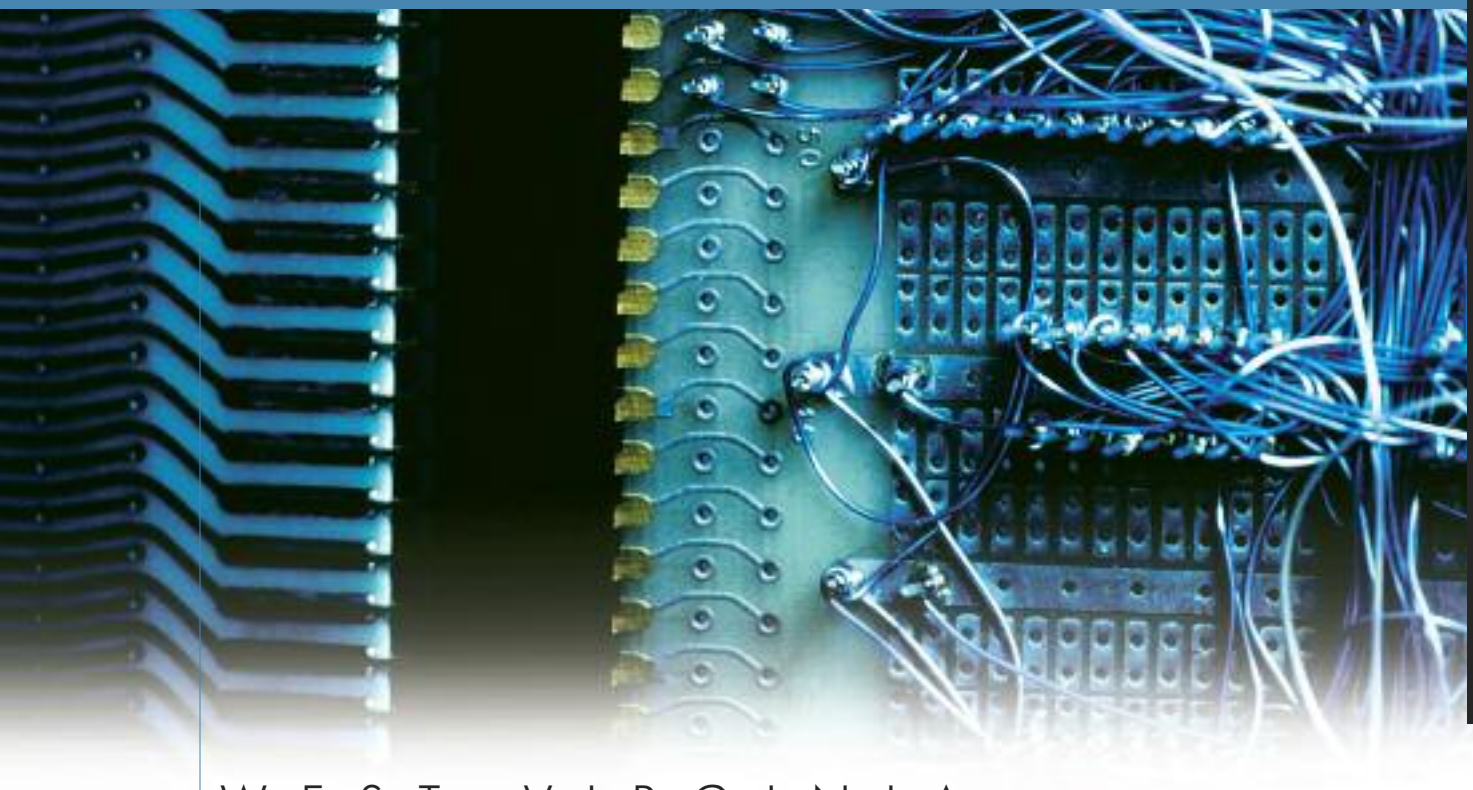

WEST VIRGINIA

Consortium on **Undergraduate Research** and **Engineering** (CURE)

January 7, 2008

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EXECUTIVE SUMMARY

The West Virginia Consortium on Undergraduate Research and Engineering (CURE) was created by the legislature in 2006 to study a variety of issues related to: (1) increasing West Virginia's capacity for high quality engineering instruction and research; (2) increasing access throughout the state to high quality instruction and research opportunities in science, technology, engineering, and math (STEM); and (3) stimulating economic development throughout West Virginia by increasing the number of professional engineers available to business and industry.

The Governor further charged CURE with responding to a national challenge to develop recommendations for STEM educational reforms that enhance the state's ability to compete and prosper in the current and future global economy.

Over the course of the last year, CURE has responded to these charges from the legislative and executive branches by working with the larger higher education, K-12, business and government communities to research and provide recommendations on STEM education and related issues, especially as they relate student interest and capacity for success in engineering programs and careers. Information was obtained through a variety of sources, including reports on education at the institutional, state, and national levels, reports introduced at CURE meetings, and comments from the public and the professional engineering and science communities in both written form and in public forums.

The CURE process revealed that West Virginia faces many of the same challenges in preparing and recruiting the next generations of STEM professionals as the rest of the country, but also some unique challenges related to its population demographics and related issues. Recruitment and retention of both K-12 teachers and higher education faculty members in STEM areas continues to be one of the key challenges due to competition from surrounding states and market forces, and West Virginia's ability to prepare and compete for these individuals in the future workforce will be crucial to the state's economic development and success. The state's higher education engineering and research programs have the capacity for continued growth and success, in both an individual and collaborative sense. Additionally, although West Virginia is directing attention and resources to STEM-related issues, ongoing follow-up is required to adequately assess the effectiveness of current and future programs in order to prioritize use of these resources. Finally, a consistent and effective forum for communication among K-12 STEM teachers, higher education STEM faculty, and the relevant professional communities is needed to address the continuing needs of students, educators, and industry in a rapidly changing global technology environment.

In any discussion of STEM education issues, it is important to note that the subjects of education strategies, student interest and recruitment, and the future needs of the STEM professional communities are necessarily fluid and currently the subject of much debate at the national and global levels. In this spirit, the members of CURE see the findings and recommendations of this report as the first in a series of steps to assure our state's continued competitiveness in a global technology-based economy. Specific recommendations include:

To increase West Virginia's capacity for high-quality engineering instruction and research

- Increase the number and distribution of engineering STEM programs that promote critical thinking skills in the K-12 setting, which would include expanding and enhancing existing programs such as Project Lead the Way, Foundations in Engineering. In structuring and funding such programs, provide for long-term involvement with students and teachers to better assess program effectiveness and provide mechanisms for formal and informal coordination among programs.
- Consider revising the manner in which GPA is calculated for Promise eligibility to prevent penalizing students who opt to take higher level math courses.
- Support the development of alternate education and certification programs for teachers in math and science in order to meet the critical shortage areas, and to provide alternative pathways to teaching for STEM career professionals.
- Encourage and reward teachers with an interest and certification in STEM content areas with differential pay incentives that address the issue of market competition, similar to the approach taken by institutions of higher education.
- Support the expansion of AP and other virtual math and science courses to increase course options for students in schools without sufficient math/science staff.
- Explore and provide additional incentives for students to optimize their participation in the full range of available high school math courses, such as providing certificates for successful completion of an identified math curriculum.
- Create and maintain a forum for more meaningful interaction between and among the K-12, higher education, and professional communities to better define the needs of the STEM stakeholders at each level of the educational and early career process and to ensure smoother transitions for students at each step of the way. Any such forum should specifically include STEM teachers and higher education faculty in engineering and other STEM disciplines without a direct K-12 counterpart, as well as working engineers and scientists, in order to improve communication regarding the effectiveness of past and present approaches and the requirements for successful STEM careers.

- Support the implementation of the technology recommendations in the West Virginia Board of Education Compre hensive Report of Findings and Recommendations for Technology in order to integrate additional technology into STEM programs.

