learning who can evaluate their own experiments with the high intensity learning practices identified by NSF and extensive other research as more effective than traditional engineering lecture-dominated, faculty-centered approaches. NAE recommendations will be followed to train CSUB faculty. BC STEM faculty will be invited to participate in all training.

[22] National Science Foundation 1996; Center for Science Mathematics and Engineering Education, Committee on Undergraduate Science Education 1999.

Summary of NAE Recommendations for Faculty SLO Assessment Training to be Implemented Through the Activity
• A description of the strategies to implement reforms, whether in a classroom or curriculum, are as crucial to convincing potential adopters to try the new approaches as evidence of effectiveness. **If the goal is to encourage widespread use of effective instructional techniques then a description of what it takes to implement the innovations is as crucial as the evidence of their effectiveness**. • Evaluation (and scholarship) on instructional innovations should distinguish between the requirements for effective teaching techniques (e.g., providing clear learning objectives for students is important in all types of instruction) from requirement for more innovative forms of instruction (e.g., studio-based learning). • Faculty should learn to develop assessment procedures to distinguish between the types of learning outcomes meaningfully measured in a single class—e.g., content knowledge—from the types of learning outcomes (e.g., application of knowledge) best assessed in subsequent courses. • Course and curriculum innovators should understand that there is no agreed upon "standard" for judging impact or statistical relationship between predictors and outcomes *among the community of potential STEM faculty adopters*. Instead, the field of STEM educational research very much needs to develop a consensus about the important of research results. • To be effective evaluations should distinguish between the type and format of information needed to help a faculty member (a) implement an innovation (formative assessment), (b) summarize the effectiveness of changes in teaching practices on student learning, (c) demonstrate effectiveness as a research project where the audience consists of national disciplinary peers, and (d) present findings to encourage other faculty members to change the way they teach. • To increase the implementation of instructional strategies shown effective requires a model of change, including the roles of research evidence, leadership, resources, faculty work load and rewards, and resources. In this context, empirical evidence is only one part of the reform effort. It is a necessary but not sufficient condition for improving teaching and learning in STEM. • Start every STEM educational reform and evaluation *as if it will eventually be disseminated and scaled up*. This approach is much more likely to lead to greater use of the instructional innovation than an evaluation focused solely on idiosyncratic factors in the classroom (or curricular) environment.

Collaborative, Cost-Effective Early Awareness and High School Preparation: Attracting students to engineering involves a combination of targeted outreach activities and support of high schools teachers by colleges and universities. This is exactly what the nationally recognized Project Lead the Way program has managed to do. CSUB and BC will continue to support PLTW programs in local high schools. PLTW partners with high schools to improve college readiness. Through an engaging, hands-on curriculum, PLTW encourages the development of

problem-solving skills, critical thinking, creative and innovative reasoning, and a love of learning. These are important to prepare students for and interest them in modern engineering education. All students who participate in local PLTW programs or CSUB/BC precollege activities will be made aware of the new engineering track and liberal engineering approach at CSBU and the open gateway at BC to all CSUB engineering degrees.

ACTIVITY IMPLEMENTATION TIMETABLE TO ACHIEVE OBJECTIVES	
Main Tasks	**Time Table for Grant Period**
Objective 1. To increase enrollment in CSUB's newly designed engineering pathway by 20 students each grant year, reaching the sustainability-ensuring level of at least 90 FTES by year 5, with Hispanic students equitably represented in all categories (first time, full-time and transfer) compared to overall enrollment.	
1a. 100% of the new courses needed for the Power/Energy Engineering track are developed by spring 2017.	By December 30, 2015 the fully representational Advisory Committee will approve the entire curriculum design for the new Power/Energy (P/E) engineering pathway. By December 30, 2015 the Engineering Coordinators and faculty will present the complete CSUB curriculum to the CSUB Curriculum Committee for approval. BC faculty will also approve the curriculum.
1b. Curriculum redesign workshops are held for 100% of the related science and mathematics courses.	By November 1 each year the workshop schedule for that year will be determined. By April 30 of next year, all workshops will be completed, evaluated with at least 80% favorable approval rate from participants.
1c. Curriculum is fully aligned with ABET consultant recommendations and by 2019 the pathway is prepared to apply for ABET accreditation. (Note: Accreditation cannot take place prior to granting of degrees to the first cohort.)	By September 1st, 2017 all Power/Energy Engineering courses will be in the schedule; student learning outcomes will be identified; success benchmarks will be determined; and assessment tools will be in place. At the end of each Spring semester thereafter student learning outcomes will be measured and reported to campus constituent groups. By September 1st of 2019 the preliminary application to ABET will be submitted.
1d. 100% of Power/Energy Engineering faculty will participate in engineering education professional development activities, offered by the National Effective Teaching Institute and the American Society for Engineering Education.	By Summer 2016 50% of P/E Engineering (P/E E) faculty will participate in technology infused engineering pedagogy seminars offered by NETI and ASEE. By Summer of 2017 the remaining faculty will complete the NETI and ASEE seminars.
1e. All grant personnel will be hired and ready to start by	By January 2016, the Liberal Engineering Curriculum Specialist, the Engineering Support Services Specialist, the Engineering

Spring quarter of 2016.	Transfer and Articulation Developer, the Data Analysis Specialist, and the BC Engineering Liaison will be hired.
1f. Existing laboratory facilities are upgraded and equipped with the latest technology to support course instruction. All laboratories will comply with state OSHA safety guidelines, and to local city and Fire Department codes. The new facilities will pass all annual inspections. Each year, all necessary physical space modifications will be completed and all network upgrades will be finished.	By January, 2016 all equipment for the new CSUB Engineering Fundamental laboratory will be purchased and installed; all equipment for BC Physics and active learning classroom lab will be purchased and installed; all necessary software programs will be acquired and configured. By January 2017, all equipment and software for the CSUB Fluids and Thermodynamics Lab will be purchased/installed; all equipment for the BC Chemistry Lab will be purchased/installed. By January 2018, all equipment and software for the CSUB Renewable Energy Engineering Lab will be purchased/installed. By January 2019, all equipment and software for the CSUB Electrical Engineering Lab will be purchased and installed. The BC STEM smart classroom will be equipped and configured. By January 2020, the final phase of the Power/Energy Engineering labs will be complete along with the BC Engineering Design Laboratory.
Objective 2. To increase by 2% each year the retention, success, and persistence rates in the new engineering curriculum by continuously monitoring student achievement of milestones and using data-driven improvements.	
2a. By spring 2016, all benchmarks for monitoring student outcomes are established.	At the end of each term, student success, persistence, and retention rates are collected and analyzed and will show incremental and significant improvement leading to completion. Data analysis will inform adjustment/improvements. An annual report will be presented to the advisory council and university.
2b. Faculty teaching courses related to Power/Energy Engineering will be trained in NSF signature pedagogies designed improve student outcomes.	By Summer of 2016, at least 50% of faculty will participate in professional development activities such as NETI, and other engineering education conferences and workshops. By Summer 2017, 100% of faculty will participate in professional development activities such as NETI, and other engineering education conferences and workshops.
2c. Faculty will be trained to collect, use, and analyze data to make data-based decisions about course improvements.	By Fall of 2016, the Office of Institutional Research will conduct training sessions for all faculty to assist them with data collection and analysis to inform future pathway improvements. New pathway faculty will receive training as needed.
2d. The IHeLP program will be developed and tested on all engineering courses in Power/ Energy Engineering.	IHeLP strategies are ready to be implemented by spring quarter 2016. Annual assessment of those strategies will take place at the end of each academic year and appropriate adjustment will be in place by fall quarter of next year.
2e. The undergraduate research program will be included in P/EE.	By Fall of 2016 engineering faculty will have identified and scheduled undergraduate research activities related to power and energy engineering; identified students that will undertake them.
Objective 3. To significantly increase the number of BC students who are formally enrolled in a fully-articulated curriculum in engineering with an approved plan to transfer on schedule and	

