

## White Paper

Institutional Plans: Colleges/Schools of Engineering, Kansas Regents Universities  
House Bill 2149: University Engineering Initiative Act

### *Background*

The National Academies report, “Rising Above the Gathering Storm,” recognizes that as much as 85 percent of measured growth in income per capita in the United States is due to technological advancement. Engineers lead the way in this endeavor. Despite downturns in many sectors of the economy, demand for engineering graduates remains high with clear projections this trend will continue.

In Kansas, the engineering profession is a primary source of the workforce. It is estimated that 80 percent of all science and technology-based occupations in the state stem from the engineering and information technology fields. In 2008, the top 25 U.S. exports via Kansas fell largely into two commodity categories – agriculture and engineering-intensive machines and equipment. Of the \$8.1 billion export value of these top 25 commodities, engineering-intensive commodities accounted for more than \$5.5 billion or two-thirds of the total.

To enhance the economic future of Kansas, its universities must supply the graduates for high-paying entry-level engineering positions, which have the potential to carry the state forward by increasing the size of the tax base. Economic impact from engineering professionals also provides a significant benefit to other segments of the Kansas workforce. In 2009, the Kansas Society of Professional Engineers hired the Wichita State University Center for Economic Development and Business Research to conduct a study which showed that for every one engineering professional, an additional 1.78 persons are employed in Kansas, and state fiscal outlays associated with an increase in engineering graduates show a benefit-cost ratio of 2.07.

In spring 2008, President of the Kansas Senate, the Honorable Steve Morris, asked the Deans of Engineering at KSU, KU, and WSU to join him at his office in Topeka. At that meeting, he expressed his concern for the assured shortage of engineers in Kansas and asked the deans to develop a proposal that would increase by more than 50 percent the size of their current graduating classes. At that moment, the deans began to work together to develop a unified plan that would change the state of Kansas. On March 10, 2011, Senate Bill 235 was announced, which would add significant state support to growing the engineering infrastructures at the regents universities with engineering programs. This bill, the “University Engineering Initiative Act,” would create Kan-grow engineering funds for each campus through expanded lottery act revenues (ELARF.)

The Kansas Board of Regents is supportive of this effort to increase the number of engineering graduates and has included it as one of the priorities for the university regents system. The Kansas Board of Regents affirmed this support in a March 25, 2011, press release where Regents' Chairman Gary Sherrer stated, "We applaud the Senate's vision, value its support, and look forward to working with the House to make this important initiative a reality." Jim Lewis, chief administrative officer of Black and Veatch, stated, "Our growth is dependent on our ability to hire good engineers. We always have the volume out there that we can do, and we often restrain that just by how many talented people we can get. So we count on the state universities to provide those people for our global growth." He went on to say, "So the only way we can grow is to have more qualified engineers."

The state's three engineering programs (KU, KSU and WSU) are the principal source of the engineering workforce at the root of this economic expansion. To fill this need for career-ready employees, an annual increase of 490 graduates from the schools (up from a five-year average of 875 graduates per year) is needed. The state's engineering programs are already stretched beyond capacity, so increases in enrollment will require expansion of resources (personnel as well as infrastructure). While each of the three institutions will implement a unique plan for its campus that maximizes the effectiveness of the state investment in this initiative, the following strategies are common to the three universities: 1) recruitment of more new students, 2) increase in the percentage of students succeeding through graduation, and 3) expansion of facilities to accommodate a larger student body. The three universities are and will remain unified in the common goal of enlarging their respective infrastructures to realize this growth.

### ***Expansion Plans***

The following sections provide a high-level review of plans at each campus to meet the desired growth required to produce 490 additional engineering graduates per year. In each case, significant matching is embedded in the plans to realize the necessary infrastructure expansions. It is expected to see matching well exceeding the required dollar-for-dollar match.

#### **■ *Kansas State University (K-State)***

The increase in graduates at K-State will be realized by improving management of the student pipeline through enhanced recruitment and retention. In Figure 1, we demonstrate new and current programs that aid in improving the size of our student body. Practically all of the programs are scalable and will be expanded with additional resources. For example, recruitment programs will be expanded by investing further in scholarships and student enlistment efforts from Kansas high schools and those in surrounding states. This will require a dramatic increase in scholarship resources to make K-State reasonably competitive. Currently, scholarship offerings exceed \$1.8M per year for the student body of 3,000. New scholarship resources will be secured to generate an additional \$1.5M per year. In view of retention, student support activities must be expanded for K-State's