To increase access throughout West Virginia to high-quality STEM instruction and research opportunities

- To address the fact that engineering and related degree programs usually require more than four years for completion, focus a portion of the Promise scholarship program on STEM majors and increase the potential student support to five years for students who attain and maintain enrollment in these programs.
- Develop and support new positions at state institutions of higher education in engineering, math and science *education* to improve and enrich the first-year experience and to increase retention in these programs.
- Better prepare students for the future by enhancing current student design/capstone experiences to include undergraduate research at an earlier point in the bac calaureate curriculum, thereby expanding the focus on opportunities for advanced studies and providing students with enhanced critical thinking and learning skills to adapt to an environment of rapidly changing technologies. Invest in such programs to make them more competitive with other opportunities for student employment, but maintain availability of co-op programs and similar internship opportunities in fields relevant to degree programs.
- Invest in the physical and intellectual infrastructure available to students by fully funding a statewide higher education research program that provides matching funds and incentives for growing the coverage and depth of research programs.

To stimulate economic development throughout West Virginia by increasing the number of professional engineers available to business and industry

- Stimulate interest of young people in training and careers in engineering and related disciplines by involving the professional and business communities in a more visible and engaged manner.
- Provide economic incentives for students to complete graduate degrees in engineering.
- Diversify the students who pursue education and careers and engineering by developing strategic initiatives focused on the recruitment and retention of traditionally underrepresented groups.

West Virginia Consortium
on **Undergraduate Research** and **Engineering** (CURE)

COLLABORATIVE ENGINEERING STRATEGIC PLAN

January 2008

Use complementary strengths of West Virginia University Institute of Technology, Marshall University, and West Virginia University to develop a plan to:

- **Goal 1:** Increase access throughout the state to high quality instruction and research opportunities in science, technology, engineering, and mathematics.
- **Goal 2:** Increase West Virginia's capacity for high quality engineering instruction and research.
- **Goal 3:** Stimulate economic development throughout West Virginia by increasing the number of professional engineers available to business and industry.

■ Create a position at each engineering college for a STEM coordinator by 2008, to provide outreach to secondary schools, mentor freshman students, and to collaborate with coordinators at other institutions. ■ Form a statewide leadership team for implementing pre-engineering programs in grades 7-12. The team shall include K-12 teachers and faculty from the state's engineering colleges. ■ Expand implementation of pre-engineering programs with activity in all counties by 2015. ■ Coordinate development and assessment of pre-engineering and other K-12 STEM programs with higher education faculty and professional community to maximize effectiveness of efforts and provide continuity.	■ Work towards goal of new faculty positions at CURE institutions to facilitate CURE recommendations over next two years, and add/formalize STEM outreach coordinator position. ■ Provide support for 20 additional students among the CURE institutions to participate in undergraduate research activities during next three years, at a cost of approximately $400,000. ■ Support and realize full potential of statewide research funding incentive program through collaboration among institutions. Focus on economic development through commercial applications of research, and recruit new engineering research faculty members for this purpose. ■ Provide additional support for statewide engineering articulation agreement and planning group, which is currently self-funded by the CURE institutions.	■ Expand incentives to attract increased number of entrepreneurial faculty members at each institution in STEM disciplines, and address faculty salary issues associated with market demand. ■ Invest in more electronic classrooms, on-line programs, and other technology driven teaching/learning facilities in order to pool resources among the engineering institutions. ■ Support inter-library collaborations at higher education institutions with the specific goal of increasing engineering and computer science related holdings. ■ Improve communication among the research branches of higher education institutions, including identification of mutual/complementary areas of interest to increase funding opportunities, and collaboration on intellectual property issues. ■ Create a forum for additional coordination between faculty, researchers and business/industry.

REPORT ON FINDINGS ■

WEST VIRGINIA

Consortium on **Undergraduate Research** and **Engineering** (CURE)

January 7, 2008

CURE BACKGROUND and PURPOSE

During the 2006 legislative session, amid considerable discussion regarding the state's undergraduate engineering programs, the West Virginia legislature enacted a provision that created the West Virginia Consortium for Undergraduate Research and Engineering (CURE). *See* W. Va. Code § 18B-1C-3. Many of the issues that were raised during the session involved baccalaureate engineering programs, including student preparation for and access to such programs, and the potential for such programs and associated research initiatives to support and enhance economic development in the State.

Also during the 2006 session, the legislative education leadership and the executive branch worked with representatives of higher education and K-12 communities to identify and fund additional initiatives to strengthen the state's position with respect to science, technology, engineering, and math (STEM) education. These initiatives included development of the statewide STEM Academy and funding for implementation of Project Lead the Way, a national, non-profit program that seeks to recruit and prepare tomorrow's leaders in engineering and related fields.

It was in this context that the concept of CURE arose. The resulting authorizing legislation was developed accordingly to provide an appropriate forum for a further and more in-depth analysis of engineering education, STEM preparation, and similar issues projected to have a significant and sustained impact on the economic competitiveness of the state and the nation.

Statutory Mission

As stated in the authorizing legislation, CURE's purposes include:

- Increasing West Virginia's capacity for high quality engineering instruction and research;
- Increasing access throughout the state to high quality instruction and research opportunities in science, technology, engineering, and mathematics; and
- Stimulating economic development throughout West Virginia by increasing the number of professional engineers available to business and industry.

The authorizing legislation further charged CURE with preparing a Collaborative Engineering Strategic Plan, in order to make the best use of the complementary strengths of West Virginia University, Marshall University, and West Virginia University Institute of Technology. To accomplish this task, the legislation created a consortium comprised of academic and research administrators from these institutions, as well as members of the professional community with expertise in engineering, research, and other applicable fields. CURE's members also invited the Superintendent of the West Virginia Department of Education to participate in the consortium.

Additional Charge from Governor

As the CURE was being created at the state level, events were occurring at the national level related to STEM education and competitiveness in a global market. One of the most significant developments of that period was a report issued in final form in 2006 by the National Academies (National Academy of Sciences, National Academy of Engineering, and the National Institute of Medicine). That report, entitled, "*Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*," provided a sobering look at challenges to the nation's economy resulting from decreasing student interest and preparation for careers in STEM disciplines and related research and innovation. In the report, the country's leading experts from industry, academia, and government addressed current trends in STEM education and professions, the importance of these disciplines to continued economic prosperity, and recommendations to ensure that the nation remains prosperous in the 21st century.

As a companion to the report, the National Academies hosted convocation in September, 2006, to discuss the report's findings and to encourage the states to develop their own recommendations for educational reforms that enhance competitiveness. Specifically, teams from the states consisting of education, government and business leaders were asked to identify at least three specific actions to be taken in their respective states to enhance their "ability to successfully compete, prosper, and be secure in the global community of the 21st century." The Governor, through his education policy advisor, asked CURE to take on this related task as part of the final report.

This report represents the work of the consortium members and many other volunteers over the course of the last year to identify the current "state of STEM education" in West Virginia, its relationship to professional workforce and competitiveness issues, general and specific challenges ahead, and recommendations for collaborative efforts to address these challenges. The report is as comprehensive and as detailed as time and circumstances allowed. However, the members of CURE are unanimous in their belief that this report should be considered as only the first step in further integrating the ideas and resources of the state's K-20 community, as well as stakeholders in the business and government sectors, in a meaningful and sustainable manner. Only in this way can we address our state's own "Gathering Storm."

NATIONAL INDICATORS AND CONTEXT

Prior to reviewing relevant facts and figures on West Virginia's particular challenges in the areas of STEM education, professional workforce development, and competitiveness, a review of the national context is useful. As noted above, the "Gathering Storm" report published by the National Academies identified in a factual and straight-forward manner the pending crisis that the nation faces in competitiveness due to lackluster performance in STEM disciplines and related research and innovation. Specifically, the report states that the members of the committee, an impressive array of known and respected professionals from the science, engineering, and education fields, are "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."

