MINUTES

Engineering Success for the Future of Kansas Task Force

March 16, 2009
Room 431-N - Statehouse

Members Present

Senator Pete Brungardt, Co-Chair
Senator Bob Marshall
Representative Terrie Huntington, Co-Chair
Representative Forrest Knox
Representative John Grange
Representative Milack Talia

Members Absent

Senator Olthea Faust-Goudeau
Senator Roger Reitz

Staff Present

Audrey Dunkel, Legislative Research
Kelly Navinsky-Wenzl
Connie Burns, Committee Assistant

Others present:

See attached list

Monday, March 16, 2009

The meeting was called to order by Committee Co-Chairperson Pete Brungardt, Monday, March 16, 2009, Room 431-N of the Statehouse at 3:30 p.m.

Post secondary Engineering Education Capacity and Needs:

Dr. John English, Dean College of Engineering, Kansas State University, stated that the National Academies report, "Rising Above The Gathering Storm," reported the shortage of professionals in science, technology, engineering and mathematics (STEM) is staggering and leading to a national and state crisis.(Attachment 1) The report pointed out that as much as 85% of measured growth in income per capita in the United States over the last 10 years has been due to technological change.

Dr. English provided background on the Task Force. In January of 2008, Senator Morris asked the Board of Regents president, and the deans from WSU, KSU and KU engineering schools to develop a plan to produce more engineers. With that charge the "White Papers" was developed.

(Attachment 2) The target response is to increase their annual number of BS engineering graduates by 50%. In September of 2008, the group met with the Joint Economic Development Committee to the raise the awareness for the need to increase the number of engineers. November 2008 met with Senator Morris, and was asked to revise the "White Papers" to reflect what industry has done to support Engineering programs.

Dean Zulma Toro-Ramos, College of Engineering, Wichita State University, spoke on recruitment and retention of students to the engineering programs. It is important to note that the efforts are being done with external and private funding. Examples of ongoing efforts to Build Kansas supply Chain of Engineers:

- Kansas Affiliate of Project Lead the Way (PLTW). The college is the state affiliate of this nonprofit, nationwide organization that provides curriculum and teacher training to implement hands-on pre-engineering education for high schools and middle schools.
- Boosting Engineering, Science & Technology (Best) Robotics. Annual sports-like competition hosted by the college that challenges high school students complete. CoE students interact with competitors, serving as spirit and sportsmanship judges, referees and volunteers.
- First Robotics Competition is a national organization that promotes teamwork and interpersonal skills in real-world settings; and promoting math, science, and engineering; is financed thru student fund raisers, grants, and financial awards.
- Shocker Mindstorms - teams of middle school students from across the state develop a robot using Lego robotics that senses its environment and responds to complete a course designed by CoE students. Professional engineers judge the event and encourage students. The event helps students build skills in design, teamwork and effective communication.

The total private investment for the last 10 years in retention efforts has exceeded $4.5 M. In the next five years, this private investment is expected to reach $5M. These programs: Great Expectations; Engineering Kansas Scholars (GEEKS); has six elements including a two-year scholarship; tutoring in STEM courses; monitoring with professional engineers; a learning community on a residence hall floor; cohort scheduling or enrollment in a set of similar courses for the students; and a three-year cooperative education opportunity. Engineer 2020 - the goal of this strategic initiative is to increase retention as well as prepare WSU CoE graduates for effective engagement in the profession in the year 2020. The CoE requires that every student complete the program requirements, including at least three of the following six activities: Undergraduate research, cooperative education or internship, global learning or study aborad, service learning, leadership and multi disciplinary education. A retention study has been completed by the WSU Psychology department to determine the key causes of student not completing their degrees.

The total private investment for the last 10 years to build capacity in the college exceeded $8.5 M. In the next five years, private investment is expected to reach $8 M; and includes: Physical Infrastructure (Facilities), Laboratory Development, Equipment and Technology Purchase and Upgrade, Facility Support (Fellowships, Endowed Chairs and Professorships)

Provided to the committee was a flow chart on Wichita Engineering Private, Public and Academic Partnership for Competitiveness (WEPPAPC) and Engineering Job Outlook chart. (Attachment 3)

Robb Sorem, Assistant Dean of Engineering, University of Kansas, spoke on the capacity component. Each of the universities will require additional capacity for handling the planned enrollment and graduation increases and are consistent with the proposed growth goal. Faculty and staff resources will focus on the increased demand in academic and career advising and classroom and laboratory teaching.

Building space is an important component and all three universities are at full capacity in engineering; increased enrollment will require additional space. Funding of new facilities will be realized through institutionally specific combinations of new bonds and donations from companies and private donors, and it envisioned that the service of new bonds will be met through institutionally specific combinations of increased tuition revenue and the proposed increased state appropriations.

The cost to the state for supporting increase of 490 graduates annually in the undergraduate degree goal is estimated to be $15 million on a continuing basis; for increases for new faculty and staff to accommodate added recruitment, teaching, advising, and retention activities for students. The total for the first funding would be $400 K. The table suggests the phase-in timing for the out-years budget.

Year		Year 1	Year 2	Year 3	Year 4 & beyond
State Support		$400,000	$5,000,000	$10,000,000	$15,000,000

Committee Discussion:

Responding to questions from the committee on the old saying of first year engineering students first day in class was "look to your left and look to your right, only one out of three will finish their degree." Dean English stated that the colleges are not going to water down the program but are doing a better job of connecting with the students through the different support programs.
The committee asked the panel to address the question of duplication of programs (i.e. all have a mechanical and electrical engineering). Dean Toro-Ramos stated that WSU has a different approach; location and industry drives programs. KSU student faculty ration is 30 to 1.

The Chairman asked how many student were on campus that would really like to be in the school of engineering, but are unable to, due to lack of space. KSU stated that the school of engineering has no limitations on enrollment. How many engineering graduates have been laid off? Research will get some numbers and information on this item.

The meeting was adjourned at 4:45 p.m.

Prepared by Connie Burns
Edited by Audrey Dunkel

Approved by Committee on:

3-5-10
(Date)

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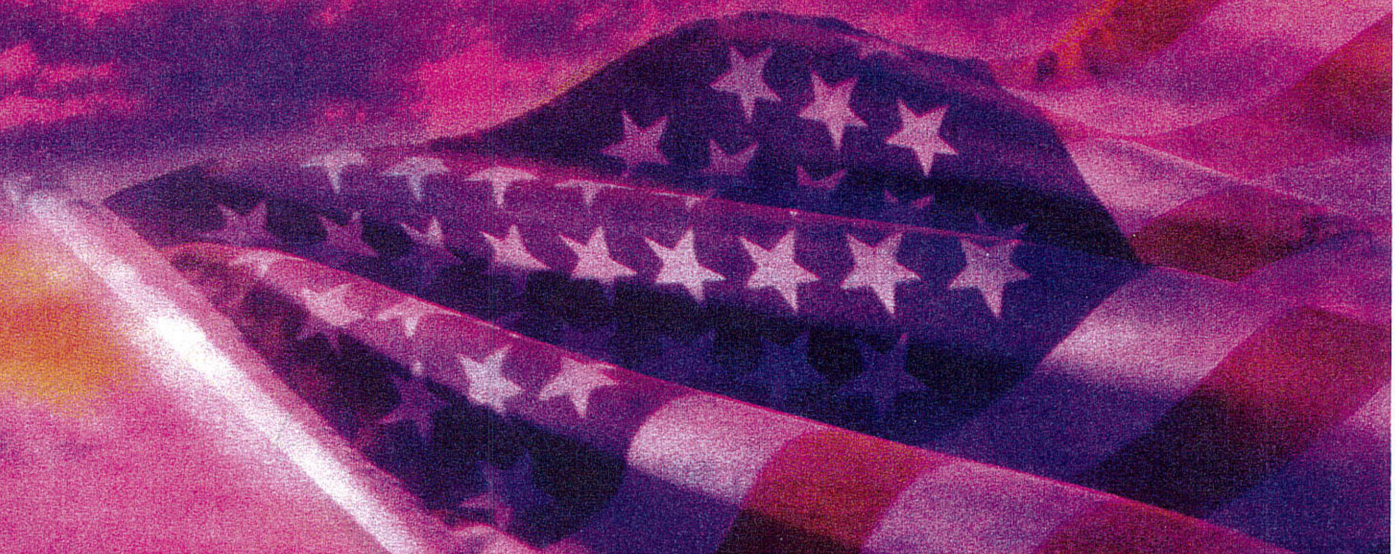
EXECUTIVE SUMMARY

RISING ABOVE THE GATHERING STORM

Energizing and Employing America for a Brighter Economic Future



NATIONAL ACADEMY OF SCIENCES,
NATIONAL ACADEMY OF ENGINEERING, *AND*
INSTITUTE O… MEDICINE
OF THE NA…

E.S.F.O.K. Task Force
Attachment 1
3-16-09

COMMITTEE BIOGRAPHIC INFORMATION

NORMAN R. AUGUSTINE [NAE*] (Chair) is the retired chairman and CEO of the Lockheed Martin Corporation. He serves on the President's Council of Advisors on Science and Technology and has served as undersecretary of the Army. He is a recipient of the National Medal of Technology.

CRAIG BARRETT [NAE] is chairman of the Board of the Intel Corporation.

GAIL CASSELL [IOM*] is vice president for scientific affairs and a Distinguished Lilly Research Scholar for Infectious Diseases at Eli Lilly and Company.

STEVEN CHU [NAS*] is the director of the E.O. Lawrence Berkeley National Laboratory. He was a cowinner of the Nobel prize in physics in 1997.

ROBERT GATES is the president of Texas A&M University and served as Director of Central Intelligence.

NANCY GRASMICK is the Maryland state superintendent of schools.

CHARLES HOLLIDAY JR. [NAE] is chairman of the Board and CEO of DuPont.

SHIRLEY ANN JACKSON [NAE] is president of Rensselaer Polytechnic Institute. She is the immediate past president of the American Association for the Advancement of Science and was chairman of the US Nuclear Regulatory Commission.

ANITA K. JONES [NAE] is the Lawrence R. Quarles Professor of Engineering and Applied Science at the University of Virginia. She served as director of defense research and engineering at the US Department of Defense and was vice-chair of the National Science Board.

JOSHUA LEDERBERG [NAS/IOM] is the Sackler Foundation Scholar at Rockefeller University in New York. He was a cowinner of the Nobel prize in physiology or medicine in 1958.

RICHARD LEVIN is president of Yale University and the Frederick William Beinecke Professor of Economics.

C. D. (DAN) MOTE JR. [NAE] is president of the University of Maryland and the Glenn L. Martin Institute Professor of Engineering.

CHERRY MURRAY [NAS/NAE] is the deputy director for science and technology at Lawrence Livermore National Laboratory. She was formerly the senior vice president at Bell Labs, Lucent Technologies.

PETER O'DONNELL JR. is president of the O'Donnell Foundation of Dallas, a private foundation that develops and funds model programs designed to strengthen engineering and science education and research.

LEE R. RAYMOND [NAE] is the chairman of the Board and CEO of Exxon Mobil Corporation.

ROBERT C. RICHARDSON [NAS] is the F. R. Newman Professor of Physics and the vice provost for research at Cornell University. He was a cowinner of the Nobel prize in physics in 1996.

P. ROY VAGELOS [NAS/IOM] is the retired chairman and CEO of Merck & Co., Inc.

CHARLES M. VEST [NAE] is president emeritus of MIT and a professor of mechanical engineering. He serves on the President's Council of Advisors on Science and Technology and is the immediate past chair of the Association of American Universities.

GEORGE M. WHITESIDES [NAS/NAE] is the Woodford L. & Ann A. Flowers University Professor at Harvard University. He has served as an adviser for the National Science Foundation and the Defense Advanced Research Projects Agency.

RICHARD N. ZARE [NAS] is the Marguerite Blake Wilbur Professor of Natural Science at Stanford University. He was chair of the National Science Board from 1996 to 1998.