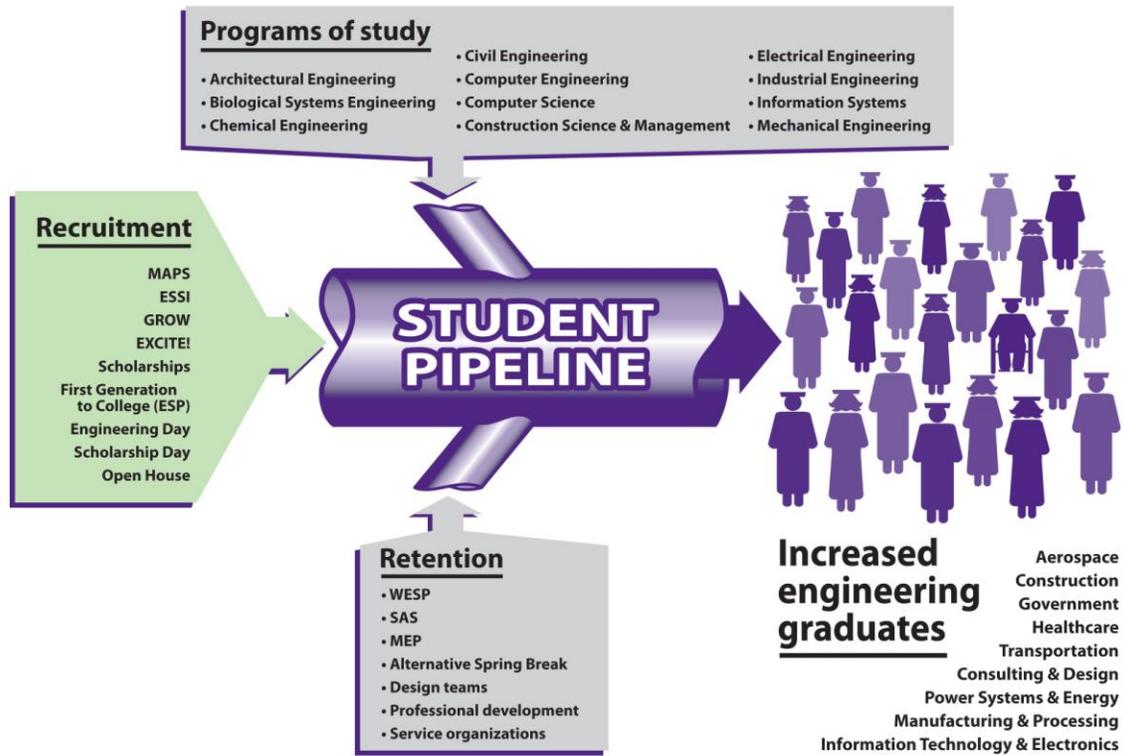


Figure 1. Kansas State University’s Management of the Student Pipeline

outstanding and nationally acclaimed programs of freshman and upper-level support, as well as its tutoring and mentoring programs.

As stated, practically all venues within the College of Engineering (COE) at KSU are scalable and can meet the growth required for Senate Bill 235 with the new resources. The Engineering Scholars Program (ESP) includes and supports multiple and impacting programs such as the Multicultural Engineering Program (MEP,) Students Assisting Students (SAS,) First Generation to College (FGC), Engineering Scholars Day (ESD), and Alternative Spring Break (ASB). Each program is designed to address certain sectors of the student body in an effort to grow the student body and retain students who have a passion to pursue engineering while providing diversity that parallels the great state of Kansas.

First Generation to College (FGC)

Kansas is a rural and eclectic state. Many prospective first-generation- to-college students exist in the state and cannot consider career options in engineering due to financial challenges. As a result, the COE has created an aggressive FGC program where such students are granted an opportunity to study engineering at KSU. The FGC program provides a student in the program debt repayment of federally subsidized loans accrued as an engineering student at KSU upon graduation from an engineering program at KSU, and

paid work/research opportunities while in college at KSU. Assuming a given student in the program is maxed out on both Pell Grants and federally subsidized loans, the student will effectively realize full support for attendance in a given engineering program at KSU. Furthermore, each student in the FGC program is supported by the SAS program where upper-level students provide tutorial services as paid part-time employees in critical courses within the curriculum. SAS is made possible through the support of student fees, private and corporate donations, and the COE. Furthermore, KSU has an active student mentoring program, where upper-level engineering students mentor lower-level students, that is to be expanded to support the anticipated growth of the student body as well. Each FGC and MEP student is encouraged to attend the ASB where students are taken on a tour of varied engineering employment venues across the state. The students enjoy exposure to various work environments and return excited and motivated about their career choice. ASB is funded by the COE, private donations, corporate sponsorships, as well as the students themselves pay a nominal charge (less that \$150.) The program typically spans four night and five days during the week of spring break.