The educational concerns that the report reveals as part of a "disturbing mosaic" include the following:

- The United States ranks 16 of 17 nations surveyed by the National Science Board in the proportion of 24-year-olds who earn degrees in natural science or engineering as compared to other majors.
- The number of students receiving bachelor's degrees in engineering has been declining at significant rates since approximately 1985. Unlike many fields where declining numbers of male students are offset by increasing numbers of female students, engineering has remained a male-dominated field of study with the lowest female representation among all types of bachelor's degrees.
- Through the 1990's, less than half of undergraduate students who entered college with the intention of majoring in science or engineering completed a degree in one of those areas.
- In Singapore, close to 70% of 24-year-olds with university degrees have a degree in the natural sciences or engineering, compared to 15% in the United States. (Data from a 2004 study.) Other countries also are out pacing the United States in this regard, including China (50% with engineering/science degrees), France (46%), South Korea (37%), Ireland (31%), and Iran (28%).
- There has been a general decline in the number of doctorates awarded in engineering since the mid-1990's.
- There were twice as many undergraduate degrees in physics awarded in the US in 1956 as in 2004.
- More S&P 500 CEOs have undergraduate degrees in engineering than in any other field.
- In 1999, 68% of 8th grade students in the United States were taught by a math teacher who did not hold a degree or certification in mathematics. Additionally, 93% of grade 5-9 students were taught physical science by a teacher lacking a degree or certification in any of these fields.
- In a recent year, less than one-third of 4th grade and 8th grade students performed at or above "proficient" level in mathematics.

The report addresses many other factors and statistics from a wide array of sources, including trends in national competitiveness and declining funding for research. Rather than simply quote serious and sometimes alarming statistics, the Gathering Storm report also includes various recommendations for improving the national STEM landscape. Many of the recommendations involve improved recruitment of qualified educators into STEM disciplines and associated initiatives to enlarge and improve the pipeline of potential students. Additionally, the report makes strong recommendations regarding increased federal investment in research and innovation. Many of these recommendations were enacted into law earlier this year through passage of the "America COMPETES" Act.

Additional studies have echoed and supplemented the information and recommendations in the National Academies report, including a National Science Board report released on October 1, 2007 ("*A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics System*"), which provides more in-depth coverage of P-20 (preschool through graduate school and first employment) issues. The NSB report advocates for more coherence in the nation's STEM education system, more attention to ensuring that students are taught by "well-qualified and highly effective teachers," and more "vertical integration" among elementary school, middle school, high school, higher education, and professional communities for successful STEM learning.

One set of statistics, at least, indicates that the news isn't all bad. The Digest of Education Statistics published by the US Department of Education's Center for Education Statistics in 2006 indicated that the number of bachelor of science degrees, although declining overall since the 1980's, was up slightly in 2004-2005, in line with 1994-1995 levels. In addition, some of the literature in education and engineering published in the wake of the Gathering Storm report provide conflicting information and analysis on these issues. Whether the Department of Education data is a statistical anomaly or evidence that intensified state and national efforts are beginning to show results, or simply increased and renewed student interest in STEM for a variety of reasons, is something that deserves close and thoughtful analysis in the coming years.

Other national and professional groups have been involved for some time in the challenge of enhancing the strength of the nation's STEM education programs, both in content and in production of successful students, engineers, and researchers. The National Governor's Association recently completed its "Innovation America" series of reports and updates, which address the development of skills and capabilities for the "innovation economy". The NGA recommends reforms aimed at producing qualified K-12 STEM teachers and better integrating STEM programs both vertically and horizontally among stakeholders, such as school systems, university systems, and employers. Both the "Gathering Storm" and the "Innovation America" reports make reference to several state initiatives of note:

New York, California, and Illinois – jurisdictions offer teachers in high-need content areas, such as math and science, a housing subsidy.

Virginia – creation of a "P-16" council, which is developing a longitudinal tracking and data system, to assess effectiveness of college-readiness and STEM programs.

Massachusetts – requiring, by 2010, that all student pass Massachusetts Comprehensive Assessment System in Science and Technology/Engineering

Florida – use of federal funding to focus on recruitment, alternative certification pathways, and retention of career-changing STEM professionals.

California – use of state and private resources to support joint effort by two university systems to double the number of credentialed math/science teachers over next five years. California Teach program – provides every STEM student in the university with the opportunity to complete both the STEM major and pedagogical training in a 4-year program.

Texas – UTeach program at University of Texas and other campuses at Austin has drastically increased the number of STEM teachers it graduates with degrees in science or mathematics and a teacher certification.

Several states have formed K-20 or P-20 working groups or councils to ensure that STEM education standards are integrated throughout the secondary and post-secondary system, and that each step in the education process is consistent with the needs and expectations associated with the following step. The groups also minimize the chances of miscommunications and misunderstandings among K-12, higher education, and the professional/employer communities.

WEST VIRGINIA STEM: CURRENT STATUS, CHALLENGES, and OPPORTUNITIES

Because STEM education impacts so many different aspects of the state's educational and economic health, the members of CURE elected to pursue the collection of data (both statistical and anecdotal) through a subcommittee process that allowed individual members to add maximum value in the areas of their expertise and to provide an opportunity to recruit volunteers in these specific areas of interest. This approach exponentially increased the opportunities for communication between CURE and the various stakeholder groups and individuals.

In accordance with this subcommittee structure, this report addresses the following subject areas: (1) K-12 issues and current programs to enhance STEM education; (2) higher education issues and current status of STEM-related efforts; (3) higher education research collaboration and current status of STEM-related efforts; and (4) facts and feedback from the professional community. As expected, quite a bit of natural overlap and interplay between and among these categories exists.

The findings identified below provide a snapshot of current conditions and cover a very wide variety of access and incentive issues related to STEM education and research. These findings informed CURE's recommendations for enhancement of STEM education at the end of the report, and also guided the development of the Collaborative Engineering Strategic Plan.

1 The Status of West Virginia's Engineering Programs, Students, and Faculty[1]

Engineering requires in-depth knowledge of mathematics and science to analyze and solve problems. In modern engineering, students innovate and transform scientific discovery for practical applications. Therefore, higher education institutions must provide students with the skills to generate new knowledge, the skills to solve problems through existing knowledge, and the training to work in industries that draw on an engineering background. The undergraduate experience is enhanced by exposure to undergraduate research, which also serves to stimulate interest in graduate research and careers.

In comparison to engineering, technology places more emphasis on utilizing existing technologies. The state needs graduates able to operate and maintain existing technology and graduates able to apply mathematical and scientific knowledge to engineering problems. WVU, WVU Tech, and Marshall address the state's various needs through their different missions, programs, facilities, and faculty.

Engineering Education in West Virginia

Public colleges and universities in West Virginia offer students the opportunity to major in standard engineering programs, including civil engineering, chemical engineering, computer engineering, electrical engineering, and mechanical engineering. In addition, specialized programs such as aerospace engineering, mining engineering, and petroleum and natural gas engineering are available. (See Appendix 1 for a complete list of majors offered by each institution.) As of fall 2007, 2,569 students were enrolled in undergraduate engineering programs at WVU, WVU Tech, and Marshall. Of this total, 2,092 students were enrolled at WVU; 332 at WVU Tech; and 245 at Marshall. (See Appendix 2 for more detailed information about student enrollment at each institution.)

Student Preparedness

Engineering students encounter a rigorous first year at college, for which their high school experience may not have adequately prepared them. A common problem has been that students are expected to take challenging math and science courses, introductory courses for engineering, and general education courses. (See Appendix 3 for first-year student course schedules recommended at each institution.) Nationally, a high percentage of students do not return for the second year of engineering studies, and on average, only about 50-60% of students who enter engineering or pre-engineering programs as first-year students graduate with engineering degrees. (See Appendix 4 for attrition rates by institution.)

Representatives from WVU, WVU Tech, and Marshall have outlined the education necessary for students to succeed in undergraduate engineering programs and have identified a number of additional factors that inhibit student success. There is a consensus that high school courses often provide inadequate preparation for the rigorous mathematics and science courses required of engineering students. High school students need more challenging math and science course work and they need help to develop better study skills, work habits, and time management skills while they are in high school. (See Appendix 5 for the qualifications high school graduates should have to be prepared for undergraduate engineering programs at each institution.) While

[1] *Authored by Gerald E. Lang, Sarah N. Denman, Galan Janeksala, and Jessika L. Thomas, with significant contribution from the engineering deans at West Virginia University, West Virginia University Institute of Technology, and Marshall University.*

ACT/SAT scores are one indicator of success in engineering programs, even students with high scores often have difficulty in completing first-year courses. In addition, advanced placement courses do not always prepare high school students for the rigors of freshman college courses, and some students falter in the subsequent courses in the sequence.