Principal Project Staff

Deborah D. Stine, Study Director
Tom Arrison, Innovation
David Attis, Research
Laurel Haak, K-12 Education
Peter Henderson, Higher Education
Jo Husbands, National Security

FOR MORE INFORMATION

*This report was developed under the aegis of the National Academies Committee on Science, Engineering, and Public Policy (COSEPUP), a joint committee of the three honorific academies—the National Academy of Sciences [NAS], the National Academy of Engineering [NAE], and the Institute of Medicine [IOM]. Its overall charge is to address cross-cutting issues in science and technology policy that affect the health of the national research enterprise.

More information, including the full body of the report, is available at COSEPUP's Web site, www.nationalacademies.org/cosepup.

NOTE

This report was reviewed in draft form by individuals chosen for their technical expertise, in accordance with procedures approved by the National Academies's Report Review Committee. For a list of those reviewers, refer to the full report.

EXECUTIVE SUMMARY

The United States takes deserved pride in the vitality of its economy, which forms the foundation of our high quality of life, our national security, and our hope that our children and grandchildren will inherit ever-greater opportunities. That vitality is derived in large part from the productivity of well-trained people and the steady stream of scientific and technical innovations they produce. Without high-quality, knowledge-intensive jobs and the innovative enterprises that lead to discovery and new technology, our economy will suffer and our people will face a lower standard of living. Economic studies conducted even before the information-technology revolution have shown that as much as 85% of measured growth in US income per capita was due to technological change.[1]

Today, Americans are feeling the gradual and subtle effects of globalization that challenge the economic and strategic leadership that the United States has enjoyed since World War II. A substantial portion of our workforce finds itself in direct competition for jobs with lower-wage workers around the globe, and leading-edge scientific and engineering work is being accomplished in many parts of the world. Thanks to globalization, driven by modern communications and other advances, workers in virtually every sector must now face competitors who live just a mouse-click away in Ireland, Finland, China, India, or dozens of other nations whose economies are growing. This has been aptly referred to as "the Death of Distance."

CHARGE TO THE COMMITTEE

The National Academies was asked by Senator Lamar Alexander and Senator Jeff Bingaman of the Committee on Energy and Natural Resources, with endorsement by Representative Sherwood Boehlert and Representative Bart Gordon of the House Committee on Science, to respond to the following questions:

> What are the top 10 actions, in priority order, that federal policymakers could take to enhance the science and technology enterprise so that the United States can successfully compete, prosper, and be secure in the global community of the 21st century? What strategy, with several concrete steps, could be used to implement each of those actions?

The National Academies created the Committee on Prospering in the Global Economy of the 21st Century to respond to this request. The charge constitutes a challenge both daunting and exhilarating: to recommend to the nation specific steps that can best strengthen the quality of life in America—our prosperity, our health, and our security. The committee has been cautious in its analysis of information. The available information is only partly adequate for the committee's needs. In addition, the time allotted to develop the report (10 weeks from the time of the committee's first gathering to report release) limited the ability of the committee to conduct an exhaustive analysis. Even if unlimited time were available, definitive analyses on many issues are not possible given the uncertainties involved.[2]

This report reflects the consensus views and judgment of the committee members. Although the committee consists of leaders in academe, industry, and government—including several current and former industry chief executive officers, university presidents, researchers (including three Nobel prize winners), and former presidential appointees—the array of topics and policies covered is so broad that it was not possible to assemble a committee of 20 members with direct expertise in each relevant area. Because of those limitations, the committee has relied heavily on the judgment of many experts in the study's focus groups, additional consultations via e-mail and telephone with other experts, and an unusually large panel of reviewers. Although other solutions are undoubtedly possible, the committee believes that its recommendations, if implemented, will help the United States achieve prosperity in the 21st century.

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[1]For example, work by Robert Solow and Moses Abramovitz published in the middle 1950s demonstrated that as much as 85% of measured growth in US income per capita during the 1890-1950 period could not be explained by increases in the capital stock or other measurable inputs. The unexplained portion, referred to alternatively as the "residual" or "the measure of ignorance," has been widely attributed to the effects of technological change.

[2]Since the prepublication version of the report was released in October, certain changes have been made to correct editorial and factual errors, add relevant examples and indicators, and ensure consistency among sections of the report. Although modifications have been made to the text, the recommendations remain unchanged, except for a few corrections, which have been footnoted.

FINDINGS

Having reviewed trends in the United States and abroad, the committee is deeply concerned that the scientific and technological building blocks critical to our economic leadership are eroding at a time when many other nations are gathering strength. We strongly believe that a worldwide strengthening will benefit the world's economy—particularly in the creation of jobs in countries that are far less well-off than the United States. But we are worried about the future prosperity of the United States. Although many people assume that the United States will always be a world leader in science and technology, this may not continue to be the case inasmuch as great minds and ideas exist throughout the world. We fear the abruptness with which a lead in science and technology can be lost—and the difficulty of recovering a lead once lost, if indeed it can be regained at all.

The committee found that multinational companies use criteria[3] such as the following in determining where to locate their facilities and the jobs that result:

- Cost of labor (professional and general workforce).
- Availability and cost of capital.
- Availability and quality of research and innovation talent.
- Availability of qualified workforce.
- Taxation environment.
- Indirect costs (litigation, employee benefits such as healthcare, pensions, vacations).
- Quality of research universities.
- Convenience of transportation and communication (including language).
- Fraction of national research and development supported by government.
- Legal-judicial system (business integrity, property rights, contract sanctity, patent protection).
- Current and potential growth of domestic market.
- Attractiveness as place to live for employees.
- Effectiveness of national economic system.

Although the US economy is doing well today, current trends in each of these areas indicate that the United States may not fare as well in the future without government intervention. This nation must prepare with great urgency to preserve its strategic and economic security. Because other nations have, and probably will continue to have, the competitive advantage of a low wage structure, the United States must compete by optimizing its knowledge-based resources, particularly in science and technology, and by sustaining the most fertile environment for new and revitalized industries and the well-paying jobs they bring. We have already seen that capital, factories, and laboratories readily move wherever they are thought to have the greatest promise of return to investors.

RECOMMENDATIONS

The committee reviewed hundreds of detailed suggestions—including various calls for novel and untested mechanisms—from other committees, from its focus groups, and from its own members. The challenge is immense, and the actions needed to respond are immense as well.

The committee identified two key challenges that are tightly coupled to scientific and engineering prowess: creating high-quality jobs for Americans, and responding to the nation's need for clean, affordable, and reliable energy. To address those challenges, the committee structured its ideas according to four basic recommendations that focus on the human, financial, and knowledge capital necessary for US prosperity.

The four recommendations focus on actions in K–12 education (*10,000 Teachers, 10 Million Minds*), research (*Sowing the Seeds*), higher education (*Best and Brightest*), and economic policy (*Incentives for Innovation*) that are set forth in the following sections. Also provided are a total of 20 implementation steps for reaching the goals set forth in the recommendations.

Some actions involve changes in the law. Others require financial support that would come from reallocation of existing funds or, if necessary, from new funds. Overall, the committee believes that the investments are modest relative to the magnitude of the return the nation can expect in the creation of new high-quality jobs and in responding to its energy needs.

The committee notes that the nation is unlikely to receive some sudden "wake-up" call; rather, the problem is one that is likely to evidence itself gradually over a surprisingly short period.

[3]D.H. Dalton, M.G. Serapio, Jr., P.G. Yoshida. 1999. Globalizing Industrial Research and Development. US Department of Commerce, Technology Administration, Office of Technology Policy. Grant Gross. 2003, October 9. "CEOs defend moving jobs offshore at tech summit." InfoWorld. Mehlman, Bruce. 2003. Offshore Outsourcing and the Future of American Competitiveness. "High tech in China: is it a threat to Silicon Valley?" 2002, October 28. Business Week online. B. Callan, S. Costigan, K. Keller. 1997. Exporting U.S. High Tech: Facts and Fiction about the Globalization of Industrial R&D, Council on Foreign Relations, New York, NY.

10,000 TEACHERS, 10 MILLION MINDS, AND K-12 SCIENCE AND MATHEMATICS EDUCATION

RECOMMENDATION A: ***Increase America's talent pool by vastly improving K–12 science and mathematics education.***

Implementation Actions

The highest priority should be assigned to the following actions and programs. All should be subjected to continuing evaluation and refinement as they are implemented.

Action A-1: Annually recruit 10,000 science and mathematics teachers by awarding 4-year scholarships and thereby educating 10 million minds. Attract 10,000 of America's brightest students to the teaching profession every year, each of whom can have an impact on 1,000 students over the course of their careers. The program would award competitive 4-year scholarships for students to obtain bachelor's degrees in the physical or life sciences, engineering, or mathematics with concurrent certification as K–12 science and mathematics teachers. The merit-based scholarships would provide up to $20,000 a year for 4 years for qualified educational expenses, including tuition and fees, and require a commitment to 5 years of service in public K–12 schools. A $10,000 annual bonus would go to participating teachers in underserved schools in inner cities and rural areas. To provide the highest-quality education for undergraduates who want to become teachers, it would be important to award matching grants, on a one-to-one basis, of $1 million a year for up to 5 years, to as many as 100 universities and colleges to encourage them to establish integrated 4-year undergraduate programs leading to bachelor's degrees in the physical and life sciences, mathematics, computer sciences, or engineering *with teacher certification.* The models for this action are UTeach at the University of Texas and California Teach at the University of California.

Action A-2: Strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in master's programs, and in Advanced Placement (AP) and International Baccalaureate (IB) training programs. Use proven models to strengthen the skills (and compensation, which is based on education and skill level) of 250,000 *current* K–12 teachers.

- *Summer institutes:* Provide matching grants to state and regional 1- to 2-week summer institutes to upgrade the skills and state-of-the-art knowledge of as many as 50,000 practicing teachers each summer. The material covered would allow teachers to keep current with recent developments in science, mathematics, and technology and allow for the exchange of best teaching practices. The Merck Institute for Science Education is one model for this action.

- *Science and mathematics master's programs:* Provide grants to research universities to offer, over 5 years, 50,000 current middle school and high school science, mathematics, and technology teachers (with or without undergraduate science, mathematics, or engineering degrees) 2-year, part-time master's degree programs that focus on rigorous science and mathematics content and pedagogy. The model for this action is the University of Pennsylvania Science Teachers Institute.

- *AP, IB, and pre-AP or pre-IB training:* Train an additional 70,000 AP or IB and 80,000 pre-AP or pre-IB instructors to teach advanced courses in science and mathematics. Assuming satisfactory performance, teachers may receive incentive payments of $1,800 per year, as well as $100 for each student who passes an AP or IB exam in mathematics or science. There are two models for this program: the Advanced Placement Incentive Program and Laying the Foundation, a pre-AP program.

- *K–12 curriculum materials modeled on a world-class standard:* Foster high-quality teaching with world-class curricula, standards, and assessments of student learning. Convene a national panel to collect, evaluate, and develop rigorous K–12 materials that would be available free of charge as a *voluntary* national curriculum. The model for this action is the Project Lead the Way pre-engineering courseware.

Action A-3: Enlarge the pipeline of students who are prepared to enter college and graduate with a degree in science, engineering, or mathematics by increasing the number of students who pass AP and IB science and mathematics courses. Create opportunities and incentives for middle school and high school students to pursue advanced work in science and mathematics. By 2010, increase the number of students who take at least one AP or IB mathematics or science exam to 1.5 million, and set a goal of tripling the number who pass those tests to 700,000.[4] Student incentives for success would include 50% examination fee rebates and $100 mini-scholarships for each passing score on an AP or IB science or mathematics examination.

Although not included among its implementation actions, the committee also finds attractive the expansion of two approaches to improving K–12 science and mathematics education that are already in use:

- *Statewide specialty high schools:* Specialty secondary education can foster leaders in science, technology, and mathematics. Specialty schools immerse students in high-quality science, technology, and mathematics education; serve as a mechanism to test teaching materials; provide a training ground for K–12 teachers; and provide the resources and staff for summer programs that introduce students to science and mathematics.

- *Inquiry-based learning:* Summer internships and research opportunities provide especially valuable laboratory experience for both middle school and high school students.