#### Multicultural Engineering Program (MEP)

The award-winning MEP supports specific needs of multicultural students in the student body and is financially supported by such organizations such as the National Action Council on Minority Engineers and several other private investors. The Multicultural Academic Program Success (MAPS) program is a summer experience for incoming freshman students. During this fully funded experience, students are exposed to student life, take six hours of freshman courses, and are exposed to impacting methods of study that lead to high retention. Most of the FGC and MEP students in the MAPS programs are supported by private, individual as well as corporate, donations.

The College of Engineering has a tradition of reaching the four corners of the great state of Kansas to attract new students to engineering. This is accomplished through the volunteer support of upper-level students deployed to their home communities with the focus of drawing new students to the COE. Furthermore, COE hosts and supports summer activities such as the Engineering Scholars Summer Institute.

To date, KSU has seen a 145% increase in the number of students from under-represented categories stemming from programs such as the MEP, Summer Bridge program for incoming freshmen, SAS tutorial program, and FGC program. As the number of students increases, increases in staff and student hourly support will be required.

#### Increased Retention, Increased Needs

It is expected that through improved retention, the engineering student body at K-State will not necessarily have to increase by 50% to net the needed increase in graduate engineers. Currently, there are approximately 3,000 undergraduate students in its eight departments which house a comprehensive suite of 11 accredited engineering programs. To net the 50-60% increase in graduate engineers, it is expected the student body should increase to approximately 4,000 if efforts are increased for retention in the scalable programs for tutoring, mentoring, and student connections.

Support of such an expansion necessarily dictates an increase in the number of professors supporting the KSU programs. To simply retain the current undergraduate student-to-faculty ratio of almost 25:1 would require an increase of 40 tenure-track faculty. A small portion of these new positions would necessarily be allocated to departments providing large numbers of service student credit hours (e.g., mathematics, physics, and chemistry).



**Figure 2. Conceptual Design, Phase IV Engineering Facilities, Kansas State University**

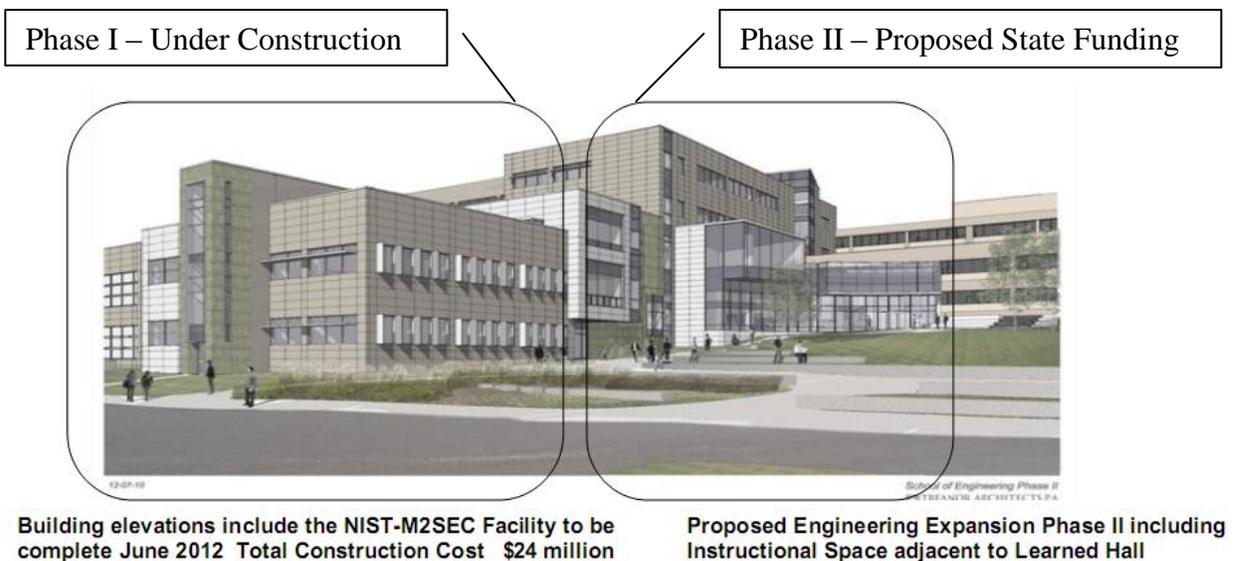
The College of Engineering is at capacity in view of facilities, and if 1,000 new students are added to the student body, classroom and laboratory facilities at K-State will be woefully inadequate. The physical infrastructure must be expanded. Expansion plans expressed as Phase IV of the Durland/Rathbone/Fiedler (Figure 2) complex exist in concept, and architectural renderings are currently being developed. Phase IV will be an addition of 80,000 ft<sup>2</sup> to the current facilities and will include significant and modern classroom facilities, open spaces for KSU's world-class design teams, and significant new laboratories for faculty research and technology development. Within these needs, three Communities of Excellence emerge as top priorities for infrastructure expansion: educational space for nationally prominent design teams (e.g., Formula Car, Quarter-Scale Tractor, ChemE Car, etc.) bridging all academic departments, computer and information systems with the focus on cyber-security, and a bio-based fuels focus that will bridge programs in both chemical engineering and biological and agricultural engineering.