Student Retention

Among students enrolled in undergraduate engineering programs, a number of factors contribute to the large number of students who elect to change majors or decide to withdraw from school. Changing majors is a much more common scenario at WVU and at Marshall. Students often have unrealistic expectations about the challenges and workload of engineering programs and are frustrated with the amount of time required for foundational coursework before they begin to work on engineering problems and design. This contributes to student attrition in or after the first year. Responses from WVU and WVU Tech also suggest that some students may enroll in engineering programs because of external or familial pressures, rather than the individual student's interest, and may not remain in the program if they have the option to change majors. (See Appendix 6 for factors that prevent students from continuing in engineering programs.)

There is a national emphasis on increasing student retention and graduation in engineering programs, and each West Virginia institution is engaged in efforts to improve retention. Since many students encounter difficulty with the level of mathematics required in engineering, institutions offer math intervention, tutoring, or extra courses; they have increased the minimum ACT score and the level of high school math required for students to enter the programs; and/or they have developed different tracks for students according to their beginning level of mathematics proficiency. To generate support networks and motivate students, programs seek to increase contact between faculty advisors and mentors, to involve first-year students in engineering clubs and organizations, and to increase students' understanding of engineering through orientation courses and employment information. (See Appendix 7 for institution-specific lists of efforts to improve student retention.)

Alternative Engineering Education

Some students who plan to major in engineering discover that they are more interested in or qualified for the application of engineering principles taught in engineering technology programs. Students overwhelmed by the mathematical and scientific coursework required in engineering programs may thrive in a hands-on educational environment that teaches them to use engineering principles. WVU Tech collaborates with the WVU Tech Community and Technical College (CTC) to advise students about associate and baccalaureate engineering technology programs, which are accredited by TAC-ABET. Through this agreement, students enrolled at WVU Tech can easily transfer into engineering technology programs at the CTC. Accredited associate degree (AS) programs at the CTC include Electrical Engineering Technology, Mechanical Engineering Technology, Drafting and Design Engineering Technology, and Civil Engineering Technology. Students who earn these degrees can continue their education to earn TAC-ABET accredited baccalaureate (BS) degrees in Electrical Engineering Technology or Engineering Technology, which has several areas of emphasis. Transfer students have been very successful in completing these degrees and have attained immediate employment at high salaries. The job placement rate of engineering technology graduates of the CTC (both AS and BS) ranges from 90 to100 percent each year.

Engineering Program Collaborations

Collaborations between institutions can reduce the overall amount of financial funding required to serve the needs of engineering students and programs across the state. Current collaborations between engineering programs in West Virginia include the WVU Tech Civil Engineering program (BSCE) at Marshall, the 4+1 Civil and Mining Engineering program with dual degrees granted by WVU Tech and WVU respectively; a 3+2 Physics and Mechanical Engineering program with dual degrees granted by WV Wesleyan and WVU respectively; and the engineering technology transfer program between WVU Tech and the WVU Tech CTC (described above). (See Appendix 8 for descriptions of individual collaborative programs in WV.)

One unique collaborative effort deserves special note. A statewide Engineering Transfer Group Agreement allows students in West Virginia to earn an undergraduate engineering degree by transferring to WVU or WVU Tech after completing up to two years of coursework at one of ten other WV institutions. This program ensures a common curriculum for the first two years of the engineering programs and establishes course equivalencies so that credits transfer easily from participating institutions into engineering programs at WVU and WVU Tech. The statewide agreement has been very effective at meeting the needs of engineering students across the state, especially those interested in disciplinary specific engineering degrees not available everywhere, and could be expanded to include additional higher education institutions in West Virginia. In order to maintain ABET accreditation, the degree-granting institution must be able to verify that the coursework completed by students prior to transferring is equivalent to the requirements at the accredited institution; consequently, course review and approval is handled by WVU or WVU Tech, and includes regular reviews to ensure standards and curricular changes are clarified, understood, and adopted by the participating institutions. Currently, this program is funded and staffed solely by the institutions in-

volved. With state funding this program could extend the services currently being provided. (See Appendix 8 for a more detailed description of this collaborative program.)

Engineering Faculty

Qualified faculty are essential to the state's ability to provide quality engineering programs. As of the fall of 2006, 142 full-time, tenure-track engineering faculty members were \employed by the state's engineering programs: 113 at WVU, 22 at WVU Tech, and 12 at Marshall. An additional 84 employees work as non-tenure track faculty or researchers: 80 work at WVU, most as academic professionals; 1 is a visiting professor at WVU Tech; and 3 are adjunct faculty and research associates at Marshall. (See Appendix 9 for faculty by institution and department.) New faculty hiring will be necessary to expand engineering programs in the state. WVU anticipates hiring 8 faculty members for 2008-09, WVU Tech 11, and Marshall 5. The total of 24 new faculty hires includes 16 to replace faculty who resign or retire and 8 new positions. The number of required hires may increase since these projections do not include unanticipated resignations. (See Appendix 10 for potential hires by institution and department.)

Although the challenges to hiring quality faculty members vary according to each institution's mission and its expectations of faculty productivity, each West Virginia institution reports that low faculty salaries make it difficult to recruit new hires. West Virginia institutions have been at the bottom of the higher education faculty salary scale published by the Southern Regional Educational Board (SREB), although WVU has been more aggressive in offering new faculty hires SREB-competitive starting salaries. However, because of the need to increase starting salaries to recruit new faculty, WVU and WVU Tech are encountering salary compression or inversions, which decrease the morale of current employees. As Marshall's program grows and additional hires are made, salary compression may become a problem there as well. New hires are also confronted with outdated teaching laboratories, limited computer resources, and/or inadequate research facilities, requiring continued institutional focus but also state and private sector commitment for increased personnel services dollars and facility investments. (See Appendix 11 for specific concerns related to entry salaries, salary inversion, facilities, and start-up support at each institution.)

Conclusions On Undergraduate Engineering in West Virginia

The obstacles facing the state as a whole are preparing high school students for engineering degree programs, recruiting students to study engineering in the state, and strengthening support networks to increase graduation rates, and increasing the interest of high school students in the study of engineering. Each institution also faces unique challenges. WVU identifies low senior faculty salaries and facilities as its most significant problems. In order to retain highly-qualified teaching and research faculty, the College of Engineering and Mineral Resources struggles annually to reduce salary compression and to invest in new teaching and research facilities and equipment. WVU Tech sees low student enrollment as its greatest obstacle, and the institution has been recruiting aggressively. In addition to increasing recruitment and retention in STEM programs, Marshall needs new faculty positions and equipment to build its growing engineering program. Each institution continues to seek grant funding to support its STEM efforts. (See Appendix 12 for descriptions of institutional efforts to address these challenges.)

Efforts to increase the recruitment and retention of students in the engineering programs at WVU, WVU Tech, and Marshall should be further enhanced. Developing a Governor's STEM or Engineering Academy could enhance the educational preparation of high school graduates and their interest in engineering programs, and would provide some uniformity and coherence to individual programs already underway at the institutions. The statewide Engineering Transfer Group Agreement should be expanded to provide more state students the opportunity to earn an undergraduate engineering degree. Additionally, the collaborative relationship between WVU Tech and the WVU Tech CTC offers an alternative engineering technology model for preparing undergraduate students for employment in engineering fields if they depart from traditional engineering programs. This transfer program could be replicated through collaborative agreements with both WVU and Marshall to allow engineering students the opportunity to transfer into engineering technology programs at the CTC. These collaborative programs would result in a greater number of graduates in the state with engineering backgrounds and would help fill the demand of the region's businesses and industries for more technical graduates.

The state can be most effective in supporting engineering programs, students, and faculty by providing dedicated and continuing funding for salaries, building renovations, and equipment. Increased salary funding is clearly the primary request of all programs. In addition to providing annual raises, institutions need to be able to offer competitive salaries, prevent salary inversion, hire new positions, and provide administrative and technical support for engineering programs. (See Appendix 13 for each institution's list of current needs.)