[4]This sentence was incorrectly phrased in the original October 12, 2005 edition of the Executive Summary and has now been corrected.

[5]The funds may come from anywhere in government, not just other research funds.

SOWING THE SEEDS THROUGH SCIENCE AND ENGINEERING RESEARCH

RECOMMENDATION B: *Sustain and strengthen the nation's traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life.*

Implementation Actions

Action B-1: Increase the federal investment in long-term basic research by 10% each year over the next 7 years through reallocation of existing funds[5] or, if necessary, through the investment of new funds. Special attention should go to the physical sciences, engineering, mathematics, and information sciences and to Department of Defense (DoD) basic-research funding. This special attention does not mean that there should be a disinvestment in such important fields as the life sciences or the social sciences. A balanced research portfolio in all fields of science and engineering research is critical to US prosperity. Increasingly, the most significant new scientific and engineering advances are formed to cut across several disciplines. This investment should be evaluated regularly to realign the research portfolio to satisfy emerging needs and promises—unsuccessful projects and venues of research should be replaced with research projects and venues that have greater potential.

Action B-2: Provide new research grants of $500,000 each annually, payable over 5 years, to 200 of the nation's most outstanding *early-career* researchers. The grants would be made through existing federal research agencies—the National Institutes of Health (NIH), the National Science Foundation (NSF), the Department of Energy (DoE), DoD, and the National Aeronautics and Space Administration (NASA)—to underwrite new research opportunities at universities and government laboratories.

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Action B-3: Institute a National Coordination Office for Advanced Research Instrumentation and Facilities to manage a fund of $500 million in incremental funds per year over the next 5 years—through reallocation of existing funds or, if necessary, through the investment of new funds—to ensure that universities and government laboratories create and maintain the facilities, instrumentation, and equipment needed for leading-edge scientific discovery and technological development. Universities and national laboratories would compete annually for these funds.

Action B-4: Allocate at least 8% of the budgets of federal research agencies to discretionary funding that would be managed by technical program managers in the agencies and be focused on catalyzing high-risk, high-payoff research of the type that often suffers in today's increasingly risk-averse environment.

Action B-5: Create in the Department of Energy an organization like the Defense Advanced Research Projects Agency (DARPA) called the Advanced Research Projects Agency-Energy (ARPA-E).[6] The director of ARPA-E would report to the under secretary for science and would be charged with sponsoring specific research and development programs to meet the nation's long-term energy challenges. The new agency would support creative "out-of-the-box" transformational generic energy research that industry by itself cannot or will not support and in which risk may be high but success would provide dramatic benefits for the nation. This would accelerate the process by which knowledge obtained through research is transformed to create jobs and address environmental, energy, and security issues. ARPA-E would be based on the historically successful DARPA model and would be designed as a lean and agile organization with a great deal of independence that can start and stop targeted programs on the basis of performance and do so in a timely manner. The agency would itself perform no research or transitional effort but would fund such work conducted by universities, startups, established firms, and others. Its staff would turn over approximately every 4 years. Although the agency would be focused on specific energy issues, it is expected that its work (like that of DARPA or NIH) will have important spinoff benefits, including aiding in the education of the next generation of researchers. Funding for ARPA-E would start at $300 million the first year and increase to $1 billion per year over 5-6 years, at which point the program's effectiveness would be evaluated and any appropriate actions taken.

Action B-6: Institute a Presidential Innovation Award to stimulate scientific and engineering advances in the national interest. Existing presidential awards recognize lifetime achievements or promising young scholars, but the proposed new awards would identify and recognize persons who develop unique scientific and engineering innovations in the national interest at the time they occur.

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[6]One committee member, Lee Raymond, does not support this action item. He does not believe that ARPA-E is necessary as energy research is already well funded by the federal government, along with formidable funding of energy research by the private sector. Also, ARPA-E would, in his view, put the federal government in the business of picking "winning energy technologies"—a role best left to the private sector.

BEST AND BRIGHTEST IN SCIENCE AND ENGINEERING HIGHER EDUCATION

RECOMMENDATION C: ***Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world.***

Implementation Actions

Action C-1: Increase the number and proportion of US citizens who earn bachelor's degree in the physical sciences, the life sciences, engineering, and mathematics by providing 25,000 new 4-year competitive undergraduate scholarships each year to US citizens attending US institutions. The Undergraduate Scholar Awards in Science, Technology, Engineering, and Mathematics (USA-STEM) would be distributed to states on the basis of the size of their congressional delegations and awarded on the basis of national examinations. An award would provide up to $20,000 annually for tuition and fees.

Action C-2: Increase the number of US citizens pursuing graduate study in "areas of national need" by funding 5,000 new graduate fellowships each year. NSF should administer the program and draw on the advice of other federal research agencies to define national needs. The focus on national needs is important both to ensure an adequate supply of doctoral scientists and engineers and to ensure that there are appropriate employment opportunities for students once they receive their degrees. Portable fellowships would provide a stipend of $30,000[7] annually directly to students, who would choose where to pursue graduate studies instead of being required to follow faculty research grants, and up to $20,000 annually for tuition and fees.

[7]An incorrect number was provided for the graduate student stipend in the original October 12, 2005 edition of the Executive Summary and has now been corrected.

Action C-3: Provide a federal tax credit to encourage employers to make continuing education available (either internally or though colleges and universities) to practicing scientists and engineers. These incentives would promote career-long learning to keep the workforce productive in an environment of rapidly evolving scientific and engineering discoveries and technological advances and would allow for retraining to meet new demands of the job market.

Action C-4: Continue to improve visa processing for international students and scholars to provide less complex procedures and continue to make improvements on such issues as visa categories and duration, travel for scientific meetings, the technology alert list, reciprocity agreements, and changes in status.

Action C-5: Provide a 1-year automatic visa extension to international students who receive doctorates or the equivalent in science, technology, engineering, mathematics, or other fields of national need at qualified US institutions to remain in the United States to seek employment. If these students are offered jobs by US-based employers and pass a security screening test, they should be provided automatic work permits and expedited residence status. If students are unable to obtain employment within 1 year, their visas would expire.

Action C-6: Institute a new skills-based, preferential immigration option. Doctoral-level education and science and engineering skills would substantially raise an applicant's chances and priority in obtaining US citizenship. In the interim, the number of H-1B visas should be increase by 10,000, and the additional visas should be available for industry to hire science and engineering applicants with doctorates from US universities.[8]

[8]Since the report was released, the committee has learned that the Consolidated Appropriations Act of 2005, signed into law on December 8, 2004, exempts individuals that have received a master's or higher education degree from a US university from the statutory cap (up to 20,000). The bill also raised the H-1B fee and allocated funds to train American workers. The committee believes that this provision is sufficient to respond to its recommendation—even though the 10,000 additional visas recommended is specifically for science and engineering doctoral candidates from US universities, which is a narrower subgroup.

Action C-7: Reform the current system of "deemed exports". The new system should provide international students and researchers engaged in fundamental research in the United States with access to information and research equipment in US industrial, academic, and national laboratories comparable with the access provided to US citizens and permanent residents in a similar status. It would, of course, exclude information and facilities restricted under national-security regulations. In addition, the effect of deemed-exports[9] regulations on the education and fundamental research work of international students and scholars should be limited by removing from the deemed-exports technology list all technology items (information and equipment) that are available for purchase on the overseas open market from foreign or US companies or that have manuals that are available in the public domain, in libraries, over the Internet, or from manufacturers.

[9]The controls governed by the Export Administration Act and its implementing regulations extend to the transfer of technology. Technology includes "specific information necessary for the 'development,' 'production,' or 'use' of a product". Providing information that is subject to export controls—for example, about some kinds of computer hardware—to a foreign national within the United States may be "deemed" an export, and that transfer requires an export license. The primary responsibility for administering controls on deemed exports lies with the Department of Commerce, but other agencies have regulatory authority as well.

INCENTIVES FOR INNOVATION

Recommendation D: Ensure that the United States is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs based on innovation by such actions as modernizing the patent system, realigning tax policies to encourage innovation, and ensuring affordable broadband access.

Implementation Actions

Action D-1: Enhance intellectual-property protection for the 21st-century global economy to ensure that systems for protecting patents and other forms of intellectual property underlie the emerging knowledge economy but allow research to enhance innovation. The patent system requires reform of four specific kinds:

- Provide the US Patent and Trademark Office with sufficient resources to make intellectual-property protection more timely, predictable, and effective.
- Reconfigure the US patent system by switching to a "first-inventor-to-file" system and by instituting administrative review *after* a patent is granted. Those reforms would bring the US system into alignment with patent systems in Europe and Japan.
- Shield research uses of patented inventions from infringement liability. One recent court decision could jeopardize the long-assumed ability of academic researchers to use patented inventions for research.
- Change intellectual-property laws that act as barriers to innovation in specific industries, such as those related to data exclusivity (in pharmaceuticals) and those that increase the volume and unpredictability of litigation (especially in information-technology industries).

Action D-2: Enact a stronger research and development tax credit to encourage private investment in innovation. The current Research and Experimentation Tax Credit goes to companies that *increase* their research and development spending above a base amount calculated from their spending in prior years. Congress and the

Administration should make the credit permanent,[10] and it should be increased from 20% to 40% of the qualifying increase so that the US tax credit is competitive with those of other countries. The credit should be extended to companies that have consistently spent large amounts on research and development so that they will not be subject to the current *de facto* penalties for having previously invested in research and development.

Action D-3: Provide tax incentives for US-based innovation. Many policies and programs affect innovation and the nation's ability to profit from it. It was not possible for the committee to conduct an exhaustive examination, but alternatives to current economic policies should be examined and, if deemed beneficial to the United States, pursued. These alternatives could include changes in overall corporate tax rates and special tax provisions providing the purchase of high-technology research and manufacturing equipment, treatment of capital gains, and incentives for long-term investments in innovation. The Council of Economic Advisers and the Congressional Budget Office should conduct a comprehensive analysis to examine how the United States compares with other nations as a location for innovation and related activities with a view to ensuring that the United States is one of the most attractive places in the world for long-term innovation-related investment and the jobs resulting from that investment. From a tax standpoint, that is not now the case.

Action D-4: Ensure ubiquitous broadband Internet access. Several nations are well ahead of the United States in providing broadband access for home, school, and business. That capability can be expected to do as much to drive innovation, the economy, and job creation in the 21st century as did access to the telephone, interstate highways, and air travel in the 20th century. Congress and the Administration should take action—mainly in the regulatory arena and in spectrum management—to ensure widespread affordable broadband access in the very near future.

[10]The previous R&D tax credit expired in December 2005.

CONCLUSION

The committee believes that its recommendations and the actions proposed to implement them merit serious consideration if we are to ensure that our nation continues to enjoy the jobs, security, and high standard of living that this and previous generations worked so hard to create. Although the committee was asked only to recommend actions that can be taken by the federal government, it is clear that related actions at the state and local levels are equally important for US prosperity, as are actions taken by each American family. The United States faces an enormous challenge because of the disparity it faces in labor costs. Science and technology provide the opportunity to overcome that disparity by creating scientists and engineers with the ability to create entire new industries—much as has been done in the past.

It is easy to be complacent about US competitiveness and preeminence in science and technology. We have led the world for decades, and we continue to do so in many research fields today. But the world is changing rapidly, and our advantages are no longer unique. Some will argue that this is a problem for market forces to resolve—but that is exactly the concern. Market forces are *already at work* moving jobs to countries with less costly, often better educated, highly motivated work forces and more friendly tax policies.

Without a renewed effort to bolster the foundations of our competitiveness, we can expect to lose our privileged position. For the first time in generations, the nation's children could face poorer prospects than their parents and grandparents did. We owe our current prosperity, security, and good health to the investments of past generations, and we are obliged to renew those commitments in education, research, and innovation policies to ensure that the American people continue to benefit from the remarkable opportunities provided by the rapid development of the global economy and its not inconsiderable underpinning in science and technology.