#### ■ *University of Kansas (KU)*

The focus of the KU effort is on growing undergraduate engineering degree production in a quality manner. A successful strategic plan currently underway has already seen considerable growth in the undergraduate student body. Engineering students, in addition, have some of the highest ACT scores and high school GPAs among the various majors at KU. However, future growth in KU's engineering programs will be hindered unless the school can address faculty and space capacity issues.

### The Master Plan

In 2010, the university completed a master plan identifying space needs essential for this initiative. An architectural firm was hired, and after extensive interaction with school leadership and faculty groups, completed architectural renderings for the master plan showing the existing engineering buildings along with the newly proposed Phase I, Phase II, and Phase III additions that will accommodate anticipated growth. Phase I and Phase III buildings will be primarily laboratory buildings, with Phase II being primarily classroom and student support space with additional student laboratory and project design areas. Phase I is already under construction and is funded through a National Institute for Standards and Technology (NIST) grant and with private donations. KU was one of only a few schools nationwide selected for this highly competitive construction grant. The figure below shows architectural renderings for the Phase I and II buildings. The full Architectural Project Description for Phase II has been submitted to the Board of Regents (KU Project 088-8941).



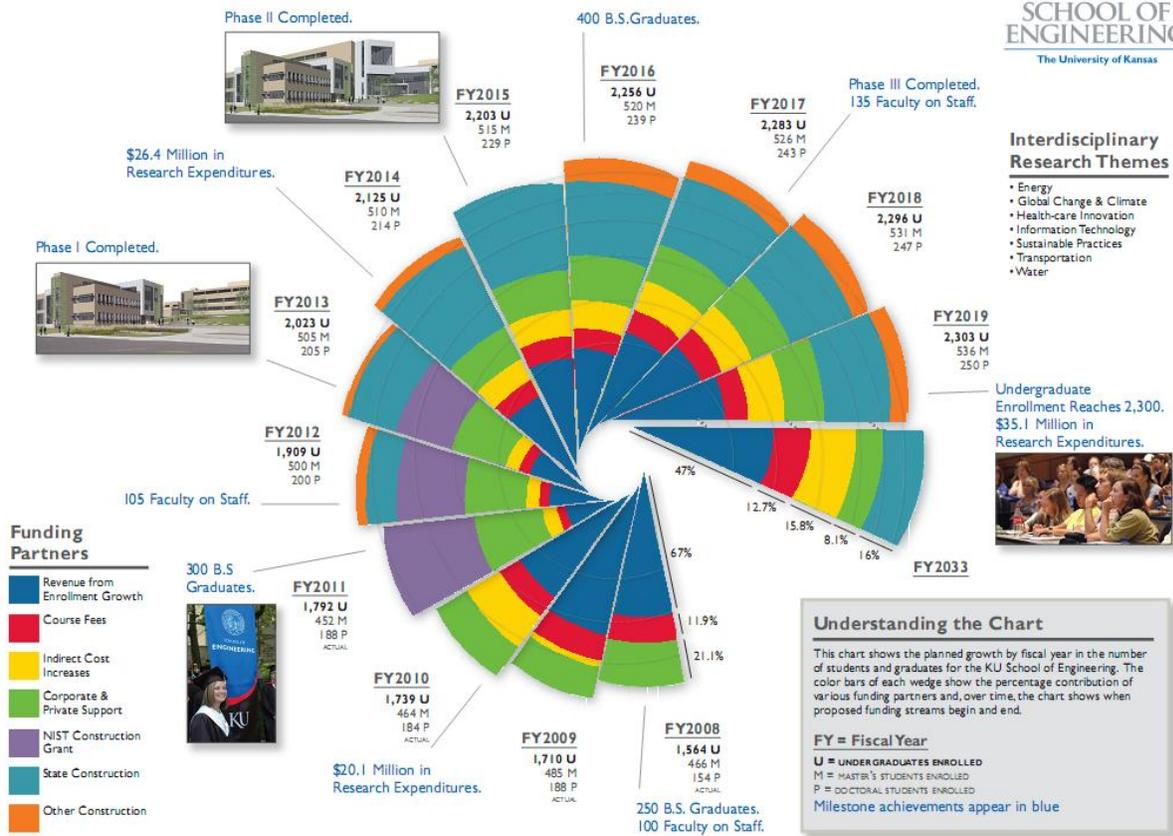
The KU master plan calls for Phase II to be funded through bonds by the University Engineering Initiative Act and \$5M per year over 20 years is estimated for the bond retirement. This 101,000-square-foot facility will accommodate growth in the student body while also addressing the hands-on project experience essential to educate and retain KU's highly successful student body. KU aerospace engineering students have won more first and second place awards in the AIAA student design competitions than any other school in the nation. The school's SAE Formula Car team has placed in the top 10 in international competitions four times since 2006. And, the school's chemical engineering seniors often dominate AIChE's annual individual design competition.