increase the number of Hispanic and other underrepresented students who complete all pathway preparation in engineering at BC on schedule.	
3a. Increase the number of students formally enrolled in a fully-articulated curriculum in engineering (and other STEM areas) with a plan to complete their degrees within six years (the national benchmark for Hispanic students).	By November 1st of each year at least 20% more students than the year before will have declared engineering as a major (tracked by the institutional MIS system) and completed an educational study plan after meeting with the BC Project Partner Director.
3b. Each year, at least 40 additional students will have an approved plan to complete their degree on schedule with a cumulative total of 200 students by 2020.	By November 1st of each year, at least 40 BC students will complete an educational plan that will prepare them to complete their AS or be "transfer ready" in two years.
3c. Increase the number of Hispanic and other underrepresented students who complete all pathway preparation at BC on schedule, as mapped out in their baccalaureate pathway education plan.	By November 1st of each year, the number of BC Hispanic students who are "transfer ready" will be at least 10% more than the year before.
3d. Intersegmental teams are established and meet bi-annually to align the engineering curriculum, to explore best practices in pedagogy, and to discuss common issues regarding success of Hispanics and other underrepresented groups.	By December 1st of 2015 the first community of scholars group (comprised of BC and CSUB engineering and other STEM areas faculty) will be formed. The Engineering-STEM group will meet at least twice a year thereafter.
Objective 4. To eliminate the gap between CSUB's six-year graduation rate for CC transfers (5.5% gap) and first-time freshman (12% gap) as compared to the statewide average.	
4a. To establish a dual engineering admission option for seamless transition and remove all other identified institutional obstacles on existing transfer pathway for degree completion from BC to CSUB. (Piloted in 2016; finalized by Fall 2017.)	By September 1st 2016, the dual enrollment agreement in STEM, between BC and CSUB will be in place. Students will have the option to enroll at BC and CSUB simultaneously with one application. This will eliminate course duplication and expedite degree completion.
4b. All new engineering students transitioning from BC who are from Hispanic or other minority groups will have developed an education plan of study to enter the P/E Eng. track.	Every year, all engineering students from BC with intent to transfer to CSUB will be formally advised by BC and CSUB STEM counselors in order to enroll in appropriate pathway courses.
4c. All new freshmen engineering students transitioning from high school who are from Hispanic or other minority groups will participate in an orientation workshop at CSUB.	Every year, all incoming freshmen engineering students will be formally advised by high school and CSUB counselors and will complete a four-year degree completion plan. Students will meet with counselors annually.
Objective 5. To double the number of Hispanic students, including transfers, who complete CSUB STEM degrees (from 2013 baseline.)	
5a. At least 20 students will enroll in the new P/E Engineering track every year starting at fall of 2016.	By September 1st 2016, the first cohort of P/E Engineering students has been identified, advised, and has completed a four-year degree plan.

5b. The course retention and success rates rate are evaluated at the end of each quarter and show an annual increase as compared to the baseline 2011-12 rate.	By Spring 2016, the baseline rates for success and retention are established and communicated to students in course syllabi. Results of the analysis are communicated to counselors.
5c. Every year, the persistence rate (enrollment from quarter to quarter) will be evaluated as a method to ensure students stay within their study plan.	By Spring 2016, the baseline rates for year to year persistence are established and communicated to students in course syllabi. Results of the analysis are communicated to all faculty and counselors.
5d. A highly qualified ABET consultant is hired to assist with the ABET accreditation application and process.	By Fall 2019, the ABET consultant, working with faculty and administrators, will have prepared the draft application to be submitted for consideration as soon as the first student graduates by 2020.
5e. By Spring 2020, students from the first cohort complete all degree requirements.	By Spring 2020, the first P/E Engineering graduates receive their degrees.

4. KEY PERSONNEL

This project requires top-level leadership at both CSUB and BC and a project director with extensive STEM experience and also deep understanding of what it takes to build an engineering pathway within the complex CSU System structures. Achieving a higher level of collaboration with Bakersfield College requires a CSUB project director who is also known and respected at BC. **Dr. Jorge Talamantes** has worked closely with BC to smooth STEM pathways for local, underrepresented students, supporting local mentoring programs and greater faculty discussion to improve student outcomes.

Dr. Talamantes will commit 100% of his time to the grant to mobilize collaboration and provide direct leadership and strong management of this institutional development grant. He will work with the counsel of the Advisory Committee, chaired by Dr. Anne Houtman, Dean of the CSUB School of Natural Sciences, Mathematics and Engineering. To support Dr. Talamantes, the day-to-day implementation of the project will be assumed by an experienced educator and long time faculty member at CSUB, Dr. Melissa Danforth, at 50% time commitment. Dr. Danforth is an experienced faculty member with a Ph.D. in Computer Science and vast experience in cultural and equity issues affecting underrepresented students. As a first generation

college student and CSUB alumna, she directly understands equity and access issues in the Valley. She is a well-respected professor at CSUB, with experience in managing Department of Education and NSF grants, undergraduate science/engineering education, and a long track record in undergraduate research, curriculum development and student support initiatives. In addition, she has experience managing Title V projects.

This project also requires high-level leadership at BC because of the need to raise articulation to a higher level for a truly seamless pathway in engineering. Improving transfer success is a top priority for BC, and as such, the college is committing the time of the Dean of Instruction-STEM at BC, **Liz Rozell**, as the Project Partner Leader. She is well qualified for this role. Dean Rozell will work in close communication with BC President, Dr. Sonya Christian, who was a Math faculty member and a former STEM dean at BC. Both have been collaborating with Dean Houtman and Dr. Talamantes at CSUB to plan this project. Dean Rozell, as the Partner Project Director, will continue to work closely with Dr. Talamantes to oversee pathway development.

Qualifications of Project Leadership Team
Dr. Jorge Talamantes' Qualifications to Lead this Project at CSUB
• Dr. Talamantes has strong academic credentials that are required for his position as the Chair of Physics and Engineering at CSUB (Ph.D. from University of California, Riverside in Physics), with more than 20 years of teaching, research and industry experience. He will work on this project communicating with the Advisory Committee, chaired by NSME Dean, Dr. Anne Houtman. • Dr. Talamantes has taught at CSUB since 1990, becoming Chair in 2011. He shares the respect of the faculty he leads due to his background as an experienced scientist, published researcher and professor of Physics. Before entering academia he gained extensive experience working in the defense and high technology industries. This experience is highly desirable for the new approach in Liberal Engineering education, due to the connection of academic learning with real world applications. • Dr. Talamantes possesses extensive experience coordinating local engineering pathways with industry professionals and PLTW leaders in the high schools. He is a traditional scientist with a substantive network of local engineering partners. • Dr. Talamantes has extensive grant management experience. Most recently, he has been the Director of an HSI STEM grant, collaborating with Bakersfield College to achieve goals.

- Dr. Talamantes knows how to navigate the cumbersome, complex CSU system process (and CSUB's own process) for new program approval (even more difficult in the current economic climate). He was instrumental in shepherding the first engineering pathways at CSUB in Computer Engineering and Engineering Sciences.
- Dr. Talamantes is deeply committed to addressing the local area need for engineers and to work closely with BC. He has attended every BC meeting to plan this project and has a track record of successful STEM collaboration with BC since their first CCRAA grant in 2008. He has been an active leader in bringing the partners together to develop articulation and transfer MOUs and several productive STEM faculty-wide events to build student pathways.

Dr. Melissa Danforth's Qualifications to Co-Coordinate Project at CSUB

- Dr. Danforth is the chair of the Computer Science/Engineering department which is one of the anchor programs for the development of the new Power/Energy Engineering track. She is a proud first-generation college student and CSUB STEM alumna (Biology, Computer Science).
- Dr. Danforth has a PhD in Computer Science, and has been a faculty at CSUB since 2006. She has been an active participant in the development the Computer Engineering pathway, and directly involved in planning this project with Dr. Talamantes and Dr. Houtman.
- Dr. Danforth has been successful in coordinating NSF grants with a research and program development focus as well as a Department of Education Minority Science and Engineering Improvement Program (MSEIP) grant to support underserved students earning Engineering degrees. She also coordinates the REVSUP program for Chevron giving underrepresented students hands-on lab experience in an intensive summer program. She is deeply committed to helping students succeed as a research mentor in the McNair Scholars and LSAMP programs.

Dean Liz Rozell's Qualifications to Lead this Project at Bakersfield College

- Dean Liz Rozell has a Masters of Engineering degree from Texas A&M University and was a full time instructor first in Mathematics and then in Engineering at Bakersfield College starting in 1989. She took on the role of STEM Dean in 2013. As the former department chair, she led BC's two-year engineering program in their Career and Technology Education (CTE) division that is well respected in the service area.
- Her background demonstrates a student-centric dedication to pedagogies of engagement and the building of professional skills. Dean Rozell is an experienced HSI STEM and Articulation Project Director and well-versed in bringing activities with scope and scale to fruition. She is experienced in curricular development and transfer, serving on the statewide Engineering Learning Council, a group of engineering faculty and administrators supporting articulated pathways, transfer agreements and greater collaboration between CCC, CSU and UC.
- She has actively promoted student support initiatives and success in mathematics and engineering among underrepresented students. Dean Rozell was responsible for attracting the MESA Program to Bakersfield College, served as the Director for two years, and was intimately involved as a faculty mentor until last year. She has also been an advisor to the local chapters of the Society of Women Engineers (SWE), Society of Hispanic Professional Engineers (HOPES-SHPE), and implemented numerous engineering design-build competitions and robotics programs for Kern County youth.