SOME COMPETITIVENESS INDICATORS

US ECONOMY

- The United States is today a net importer of *high-technology* products. Its trade balance in high-technology manufactured goods shifted from *plus* $54 billion in 1990 to *negative* $50 billion in 2001.[1]
- In one recent period, low-wage employers, such as Wal-Mart (now the nation's largest employer) and McDonald's, created 44% of the new jobs while high-wage employers created only 29% of the new jobs.[2]
- The United States is one of the few countries in which industry plays a major role in providing health care for its employees and their families. Starbucks spends more on healthcare than on coffee. General Motors spends more on health care than on steel.[3]
- US scheduled airlines currently outsource portions of their aircraft maintenance to China and El Salvador.[4]
- IBM recently sold its personal computer business to an entity in China.[5]
- Ford and General Motors both have junk bond ratings.[6]
- It has been estimated that within a decade nearly 80% of the world's middle-income consumers would live in nations outside the currently industrialized world. China alone could have 595 million middle-income consumers and 82 million upper-middle-income consumers. The total population of the United States is currently 300 million and is projected to be 315 million in a decade.[7]
- Some economists estimate that about half of US economic growth since World War II has been the result of technological innovation.[8]
- In 2005, American investors put more new money in foreign stock funds than in domestic stock portfolios.[9]

COMPARATIVE ECONOMICS

- Chemical companies closed 70 facilities in the United States in 2004 and tagged 40 more for shutdown. Of 120 chemical plants being built around the world with price tags of $1 billion or more, one is in the United States and 50 are in China. No new refineries have been built in the United States since 1976.[10]
- The United States is said to have 7 million illegal immigrants,[11] but under the law the number of visas set aside for "highly qualified foreign workers," many of whom contribute significantly to the nation's innovations, dropped to 65,000 a year from its 195,000 peak.[12]
- When asked in Spring 2005 what is the most attractive place in the world in which to "lead a good life", respondents in only one (India) of the 16 countries polled indicated the United States.[13]
- A company can hire nine factory workers in Mexico for the cost of one in America. A company can hire eight young professional engineers in India for the cost of one in America.[14]
- The share of leading-edge semiconductor manufacturing capacity owned or partly owned by US companies today is half what it was as recently as 2001.[15]
- During 2004, China overtook the United States to become the leading exporter of information-technology products, according to the OECD.[16]
- The United States ranks only 12th among OECD countries in the number of broadband connections per 100 inhabitants.[17]

K-12 EDUCATION

- Fewer than one-third of US 4th-grade and 8th-grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform even basic mathematical computations.[18]
- In 1999, 68% of US 8th grade students received instruction from a mathematics teacher who did not hold a degree or certification in mathematics.[19]
- In 2000, 93% of students in grades 5-9 were taught physical science by a teacher lacking a major or certification in the physical sciences (chemistry, geology, general science, or physics).[20]
- In 1995 (the most recent data available), US 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science.[21]
- US 15-year-olds ranked 24th out of 40 countries that participated in a 2003 administration of the Program for International Student Assessment (PISA) examination, which assessed students' ability to apply mathematical concepts to real-world problems.[22]
- According to a recent survey, 86% of US voters believe that the United States must increase the number of workers with a background in science and mathematics or America's ability to compete in the global economy will be diminished.[23]
- American youth spend more time watching television[24] than in school.[25]
- Because the United States does not have a set of national curricula, changing K-12 education is challenging, given that there are almost 15,000 school systems in the United States and the average district has only about 6 schools.[26]

HIGHER EDUCATION

- In South Korea, 38% of all undergraduates receive their degrees in natural science or engineering. In France, the figure is 47%, in China, 50%, and in Singapore 67%. In the United States, the corresponding figure is 15%.[27]
- Some 34% percent of doctoral degrees in natural sciences (including the physical, biological, earth, ocean, and atmospheric sciences) and 56% of engineering PhDs in the United States are awarded to foreign-born students.[28]
- In the US science and technology workforce in 2000, 38% of PhDs were foreign-born.[29]
- Estimates of the number of engineers, computer scientists, and information technology students who obtain 2-, 3-, or 4-year degrees vary. One estimate is that in 2004, China graduated about 350,000 engineers, computer scientists, and information technologists with 4-year degrees, while the United States graduated about 140,000. China also graduated about 290,000 with 3-year degrees in these same fields, while the United States graduated about 85,000 with 2- or 3-year degrees.[30] Over the past 3 years alone, both China[31] and India[32] have doubled their production of 3- and 4-year degrees in these fields, while the US[33] production of engineers is stagnant and the rate of production of computer scientists and information technologists doubled.
- About one-third of US students intending to major in engineering switch majors before graduating.[34]
- There were almost twice as many US physics bachelor's degrees awarded as in 1956, the last graduating class before Sputnik than in 2004.[35]
- More S&P 500 CEOs obtained their undergraduate degrees in engineering than in any other field.[36]

RESEARCH

- In 2001 (the most recent year for which data are available), US industry spent more on tort litigation than on research and development.[37]
- In 2005, only four American companies ranked among the top 10 corporate recipients of patents granted by the *United States* Patent and Trademark Office.[38]
- Beginning in 2007, the most capable high-energy particle accelerator on Earth will, for the first time, reside outside the United States.[39]
- Federal funding of research in the physical sciences, as a percentage of GDP, was 45% less in FY 2004 than in FY 1976.[40] The amount invested annually by the US federal government in research in the physical sciences, mathematics, and engineering combined equals the annual increase in US health care costs incurred every 20 days.[41]

PERSPECTIVES

- "We go where the smart people are. Now our business operations are two-thirds in the U.S. and one-third overseas. But that ratio will flip over the next 10 years." –Intel spokesman Howard High[42]
- "If we don't step up to the challenge of finding and supporting the best teachers, we'll undermine everything else we are trying to do to improve our schools."—Louis V. Gerstner, Jr., Former Chairman, IBM[43]
- "If you want good manufacturing jobs, one thing you could do is graduate more engineers. We had more sports exercise majors graduate than electrical engineering grads last year." —Jeffrey R. Immelt, Chairman and Chief Executive Office, General Electric[44]
- "If I take the revenue in January and look again in December of that year 90% of my December revenue comes from products which were not there in January." – Craig Barrett, Chairman of the Intel Corporation[45]
- "When I compare our high schools to what I see when I'm traveling abroad, I am terrified for our workforce of tomorrow." –Bill Gates, Chairman and Chief Software Architect of Microsoft Corporation[46]
- "Where once nations measured their strength by the size of their armies and arsenals, in the world of the future knowledge will matter most." –President Bill Clinton [47]
- "Science and technology have never been more essential to the defense of the nation and the health of our economy."—President George W. Bush[48]

NOTES for SOME COMPETITIVENESS INDICATORS and PERSPECTIVES:

[1]For 2001, the dollar value of high-technology imports was $561 billion; the value of high-technology exports was $511 billion. See National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04-01). Arlington, VA. National Science Foundation. Appendix Table 6-01. Page A6-5 provides the export numbers for 1990 and 2001 and page A6-6 has the import numbers.

[2]Steve Roach. More Jobs, Worse Work. New York Times. July 22, 2004.

[3]Chris Noon. 2005. "Starbuck's Schultz Bemoans Health Care Costs." Forbes. com, September 19.Available at:http://www.forbes.com/facesinthenews/2005/09/15/starbuckshealthcarebenefitscx_cn_0915autofacescan01.html?partner=yahooti; Ron Scherer. 2005. "Rising Benefits Burden." Christian Science Monitor, June 9. Available at: http://www.csmonitor.com/2005/0609/p01s01-usec.html.

[4]Sara Kehaulani Goo. Airlines Outsource Upkeep. Washington Post. August 21, 2005. Available at: http://www.washingtonpost.com/wp-dyn/content/article/2005/08/20/AR2005082000979.html. Sara Kehaulani Goo. Two-Way Traffic in Airplane Repair. Washington Post, June 1, 2004. Available at http://www.washingtonpost.com/wp-dyn/articles/A5138-2004 May31.html.

[5]Michael Kanellos. 2004. "IBM Sells PC Group to Lenovo." News.com. December 8. Available at: http://news.com.com/IBM+sells+PC+group+to+Lenovo/2100-1042_3-5482284.html.

[6]http://www.nytimes.com/2005/05/05/business/05cnd-auto.html?ex=1137128400 &en=ac63687768634c6d&ei=5070.

[7]For China, see Paul A. Laudicina, 2005. World Out of Balance: Navigating Global Risks to Seize Competitive Advantage. New York: McGraw Hill, p. 76. For the United States, see US Census Bureau. US. Population Clock. Available at www.census.gov for current population and for the projected population, see Population Projections Program, Population Division, U.S. Census Bureau. Population Projections of the United States by Age, Sex, Race, Hispanic Origin, and Nativity: 1999 to 2100. Washington, D.C. January 13, 2000. Available at: http://www.census.gov/population/www/projections/natsum-T3.html.

[8]Michael J. Boskin and Lawrence J. Lau. 1992. Capital, Technology, and Economic Growth. In Nathan Rosenberg, Ralph Landau, and David C. Mowery, eds. Technology and the Wealth of Nations: Stanford University Press: Stanford, CA.

[9]Paul J. Lim. Looking Ahead Means Looking Abroad. New York Times. January 8th 2006.

[10]Michael Arndt. 2005. "No Longer the Lab of the World: U.S. Chemical Plants are Closing in Droves as Production Heads Abroad." BusinessWeek, May 2. Available at: http://www.businessweek.com/magazine/content/05_18/b3931106.htm and http://www.usnews.com/usnews/biztech/articles/051010/10energy.htm.

[11]As of 2000, the unauthorized resident population in the United States was 7 million. See US Citizenship and Immigration Services. 2003. "Executive Summary: Estimates of the Unauthorized Immigrant Population Residing in the United States: 1990 to 2000." January 31. Available at: http://uscis.gov/graphics/shared/statistics/publications/2000ExecSumm.pdf.

[12]Section 214(g) of the Immigration and Nationality Act (Act) sets an annual limit on the number of aliens that can receive H-1B status in a fiscal year. For FY2000 the limit was set at 115,000. The American Competitiveness in the Twenty-First Century Act increased the annual limit to 195,000 for 2001, 2002, and 2003. After that date the cap reverts back to 65,000. H-1B visas allow employers to have access to highly educated foreign professionals who have experience in specialized fields and who have at least a bachelor's degree or the equivalent. The cap does not apply to educational institutions. In November 2004, Congress created an exemption for 20,000 foreign nationals earning advanced degrees from US universities. See Immigration and Nationality Act Section 101(a)(15)(h)(1)(b). See US Citizenship and Immigration Services. 2005. "Public Notice: "USCIS Announces Update Regarding New H-1B Exemptions" July 12. Available at: http://uscis.gov/graphics/publicaffairs/newsrels/H1B_06Cap_011806PR.pdf. and US Citizenship and Immigration Services. 2000. "Questions and Answers: Changes to the H-1B Program" November 21. Available at: http://uscis.gov/graphics/publicaffairs/questsans/H1BChang.htm.

[13]Pew Research Center. 2005 "U.S. Image Up Slightly, But Still Negative, American Character Gets Mixed Reviews" Pew Global Attitudes Project. Washington, DC. Available at: http://pewglobal.org/reports/display.php?ReportID=247 The interview asked nearly 17,000 people the question: "Suppose a young person who wanted to leave this country asked you to recommend where to go to lead a good life–what country would you recommend?" Except for respondents in India, Poland, and Canada, no more than one-tenth of the people in the other nations said they would recommend the United States. Canada and Australia won the popularity contest.

[14]United States Bureau of Labor Statistics. 2005. International Comparisons of Hourly Compensation Costs for Production Workers in Manufacturing, 2004. November 18. Available at: ftp://ftp.bls.gov/pub/news.release/History/ichcc.11182005.news.

[15]Semiconductor Industry Association. 2005. "Choosing to Compete." December 12. Available at: http://www.sia-online.org/downloads/FAD%20'05%20-%20Scalise%20Presentation.pdf.