### Building on Excellence Expansion Overview

KU's Building on Excellence Initiative is the comprehensive plan that has been developed over the past three years for growing the number of engineering graduates. The figure below provides a summary of the plan and the timeline for the overall expansion plan. The timeline is read by moving clockwise around the figure and notations are included, indicating key milestones from FY2008 forward. Funding for the overall expansion

program will be provided by several partners and sources, including revenue from enrollment growth, course fees, indirect funds, donations from individuals and corporate partners, the NIST construction grant, state funding for Phase II, and other sources. The relative percentage of funding from sources is indicated by length of the pie shape for each color in a given year. As evident in the figure, state funding for Phase II (lighter blue) will be leveraged many times over by other non-state resources. Those non-state resources will pay for the additional faculty, staffing, scholarships, professorships, building maintenance and operations, as well as construction of Phase I and Phase III buildings.

## KU SCHOOL OF ENGINEERING BUILDING ON EXCELLENCE INITIATIVE



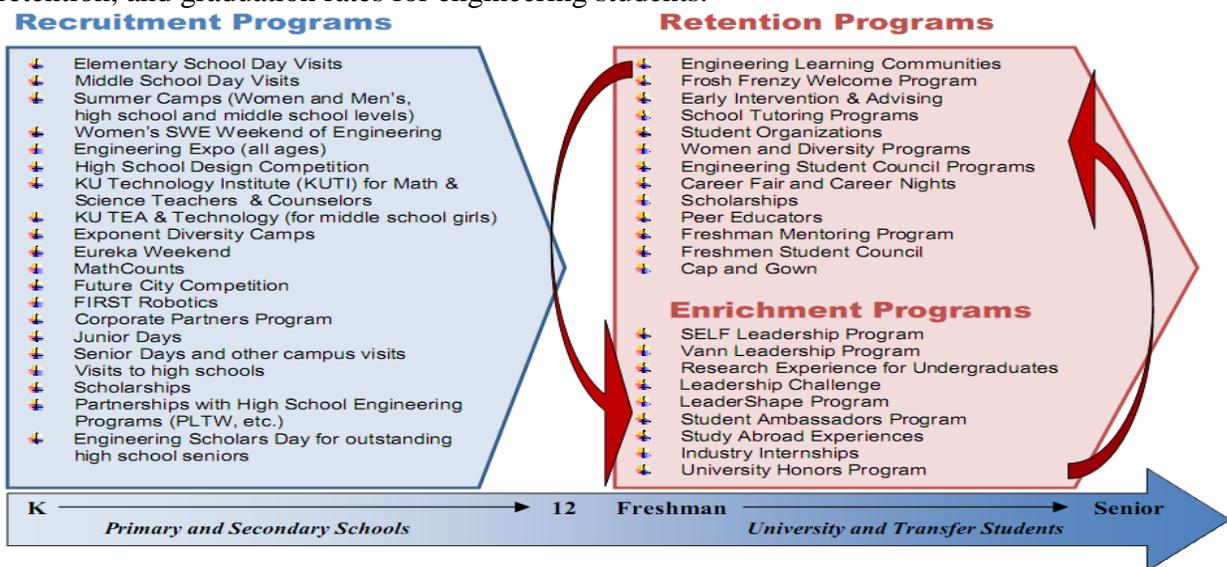
Over the last year, the faculty has identified strategic areas that best serve the needs of Kansas and the nation, and that the school is well-positioned to address. Those areas are shown in the figure above and include 1) energy, 2) information and technology, 3) transportation, 4) water, 5) sustainable practices, 6) health care innovation, and 7) global topics. In 2002, the single major research center led from the School of Engineering was the Information and Telecommunications Technology Center (ITTC), a center that continues to be very successful. Over the past few years, the school has led the development of five new interdisciplinary centers including the Center for Environmentally Beneficial Catalysis, the NSF Center for Remote Sensing of Ice Sheets, the Bioengineering Research Center, the KU Transportation Research Institute, and the Energy Research Council. The school's Building on Excellence Initiative capitalizes on

those successes, as well as the interdisciplinary themes described above that address grand challenges and will build university as well as national prominence in those areas.