2 Existing K-12 Initiatives and Challenges

The System

Discussion of the challenges to West Virginia's STEM education and reform efforts are not new within the Department of Education and related state agencies. However, the challenges have become increasingly significant and more urgent in the face of the disturbing national trends, coupled with the state's unique problems associated with declining high school populations and related issues.

With respect to math and science education, in particular, recent reports and statistics compiled by the West Virginia Department of Education highlight the concerns. According to the most recent "Educational Personnel Data Report," only 65 teachers completed an endorsement in Comprehensive (includes Calculus) Mathematics for the 2005-2006 school year. Similar concerns have been raised about the qualifications and certifications of high school teachers in chemistry and physics. This is occurring at a time when over 3,000 educators currently satisfy state criteria for retirement, and state Board of Education members report that up to 6,000 teachers will be eligible to retire next year. (See "Teacher Shortage Looms," *Charleston Gazette*, October 10, 2007.

Many of these projected shortages will occur in math and science, two areas that are critical for the future competitiveness of West Virginia's students and economy. Some statistics from reports available on the Department of Education's web-site and related news releases (primarily the state's most recent "Personnel Data Report") include:

- Approximately 56 percent of chemistry classes in West Virginia are not taught by certified chemistry teachers. Math teachers who are certified to teach calculus ("comprehensive" as opposed to "algebra" endorsement) are also increasingly difficult to find.
- Out of 217 open mathematics positions for the 2006-2007 academic year, 33 were not filled. Lack of qualified applicants was reported as the reason for the majority of these unfilled vacancies. Almost half of the open chemistry positions for the same period went unfilled primarily due to unqualified applicants. This trend was not evident in most other disciplines, as categorized by the Department of Education. For instance, out of 912 elementary education positions only 21 were not filled, most of which were not related to availability of unqualified applicants.
- The number of college graduates completing a mathematics education program was effectively stagnant during the past several years, while the number of science education graduates decreased.
- Approximately 30% of mathematics education graduates for 2005-2006 are working as educators in other states; another third is untraceable and most probably not currently working in K-12 education or working out-of-state.
- Of the mathematics teachers who did not return to state schools during the 2006-2007 year, over half retired and one-fourth left to accept a position in another state.
- During the 2005-2006 school year, for graduates with a comprehensive mathematics content specialization, 57 professional certificates were completed in-state, and 50 were completed out-of-state. For chemistry content specializations, seven professional certificates were completed in-state, and seven out-of-state. For physics, three certificates were completed in-state, and four out-of-state.

These statistics represent only a sample of the current circumstances that portend the coming crisis in STEM education in the state. As the reports show, West Virginia's challenges with respect to shortages in STEM education professionals are compounded by competition with other states. According to 2006 Educational Personnel Data Report, the average salary for beginning classroom teachers in the state is $30,600 per year, and the average salary including all teachers is $42,600. (The National Education Association reports these averages as $28,604 and $38,360, respectively.) According to the National Education Association, the national average teacher salary in 2006 was $47,674, and West Virginia saw a 7.5% decrease in teachers' salaries from 1995 to 2005, after adjusting for inflation (one of only ten states that saw a relative decrease). Compounding this scenario is the fact that the state's schools also are in competition with industry for individuals with aptitude and education in math and science. Professional groups routinely report that starting salaries for engineers, chemists, IT professionals, safety professionals, and related positions are significantly higher and as much as double the compensation for first-year teachers. This may explain the fact that the number of male teachers has hit a record 40-year low, as reported by the National Education Association. The bottom line is that geographic and occupational market forces work against West Virginia in terms of recruiting and retaining qualified teachers.

The Students

The issues related to recruitment and retention of qualified math and science K-12 educators represent only one aspect of the current status of STEM education in West Virginia. Another important indicator is current performance and attitudes of West Virginia's students as it relates to math and science. The National Assessment of Educational Progress (NAEP) tests compiled by the National Center for Educational

Statistics (NCES) is the current standard for measuring student educational performance across the states. The NAEP data, commonly referenced as the Nation's Report Card, is also used by a number of other educational reporting organizations. NAEP data exists for 8th grade and 4th grade math since 1990 and 1992, respectively, while comparable science data exists since 2000 for 4th grade and 1996 for 8th grade. Data for the most recent year was released in October 2007, and shows the following trends:

- In 2007, the average math score for 8th graders in West Virginia was 270, compared to a national average of 280. (The total possible score is 500.) State average scores for 2000, 2003, and 2005 were 266, 271, and 269, respectively.
- In 2007, 19% of West Virginia 8th graders scored above "proficient" in math, while 61% scored above "basic." In 1990, 9% scored above "proficient", while 42% scored above "basic."
- The state's 4th graders averaged a scaled math score of 236, as compared to 239 nationally. Thirty-three percent of 4th graders scored above "proficient" in 2007, and 81% scored above "basic."
- In science, West Virginia 8th graders scored at the national average of 147 in 2005, not appreciably different from the state's 8th grade science score in 1996. Fourth graders in the state averaged a scaled score of 151 in 2005, two points above the national average, and two points higher than the state's 2000 score.
- In the most recent NAEP report, West Virginia was one of 15 states identified as having a lower average scaled overall score than the focal jurisdiction. This trend was true across virtually all demographic groups, except for the group that included only students eligible for reduced or free lunch, where West Virginia's overall score was not statistically different from the focal state score.
- Of the 52 states and other jurisdictions that participated in the 2007 eighth-grade assessment, the average scaled score in West Virginia was higher than those in three jurisdictions, not significantly different from those in five jurisdictions, and lower than those in 43 jurisdictions.

With respect to "career aspirations" as identified by students who take the ACT examination each year, 4% of West Virginia's "Class of 2007" indicated an interested in engineering, which is the same as the national average in that year, and also the same as surrounding states. However, 3% of West Virginia's students indicated an interest in physical and biological sciences, compared to 5% nationally. Only 1% of students nationally indicated an interest in mathematics as a career, and less than 1% in West Virginia. West Virginia students indicating an interest in education and teacher education, 4% and 3% respectively, also mirrored the national average. At both the state and national levels, the most commonly selected career aspiration in the 2006-07 testing year was health sciences and allied health (26% state, 18% national). The second highest area selected was "undecided," perhaps indicating a fertile recruitment for under-represented majors among college freshman. The third highest area of interest both state-wide and nationally was business/management (7% state, 9% national). (This data is available at www.acet.org.)

In the course of several public meetings and panel discussions, students and parents provided some anecdotal evidence of challenges to math and science education. Although not statistically verifiable, some of their comments deserve mention here. For instance, parents and teachers reported to CURE members that some students are shying away from higher level math courses in high school because they perceive them to be a threat to their grade point averages and corresponding Promise scholarship eligibility. Moreover, some parents are concerned that their children are being discouraged and in some cases actively counseled against pursuing higher level math courses and potential careers in engineering and the sciences due to their choices and performance in middle school. This system may sometimes close doors too early to students who may not be mature enough to make the appropriate grades or choices prior to high school or even college. This observation was repeated often during discussions with practicing engineers and other professionals.

Current Initiatives

In response to these and related trends, government and K-12 leaders, often in partnership with industry or higher education organizations, have developed and implemented a number of programs aimed at increasing the number of qualified math and science teachers and the related goal of recruiting more students into STEM university programs. The state also has made great strides as an early leader in the "Development of 21st Century Skills" program and reforms to math and science course requirements and curricula for high school students (described more fully below). In fact, the state's K-12 community has been proactive in the consideration and implementation of a wide variety of content and delivery issues, such as how to balance "breadth versus depth" issues in the delivery of math programs in middle school and high school math programs.

In an informal survey of education personnel in the state, CURE identified a list of over 40 programs directed toward strengthening the STEM education experience and recruiting more students into engineering, computer science, the natural sciences, and related disciplines. A list of these programs, along with a summary description, is included as Appendix 14.[2]

[2] The information on STEM programs and initiatives was compiled by Paul Hill, Vice Chancellor for Science and Research, Higher Education Policy Commission, and John Putnam, West Virginia Department of Education.