[16]OECD. 2005. "China Overtakes U.S. As World's Leading Exporter of Information Technology Goods." December 12. Available at: http://www.oecd.org/document/60/0,2340,en_2649_201185_35834236_1_1_1_1,00.html. The main categories included in OECD's definition of ICT (information and communications technology) goods are electronic components, computers and related equipment, audio and video equipment, and telecommunication equipment.

[17]OECD. 2005. "OECD Broadband Statistics, June 2005." October 20. Available at: http://www.oecd.org/document/16/0,2340,en_2649_201185_35526608_1_1_1_1,00.html#data2004.

[18]National Center for Education Statistics. 2006. "The Nation's Report Card: Mathematics 2005." See http://nces.ed.gov/nationsreportcard/pdf/main2005/2006453.pdf.

[19]National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04-01). Arlington, VA: National Science Foundation. Chapter 1.

[20]National Center for Education Statistics. 2004. Schools and Staffing Survey, "Qualifications of the Public School Teacher Workforce: Prevalence of Out-of-Field Teaching 1987-88 to 1999-2000 (Revised)," p. 10. See http://nces.ed.gov/pubs2002/2002603.pdf.

[21]National Center for Education Statistics. 1999. Highlights from TIMSS http://nces.ed.gov/pubs99/1999081.pdf.

[22]National Center for Education Statistics.2005. "International Outcomes of Learning in Mathematics Literacy and Problem Solving: PISA 2003 Results from the U.S. Perspective," pp. 15 and 29. See http://nces.ed.gov/pubs2005/2005003.pdf.

[23]The Business Roundtable. 2006. "Innovation and U.S. Competitiveness: Addressing the Talent Gap. Public Opinion Research." January 12. Available at: http://www.businessroundtable.org/pdf/20060112Two-pager.pdf.

[24]American Academy of Pediatrics. "Television—How it Affects Children." Available at http://www.aap.org/pubed/ZZZGF8VOQ7C.htm?&sub_cat=1. The American Academy of Pediatrics reports that "Children in the United States watch about 4 hours of TV every day"; this works out to be 1460 hours per year.

[25]National Center for Education Statistics. 2005. The Condition of Education. Table 26-2 Average Number of Instructional Hours Per Year Spent in Public School, By Age or Grade of Student and Country: 2000 and 2001. Available at http://nces.ed.gov/programs/coe/2005/section4/table.asp? tableID=284. NCES reports that in 2000 US 15-year-olds spent 990 hours in school, during the same year 4th graders spent 1040 hours.

[26]National Center for Education Statistic (2006), "Public Elementary and Secondary Students, Staff, Schools, and School Districts: School Year 2003–04". See http://nces.ed.gov/pubs2006/2006307.pdf.

[27]Analysis conducted by the Association of American Universities. 2006. National Defense Education and Innovation Initiative. Based on data in National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04-01). Arlington, VA: National Science Foundation. Appendix Table 2-33. For countries with both short and long degrees, the ratios are calculated with both short and long degrees as the numerator.

[28]National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04-01). Arlington, VA: National Science Foundation. Chapter 2, Figure 2-23.

[29]National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04-01). Arlington, VA: National Science Foundation.

[30]G. Gereffi and V. Wadhwa. 2005. Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with China and India. http://memp.pratt.duke.edu/downloads/duke_outsourcing_2005.pdf.

[31]Ministry of Science and Technology (MOST). 2004. Chinese Statistical Yearbook 2004. People's Republic of China, Chapter 21, Table 21-11. Available at http://www.stats.gov.cn/english/statisticaldata/yearlydata/yb2004-e/indexeh.htm. The extent to which engineering degrees from China are comparable to those from the United States is uncertain.

[32]National Association of Software and Service Companies. 2005. Strategic Review 2005., India. Chapter 6. Sustaining the India Advantage. Available at http://www.nasscom.org/strategic2005.asp.

[33]National Center for Education Statistics. 2004. Digest of Education Statistics 2004. Institute of Education Sciences, Department of Education, Washington DC, Table 250. Available at http://nces.ed.gov/programs/digest/d04/tables/dt04_250.asp.

[34]Myles Boylan. 2004. Assessing Changes in Student Interest in Engineering Careers Over the Last Decade. CASEE, National Academy of Engineering. Available at http://www.nae.edu/NAE/caseecomnew.nsf/ weblinks/NFOY-6GHJ7B/$file/Engineering%20Interest%20-%20HS%20through%20College_V21.pdf; Clifford Adelman. 1998. Women and Men on the Engineering Path: A Model for Analysis of Undergraduate Careers. Washington DC: US Department of Education. http://www.nae.edu/nae/diversitycom.nsf/98b72da8aad70f1785256da20053deaf/85256cfb00484b5c85256da000002f83/$FILE/Adelman_Women_and_Men_of_the_Engineering_Path.pdf). According to this Department of Education analysis, the majority of students who switch from engineering majors complete a major in business or other non-science and engineering fields.

[35]National Center for Education Statistics Digest of Education Statistics. The American Institute of Physics Statistical Research Center.

[36]Spencer Stuart. 2005. "2004 CEO Study: A Statistical Snapshot of Leading CEOs." Available at: http://content.spencerstuart.com/sswebsite/pdf/lib/Statistical_Snapshot_of_Leading_CEOs_relB3.pdf#search='ceo%20educational%20background'.

[37]US research and development spending in 2001 was $273.6 billion, of which industry performed $194 billion and funded about $184 billion. National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04-01). Arlington, VA: National Science Foundation. One estimate of tort litigation costs in the United States was $205 billion in 2001. Jeremey A. Leonard. 2003. "How Structural Costs Imposed on U.S. Manufacturers Harm Workers and Threaten Competitiveness." Prepared for the Manufacturing Institute of the National Association of Manufacturers. Availbale at: http://www.nam.org/s_nam/bin.asp?CID=216&DID=227525&DOC=FILE.PDF.

[38]US Patent and Trademark Office.2006. USPTO Annual List of Top 10 Organizations Receiving Most U.S. Patents. January 10, 2006. See http://www. uspto.gov/web/offices/com/speeches/06-03.htm

[39]CERN. Internet Homepage. http://public.web.cern.ch/Public/Welcome.html.

[40]American Association for the Advancement of Science. 2004. "Trends in Federal Research by Discipline, FY 1976-2004." October. Available at: http://www.aaas.org/spp/rd/disc04tb.pdf and http://www.aaas.org/spp/rd/discip04c.pdf.

[41]Centers for Medicare and Medicaid Services. 2005. National Heath Expenditures. Available at: http://www.cms.hhs.gov/NationalHealthExpendData/downloads/tables.pdf.

[42]In: Wallace, Kathryn. 2005. "America's Brain Drain Crisis Why Our Best Scientists are Disappearing, and What's Really at Stake." Readers Digest. December.

[43]Louis V. Gerstner, Jr. Former Chairman, IBM In The Teaching Commission. 2004. Teaching at Risk: A Call to Action. New York: City University of New York. See www.theteachingcommission.org.

[44]Remarks by Jeffrey R. Immelt to Economic Club of Washington as reported in Neil Irwin. 2006. "US Needs More Engineers, GE Chief Says." Washington Post. January 23, 2006.

[45]Craig Barrett. 2006. Comments at public briefing on the release of The Gathering Storm report. October 12, 2005. See http://www.nationalacademies.org/morenews/20051012.html.

[46]Bill Gates. 2005. Speech to the National Education Summit on High Schools. February 26. Available at: http://www.gatesfoundation.org/MediaCenter/Speeches/BillgSpeeches/BGSpeechNGA-050226.htm.

[47]William Jefferson Clinton "Commencement Address at Morgan State University in Baltimore, Maryland." May 18, 1997 Government Printing Office. 1997 Public Papers of the Presidents of the United States, Books I and II. Available at: http://www.gpoaccess.gov/pubpapers/wjclinton.html.

[48]Remarks by President George W. Bush in meeting with High-Tech Leaders. March 28, 2001. Available at: http://www.whitehouse.gov/news/releases/ 2001/03/20010328-2.html.

1-15

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"A White Paper on
Increasing the Engineering BS Graduates in the State of Kansas"

Prepared by
Kansas State University, The University of Kansas, Wichita State University

Executive Summary:

Proposal description. This proposal is in response to a request made to the deans at Kansas' three engineering schools and colleges (KSU, KU and WSU) to increase their annual number of BS engineering graduates. The target is an annual increase of 490 additional graduates from the schools (up from a five-year average of 875 graduates per year). Despite downturns in some sectors of the economy, the demand for engineering graduates at national and state levels has been increasing rapidly, and projections indicate this trend will continue through 2016. Currently, 80 percent of all science and technology-based occupations in Kansas are in the engineering and IT fields. The state's engineering programs are the primary source of this workforce. As all three universities are essentially at capacity in engineering, increases in enrollment will necessitate expansion of resources (personnel as well as infrastructure). To fill this growing need for career-ready employees, resources are needed for:

1) Additional facilities at each of the three universities, and
2) Annual operating budget increases for new faculty, staff and program support to accommodate recruitment, teaching, advising, and retention activities for added students.

Strategic alignment. In the National Academies report, "Rising Above The Gathering Storm," the shortage of professionals in the science, technology, engineering and mathematics (STEM) areas was reported to be staggering and leading to a national and state crisis. The report pointed out that as much as 85 percent of measured growth in income per capita in the United States over the last several years has been due to technological change. And, unless we act, the technological innovation responsible for so much of the prosperity that Kansans and Americans enjoy will fade from our interests and our shores. In January, 2008, two of the literally hundreds of engineering firms of the region, Burns & McDonnell and Black & Veatch, publicly announced they will add 550 jobs in the Kansas City area by year's end. The news article cited that the "soaring demand for engineering work in areas such as energy, pollution control, water, health care and aviation facilities" is driving this demand. Garmin in Olathe has expressed its plans to hire 400 new engineers. Economic challenges notwithstanding, demand for engineering graduates remains healthy. And, with the focus on infrastructure spending in stimulus plans, the demand for engineers will likely increase. Certainly, it is believed that industries that employ engineers will drive much of the economic recovery in Kansas and the United States over the next several years. Preparing a sufficient engineering workforce for Kansas is imperative to the economic development of the region.

Budget requirements. Across the three universities, the first year cost to the state to start this effort is $400,000. The eventual continuing annual cost to the state is estimated to be around $15 million. Those costs include a portion of faculty, staff, operating expenses and costs for space expansion to support the goal of adding 490 new graduates per year. Additional sources from industry, donors and universities will leverage the state investment. The four-year phase in period is:

Year 1: $400,000
Year 2: $5 million
Year 3: $10 million and
Year 4 and beyond: $15 million.

E.S.F.O.K. Task Force
Attachment 2
3-16-09

Introduction:

In 2006 the National Academies released a report resulting from a congressional charge to investigate and address the national crisis in the shortage of professionals concentrating in basic areas of the science, technology, engineering and mathematics (STEM) in the United States. The shortage of professionals in the STEM areas described in the report "Rising Above The Gathering Storm" is staggering and is a national and state crisis. Just a few of the observations in this report include:

- Economic studies have shown that as much as 85 percent of measured growth in income per capita in the United States and its states is due to technological change.

- The United States is falling behind as a location for technology-based companies. One example cited: Chemical companies closed 70 facilities in the United States in 2004 and tagged 40 more for shutdown. Of 120 chemical plants being built around the world with price tags of $1 billion or more, one is in the United States while 50 are in China. No new refineries have been built in the United States since 1976.

- A company can hire nine factory workers in Mexico for the cost of one in America. A company can hire eight young professional engineers in India for the cost of one in America.

- The share of leading-edge semiconductor manufacturing capacity owned or partly owned by U.S. companies today is one-half what it was as recently as 2001.

These items are only a few of the facts put forward in that report, which documents a disquieting trend. The technological innovation responsible for so much of the prosperity that Kansans and Americans enjoy is fading from our interests and our shores.

If that's not enough, we also have fewer students in the United States choosing to pursue degrees in science and engineering, careers that fuel innovation in our state and nation. The American Society for Engineering Education (ASEE) reports that undergraduate graduation rates over the last several years have been essentially flat. Figure 1 shows the trends of science and engineering degrees in the United States for the last 20 years.