Growth in enrollment and graduation numbers cannot be sustained without additional faculty resources. By improving retention rates and taking advantage of economy of scale, it is estimated an additional 30 faculty will enable the school to meet the growth goal in bachelor's degree graduates, and meet the school's discovery, innovation, and scholarly engagement goals. Additional faculty, many of whom will bring highly regarded research expertise to Kansas, will be added over a five-to-six-year period and will be supported by non-state resources.

**Recruitment, Retention, and Enhancement Programs**

The KU School of Engineering student body is a critical source of outstanding job candidates for Kansas' industries. Incoming freshman students in engineering typically lead the university in terms of ACT scores and National Merit awards, with roughly one-third of all students receiving some form of scholarship support. The school has also doubled the ethnic diversity representation in the incoming freshman cohort since 2002, with roughly 10% of new freshmen being from under-represented groups in Kansas. The target is to match the state demographic. The University of Kansas is a leading source of women engineering graduates with about 20% of all B.S. degrees being earned by females; this is a pool with excellent expansion potential that is also in high demand by industry. The figure below provides a snapshot of the KU approach to building greater recruitment, retention, and graduation rates for engineering students.



The school's goal is to maintain the quality of its students while simultaneously increasing their quantity and success rate. Additional investments will be required for recruiting and serving the larger student body. Current K-12 recruitment programs such as KU summer engineering camps, KU programs for math and science teachers, and KU Diversity & Women's Engineering Programs will be enhanced and expanded for greater reach and effectiveness. Corporate and private-funded scholarships play a key role in growing the pool of the incoming class (freshmen and transfers) each year. Additional scholarship support, through programs such as the Self Engineering Leadership Fellows (SELF)

Program, will play an important part in recruitment, retention, and enrichment of a larger engineering student body. Additional staff will expand the retention programs that focus on providing early intervention, student engagement, and support to students who otherwise might not be able to graduate and have successful engineering careers. Enrichment programs provide opportunities for students to gain additional experiences that industry values and that broaden their skills as they enter the workplace.

■ **Wichita State University (WSU)** This section presents WSU College of Engineering's plan to achieve the proposed increase in number of degrees awarded to domestic students while elevating WSU to be a Center for Excellence in Aerospace Engineering Education and Research through an Integrated Engineering Education Model (IEEM) (See Figure 1).

#### WSU College of Engineering Relationship with Local Industry

What is today the WSU College of Engineering (CoE) started in the fall of 1928 as the Department of Aeronautical Engineering in response to the need of the local aircraft companies to train engineers, professional pilots and industry managers. From its origins, the local industry has relied on the WSU-CoE to satisfy its learning, exploration and research needs.

Located in the "Air Capital of the World" and as part of the only urban serving research university in the state of Kansas, the CoE at WSU strives to be recognized nationally and internationally for its: experience-based undergraduate and graduate degree programs; collaborative efforts with industry; and research programs to support the economic development and global competitiveness of the Wichita metropolitan area, the state of Kansas, and the nation.

The WSU Cisco Technical Research Center, the only facility of its nature located in an institution of higher education, along with a five-year average of 264 engineering student cooperative education placements per academic year are evidence of the strong collaboration between the College and industry. In addition, it is important to point out that 34 percent the Wichita area industry engineers are WSU alums and that in 2008, the National Science Foundation ranked WSU third among all U.S. universities in money spent in aerospace research and development.

#### WSU College of Engineering Current State of Affairs

An analysis of the undergraduate student body at WSU CoE reveals that 80 percent are from Kansas, approximately 50 percent of these come as transfers and 76 percent of them work between 5 and 40 hours per week. Around 30 percent of the students attend college part-time.

Based on a review of a five-year average of the retention rate and six-year graduation rate for the first-time freshman, it can be concluded that these are areas of opportunity if WSU CoE is to increase the number of degrees awarded in engineering.

The CoE at WSU has been involved in two main strategies to increase the number of domestic students pursuing engineering degrees, namely, exciting more elementary, middle and high school students performing well in math and science to select engineering

as their career choice and to better prepare students who are not doing well in math and science so they can also opt for engineering as a career choice. An array of programs has been employed by the College in the implementation of these strategies to broaden participation in engineering including: Project Lead the Way (PLTW), Science and Engineering Educational Development for Students (SEEDS), Boosting Engineering, Science & Technology (BEST), SHOCKER MINDSTORMS, Engineering Summer Camps, and Changing Faces.