These listed programs and related efforts are commendable for their scope and their success in enlisting the time, talents, and enthusiasm of many volunteers from the public and private sectors. However, due primarily to insufficient resources, most of these programs have not had an opportunity to track the success of student participants, nor to collect similar assessment data that would inform choices regarding the content and delivery of the programs. In addition, in many cases, the programs operate independently, without an appropriate opportunity or forum to share information and experiences with representatives of different programs and steps on the "P-20" ladder. Consequently, these programs, while providing invaluable and no doubt life-changing experiences to students on an individual basis, have not resulting in a comprehensive understanding on such issues as what works and what does not, the grade levels at which the programs are most effective, and whether or not any of this is impacting the numbers and quality of students who seek to major in engineering or the sciences.

The West Virginia Department of Education has been engaged in systematically changing policy and program requirements and practice to provide instruction and learning in the classroom that prepares students to be successful citizens in the 21st century global economy. The WVDE has developed a comprehensive Math/Science Achievement Plan to support the preparation of students for further study and work in math, science, and engineering fields. This all includes redefining the core curriculum to include 21st century skills, content and technologies; increasing the rigor in performance standards; utilizing the latest research on learning to guide instructional processes; emphasizing balanced and authentic means of assessment that go beyond the limits of norm-referenced tests; and focusing on providing learning for all students regardless of race, handicap or socio-economic background. The following summarizes recent and proposed WVDE initiatives directed toward improving math and science instruction and learning.[3]

Recent WVDE Initiatives

- Revised all Math & Science Content Standards and Objectives to increase the level of rigor and depth of knowledge and to more closely align with SAT, ACT, NAEP and international assessments.
- Added a new Algebra III course and developed content standards and objectives designed for work beyond Algebra II, transitioning students from Algebra II to Trigonometry or Trigonometry to Pre-Calculus.
- Developed standards and objectives for Calculus, a course that has been taught throughout West Virginia for which no state content standards and objectives were approved.
- Scheduled to complete development of new content standards and objectives for Biology II, Chemistry II and Physics II by January, 2008.
- Developed a comprehensive standards based units of instruction for Algebra I required course…over 100 lessons have been developed that have research-based instructional strategies, learning skills, technology tools, resources such as SAS in Schools & Think-Finity, formative assessment rubrics, summative assessments with rubrics and accompanying interactive Java Applet to support student success in this *gatekeeper* course for future math success.
- Started development of comprehensive standards based units of instruction for Geometry and & 7th grade math courses…scheduled for completion spring 2008.
- Established and supported with Benedum funding the *Carnegie Learning – Cognitive Tutor* program in 37 counties (one high school in each county). Preliminary studies show much success with this Algebra I instructional resource (7 sites were administered pre and post tests with an average 12.2% increase in achievement).
- Developed *Instructional Guides to support Math and Science Achievement* at each grade level…4 instructional guides per content area per grade level.
- Developed a *Teach 21 Web Site* with interactive content standards and objectives, learning skills and technology standards and objectives, learning resources, instructional guides and units of instruction to support standards based instruction and higher skill acquisition… **http://wvde.state.wv.us/teach21**
- Established a *Mathematics Program Improvement Review Process* – a proven evaluation process focused on standards for high quality mathematics programs in grades K-12. Forty-one counties to date have been trained and are implementing the review.
  - Revised Policy 2510 to establish more rigorous course requirements:
  - Required 4 units of math;
  - Recommended students in the professional pathway take Algebra I in the 8th grade;
  - Established a Transition College Math Course for all students not meeting college benchmark assessment standards;
  - Required a science sequence for all students: physical science, biology and chemistry;
  - Eliminated the entry pathway;

[3] Provided by the West Virginia Department of Education..

  - Required all high schools to offer a minimum of four AP courses;
  - Recommended that all middle school students complete a technology course, and
  - Required completion of an on-line learning course prior to graduation.
- Established *College Readiness Standards for Mathematics* with Higher Education. These standards have been identified as those needed for a student to be enrolled and succeed without remediation in a minimum credit-bearing college level mathematics course at a postsecondary institution.
- Established a *Response to Intervention Requirement* in Policy 2419 that requires early intervention with students not mastery reading and math skills.
- Established a *21st Century Science and Technology Initiative* to provide intensive hands-on professional development to high school science teachers to use NOVA5000 Data Loggers to obtain and interpret information from science experiments. The training provides teachers with technological experience and the curricular models and materials to deliver a rigorous program that incorporates our newly revised and more rigorous state standards.
- Established with the assistance of NSTA a *SciPak Middle School Initiative* that allowed middle school and special education teachers to acquire quality, interactive professional development in specific content areas of science.
- Implemented the *Math Science Partnership Program* in 24 counties that is designed to increase the academic achievement of students in mathematics and science by enhancing the content knowledge and teaching skills of classroom teachers.
- Established *Project Lead the Way* in pilot counties that is designed to support the establishment of a high school pre-engineering program taken in conjunction with a college-preparatory level academics to better prepare students for post-secondary engineering studies. The state leadership team includes representatives from industry, higher education, government, K-12 and other stakeholders.
- Developed a *Balanced Assessment Program* to support summative, formative and classroom assessment of math and science content standards and objectives.
- Developed a *Comprehensive Report of Findings and Recommendations for 21st Century Technology* that supports the provision of hardware, software, infrastructure, technical and instructional support and professional development for the integration of technology in math and science instruction and learning in all classrooms.
- Implemented *Foundations in Engineering* program to introduce students to basic principles of materials, mechanisms, structures, electricity, electronic control, fluidics, computer control and graphic communication. Students work in engineering teams to develop work process skills such as researching, writing, organizing, modeling, calculating, and communicating with others.

Proposed WVDE Initiatives

- Development of alternate certification routes to increase the number of highly qualified math and science teachers as recommended by the *Critical Teacher Shortage Task Force*.
- Continued expansion of the NSTA Professional Development Modules to support improved content knowledge of middle school science teachers.
- Established of Inquiry Based Elementary Science Modules/Kits to support interactive science instruction in our elementary schools.
- Continued provision of professional development to support improved content knowledge of all math and science teachers.

West Virginia Engineering, Science and Technology Scholarship Program

The West Virginia Engineering, Science, and Technology Scholarship Program is a state-funded student aid program designed to enable and encourage students to pursue careers in the fields of engineering, science, and technology. Scholarships, are awarded on the basis of academic qualifications and interest in the fields of engineering, science, and technology, and require a commitment to the initial pursuit of a career in West Virginia.

3 Facts and Feedback from the Professional and Business Communities

Economic Development Indicators

All of the national reports agree that STEM education, and its future evolution and reform, is vital to the future economic success of the nation as a whole and of the individual states. A corollary to this finding is that West Virginia must be able to compete both nationally and globally. A 2007 Economic Development Report Card produced by a national non-profit group (available at **www.cfed.org**) gives West Virginia low marks and rankings in the three rated categories of Performance, Business Vitality, and Development Capacity.

Regarding the data and sub-categories that provide the basis for the report card, West Virginia ranked high in "Amenity Resources", such as low cost of power, access to qualified health professionals, air pollution, and affordable housing. However, with respect to "Innovation Assets"," the state ranked low in most education-related categories such as number of graduate students in science and engineering, academic research and development, businesses created with university R&D, number of PhD level scientists and engineers, and patents issued, earning a rank of 47 and a grade of "F" in this category. The state did score highly with respect to the increase in the number of individuals attaining high school graduation, but ranked 43 with respect to the change in math proficiency scores. Similar data and rankings are available in a 2004 report published by the United States Department of Commerce. (*See* "The Dynamics of Technology-Based Economic Development: State Science and Technology Indicators," Office of Technology Policy, 2004.)