Description of the roles and responsibilities of other Activity personnel is presented in Section 7:

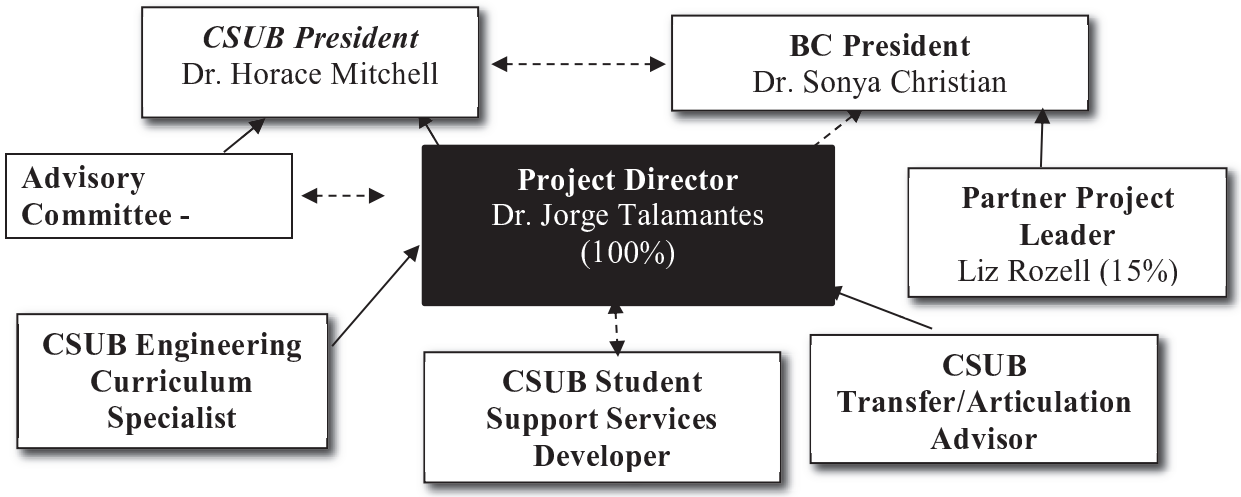
Budget Narrative. Full details are included in the Activity Budget Detail Form.

5. PROJECT MANAGEMENT PLAN

Dr. Jorge Talamantes will serve as Project Director, assisted on a daily basis by Activity Coordinator, Dr. Danforth, and working closely with the Advisory Council led by Dean Anne Houtman. As the lead institution, CSUB will take full responsibility for project management. Dr. Talamantes is a respected faculty member, scholar and researcher with significant industry experience. He is esteemed as an innovative and education advocate in the community. He has been involved in multiple CSUB partnerships with BC and local high schools over the last decade. Dr. Talamantes will be directly responsible to the CSUB president for meeting the objectives of this Title V Project, and he will have full authority and autonomy to administer the project according to the federally approved plan of operations.

CSUB's management of the project will be assisted by an excellent leadership team at Bakersfield College that will cooperate fully with all CSUB management activities and requirements. Dr. Talamantes at CSUB and Dean Rozell at BC have been involved from the beginning in the CSUB-led initiatives to develop an intersegmental degree pipeline, engaging in active collaboration for several years. Both are experienced project and grant managers with strong commitment to the goals and objectives of this project

Cooperative Management Organizational Chart



6. PROJECT EVALUATION: Project Evaluation will be the responsibility of the lead institution and will be managed by Dr. Talamantes, working with Dr. Steven Daniels, Director of the CSUB Public Service Institute (PSI). The strong evaluation design, which is needed for a project this important to the partnering institutions and the service area, requires external evaluation services from a well-qualified professional group familiar with CSUB's research operations.

Role and Qualifications of Dr. Daniels/Director of CSUB Public Service Institute (PSI):
The PSI is sufficiently independent and well-qualified to conduct valid, objective evaluation working with the research offices at both CSUB and BC. Dr. Steven Daniels has been on the faculty in Public Administration at CSUB since 2002. He has strong academic credentials in public administration and political science and extensive university teaching experience. He is a strong advocate of evidence-based public policy and practice in addressing problems. He teaches research methodology on the graduate and undergraduate level. The Public Service Institute (PSI) is the applied research arm of the CSUB Department of Public Policy and Administration. Its director, R. Steven Daniels, has extensive experience in assessment, program evaluation, research methods, and statistics, and he knows CSUB very well. He was the principal author on the CSUB proposal for re-accreditation through the Western Association of Schools and Colleges (WASC) and was the principal author of the final report of the CSUB Foundations of Excellence First-Year Experience Steering Committee. He is the assessment coordinator for the School of Business and Public Administration and the Department of Public Policy and Administration. He has served on the University Program Review Committee (UPRC), the Committee for Academic Requirements and Standards (CARS), and the CSUB Assessment Council.

Dr. Daniels will be primarily responsible for overseeing implementation of the project evaluation plan, which was informed by his Institute's data-based evaluation approach. He will work closely with the CSUB Office of Institutional Research, Planning, and Assessment (IRPA) to ensure that data collection and analysis meet the standards/ objectives of the project and are appropriate to provide evidence for continuous improvement and efficacy of the new engineering pathway. He will also work with Dean Rozell and BC's research office to ensure relevant BC data is consistent and accurate. He will help develop all the tools and methods needed for longer-term evaluation relevant to the project objective. He will provide objective detailed

reports to the management team that include recommendations to improve the validity and value of data as needed. He will assist in meeting all federal reporting requirements.

The Advisory Committee (a fully representative group including CSUB and BC faculty and administrators, local industries and engineering students) will serve as the project monitoring team. Dean Houtman will form this advisory committee and provide continuous leadership to ensure that it is effective in project oversight. The external evaluation consultants will support the work of this committee to oversee formative and summative evaluation.

Data Elements and Collection. PSI will oversee the project data collection process and lead the analysis and interpretation of data. The CSUB IRPA will work closely with the Data Analysis Specialist to implement and maintain data tracking procedures and insure that data collection for the project at both CSUB and BC is fully integrated with CSUB's current processes and procedures which comply with CSU system reporting requirements.

The following data elements will be collected for all BC/CSUB students. Most are routinely collected by the institutional research offices. Additional data elements are included to provide information specific to project objectives. Pathway students will be tracked and monitored from entry at BC to graduation at CSUB. All will be analyzed using standard research methodology.

Student Data Elements to Assess Student/Institutional Impact
Graduation Rate. There are many rates, and the four-year rate (as defined by USDE) will be used during this grant period. All potential engineering pathway students will be tracked from gateway in PLTW to degree completion to determine what intervention strategies work best.
Time to Completion. Amount of time to degree completion. Students who declare a Power/ Energy engineering major will continue to be tracked over six years to degree completion (and rate compared to current CSUB and national 6-yr rate to assess degree completion longer term).
Retention Rate. Retention of all Power/Energy Engineering pathway students will be tracked from declaration of intent (at BC or CSUB) to degree completion and data will be analyzed at specific milestones known to be critical to Hispanic degree completion. Data will be collected on student use of advising/other services and faculty use of new pedagogy and practices recommended by NSF for STEM success with underrepresented students.
Students Learning Outcomes. CSUB and BC faculty involved in curriculum and pedagogy development will agree on specific SLOs for all pathway courses. These will reflect local and