According to the engineering education literature, engineering students tend to drop out of college primarily in the first two years due to: 1) limited engineering involvement in the first two years and 2) student difficulty with calculus and physics. Based on these facts, the CoE at WSU has implemented the Great Expectations: Engineering Kansas **Scholars** (GEEKS) and Engineer 2020 programs to address the student-retention issue.

Currently the most critical capacity limitation for the WSU CoE relates to faculty. The student-faculty ratio is well above what is recommended by accreditation standards. In 2009, the number of degrees awarded and amount of research funding per WSU CoE full-time equivalent faculty was nearly 7 degrees and \$100,000, respectively.

#### WSU College of Engineering Ten-Year Goals

With the goal of increasing the number of degrees awarded by nearly 60 percent by the year 2021, WSU CoE will implement a plan based on three strategies: 1) to expand efforts and programs to build and strengthening the pipeline or supply chain of students interested in pursuing engineering careers, this will involve motivating and preparing them for the rigor of an engineering academic program or engineering the engineers of tomorrow (See Figure 2); 2) to augment the student success programs aimed at retaining and graduating the students in a timely manner; and 3) to expand our Engineer 2020 program and experience-based education approach with the objective of developing in all of our students the knowledge and skills that will prepare them to be productive engineers the first day they start working. Specifically, in ten years WSU CoE will achieve the following goals:

1. increase the six-year graduation rate of the full-time, first-time freshman from 34 percent to 65 percent,
2. grow the transfer student retention from 69 percent to 75 percent,
3. augment the size of the full-time, first-time freshmen class from 222 to 310,
4. increase the number of new transfer students per year from 140 to 220, and
5. augment the number of WSU CoE graduates employed by the local industry.

#### Achieving the Ten-Year Goals

Achieving goals one and two, increasing student success, will require: 1) the expansion of the GEEKS program, 2) additional curriculum reforms and 3) expansion of laboratory facilities. Support in the form of additional staff and faculty will be required. Investment in laboratory infrastructure will also be required.

The faculty to be added will have expertise in one or more of the seven strategic research thrusts areas identified by the WSU CoE, namely, Aerospace Engineering, Bio-

engineering, Composite Materials, Engineering Education, Information Technology, Nanotechnology and Sustainability.

To achieve goals three and four, the CoE at WSU will take advantage of being the only urban serving research institution in the state of Kansas. Specifically, the College will expand the array of programs described in Section 3.0. Further, new outreach and community engagement programs will be established, additional partnerships with elementary, middle and high schools will be formed, and a new scholarship program in collaboration with local industry will be launched.

The existing articulation agreements with the area community colleges will be expanded to include all the engineering programs offered in the College and thereby broadening the pathway for students to transfer to WSU CoE. New articulation agreements will be signed with community colleges across the state. Additional staff will be required to increase the size of both the full-time freshmen and transfer classes.

To achieve the last goal, the implementation of the third strategy of the plan is imperative and it will involve the expansion of the College's service and community engagement as well as our research and discovery programs. Additional faculty support will be required in this case.