Vision 2015

Recently, West Virginia developed the Vision 2015 plan, which is a strategic framework of actions and initiatives aimed toward the achievement of measurable growth in the state's technology-based economic development. The vision provides that, by 2015, "research and innovation will be the number one driver of West Virginia's new, diverse and prosperous economy." The plan requires the investment of significant resources in both human and physical infrastructure, with the goal of creating a large return in high-paying jobs and associated economic impact.

Under the plan, West Virginia will grow the research enterprise by hiring nationally prominent and promising faculty, increasing the production of scientists and engineers, and building research facilities and parks. Surrounding states have initiated similar strategic plans – and aggressive state funding – for capitalizing on research growth, and recreating universities as the nucleus of economic strength, entrepreneurship, and innovation. In addition, there is a related effort to create a West Virginia research incentive fund that provides matching dollars for university research activities, similar to programs such as Kentucky's "Bucks for Brains" program.

Workforce Data

From the beginning, the members of CURE felt it was important to engage members of the professional community regarding trends that they see, both currently and emerging, regarding such issues as qualified employee base and STEM education at all levels. CURE also reviewed several sources of data and reports provided by engineering employers and professional organizations.

Of the public engineering employers in the state, the West Virginia Department of Transportation, along with the Huntington District of the US Army Corps of Engineers, has traditionally been one of the largest. Earlier this year, the WVDOT commissioned a study focusing on past trends and projections regarding their workforce at all levels. (*See* "Workforce Development Study Report," West Virginia Department of Transportation and Nick J. Rahall, II Appalachian Transportation Institute, 2006.) According to the study, 43% of the current WVDOT workforce will be eligible to retire in the next five years. That figure includes a quarter of the agency's 325 engineers, and approximately 40% of the workers in related science and technology. In addition, a large percentage of employees in these classifications that will not be eligible to retire in five years report that they are likely to look for another job in the next year. WVDOT currently is undertaking a variety of efforts to address these workforce issues, and education is a key component of those efforts.

Although most of the engineering professionals and employers who interacted with CURE did not have the kind of documentation provided by WVDOT, virtually all of the employers and professionals contacted by CURE indicated similar types of projections. For instance, the US Army Corps of Engineers reported that they plan to hire 30+ engineers over the next three years due to retirements and attrition, not counting other unpredicted vacancies, which represents approximately 15% of its engineering workforce.

The West Virginia State Board of Registration for Professional Engineers provided statistics on the two examinations required for professional registration – the Fundamentals of Engineering examination (FE) and the Professional Engineering examination (PE). These are national examinations developed by the National Council of Examiners for Engineering and Surveyors and administered nationally two times per year. An applicant must pass both examinations to become a "registered professional engineer." The FE examination may be taken while a student is a senior in college, but the PE examination may be taken only after the accumulation of several years of qualified work experience after passing the FE exam.

Regarding total number of exam takers in West Virginia, the number of individuals taking the FE examination increase during the past year after remaining relatively stagnant for the past 3-4 years, while the PE exam takers increased this year after 3-4 years of relative decline in numbers. According to board members and staff, they attribute this increase to various marketing and incentive campaigns by professional groups in the state to increase the number of test-takers, especially those who are seniors in qualified engineering degree programs.

With respect to pass rates, in the past three administrations of the FE exam, West Virginia test takers averaged a pass rate of 37%, which includes scores for first-time and repeat test-takers. The West Virginia average compares to a national average on the same examination of 75% for first-time test-takers, and 32% for repeat takers. (Repeat test takers traditionally have a much lower pass rate, and West Virginia's pass rate of 37% includes that group of test takers.) At WVU, the first-time pass rate for a recent FE examination was 54%, which may reflect that the PE board has been waiving the fee for students in order to provide an incentive to first-time test-takers. However, students must also prepare well for this examination. All three CURE institutions offer free review sessions for students, as well as practice exams. Results of a recent practice examination at WVU suggest that more engineering students will be better prepared to take and pass the FE exam in future administrations of the test.

West Virginia's PE examination pass rates for the last three administrations of the examination were 39, 47, and 51%, respectively, which includes all disciplines of engineering and also includes first-time and repeat test-takers. The national examination pass rates for the Civil Engineer PE exam, which is the most common PE registration in West Virginia, were 67% for first-time test takers and 34% for repeat test-takers. Although the state and national data was not available in exactly comparable formats, it appears that the state's scores on the FE exam recently have been lower than the national average, while the state's scores on the PE exam, which can be taken only after four years of applicable work experience, are closer to the national average. Discussions with board staff and members confirmed that West Virginia has consistently been among the lowest of the FE exam pass rates during the past several years.

Public Meetings

In an effort to engage as many members of the professional community as possible, CURE conducted two public meetings in association with several professional groups. The West Virginia Construction and Engineering EXPO is an annual event that takes place at the Charleston Civic Center. Over 6,000 attendees participated in the 2007 event, and CURE attracted a crowd of approximately 200 engineers, limited only by the space in the assigned room, and other technical professionals for its panel discussion of STEM education and professional issues. By their attendance at this seminar, which experienced among the highest attendance of all the many free seminars and professional meetings offered during EXPO, the professional community exhibited a strong interest in the issues addressed in this report.

During the open meeting and panel discussion at EXPO, as well as during a similar meeting in Huntington hosted by the Society of American Military Engineers and the Engineers Club of Huntington, the participants from the professional engineering and employer communities raised the following points:

- Most of individuals who made comments felt that their work place was "aging" with respect to its population of engineers, and that competition for younger engineers is becoming increasingly intense. In most disciplines, engineering and related salaries in other states are higher than those offered here, even though the state engineering and science salaries in West Virginia greatly exceed state math and science teacher salaries.
- Many who spoke at the meetings noted that they feel disconnected from the current educational process at all levels, but especially with respect to lack of opportunities to provide input on what they perceive to be the needs of the profession in regard to math skills taught in middle school and high school.
- With respect to math requirements, many participants felt that the issue is not whether or not students take Calculus in high school, but that the students should have a complete understanding and comfort level with algebra and geometry prior to entering college. Most of the engineers in the room did not have the opportunity to take Calculus when they were in school, and AP courses didn't exist.
- Most engineers and scientists report that it was an interested and enthusiastic math or science teacher that got them interested in pursuing an engineering degree.
- Several retired engineers who spoke during the meetings are substitute teachers in public school systems, and reported that their primary concern is with the curriculum, and not with the teachers. These individuals felt that the math and science teachers with whom they interacted in the school system were diligent and prepared in the context of a challenging work en vironment and relatively low wages.

- Many engineers feel that children are being discouraged from pursuing careers that involve math and science because of math classes they take or do not take in middle school, and that the "career cluster" program has contributed to this situation.
- A common comment from the professional groups was related to what they perceived to be a need to enhance critical thinking skills in new engineering graduates and give them the confidence to pursue solutions and new concepts on their own.
- The groups of engineers pointed out that not all engineers are cut from the same cloth, nor should they be because engineering disciplines are diverse and varied, as are the job descriptions within a single engineering discipline. Not every engineer was a straight-A student in math and science, for instance, but had the perseverance to keep working at it.
- Most participants felt that the pay issue for math and science teachers should be addressed, and that highly qualified math and science teachers should be compensated as such, in accordance with market demands. They also said they would like to see a mechanism for moving engineers and scientists into the teaching profession that did not involve returning to college.
- Both groups were encouraged and gratified to learn that the state's government leaders are paying attention to engineering, and said they would like to be involved. The professional societies at the Huntington meeting challenged their members to do more to reach out to and interact with the education community.

Although these comments do not and could not include every single word that was said during the public meetings, they provide a general sense of the current attitude and opinion of the state's engineering community. The comments also are consistent with comments from meetings with engineering employers. In most cases, the participants held intense views on the subjects addressed and, more than anything, were happy to have an opportunity to voice their concerns and ideas. The professional community is anxious to be involved and appears enthusiastic about participating in additional meetings, forums, or planning sessions, or working more directly with educators.

4 Current Status of Research Collaborations and Opportunities[4]

As the name of the consortium implies, a part of CURE's mission is to identify and address issues associated with undergraduate research in the state. As a general matter, use of hands-on, interactive activities have been identified in multiple publications and reports as a teaching methodology that should be used to a greater extent in programs such as undergraduate engineering and science. The consensus is that such programs increase interest in pursuing further study and careers in these fields, thereby enhancing recruitment and retention.