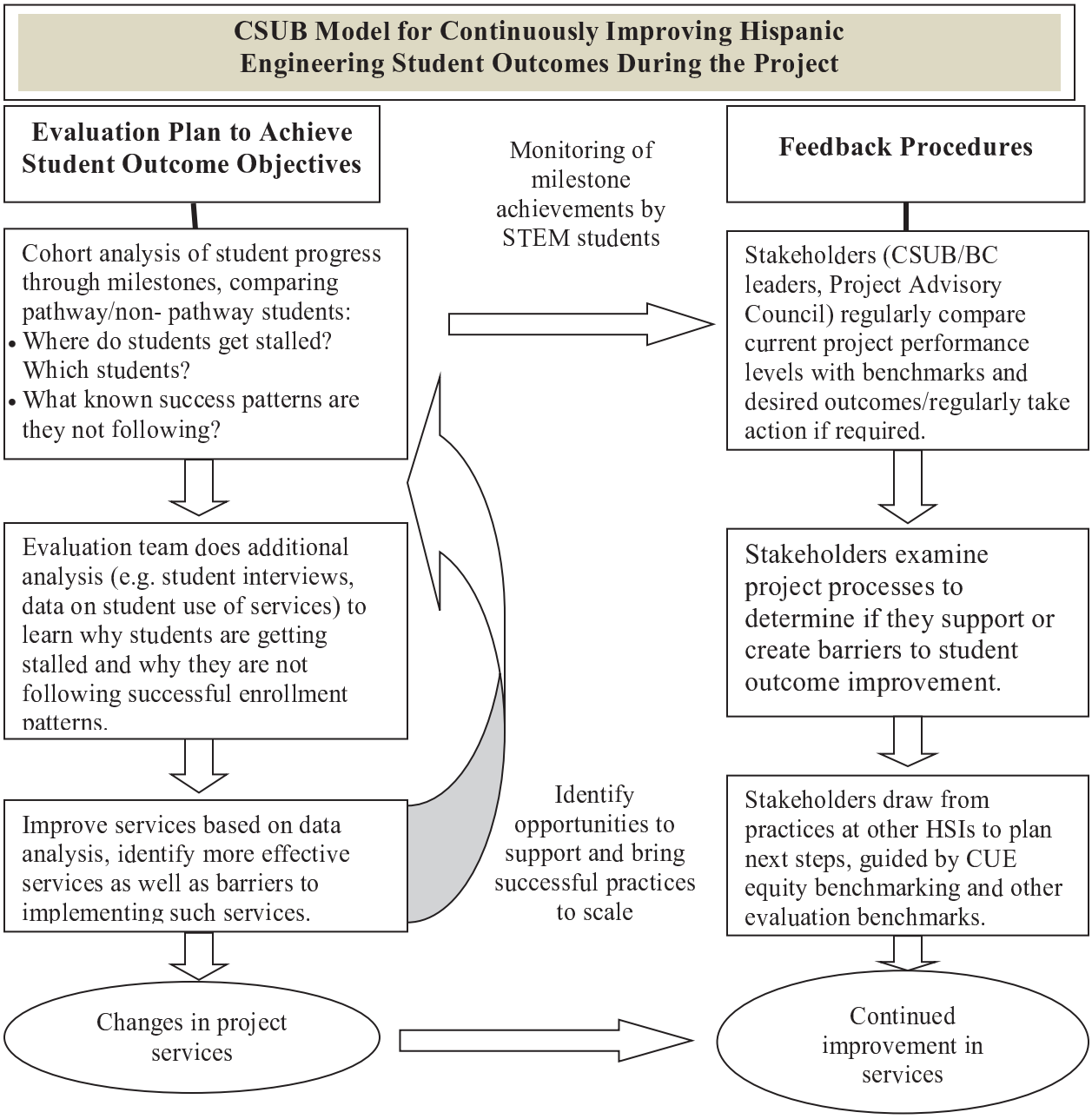
national industry and accreditation standards. SLOs will be used to assess curriculum and pedagogy. Relevant data will be continually collected and analyzed to improve student learning.
Student Satisfaction. Surveys will be developed by the Evaluation Team, administered by IRPA to measure student satisfaction with outreach advising and other services, instruction, capstone projects and other research opportunities.
Student Participation in Engagement Opportunities/Use of Services. Data will be collected to measure student participation and use in order to study the impact of specific components on engineering pathway student success and completion. This is essential to ensure that only the most effective components are scaled up.

Data analysis techniques to evaluate piloted new practices will include control groups wherever possible and use basic measures of central tendency such as the mean, median, standard deviation (t-test of the significance, etc.) and tabular analysis employed to provide clear and descriptive formative and summative data on the milestones and factors leading to accomplishment. Data will also be collected on team collaboration and faculty satisfaction with training (to improve it) and satisfaction of the service area stakeholders with the developing Engineering pathway. Stakeholders on the Advisory Committee will become focus groups, will be surveyed for feedback continuously (as well as informed of progress) in order to develop a responsive pathway.

NSF Recommendations on STEM Pathway Evaluation Tied to Results of BEST Project	Project Evaluation Strategies to Build Accessible, Intersegmental Power/Energy Engineering Pathway and Ensure Continuous Improvement through Data-based Decision-Making.
Evaluation is guided by the logic model and asks basic questions about process and outcomes: What is being achieved? How do these outcomes measure up against institutional goals? How do they compare to best practice programs?	Evaluation of this pathway project is guided by the CDP goals and objectives collaboratively determined by CSUB. **The logical process question is: what is being achieved each grant year toward these goals and objectives?** Practices developed through the project will be benchmarked against national best practices and adjusted over the grant period if they are not showing significant potential. (The project logic model is found in the Project Design section.)
There are meaningful, measurable outcomes in terms of student success in STEM (a tough challenge) with related measures	The grant period objectives and outcome measures are planned to be benchmarks of progress toward a fully articulated, accredited and self-sufficient Power/Energy Engineering pathway. Both quantitative and qualitative data will be collected relevant to these benchmarks and additional benchmarks will be added as needed

(outputs) to assess progress toward these longer term objectives. Process objectives are as measurable as possible.	to strengthen evaluation and increase its value to stakeholders in this project. Many related measures have been established to assess progress.
There are systems in place to track and assess student progress from early awareness in high school through each step of degree completion.	One key evaluation strategy of the proposed project is to develop accessible, **efficient intersegmental engineering pathway tracking capability** that does not exist at either CSUB or BC yet (although the State is now making this capability possible through CalPASS), in order to assess progress toward the long-term overarching objective of this project (which is fully consistent with the performance indicators for the Title V program) to increase the number of Hispanic students attaining Engineering degrees.
There is continual monitoring of student data to guide pathway development and also to intervene with appropriate services when pathway students are at risk.	**Continuous monitoring** during each pilot test will use data collected from official student records and from participants, staff, Advisory Committee, pipeline high schools and Bakersfield College to determine what program adjustments are needed to meet project objectives. This consistent feedback from participants regarding program services, consistent monitoring of student progress, and basic record-keeping will provide early warnings; the project leadership and development teams will be able to immediately pinpoint difficulties students are having in time to personally step in, and facilitate needed improvements.
A variety of assessment instruments are used in addition to tracking standard student success indicators (high school graduation, college enrollment, retention, learning).	The continuous monitoring of project outcomes will require a **variety of assessment instruments**, including intake and exit surveys, pre/post-tests, interviews/surveys using satisfaction scales, as well as complete written evaluations. In addition, as suggested by the American Society of Engineering Education, assessment that demonstrates knowledge transfer from the math and science to engineering courses should me made regularly, in order to evaluate alignment of outcomes between engineering courses and the math and science prerequisites.
There is a continuous improvement process during pathway development which involves all STEM pathway stakeholders.	To achieve the desired high levels of interactive, collaborative evaluation and project improvement leading to greater productivity, **the plan offers a model of continuous review,** periodic assessment, shared observations, review and analysis, exploration and implementation of corrective measures, subsequent evaluation and reporting. Project staff will use weekly meetings, mid- and end-of-term assessments and continuous planning for improvement. Advisory Committee meetings will increase the feedback necessary to assess progress and review performance as related to intended outcomes. If an individual staff member's performance, a component of the pathway's design or a particular activity does not enhance the project progress toward goals, then the management team will

	make the necessary changes.
Evaluation provides decision makers with data and information to inform.	A **data-driven decision-making process** will be ongoing by evaluating achievement of milestones in student progress such as: (1) The time to complete 30, 60, 90 units of the pathway; (2) The number of units completed per quarter and per year; (3) Persistence rates from quarter to quarter; (4) course success and retention rates during each quarter. Student surveys will also be used to gauge satisfaction. All partnership stakeholders will be given an opportunity to provide feedback regarding outcomes, and their responses, which often lend rich insight to the interpretation of outcomes, will be incorporated into reports. Qualitative data will be analyzed as rigorously as quantitative data. Focus groups and interviews will be taped and transcribed. Coding categories will be established, and data will be coded and analyzed for patterns and trends that may provide decision-relevant information, illuminate successes or failures in program efficacy, and provide a context for understanding program outcomes. Staff will present monthly status reports to the grant management team, quarterly written progress reports, and year-end evaluation reports. CSUB will comply with all federal requirements for evaluation/reporting of data.
Crossfunctional, intersegmental teamwork is continuous in the project and formative evaluation promotes the effectiveness of collaboration as well as assessing and improving its effectiveness in terms of project objectives.	Formative evaluation activities will be conducted annually including 1) Administering a **"levels of collaboration" assessment tool** to all CSUB/BC intersegmental teams examining desired and actual levels of collaboration, as well as satisfaction with the collaborative process; 2) Assessing and documenting members' level of satisfaction with the functioning of the intersegmental team and other collaborative task forces; 3) Designing and implementing a tool to assess the degree to which the partnership focuses on and accomplishes proposed tasks related to achieving objectives; 4) Documenting and assessing the degree to which data from the continual assessment process is used in strategic planning (i.e., evidence-based planning for next steps); 5) Assessing changes in the knowledge, attitude and performance of participants receiving training; and 6) Documenting challenges and successes faced by the partnership in carrying out proposed activities. These activities are in addition to assessing student outcomes in services piloted during the grant period. Results will be used to **improve the collaborative activities at the heart of this project.**



7. BUDGET NARRATIVE.

All budget requests were carefully considered and all requested funds are necessary to achieve project objectives as explained in Narratives, Key Personnel, and in the Activity Budget Detail Form and Summary Budget Form 524. Full explanations of roles, tasks, uses, purposes and responsibilities for all personnel, services, and items, are included in these documents. All

costs are tied directly to achieving the Activity Objectives. In determining the budget, all project planning members were careful that all project costs were necessary means to a long-term comprehensive solution to the problems delineated in the CDP.