And, how do we do globally? Answer: Fewer U.S. students pursue science and engineering degrees than in other countries. About 6 percent of American undergraduates currently major in engineering; that percentage is the second lowest among all developed countries. Engineering students make up about 12 percent (double) of undergraduates in most of Europe, 20 percent (triple) in Singapore, and more than 40 percent (seven-fold) in China.

Is there an economic impact to Kansas and the nation? In 1986, the United States ranked no. 1 in the world in "high tech" exports and the United Kingdom ranked no. 4. By 2005, the United States had fallen to no. 2 and the U.K. to no. 10, likely to not return to a top-10 status again. Considering "new economy" indicators including entrepreneurial activity, initial public offerings, fast growing firms and inventor patents, today Kansas scores well below the U.S. national average and is lagging behind most of our neighboring states.

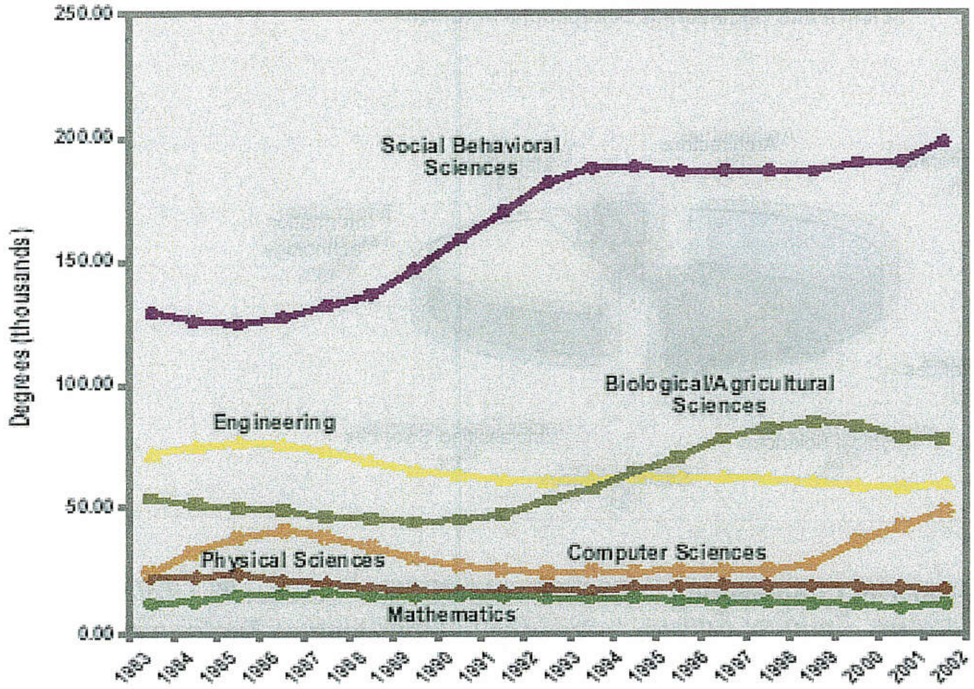


Figure 1. U.S. S&E Bachelor's Degrees by Fields 1983-2002. Source: *The Talent Imperative, Building Kansas' Capacity in Mathematics, Engineering, Technology and Science, December 2007.*

Today the demand for engineering graduates has been growing at a staggering rate. Evidence of this trend can be seen in career services data collected from any major university. In Kansas universities, the growth in number of engineering companies searching for graduates has more than doubled over the last three years. Similarly, job postings at the universities are providing conclusive evidence that the growth in engineering and IT career opportunities is dramatic and exceeds that of most other majors. These trends are being observed at all three of the engineering degree granting universities in Kansas.

The National Association of College and Employers released the publication *Job Outlook 2008* in November 2007. In that volume, engineering and computer-related fields were among the list of highest demand by employers. Of the top 10 bachelor's degrees in demand listed by this report, four were engineering programs. Of the top five master's degrees in demand, three were from engineering. Of the top five doctoral degrees in demand, four were engineering. Kansas has an opportunity to better meet these demands and strengthen the state economic development for years to come.

According to a recent report prepared by *Building Engineering & Science Talent (BEST)*, the engineering and information technology sectors in Kansas account for 80 percent of all science and engineering occupations. The data from the report are shown in Figure 2. Clearly, if Kansas is to position itself to meet the growing demand for high-tech jobs in the state and attract more companies, engineering graduates are going to drive this process.

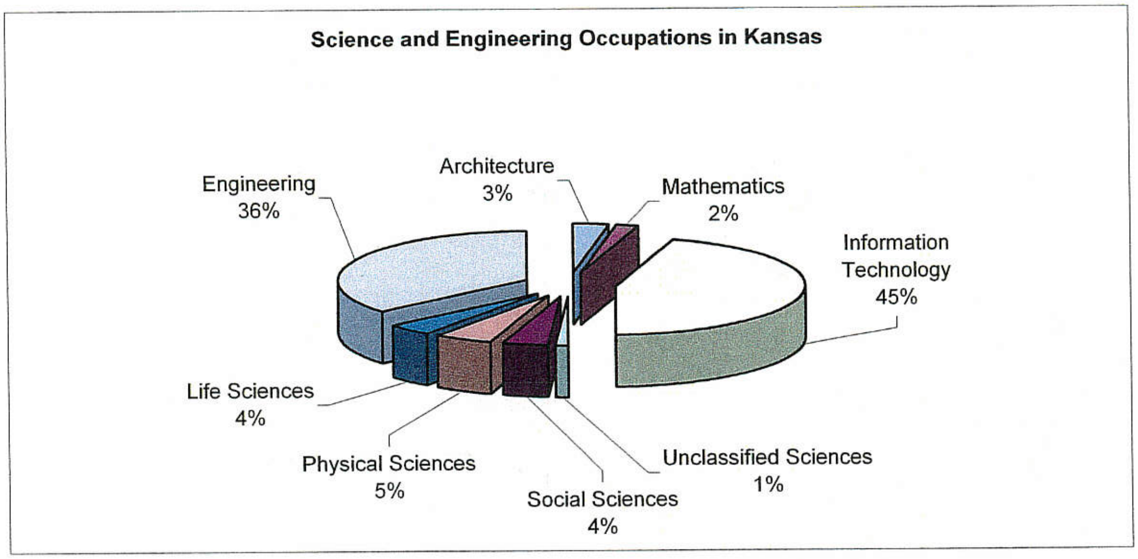


Figure 2. Science and Engineering Occupations in Kansas. Source: *The Talent Imperative, Building Kansas' Capacity in Mathematics, Engineering, Technology and Science, December 2007.*

In the *Kansas City Star* (1/24/2008), Burns & McDonnell and Black & Veatch announced they would add 550 jobs in the Kansas City area in 2008. The article states, the "soaring demand for engineering work in areas such as energy, pollution control, water, health care and aviation facilities" is driving this demand. Garmin in Olathe expressed its plans to hire 400 new engineers in 2008. And, while the aviation industry in Wichita has seen recent downturns, these will be temporary, and the high demands from those industries will soon return. A *Seattle Times* article (2/10/2008), which included several sources and referenced the Wichita, Kansas, market found, "The demand for aerospace, electrical, mechanical and computer engineering disciplines is expected to be double what it was 10 years ago… and…analysts and corporate bosses say higher education is turning out far too few engineering and aeronautical graduates to fill future vacancies."

Although the economy has turned downward in the last few months, demand for engineering graduates has remained good. And, with the focus on infrastructure spending in stimulus plans, it is expected that the demand for engineers will likely increase. Certainly, it is believed that industries that employ engineers will drive much of the economic recovery in Kansas and the US over the next several years. Preparing a sufficient engineering workforce for Kansas is imperative to the economic development of the region.

The state's three engineering programs annually produce around 875 undergraduates, approximately 70 to 80 percent of these are native Kansans. The employment base in the state is doing an exceptional job in recruiting local engineering graduates. To meet the demand for more engineers in Kansas, the state must invest in the promotion of the engineering programs and synergistically grow the student enrollment and generation of successful undergraduates.

Proposed Goals:
In order to meet the needs of the engineering companies in Kansas and to support the growth of high tech opportunities for Kansas students, the deans of the three engineering degree granting institutions have prepared this joint plan. With the necessary resources being provided by the state and industry partners, the engineering schools propose to increase the number of engineering graduates by 490 graduates over the next five years. Table 1 shows the five-year average production of BS degrees in engineering degrees from KSU, KU and WSU.

Table 1. Five-year Averages of Undergraduate Degree Earners in Engineering Programs in Kansas.

School	**Undergraduate Engineering Degrees Awarded Annually**
Kansas State University	423
University of Kansas	255
Wichita State University	197
Total	**875**
Increase Goal:	*490 additional graduates*

The goal is aggressive and will require considerable investment on the part of the state, universities and constituent companies. It is anticipated the growth will be accomplished through integrating our efforts in:

1) Recruiting more Kansas high school students to study engineering,
2) Retaining a greater fraction of those students who start in these fields through graduation, and
3) Providing the faculty, staff and facilities to accommodate the growth.

The institutions will work with prospective students to help them find the degree program that best fits their career aspirations. The institutions will work together to discover and share best practices in recruitment and retention to ensure more students seek and earn their degrees.

Proposed Plan:
While each of the three institutions will implement a unique plan for its campus that maximizes the effectiveness of the dollars committed to this proposal, there are several cross-cutting strategies common to the universities. The three overarching tasks are recruitment of new students; retention of those students; and building capacity in the schools to accommodate the larger number of students in school.

Recruitment
The universities rely on an adequate supply of motivated and prepared high school students to enter their programs. Each of the universities has significant recruitment efforts that work with K-12 in attracting students to programs. Engineering programs are somewhat atypical to most academic units in universities in that they have very close ties to their constituent companies. For example, the engineering schools/colleges in Kansas all have multiple industry boards that serve the schools/colleges and departments. These boards provide a direct link between the academic programs and the needs in industry and they provide assistance with various recruiting activities on behalf of the schools as well as providing financial support. Companies in Kansas

provide excellent support to the schools through student scholarships, assistance in K-12 recruiting (such as support for Boosting Engineering, Science & Technology (BEST) Program, FIRST Robotics Competition, Project Lead The Way, and the Future Cities Competition) and through career planning and services. Examples of the support being provided by industry and other partners at each of the schools are included in the appendix. As demonstrated in the appendix, the universities already have tapped many other sources to help provide resources needed for growth. And, this proposal will require extensive coordination across our programs and further collaboration and support from our engineering companies as well as the State of Kansas.

Retention

In programs across the country less than one-half of students who begin their studies in engineering complete degrees in engineering. Many of those students transfer to other fields and still complete a bachelor's degree, and as a result, the institutional graduation rates of students starting in engineering, although they may not graduate in engineering, are often the highest for a university. In 2008, the National Academies issued a new document entitled "Changing the Conversation." The text embeds the concept that K-12 teachers and students have poor understanding of what engineers do. Evidence is provided that demonstrates that the public believes engineers are not as engaged in societal and community concerns. When you couple this concern with the predictions described in "Rising above the Gathering Storm," it is clear that public perception must change. In fact, engineering in all undergraduate retention and recruitment efforts should be significantly modified to impress upon the public that engineers sustain the United State's capacity for technological innovation. For example, one cannot get to work on a daily basis without utilizing the benefits for ingenuity (e.g., alarm clock, programmable coffee pots, water, power, highways, cellular phones, wireless connectivity, etc.).