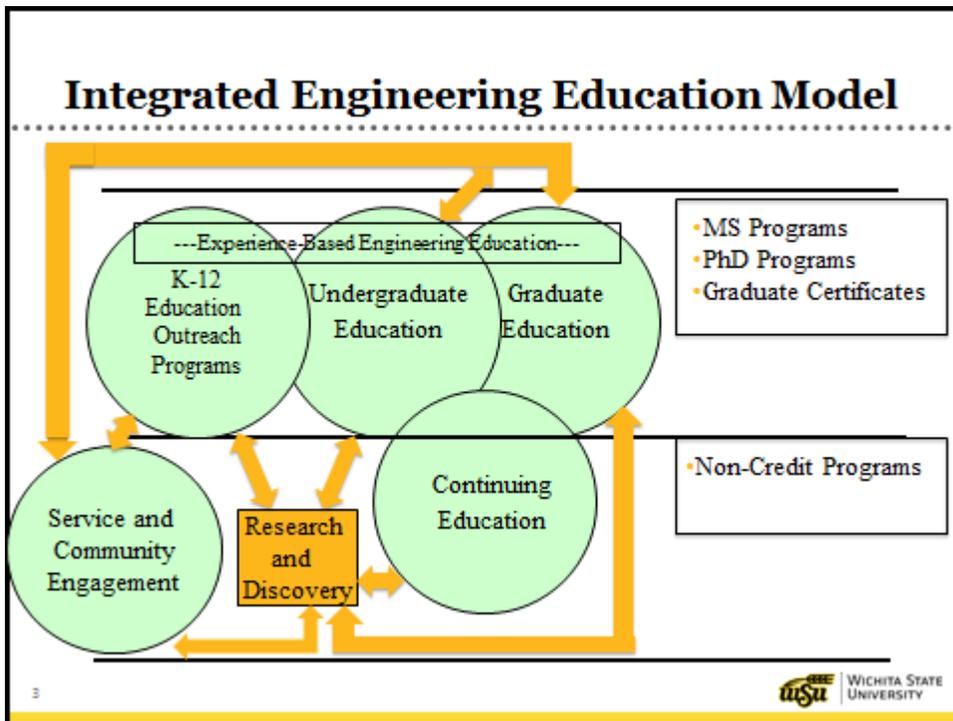


Figure 1. WSU CoE Integrated Engineering Education Model.

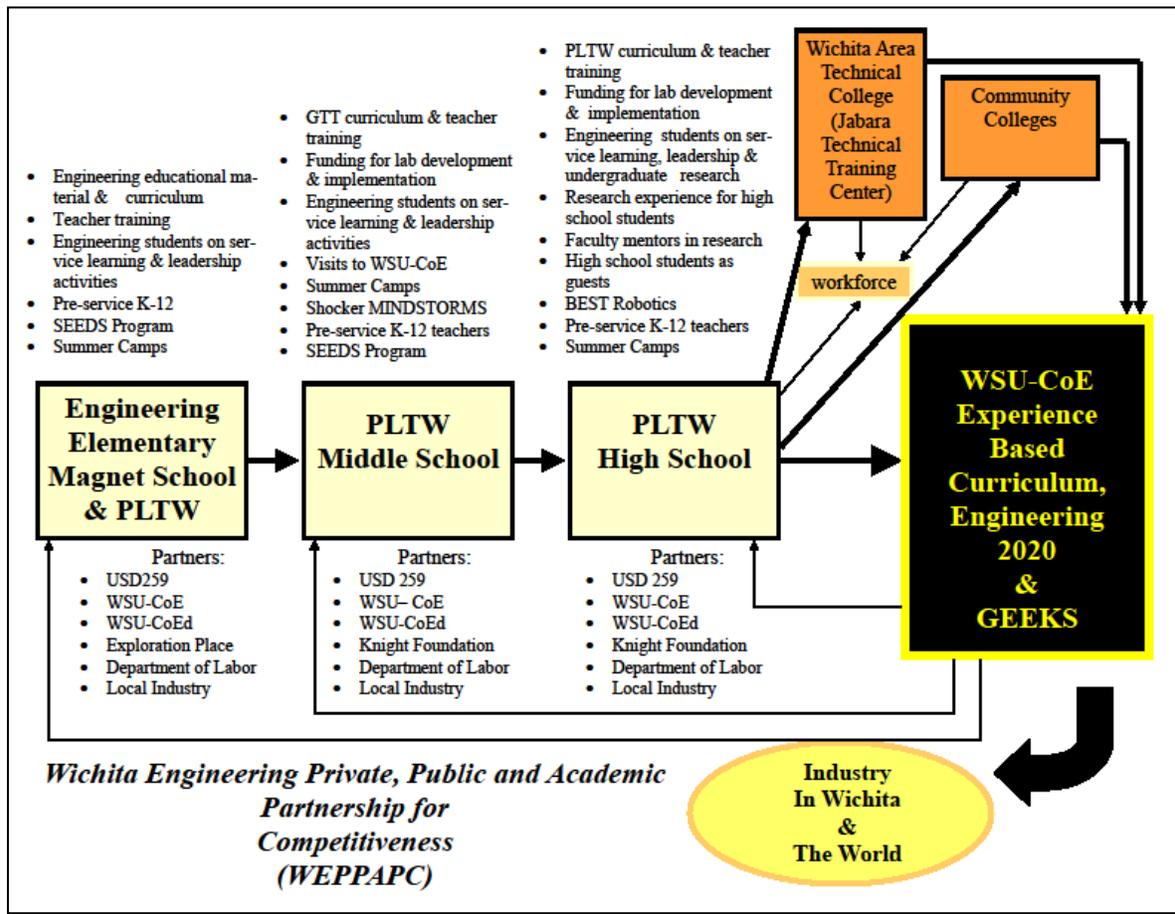


Figure 2. WSU CoE Engineering Engineers of Tomorrow.