Costs	Why Needed to Achieve Project Objectives
Positions	
CSUB-Project Director (100% all years)	A fulltime, highly qualified person is needed to direct, manage and coordinate the complex implementation and evaluation plan for this project. Dr. Talamantes will manage the grant in compliance with federal regulations and, provide project leadership and play a significant role in evaluation. He will also be responsible for overseeing and coordinating the dual admission program with BC for the Power/Energy Engineering pathway.
CSUB-Project Assistant (100% all years)	A fulltime administrative assistant will assist the grant Management Team in achieving the goals and objectives of the grant by providing the extensive logistical support for a project of such magnitude.
CSUB- Engineering Coordinator (50% all years)	This project is a product of the vision that Drs. Talamantes, Houtman, and Danforth have had for a long time in transforming CSUB to a model engineering university responsive to industry and community needs. Dr. Danforth will act as the Engineering Coordinator and will assist the PD with the day-to-day operations of the grant, coordinate efforts for curriculum development, and communicate regularly with BC. She will also work with faculty to develop online Just in Time Teaching modules, oversee the development of labs, purchasing of equipment and supplies, as well as monitor the overall budget.
CSUB-Engineering Student Support Services Specialist (50% Yr1; 40% Yr2-Yr3; 25% Yr4-Yr5)	The ESSS will be tasked with developing IHeLP at CSUB, including developing the online e-Advising model for pathway students as well as testing the online advising strategies. He/she will be responsible for supervising and training SI leaders for the e-SI component. The ESSS's funding will be reduced by 25% each year, reaching institutionalization after year 5.
CSUB- Engineering Curriculum Specialist (100% Yr1; 75% Yr2; 50% Yr3; 25% Yr4; 25%Yr5)	A well-qualified engineering professor is needed to develop the necessary specialized curriculum in energy engineering. The ideal candidate will have a PhD in energy engineering or other related area. This person will also be responsible to establish the CSUB undergraduate research program and recruit and train upperclassmen as research apprentices. The recruiting and hiring process will follow state standards that ensure equal employment opportunity for all applicants, but efforts will be made to advertise in Hispanic publications as well as consult Hispanic organizations such as HACU. The ECS's funding will be reduced by 25% reaching institutionalization of a new faculty position after year 5.
CSUB-Engineering Transfer/Articulation Advisor (50% all years).	The ETAD will be responsible for overseeing and coordinating the dual admission program with BC for the Power/Energy Engineering pathway. He/she will assist BC faculty and counselors to identify early candidate for the new engineering pathway and assist in student advising. This person will work closely with faculty and administrators at BC, as well as communicate regularly with high school counselors and teachers.

CSUB-Data Analysis Specialist/ Researcher (50% all years.)	For such an intensive data-based project a specialist with experience in education statistics is necessary to assist faculty with collection, analysis, and the establishment of benchmarks for tracking student outcomes that will further improve of the project. This person will also develop a student database for tracking purposes and use for longitudinal data analysis.
BC-Partner Project Leader (15% all years). No cost to the grant.	Liz Rozell, Dean of Instruction- Science, Math, Engineering-will provide the necessary leadership to ensure completion of all collaborative activities at BC at no cost to the grant. She will work closely with the BC engineering liaison to ensure close communication between the partners.
BC-Engineering Liaison (50% all years)	The EL will coordinate articulation, outreach and student services efforts for identified BC students with interest in an engineering degree. He/She will liaise with Counseling for student advisement and facilitate faculty and student communications.
BC-Faculty Release (Years 1-5 @ 10% of full time equivalent):	BC faculty will be compensated for extra assignments/will work closely with CSUB faculty to align the engineering curricula and reform existing courses and laboratories. BC faculty will also receive training to develop student outcomes that align with national ABET accreditation standards.
Fringe Benefits	
Fringe benefits are calculated on the basis of Federal and State laws and College agreements with staff. Fringe benefits are calculated at an average rate of 30% for all employees.	
Travel	
Minimal funds are needed each year for travel to support costs associated with CSUB faculty/staff in activities directly related to project objectives.	
Equipment/Supplies	
Funds are requested to develop the necessary Power/Energy engineering labs at CSUB, (see conceptual map for the development of the laboratories in Activity Budget Detail Form) and strengthen the gateway science and mathematics labs and classrooms at BC. Funds are requested to assist with outreach activities current Project Lead the Way high school students. Funds also are requested for undergraduate research project-based learning implementation.	
Other	
External Evaluator	The well-qualified local evaluation agency will provide extensive, valuable formative and summative evaluation of project activities cost-effectively.
Tutors/Peer Mentors	Minimal grant funds are requested each year to integrate a mentoring and tutoring program to the Engineering pathway at CSUB, and the MESA and STEM programs at BC.
Research Apprentices	Minimal grant funds are requested for costs associated with upperclassmen or graduate students to assist faculty in undergraduate research projects that are an integral part of the liberal engineering teaching and learning approach being developed and tested.
ABET Consultant	ABET accreditation is critical for the eventual sustainability of the new pathway. The accreditation process is very rigorous and lengthy and requires extensive planning at the early stages. Grants funds are requested in years 4 and 5 only to hire an experienced consultant who will advise CSUB during the initial steps towards accreditation.

8. QUALITY OF THE PROJECT DESIGN

The overarching purpose of this project is to propel CSUB and BC forward in responding to student and service area needs. **Hispanic students are a virtually untapped natural resource in Kern County for developing the strong STEM workforce that is so critically and urgently needed.** But more must be done, and done better, to support the academic success of Hispanic students in the service area who are typically low-income, attend low-achieving and underfunded schools systems, and are not adequately exposed to STEM opportunities. The project is intentionally designed to significantly increase the participation and degree completion rates of Hispanic students in engineering not only to develop a well-educated workforce which is in high-demand in the San Joaquin Valley but also to broaden degree opportunity for a large group of high need potential Hispanic engineers.

The engineering pathway was designed following principles gleaned from the largest and most respected study (the BEST project cited in CDP) of what works to keep underrepresented students on track to an engineering degree. The pathway and the project as a whole have an equity-minded design, directly reflecting research by Excelencia in Education about what works to help Hispanic students succeed in degree completion.

The Appropriateness of Project Design to Address Identified Needs.

The project was designed to combine and fully integrate the strategies most highly recommended by the most reputable relevant sources and most supported by CSUB's own experience and research. It was designed to accelerate CSUB's progress toward meeting the magnitude of service area need for modern, relevant engineering education that produces many more well-qualified engineers who will stay in the area.

Olin College of Engineering in Massachusetts was an inspiration to CSUB in designing this project even though CSUB can never fully adopt Olin's well-funded liberal engineering education model. Olin College is not an HSI, and its mission is distinctly different from CSUB's. Olin was featured in the *Educating the Engineer of 2020* report as one of the best models of engineering education today, however, and is widely recognized as the very best model today in implementing NAE recommendations to reform engineering through an exemplary collaborative process. Olin was built from scratch starting in 1997 with a $200 million foundation gift as a deliberate effort to show that better engineering education would make a big difference in learning and retention. Olin College curriculum was explicitly framed by ABET and NSF recommendations on how to produce engineers with the desired 21st Century attributes. This college has proven that following these recommendations does significantly improve engineering outcomes.

CSUB school of Natural Science and Math and Engineering (NSME) faculty visited Olin College on two separate occasions and observed their trademark dedicated engineering design classrooms. The student engagement at Olin College was palpable, and the CSUB faculty were impressed by all they learned about Olin's approach to engineering education in their visit. Olin leaders encouraged the CSUB team to adapt Olin methodologies to fit a public institution and cited Illinois University as one example of a public institution adapting Olin's model.

Olin's curriculum emphasizes the arts and humanities as well as engineering and related sciences. A distinctive feature of their curriculum is a design stream across the four-year engineering curriculum. The CSUB visiting team could see how this approach would excite all their students and increase learning. The two CSUB faculty immediately began to envision design courses for their students. The CSUB team also learned at Olin how much would have to

change to create the same stimulating learning environment at CSUB. New design courses alone would not be enough. Even learning spaces needed to be rethought to achieve Olin's impressive outcomes.