In essence the language must change so young people are attracted to careers in engineering, and to drive this, the technological literacy of our societies must be improved. As sited in the text, contrary to wide-spread opinion, only 15% of those polled see engineers associated with "nerdy" or "boring" and most respect engineers, but they don't want to become one! Therefore, engineering must be "branded" to appeal to teens and adults. In fact, the text suggests that engineering should be presented as a field built upon concepts that are well liked (verses focusing on required skills and personal benefits) by embedding concepts such as :

"Engineers make a world of difference"
"Engineers are creative problem solvers"
"Engineers help shape the future," or
"Engineering is essential to our health, happiness and safety"

A component of the proposed effort will be to increase the engineering retention rates in each of the schools by embedding in our recruitment and retention activities the "new perspective" of the impact of engineering. Furthermore, activities such as intervening early with students who show signs of struggle will result in more students successfully completing engineering degrees. Providing greater contact with new students and offering tutoring for courses known to be difficult for entering students are other ways to enhance retention. To the greatest extent possible, the three schools will coordinate the recruiting and retention activities. The schools already coordinate several student competition activities such as MathCounts and the Future City Competition. Project Lead the Way is another program that is gaining widespread national attention and WSU is currently coordinating that effort in Kansas.

Capacity
Each of the universities will require additional capacity for handling the planned enrollment and graduation increases. The planned resources are consistent with the magnitude of the proposed growth goal. Faculty and staff resources will focus on the increased demand in academic and career advising and classroom and laboratory teaching. Simply stated, serving hundreds of more students will require some new people.

Building space is the final capacity element, as all three universities are essentially at capacity in engineering, and increases in enrollment will necessitate additional space. Each of the engineering programs already has begun informal planning for increasing space. The needs include space required for classrooms, academic laboratories and office space for faculty and staff. Funding of new facilities will be realized through institutionally specific combinations of new bonds and donations from companies and private donors. It is envisioned that the service of new bonds will be met through institutionally specific combinations of increased tuition revenue and the proposed increased state appropriations.

Budget:
The state's three engineering schools propose efforts that, within five years, will produce an increase of an additional 490 graduates annually. The cost to the state for supporting this undergraduate degree goal is estimated to be $15 million on a continuing basis. In addition to the increase in state appropriation, significant leveraging from new private donations, issuance of new bonds, and increased tuition revenue from the increase in enrollment institutionally will be realized.

Recognizing the economic pressures on the state, the request for the first year is focused on *initiating* this plan. In the first year, the funds would be used to 1) hold a "Summer Engineering Institute" for secondary counselors and science teachers; 2) provide a small investment for each school to strengthen and expand "Retention Programs"; and 3) provide a modest fund for completing preliminary space planning on each campus. The Summer Institute will help those in secondary education better understand the field of engineering so they can provide a greater level of information to students with whom they interact. Counselors and teachers will learn about the exciting challenges engineers address, career opportunities for graduates and spend time on each campus to experience what a typical engineering student sees. Strengthening and expanding the retention efforts would start small with the first year resources, but would allow these efforts to have early and significant impact. And, finally, approximately $100,000 would be split between the three campuses to allow preliminary planning on space needs for each campus. A deliverable of the planning would be facility drawings and supporting materials that could be used to engage potential partners.

The total for these three items for the first year would be $400,000. The suggested phase-in timing for the out-years' budget is shown in Table 2.

Table 2. Requested State Support

Year →		Year 1	Year 2	Year 3	Year 4 & beyond
State Support		$400,000	$5,000,000	$10,000,000	$15,000,000

Appendix A: Industry Support for Engineering Education

Kansas State University College of Engineering
Ongoing Efforts in Support of Students Earning Engineering Degrees

Kansas State University's College of Engineering continues to maintain a modest but sustained growth in its undergraduate programs. During the past five years approximately 450 undergraduates per year have earned their degrees from the twelve undergraduate degree programs offered by eight academic departments. About 40 percent of these graduates are employed by industries (small and large) located in Kansas. Recent data (FY08) indicate employment of these engineering graduates in 125 different industries in the state of Kansas, thus giving recognition to the fact that a broad spectrum of Kansas industries profit from the hiring of our engineering graduates.

Many Kansas industries partner with K-State's College of Engineering and support enhancement of its undergraduate programs. In the past two fiscal years (FY08 and FY09) 116 Kansas industries have provided a total of $9M in the form of Scholarships, Faculty support, support of Facilities, and in the category of Excellence. It should be noted that during these two fiscal years individuals, many employed by these same 116 industries, contributed over $25M in support of scholarships, faculty, facilities, and the promotion of excellence.

Types of support can be identified as cash, pledges, deferred gifts, and Gift-in-Kind. The Scholarship category includes scholarships, student awards, student fellowships and other student assistance and support. The Faculty category includes professorships, faculty fellowships, and other faculty/staff assistance and support. The Facilities category relates to property, plant, and equipment and operational maintenance of the plant. The Excellence category relates to departmental or dean's support for areas of greatest need of supplemental support, e.g., undergraduate scholarships, summer camps. Also, major types of Gift-in-Kind (GIK) include software for engineering coursework, art work, books and publications, closely held stock, equipment, real estate, GIK services, rental services, construction, and marketable securities.

In the context of this proposal, it is beneficial to discuss specific investments made to support efforts of recruitment, retention, and capacity. In particular, industrial support of such efforts allows K-State's College of Engineering to advance and prosper.

A. Recruitment

Programs focusing on recruitment activity are offered to students from elementary/middle school through high school. A few of these important efforts are enumerated here.

1. Middle and high school design competitions. Examples include Future City Competitions, Bridge Building, K-State's Engineering and Science Summer Institute (for high school students and teachers), MathCounts, Science Olympiad, and US FIRST Robotics. Industry support includes cash donations, speakers, mentors, judges (e.g., 73 judges from industry are supporting the 2009 Future City Competition on January 24, 2009), administrative support, and equipment.
2. Industry support for science and engineering explorations for middle and high school students in their own communities throughout the state.
3. Programs focusing on increasing the number of females in engineering curricula. For the past several years K-State's Girls Researching Our World (GROW) summer workshops and Explore sCIence Technology & Engineering (EXCITE) programs have been offered to middle and high school girls to encourage them to consider pursuing engineering fields.

4. Career Nights and other career events hosted by industries. These events are held at various locations around the state and average 300+ students and parents per event.
5. Industry personnel support outreach program. In the past two years there have been hundreds of volunteer hours and related donations (mileage, meals, and supplies) given by industry personnel to support outreach activities around the state.
6. Scholarships offered by the College of Engineering. In addition to scholarships offered to freshmen by the University Scholarship Program, students enrolled in the college receive an additional $230-250K in freshmen scholarships.

B. Retention

A wide range of retention programs and scholarships (over 600/year, total of $1.5M from endowments and discretionary funds) are offered to assist students. Many of the retention programs emanate from the support programs of the Multicultural Engineering Program (MEP) and the Women in Engineering and Science Program (WESP). Examples of the scholarship and support programs include the following:

1. Merit-based Scholarship Program. Industry support of the College of Engineering's overall scholarship program is significant, e.g., one industry supports 16 $6000 scholarships/year.
2. Minority scholarship program. The National Action Council for Minorities in Engineering (NACME), a philanthropic organization supported in part by industry, provides 24 $2500 scholarships/year.
3. Learning Communities. Faculty led learning communities foster academic support groups and build upon the notion of developing a better understanding of how individuals learn and how they can be more productive in group settings.
4. Personal and Professional Development course. Industry supports student salaries and course materials for this course. Students are required to work on projects in a team environment and make presentations to industry personnel.
5. Leadership Days. Several Leadership Days and Leadership Workshops throughout the year are supported by industries.
6. Activities such as New Student Orientation Sessions, Rally Days, Annual Engineering Open House, Honors Research Projects, Scholars Assisting Scholars Program, Career Fairs, and other similar events support and encourage students to continue and be successful in their chosen engineering, computer science, and construction science curricula. Furthermore, they promote an exciting student focused community.

C. Capacity

Over $7.5M of the $9M of industry support during FY08 and FY09 has been used to support senior design projects, competition teams and student organizations, laboratory development and equipment, purchase of specialized equipment, faculty support, and physical infrastructure.

University of Kansas School of Engineering
Industry Support Overview

More than 225 corporations and foundations contributed more than $1.5 million to support the University of Kansas School of Engineering during fiscal years 2007 and 2008 (non-capital campaign years). Company and agency staff members also provided untold hours in service to further our shared goals of increasing the number of engineering graduates.

RECRUITMENT:

1. **Corporate Partners Program:** KU's Corporate Partners Program gives industry an opportunity to assist in increasing the number and quality of engineering students and graduates. The program underwrites staff who recruit high school students into the School of Engineering. Corporate Partners for 2008 include Burns & McDonnell, Chevron Phillips Chemical Co. LP, CVR Energy, Embarq Corporation, Garmin International, HEMCO Corporation, Kiewit Power Constructors, Sabre Holdings, and Spirit Aerosystems.
2. **Scholarships:** More than 600 students in the School of Engineering received more than $2 million in scholarships for the 2008-2009 academic year. Scholarship funding comes from private and corporate donors to the school and the university.
3. **Engineering Expo:** More than 1,000 K-12 students from Kansas and the Kansas City region attend this free School of Engineering open house in February. KU students organize and create interactive displays, run contests for K-12 visitors, and invite industry speakers. Expenses for the event are borne in part through industry contributions.
4. **Project Discovery** and **KU Survivor Camp:** KU offers two different weeklong summer technology exploration camps, one for girls (Project Discovery) and one for boys (KU Survivor Camp). Industry provides speakers, company tours and contributes funding to underwrite some of the program expenses and/or attendance fees for some campers.
5. **SWE Weekend of Engineering:** High school girls attend a weekend engineering experience at KU during either the fall or spring semester. Members of regional chapters of the Society of Women Engineers – professionals in the field – take part in presentations to give students a glimpse into the exciting world of engineering.
6. **Exponent:** Underrepresented minority high school students are invited to spend the weekend at KU and learn about opportunities in engineering. Companies underwrite some of the expenses, provide tours of their facilities and offer engineers as speakers who can address career opportunities and the work experiences of minority engineers.
7. **Engineer Your Career:** Girls in eighth through 12th grade can attend a half-day information session about opportunities as engineers and meet with women engineering students at KU. Expenses are covered in part through contributions to the school.
8. **Eureka Weekend:** Students in sixth, seventh and eighth grades are invited to a Saturday of engineering discovery at KU. Easy but eye-opening experiments, lab tours and presentations keep students focused on the coolness of engineering. Program expenses are underwritten in part through contributions to the school.
9. **KUTI:** High school science teachers and counselors are invited to an extended weekend at KU with hands-on lessons and information they can take back to the classrooms. Program costs are underwritten through contributions to the school.
10. **Celebration of Excellence and Diversity:** Underrepresented minority high school seniors are invited to take part in an information and scholarship-presentation session hosted by an industry partner. Two CEDs are held each year, one in Kansas City, another in Wichita.

11. **MathCounts:** KU hosts the annual competition of the Topeka Region Chapter of MathCounts, a national math contest for middle school students. The Kansas Society of Professional Engineers and industry volunteers assist to make this event a success.
12. **Future City Competition:** Several engineering employers provide financial support and volunteers to assist with mentoring, coordination and judging at the Great Plains Region Future City Competition for seventh- and eighth-graders. This annual program held every other year at KU lets students explore infrastructure and planning issues.

RETENTION:

1. **Engineering Learning Community:** KU ELCs help freshmen connect with their peers, develop study skills and learn about career opportunities and employers through tours and activities. The free program also provides tutoring and mentoring from upperclassmen.
2. **Student Projects, Capstone Design Projects and Engineering Expo** (Jayhawk Motorsports, ASCE Concrete Canoe Club, Engineers Without Borders, Solar Decathlon etc.): Students raise funds from engineering firms to support completion of their student projects, or work on projects specifically requested by firms. Such projects help students connect with peers and faculty while applying engineering principles and completing projects.
3. **Engineering Student Council:** KU Engineering Student Council organizes numerous activities throughout the year designed to help the engineering student body become more cohesive and achieve its goals. Students seek funding and involvement from industry.
4. **Scholarships:** Contributions in the form of scholarships from firms such as Garmin and ExxonMobil let students focus on learning.
5. **Career Fairs and Career Nights:** Students are invigorated to know numerous employers waiting for them to graduate. Corporations and agencies pay a fee to attend career fairs where they can interact with students and cultivate ties for future employees and interns.
6. **Industry Internships:** Often the first opportunity for students to become immersed in their chosen discipline, an internship provides a real-world connection to classroom learning as well as funds for the next school year.