Clearly CSUB cannot be Olin College. Olin is more selective than MIT and richly endowed. CSUB must struggle hard to even provide the basic technical infrastructure for teaching engineering effectively. CSUB can at best be a cross between Olin and Wal-Mart because of limited resources and the range of student needs. But CSUB students need to be engaged in learning engineering even more than those at Olin, and the principles underlying Olin's success apply equally if not more so to CSUB. In many ways CSUB is as motivated and ready to reinvent engineering as Olin was when it began an engineering college from scratch with almost unlimited private funds. **Project design reflects this commitment.**

CSUB Hispanic students need to be able to get excited about the relevance of engineering to their own lives, problems and dreams, and CSUB has some advantages over larger, much better established engineering schools in following in Olin's footsteps. CSUB is well positioned in many ways to design an engineering program that meets NAE recommendations – using an outstanding liberal engineering model, and adopting that model to be accessible to Hispanic students because it is designed specifically to help Hispanic students succeed in engineering degree completion.

Summary of CSUB Readiness to Develop a Best Practice "Liberal Engineering" Approach for Hispanic Students With Additional Options to Prepare for Local Careers
• CSUB is already working with BC to develop a fully-articulated STEM pathway and has increased the number of Hispanics completing degrees in STEM from 22 to 222 since 2007. • CSUB as a whole has initiatives underway to increase learning and retention in at risk students, which are fully consistent with a liberal engineering approach. • CSUB is guided by a comprehensive local engineering needs assessment that found evidence of high need for relevant local engineering degree programs. • CSUB has already developed a successful engineering degree program in Computer Engineering, adapting the existing Computer Science program; CSUB and BC are working together to develop this program as a fully-articulated STEM pathway which is designed to attract and retain Hispanic

students to degree completion and also meet ABET criteria.

- The Power/Energy engineering track will share resources for the first two years of study with the Computer Engineering program that is under development. This will result in significant savings in equipment and supplies while increasing the efficiency of existing university resources.
- The Power/Energy engineering track will require substantial investment in equipment and supplies (see Budget Narrative form) but it will also be supported by the local energy industry that has already committed to share specialized resources to be used in undergraduate research and senior projects that will be required for degree completion.
- CSUB's main feeder CC (Bakersfield College), an HSI equally committed to STEM equity, has an established 2-year engineering program. BC has a successful MESA program and a chapter of the Society of Hispanic Professional Engineers (SHPE). Students who complete BC's program have to move out of the area to complete a degree in engineering, so BC is also fully committed and ready to develop a local, seamless intersegmental "liberal engineering" pathway with tracks that will attract local Hispanic students to engineering degrees at CSUB.
- CSUB's science faculty has experimented with some best practice innovations relevant to NAE pedagogy recommendations and is strongly committed to NAE and NSF basic principles of best practice to improve STEM learning and develop the signature engineering pedagogies that have been proven to increase learning.
- CSUB can start fresh in many ways in designing a general engineering degree program that aligns with engineering practice in the workplace now and in foreseeable future.
- CSUB has visited Olin College twice and developed a plan to use some of their resources and models with strong encouragement from Olin's leaders.
- CSUB has also studied other redesigned engineering programs including University of Illinois and Boise State. Illinois has one of the most outstanding and innovative public university engineering programs. Boise State has won recent NSF awards for engineering innovation.

CSUB must design its own unique liberal engineering (LE) model for at risk underrepresented students and must make sure that BC students are taken into account. BC's two-year engineering program must be adapted to articulate seamlessly with CSUB's program. The project design includes extensive intersegmental collaboration at each stage of engineering pathway development.

How NAE Recommendations Influenced Project Design to Achieve Goals 1 and 3	
Recommendations to Produce Well-Qualified Engineers for Today's Workplace	**Project Design to Implement Recommendations**
• Adopt a broader view of the value of an engineering education to include providing a "liberal" engineering education that develops a wide range of aspirations and attributes in engineering students and provides a springboard to many career pursuits in addition to specialization options.	• CSUB's new engineering approach will offer a B.S. degree in Power/Energy Engineering The project aims to implement "engineering learning" across the curriculum, however, not just develop traditional engineering courses that are discipline-centered.
• Exploit the flexibility inherent in the ABET outcomes-based accreditation approach to	• The design of CSUB's liberal engineering model will be based on proven models like

experiment with most new models and approaches that address the serious problem facing traditional engineering education – declining interest in fastest growing, underrepresented groups particularly Hispanics, and poor retention to degree completion. Make sure that the models and approaches are responsive to the needs of these students rather than continuing the traditional engineering methodologies that have now been proven to be a root cause of this problem.	Olin's, but it will be adopted to meet the needs of BC and CSUB and be sustainable with their limited resources after development. It will include the critical Olin elements. The project design includes extensive experimentation by CSUB faculty as an integral part of faculty development. CSUB and BC will work together to develop methodologies and approaches that implement NSF/NAE recommendations, and they will assess learning in their courses in terms of student outcomes established collaboratively.
• The essence of engineering, the iterative process of designing, predicting performance, building and testing, should be taught from the earliest stages of the college curriculum, and the curriculum for the entire first year for engineering students should be fully integrated, interdisciplinary, and design-focused.	• The design encompasses re-engineering of the CSUB FYE and General Education (GE) curricula as well as development of new engineering track options. A new first year integrated engineering curriculum will be developed with an emphasis on teaching the "essence of engineering" using best practice methods and an emphasis on design.
• Engineering faculty should participate in student learning outcome (SLO) research as a means to enhance and personalize the connection to undergraduate students, to understand how they learn, and to appreciate the pedagogical approaches that excite them. • Research in teaching and learning as it pertains to curriculum redesign and SLO assessment is recommended by the American Society for Engineering Education as a proven best practice for increased student learning outcomes	• CSUB needs to grow its own faculty learning assessment specialists in order to implement the NAE recommendations that influenced project design. The project will bring in outside experts and provide extensive training opportunities to help faculty assess and improve their teaching practice. • As learning assessment specialists, CSUB/BC faculty will be able to measure and improve learning as indicated by students meeting learning milestones at the course, program and degree levels.
• Strengthen ties binding engineering education to industry practice because of the growing disconnect advanced as technology revolutionizes the workplace. Make sure that industry is engaged in all engineering program development/ evaluation.	• The design of CSUB's liberal engineering model will fully integrate methodology to make this connection unavoidable, including internships and design teamwork projects involving local industry representatives in teaching and mentoring of engineering students at BC and CSUB.
• Teach engineering students how to learn, and introduce interdisciplinary learning early because real world problems are rarely defined along traditional discipline lines.	• BC and CSUB will develop new and adapt existing curriculum to introduce much more interdisciplinary "liberal engineering" learning early to students whether they are majoring in engineering or not.
• Facilitate seamless articulation between two and four year engineering programs in order to increase access and success for low income underrepresented groups. Articulation should	• NSF recommendations for "second-level" articulation will be followed to strengthen BC and CSUB articulation. A second level articulation includes more structured,

include collaborative effort to improve K-12 outreach and educate the community about the requirements and opportunities provided by the liberal engineering degree pathway from BC through graduation at CSUB.	purposeful and extensive collaboration between two and four-year institutions to attract K-12 students to STEM and increase retention and completion rates. CSUB and BC must educate the community and face their service area challenges together.
Note that these recommendations were gleaned from the seminal report by the National Academy of Engineering cited in the CDP as the main source of information for collaboratively planning a modern engineering approach that would be most effective with underrepresented, underprepared Hispanic students.	