CAPACITY/BUILDING:

1. **Infrastructure:** Industry has long supported infrastructure improvements. Students, faculty and staff also benefit through equipment and software donations as well as improvements to labs, classrooms and other facilities. Recent physical improvements include:
   • KU's Bioengineering Research Center, made possible through monetary and in-kind gifts from the leaders of HEMCO
   • The Robison-Veatch Office Complex for the Department of Civil, Environmental and Architectural Engineering
   • The Garrison Flight Research Center at the KU Hangar, portions of which were renovated with funds from Cessna
   • Eaton Hall, which was built entirely through donations to the School of Engineering and includes support from Daimler-Chrysler, SWB (now AT&T) and Butler Manufacturing.

2. **Faculty Support:** Industry supports faculty through endowed professorships and consulting opportunities during semester breaks. In addition, industry seeks and provides support for research through KU's research Centers of Excellence, such as the Center for Environmentally Beneficial Catalysis.

Wichita State University College of Engineering
Ongoing Efforts to Build Kansas Supply Chain of Engineers

The College of Engineering (CoE) at Wichita State University (WSU) has worked on building Kansas' "Supply Chain of Engineers" for the last decade. Below is a summary of key efforts under way in the college in three areas: recruitment, retention, and capacity building.

Recruitment. The total private investment for the last 10 years in recruitment activities has exceeded $4M. In the next five years, this private investment is expected to reach $5M.

1. Kansas Affiliate of Project Lead the Way (PLTW). The college is the state affiliate of this nonprofit, nationwide organization that provides curriculum and teacher training to implement hands-on pre-engineering education for high schools and middle schools.
2. Boosting Engineering, Science & Technology (BEST) Robotics. Annual sports-like competition hosted by the college that challenges high school students to build a robot that accomplishes a defined task. More than 400 high school students compete. CoE students interact with competitors, serving as spirit and sportsmanship judges, referees and volunteers.
3. Changing Faces. Groups of students from underrepresented groups in engineering are brought to the college to participate in a set of hands-on events.
4. Switch On Saturdays (SOS). A free semimonthly program to increase interest in Science, Technology, Engineering, and Math (STEM) among middle school students, specifically females and minorities. Professional engineers and CoE students hold classes at a local museum and WSU. SOS provides a fun, hands-on, learning experience of STEM topics, and shows participants what engineers do and how what they learn is applied in the real world.
5. SEEDS. Hands-on engineering lessons are taught to local K-12 students in the classroom, exposing them to the practice of engineering in a fun and active environment.
6. Shocker Mindstorms. Teams of middle school students from across the state develop a robot using Lego robotics that senses its environment and responds to complete a course designed by CoE students. Professional engineers judge the event and encourage students. The event helps students build skills in design, teamwork and effective communication.
7. Engineering Summer Camps. Six to seven camps are offered per year to different age groups in fourth through 12th grade. Held to build interest in engineering, science and math.
8. Boys and Girls Club Partnership. WSU engineering students serve as mentors in an afterschool Lego robotics program for club members. The program strives to develop design, teamwork, and effective communication skills of participants.
9. Mueller Elementary and Aerospace Engineering Magnet School Partnership. WSU CoE supported Mueller as it obtained board approval to become a magnet school. CoE faculty members are helping teachers develop the pre-engineering curriculum to be offered.
10. Wallace Invitational for Scholarships in Engineering (WISE). Over 160 high school seniors participate in this annual event, which includes a student panel where engineering students from each major discuss their experiences as engineering students, coop programs, and extra-curricular activities. Students also tour the college, view senior design project presentations, visit unique laboratory facilities and take part in a group hands-on activity.
11. Principal and Counselor Day. The CoE was the focus of this event that aims to stimulate discussion about WSU's engineering program between counselors and high school students.
12. Community College Day. Community college advisers and staff visit the college every year to learn more about engineering and engineering programs at WSU.

13. Engineering Open House. The facilities of the CoE are open to the community once a year. Invitations are sent to high schools interested in engineering and about 250 students are given personal tours, which includes more than 80 senior design projects on display.
14. Recruiting Scholarships. Between 65 and 70 scholarships are given to high school seniors on an annual basis. The scholarships are offered based on academic achievement, participation in PLTW, or for recruitment of specific student populations of interest to industry.
15. Coordinating Opportunities for Engineering Careers System (COFEC). A system to address the need for centralized strategic management and distribution of funding and support for technical education in the Wichita area. A partnership of WSU and Wichita industry.

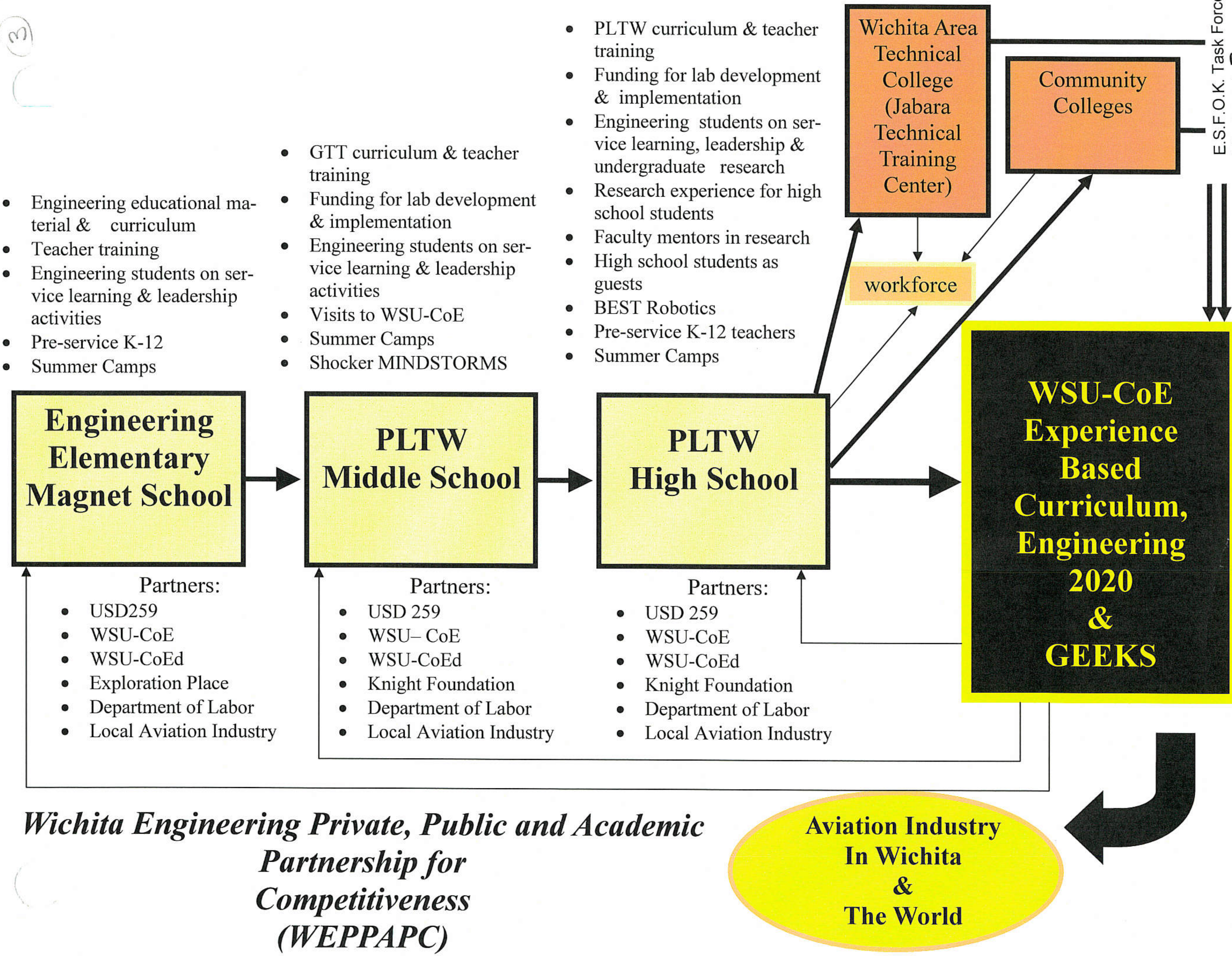
Retention. The total private investment for the last 10 years in retention efforts has exceeded $4.5 M. In the next five years, this private investment is expected to reach $5M.

1. Great Expectations; Engineering Kansas Scholars (GEEKS). The program has six elements including a two-year scholarship; tutoring in STEM courses; mentoring with professional engineers; a learning community on a residence hall floor; cohort scheduling or enrollment in a set of similar courses for the students; and a three-year cooperative education opportunity.
2. Engineer 2020. The goal of this strategic initiative is to increase retention as well as prepare WSU CoE graduates for effective engagement in the profession in the year 2020. This initiative has been in effect for all CoE undergraduate students since Fall 2007. The CoE requires that every student complete the program requirements, including at least three of the following six activities: Undergraduate research, cooperative education or internship, global learning or study abroad, service learning, leadership and multidisciplinary education.
3. Retention Study. A study has been completed by the WSU Psychology Department to determine the key causes of students not completing their degrees.
4. Faculty Mentoring Program. A program which matches new faculty with mentors with the objective of developing the skills needed to facilitate student success.
5. Faculty Development Program. Aimed at providing faculty with tools and knowledge to improve teaching quality, student learning and engagement and student success.
6. Ice Cream Socials. Twice a year, free ice cream is served to CoE students by faculty and staff to promote connection and relationships.
7. Engineering Scholarship Receptions. Students receiving scholarships from the CoE have a reception to meet their donor and be recognized by the college.
8. Wallace Scholars Socials. Each semester, bowling and pizza parties are held to facilitate camaraderie and bonding between the Wallace Scholars.
9. New Student Orientation. All new engineering scholarship recipients are introduced to the college and trained on the use of *myWSU*, email and Blackboard.
10. Engineering Block Party. An informal fall social event that introduces freshmen to the CoE and helps them forge a connection at WSU.
11. Scholarship Programs. Multiple scholarships programs provide around 250 scholarships every year encouraging students in good academic standing to persevere.

Capacity Building. The total private investment for the last 10 years to build capacity in the college exceeded $8.5M. In the next five years, private investment is expected to reach $8M.

1. Physical Infrastructure (Facilities)
2. Laboratory Development, Equipment and Technology Purchase and Upgrade
3. Faculty Support (Fellowships, Endowed Chairs and Professorships)

E.S.F.O.K. Task Force
Attachment 3
3-16-09



Wichita Engineering Private, Public and Academic Partnership for Competitiveness (WEPPAPC)

Wichita State University
College of Engineering Answers to
Legislative Engineering Task Force
"Engineering Success for the Future of Kansas"
3/16/2009

Engineering Job Outlook

Table 1 Occupational Alignment, Kansas Aviation Cluster, Bachelor's Degree Only. From Kansas Aviation Manufacturing, 2008 (CEDBR).

Occupational Title	Educational Attainment	Base Year Employment (2004)	Projected Year Employment (2014)	Training Leakage	Total Number Needed to be Trained
Industrial Engineers (including MfgE)	Bachelors	1,017	1,209	47.5%	837
Mechanical Engineers	Bachelors	752	950	47.5%	769
Business Operations Specialists	Bachelors	620	784	34.5%	412
Computer Software Engineers	Bachelors	378	520	46.5%	337
Accountants and Auditors	Bachelors	286	342	33.4%	165

Table 2 Employment outlook for engineers from The Occupational Outlook Handbook 2008-09 Edition.

Occupational title	Employment, 2006	Projected employment, 2016	Change, 2006-16	
			Number	Percent
Engineers	1,512,000	1,671,000	160,000	11
Electrical and electronics engineers	291,000	306,000	15,000	5
Civil engineers	256,000	302,000	46,000	18
Mechanical engineers	226,000	235,000	9,400	4
Industrial/Manufacturing engineers	201,000	242,000	41,000	20
Electrical engineers	153,000	163,000	9,600	6
Aerospace engineers	90,000	99,000	9,200	10