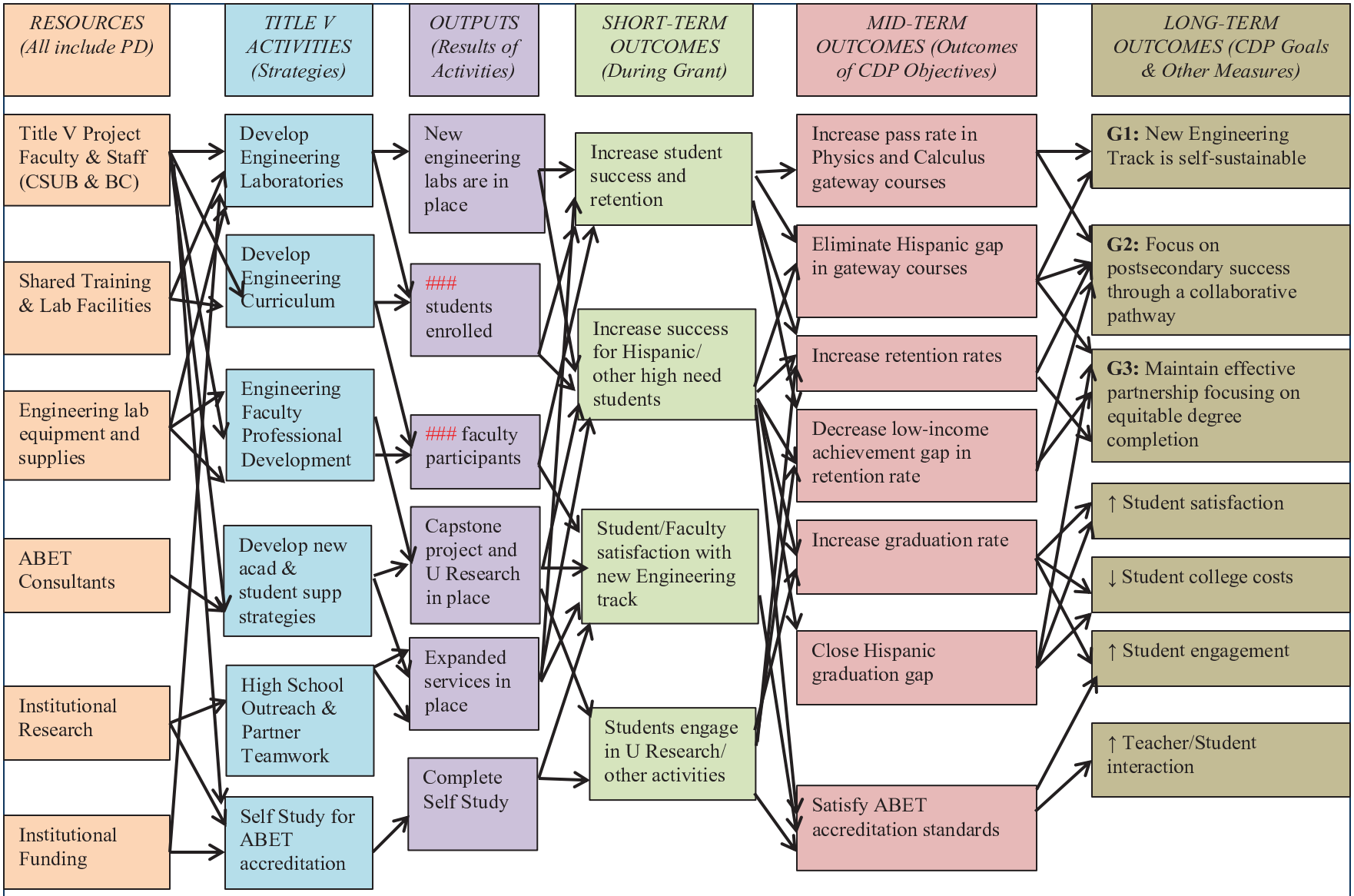
The design of the project strategies to achieve Goal 2 was most influenced by the findings of a recent comprehensive California Community College (CCC) study of transfer issues and solutions.[23] The research group that studied CCC transfer in general also studied engineering transfer specifically, and their findings influenced project design. The CTE Transfer Research Project found that the transfer pipeline is long and leaky for CCC students. There are many unnecessary obstacles.[24] This study was particularly useful because actual engineering transfer students were surveyed and interviewed, and their transfer journey was tracked closely. These students confirmed that this journey was an ordeal. Engineering students need dedicated, effective transfer advising, and California public institutions must work together even harder to articulate engineering coursework because of systemic problems.

How CCC Transfer Research Influenced Project Design to Achieve Goal 2	
Main Obstacles to Transfer Between CCCs and California State Universities	**Project Strategies to Remove Obstacles in CSUB's the Engineering Pathway**
Curriculum misalignment. Transfer of credits is the biggest barrier for students in CCCs (and nationally). Community college students often have to repeat courses at the university that they have already passed at the community college due to lack of articulation..	The intersegmental, faculty-led team now working to improve alignment in STEM will be expanded/supported and charged with conducting a thorough transfer audit, developing consistent, sequential learning outcomes for all courses in the pathway.
Inadequate "Structures of opportunity." Degree pathways are not clearly marked and structured to help students stay on course to	Accurate roadmaps and road signs will be developed for the engineering pathway. Students will be advised about successful patterns and

[23] Andrea Serban, *Transfer Issues and Effective Practices: A Review of the Literature, The Research and Planning Group for CCCs* February 2008. (See also Section 3b.)
[24] *Improving Transfer for Engineering Students*/ CTE Transfer Research Project Brief/ Fall 2010.

degree completion. When at risk students are not guided closely, they are less likely to complete a degree. They have a much better chance of success if they follow specific attendance patterns.	monitored. An eAdvisor system will be developed to provide accurate information to support more structured education planning and clear delineation of milestones toward degree completion.
Transfer support programs that are not effective – too isolated, general and passive. Transfer centers are not used by students who need them most. Engineering students need transfer support that reflects their special needs.	MESA has one of the best reputations as a transfer program that works for Hispanic engineering transfer students, providing them with a support system and peer group. CSUB and BC will collaborate to provide a strong, continuous MESA program.
Beginning level articulation agreements that do not encourage community college students to envision themselves as university graduates, that do not remove the identified obstacles impeding transfer student success which result from inadequate institutional practices.	CSUB and BC will develop a second-level articulation partnership and will work collaboratively to articulate the liberal engineering pathway for seamless transfer; best practice methods will be used to achieve productive articulation collaboration.
Inadequate transfer research support for continuous improvement of intersegmental collaboration and articulation. Few four-year institutions systematically study transfer systems and intervention to determine what works best to increase the success and degree completion of transfer students.	Second-level articulation requires collaborative research that goes beyond easily measured outcomes (number of credits or courses) to assess and align fully student learning outcomes and competencies. The project will develop an intersegmental articulation tracking system.

ABSOLUTE PRIORITY: How the Absolute Priority is addressed by Project Design: The new Power/Energy Engineering pathway is specifically designed to address local need for college degree opportunity in a service area in which almost all the college-age population fits the federal definition of "high need students." Every feature of the degree pathway was selected for its potential to increase the number of these high needs students who are prepared for and able to complete an engineering degree. Because so many local potential engineers are low-income and underprepared, the seamless, fully supported pathway starts at Bakersfield College. The pathway provides a ladder for these students, most of whom need a good job as soon as possible. They can start at an open admission, low-cost community college and enroll in Career and Technical Education certificate programs and applied degrees. They will have the option to go further to a university degree without losing credits.



LOGIC MODEL FOR THE DEVELOPMENT OF THE POWER/ENERGY ENGINEERING PATHWAY

10. COMPETITIVE PREFERENCE PRIORITIES:

Competitive Preference Priority 1. This cooperative arrangement project directly addresses the mission-critical goal of both partnering HSIs to improve academic success. It thus directly addresses Title V Priority 1. Both HSIs recognized that the biggest challenge in building an engineering degree pathway in their high need service area was to help underrepresented Hispanic students to succeed in completing an engineering degree. Services to be included in the pathway were selected on the basis of their potential to help CSUB produce 120 more engineering graduates (=90FTES) by 2020. Doing this will take much more than an ABET certified engineering degree program although that is absolutely required. Turning high need, underprepared Hispanic students into engineers requires clustering unavoidable high impact practices and framing the entire intersegmental degree pathway following "liberal engineering" principles. It requires providing support services until degree completion.

> "Students count as individuals in effective [engineering and science] programs. At their core are student-centered teaching and learning methods, along with mentoring, tutoring and peer interaction" (p. 2)[25]

Pathway Student Services to Support Achievement and Completion
• **Advising and mentoring each step of the way –** to included dedicated faculty and peer advising and mentoring integrated with classroom instruction and online advising following identified principles of best practice by the National Academic Advisory Association. • **Guidepost courses at important junctures –** to include a freshman year experience linked to engineering and capstone course that links students to the local workplace. • **Continuous monitoring each step of the way –** to include an early warning system, coaching from successful, on track peers and pathway faculty and methods to monitor and ensure learning is happening in every course. • **Learning assistance each step of the way –** to include active learning in every classroom supported by both face to face and online Supplemental Instruction – the proven best tutoring approach. Undergraduate research and other high impact practices will be used to increase engagement in learning. • **Activities to engage students in college and in engineering each step of the way –** to include, integration of the CSUB fab lab and Energy Center into the curriculum and internship opportuniy in local related industries.

[25] *What Works: Building Engineering and Science Talent* (BEST).

- **Undergraduate research** – to include opportunity to work with faculty in the fab lab and Energy Center on real ongoing research projects. Undergraduate research has been identified by the American Association of Colleges and Universities as having the most potential to engage and retain high need underrepresented students in engineering and science.

Supplemental Instruction is a featured pathway service for good reason. SI is more efficient that traditional one-on-one tutoring and much more effective. It is not, however, an ideal model for today's large, underfunded public HSIs in which almost every course is challenging to almost all students. Therefore, an online version will be created following the same principles underlying the traditional SI model. (See more Information in Priority 2 narrative.

SI Practices Found to Improve Learning/Retention of High-Risk Students

- **SI Leaders.** Successful students in targeted courses are trained intensively to facilitate sessions and serve as role models/mentors/guides. Training includes modeling of SI sessions. SI student leaders learn as much as the students they help. They work closely with faculty to understand assignments and also serve as peer mentors.
- **Challenging courses targeted** rather than struggling students. SI is a particularly effective strategy for high need students because it targets the highest risk courses and saves them time while supporting learning community.
- **Dual-purpose methodology** that combines tutoring in course content and development of foundational learning skills. The hallmark of the SI model is that struggling students are not just tutored in difficult subject matter; the method also helps develop academic skills.
- **Faculty direction and support.** Faculty must provide leadership and mentor the SI leaders for SI to be effective. Thus SI serves as a faculty development method, a way to get faculty more in touch with student learning obstacles.
- **Collaborative Learning Community** is created by group sessions and activities that encourage collaborative learning. Collaborative learning has been identified consistently as a high impact practice for at risk students.

Hurley, M., Jacobs, G., & Gilbert, M. (2006). The Basic SI Model. *New Directions for Teaching and Learning,* 106, 11-22.
Malm, J., Bryngfors, L., & Morner, L. (2012). Supplemental instruction for improving first-year results in engineering studies. *Studies in Higher Education*, 36(6), 655-666.
McGuire, S.Y. (2006). The Impact of Supplemental Instruction on Teaching Students *How* to Learn. *New Directions for Teaching and Learning,* 106, 3-10.

Another pathway feature for Priority 1 is Just-in-Time Teaching (JiTT), a teaching and learning strategy based on the interaction between web-based study assignments and an active learner classroom. JiTT is an ideal hybrid, integrated strategy to scaffold the pathway for student

success. Students respond electronically to carefully constructed web-based assignments which are due shortly before class, and the instructor reads the student submissions "just-in-time" to adjust the classroom lesson to suit the students' needs. Thus, the heart of JiTT is the "feedback loop" formed by the students' outside-of-class preparation that fundamentally affects what happens during the subsequent in-class time together. JiTT is also a faculty development strategy because it enables faculty to monitor student learning and make improvements.

The JiTT Feedback Loop: How it Serves Students

JiTT web pages fall into three major categories:
1. Student assignments in preparation for the classroom activity: WarmUps and Puzzles.
2. Enrichment pages. Short essays on practical, everyday applications of the course subject matter, peppered with URLs to interesting material on the web. These essays have proven themselves to be an important motivating factor in introductory service courses, where students often doubt the current relevance the subject.
3. Stand-alone instructional material, such as simulation programs and spreadsheet exercises.

WarmUps and Puzzles are the heart of the JiTT web component. These are short, web-based assignments, prompting the student to think about the upcoming lesson and answer a few simple questions prior to class. These questions, when fully discussed, often have complex answers. The students are expected to develop the answer as far as they can on their own. We finish the job in the classroom. These assignments are due just a few hours before class time. The responses are delivered to the instructor electronically to form the framework for the classroom activities that follow. The interactive classroom session, built around these responses, replaces the traditional lecture/recitation format.

Students complete the WarmUp assignments before they receive any formal instruction on a particular topic. They earn credit for answering a question, substantiated by prior knowledge and whatever they managed to glean from the textbook. The answers do not have to be complete, or even correct. In fact, partially correct responses are particularly useful as classroom discussion fodder. In contrast to WarmUps, Puzzle exercises are assigned to students after they have received formal instruction on a particular topic. The Puzzles serve as the framework for a wrap-up session on a particular topic. The WarmUps, and to some extent the Puzzles, are undergirded by education research and target a variety of specific issues. The list of targeted issues might contain: developing concepts and vocabulary, modeling -- connecting concepts and equations, estimation- getting a feel for magnitudes, relating technical scientific statements to "common sense", understanding the scope of applicability of equations, etc.

Novak, G, Patterson, E.T., Gavrin, A.D., and Christian, W. (1999). *Just-In-Time Teaching: Blending Active Learning with Web Technology,* Upper Saddle River, NJ: Prentice Hall.

Competitive Preference Priority 2. The project also clearly addresses Title V Priority 2. An Integrated Holistic e-Learning Program (IHeLP) has been planned to meet the specific needs of CSUB Hispanic high-need students and supplement inadequate face-to-face services. Neither HSI can afford a large enough student services program. Providing online support is the only way to address the magnitude of student need, with severely limited resources. Pathway students will have access to both institutions' traditional but customized and improved face to face advising and counseling, but these isolated services are essentially inaccessible for many. The IHeLP model, which will be piloted in engineering pathway courses, has the potential of becoming the standard across the school of Natural Sciences, Mathematics, and Engineering and even throughout the whole campus. The IHeLP program is designed on the principles of good practice for promoting learning and engagement in high need college students. Technology will simply be the means to deliver and scale up services. (See more information about IHeLP services in Implementation Rationale.)

There is now a large body of research on the effectiveness of online instruction and learning support. One impressive recent review of studies of online effectiveness by the Department of Education found some evidence that online instruction can be even more effective than traditional instruction in a college classroom.[26] **However, this meta-analysis concluded that the mode of delivery is not as important to student learning and completion as other factors –** the same factors essentially as those which have been found to determine success in traditional classrooms. Students who need high intensity practices to learn and complete need them in every course they take until completion. They also need the most effective online design

[26] Means, Barbara, et. al., Center for Technology in Learning. *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies.* U.S. Department of Education Office of Planning, Evaluation, and Policy Development Policy and Program Studies Service, Revised Sept. 2010.

and learning assistance. Clearly, providing learning assistance online has potential advantages for students who need more learning time according to the Department of Education meta-analysis.

Verbatim Conclusions of US Department of Education Report on Online Instruction

"In recent experimental and quasi-experimental studies contrasting blends of online and face-to-face instruction with conventional face-to-face classes, blended instruction has been more effective, providing a rationale for the effort required to design and implement blended approaches. When used by itself, online learning appears to be as effective as conventional classroom instruction, but not more so.

However, several caveats are in order: Despite what appears to be strong support for blended learning applications, the studies in this meta-analysis do not demonstrate that online learning is superior as a *medium.* In many of the studies showing an advantage for blended learning, *the online and classroom conditions differed in terms of time spent, curriculum and pedagogy.* It was the *combination* of elements in the treatment conditions (which was likely to have included additional learning time and materials as well as additional opportunities for collaboration) that produced the observed learning advantages. At the same time, one should note that online learning is much more conducive to the expansion of learning time than is face-to-face instruction."[27]

Another meta-analysis of studies of online instruction is much less positive about its potential to increase the academic access, progression and success of low income and underprepared students.[28] This analysis found that online instruction may hinder progression for these students. **Therefore, the project will not feature development of online courses but rather will include strategies to deliver the services that are most needed to improve the learning and retention of pathway students using online and hybrid modes.** JiTT is an ideal multi-purpose strategy with web-based features. All services will be built on the same principles of intensity, quality and scale that must inform all design for Hispanic student success. Pathway students who enroll in CSUB online courses will also be provided IHeLP services. (CSUB is in the process of developing online and hybrid courses across the curriculum.)

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[27] Ibid, p. XVIII.

[28] Smith Jaggars, Shanna. *Online Learning: Does It Help Low-Income and Underprepared Students?* CCRC Working Paper No. 26, Community College Research Center, Teacher's College, Columbia University, Jan. 2011.

The development of the e-SI component of IHeLP will be modeled after the highly successful program developed at the University of Wyoming[29]. Supplemental Instruction (SI) is one of the best known and most respected methods of providing learning assistance. It is simply too expensive to provide SI only using the proven face to face model but there is good reason to believe online SI can work well.

Description of the CSUB e-SI program
What is e-SI?: e-SI is a series of out-of-class sessions led by a student who has taken the course e-SI is offered in successfully. The program targets courses, not students. While all students might not take advantage of the voluntary opportunity, it is expected to attract an equal proportion of students from differing ability and cultural groups. E-SI does not segregate students based on prior academic performance or predictions of academic success. In fact, e-SI works best with heterogeneous groupings of students.
The Role of e-SI Leaders: The e-SI leader functions as "model student" of the discipline rather than authority figure. E-SI leaders help students formulate and answer their own questions. This process helps students develop a more sophisticated approach to learning while maintaining the focus on content mastery. The e-SI sessions integrate the review of lecture notes, textbook readings, outside supplemental readings along with appropriate modeling of learning strategies. "How to learn" is embedded into e-SI sessions along with "what to learn." Through practice and mastery of effective learning strategies, students can adopt and transfer these strategies to other subjects and content areas. Collaborative learning strategies are used in e-SI sessions as a means of creating a more active learning environment for student participants.
How e-SI is done online: The CSUB e-SI sessions will be conducted in real-time via a web-conferencing program. Nothing is installed on the student computer and there are capabilities of audio, video, screen-sharing, white board and other tools.
Sources: See Implementation Strategy rationale for research supporting effectiveness of Supplemental Instruction.

[29] University of Wyoming, Online Supplemental Instruction, http://www.uwyo.edu/learn/si/.