The consortium members, in collaboration with interested faculty members and students, discussed this throughout the past year, and also made use of information and articles on undergraduate research provided by faculty members and a national association of participants in undergraduate research. The clear message from everyone involved was that undergraduate research normally is an overwhelmingly positive experience for students who have the opportunity to get involved. Whether the research is applied or more academic in nature, both students going straight into careers in engineering and students planning on entering graduate or professional schools have benefited.

Despite the positive benefits of undergraduate research, its application in the state (and at institutions in other states, as well) appears to be limited by several factors, all related to available resources. First, successful engineering and science related undergraduate research programs are built on the foundation of strong graduate research programs, in general. This is usually, but not always, the only way to bring faculty members with an interest a nd capability to engage in undergraduate research into a particular education community, and it also provides some resources usually not available in programs that do not have a research focus. This is especially true for the STEM disciplines, where laboratory equipment can be prohibitively expensive. Secondly, many faculty members feel that they would be making a sacrifice to their professional careers by engaging in undergraduate research activities because of the time investment required in mentoring undergraduate student research projects. Spending time on this activity, which sometimes is valued differently in the evaluation and compensation process than more traditional faculty research and creative activities, can be considered unattractive by newer faculty members, especially. In departments with a smaller faculty, it can also mean that attention diverted to undergraduate research may cause critical shortages in other areas of teaching, advising, research, and accreditation.

[4] Compiled by John Weete, former Vice President for Research and Economic Development at West Virginia University, and Howard Aulick, former Vice President for Research at Marshall University, with assistance from faculty researchers at both institutions.

In spite of the challenges, faculty and students in West Virginia have been successfully engaged in undergraduate research, often in a collaborative context among different institutions, agencies, and research organizations. However, while undergraduate research is important and can benefit students, not all undergraduates are inclined or interested in pursuing such opportunities. In addition, engineering is a discipline that engages students in professional organizations, national competitions, and open-ended design activities that provide student many of the same benefits as undergraduate research. WVU has found that undergraduate engineering research experiences are best focused on helping students interested in pursuing graduate education opportunities to learn about and engage in laboratory learning the scientific inquiry process. For example, WVU recently initiated a program to provide top undergraduates the opportunity to pursue a combined BS/MS degree option, which is expected to significantly impact graduate engineering education. A summary description of undergraduate research activities is provided below.

Undergraduate Research Opportunities in West Virginia

1 Specific Institutional Programs

AT MARSHALL UNIVERSITY

Capstone - Every major department designs a capstone experience that must be completed by all undergraduate majors by the end of their senior year. Approximately half of capstone experiences for STEM majors involve either re search projects or internships with both written and oral presentations. With the exception of Biology and Physics, most of this research is funded by institutional resources.

SURE (Summer Undergraduate Research Experience) - At Marshall, SURE is a 10-week program for undergraduate students who have had previous research experience. The program, supported by the WV Research Challenge Fund and administered through the West Virginia Experimental Program to Stimulate Competitive Research Office, is targeted toward students highly motivated to obtain graduate (PhD and MS) degrees after finishing their undergraduate programs. A panel of Marshall scientists selects the most competitive 10-15 applicants and places each with research active faculty of their choice. Each student works under the direct supervision of the faculty mentor who not only guides their research experience but also helps them develop written and oral research presentation skills.

SURF (Summer Undergraduate Research Fellowships) is a competitive undergraduate program for highly motivated students contemplating a career in scientific research. Specifically, the program is to introduce state-of-the-art methods to solve cutting-edge problems at the interface of biology and chemistry (i.e. structural biology). Recognizing the need for a multidisciplinary environment to effectively probe issues in structural biology, collaborative and group efforts are encouraged. Students are mentored by participating faculty in both the chemistry and biology departments.

Departmental scholarships for STEM students in College of Science (Biology has 8 options, Chemistry 9, Geology 4, Physics 6, Pre-Health 2)
http://www.marshall.edu/cos/scholarships.asp

Sigma Xi Research Day - The Marshall University Chapter of Sigma Xi holds its annual research day in April. This Research Day features undergraduate and graduate student and faculty research presentations, a luncheon, and a keynote speaker.

AT WEST VIRGINIA UNIVERSITY

Capstone Experiences - All undergraduate students at WVU are required to complete a capstone course in their discipline in order to receive their degree. These courses generally are designed to provide students with insight into scholarship within the discipline. A good example is the Total Science Experience Capstone Biology 321. In this course research teams consisting of three undergraduate students develop a proposal for a joint research project. The proposal is reviewed by GTA's and feedback given to the team. The team then undertakes that project and presents their results in written and/or oral presentations. The cost of such capstone experiences is funded by departmental resources.

SURE (Summer Undergraduate Research Experience) – This is a competitive undergraduate program for highly motivated students seeking to expand their exposure to scientific research. Students from WVU and other institutions within WV are placed in individual faculty laboratories and undertake individualized research under the guidance of graduate student research mentors, who are, in turn, trained through a mentorship program. Students are introduced to state-of-the-art methods in real time research programs to solve cutting-edge problems in the sciences. This program is funded by the State and administered through the Honors College.

NSF REU in Nanosciences - Undergraduate students are recruited from Universities across the country to work during the summer with faculty, postdocs, and graduate students conducting research at WVU in nanoscience and engineering. The students participate as members of the research team and work daily in the laboratory as well as attending group meetings. They are often invited to make

presentations of the work at national conferences of the various professional societies. NSF REU grants are competitively awarded to faculty. A state equivalent program would provide significant additional benefits.

Undergraduate Research – Students have the opportunity to pursue individualized research projects in faculty laboratories for course credit. These opportunities may occur across departments. Students participate throughout the year and across many semesters. Like the situation in the REU, the student becomes an active member of the research team participating in group meetings, presenting results at local, regional, and national conferences of the professional societies, as well as providing written reports of progress and accomplishment at the end of each semester. Funding for undergraduate student research is usually provided by an external grant to the faculty member in the relevant area of expertise from agencies such as NSF, NIH, DoD, or DoE. This option is open to many students for course credit, salary, and/or the opportunity to gain laboratory research experience, and is becoming more popular with undergraduate students for all of these reasons.

Honors Research and Thesis – The most motivated students participating in undergraduate research may elect to pursue the Thesis option, which requires a guided and independent research project over a three-semester period. This experience requires both a formal seminar presentation and the submission of a written thesis. Funding is also provided via external grants to the faculty member for their research and the thesis credits count as technical electives in the degree program.

AT WEST VIRGINIA UNIVERSITY INSTITUTE OF TECHNOLOGY

Tech EDA University Center Program. Each year this program awards at least $108,000 toward various economic development related research projects in partnership with business and industry. All of these projects involve higher education faculty and students. Many are conducted by students in senior project or capstone classes in science, technology, engineering, mathematics, and computer science. Others involve faculty with needed expertise that engage the best of their students.

AT FAIRMONT STATE UNIVERSITY

Undergraduate Research Program (URP) is a competitive program open to all FSU and Pierpont Community and Technical College students. It is coordinated by the Vice President for Research with the guidance of the Undergraduate Research Advisory Council. The Council is comprised of faculty members from diverse disciplines who conduct research that engages undergraduates. The program's primary goal is to provide motivated students in all disciplines the opportunity to conduct research, scholarly and creative activities appro priate to their disciplines under the guidance of faculty mentors. Students submit research proposals that delineate their proposed projects including request for funds to support their work. Funds may be used for supplies/equipment, appropriate travel, including attendance at regional professional meetings to present the results of their research, and stipends. The research activities are limited to the academic year with specific time parameters for proposal submission.

Summer Undergraduate Research Experience (SURE) is a competitive program open only to baccalaureate students who have completed 60 semester hours of academic credits with an overall GPA of 3.0. It is coordinated by the Vice President for Research with the guidance and input of the Undergraduate Research Advisory Council. The program's primary goal is to provide exceptionally motivated, highly successful students the opportunity to conduct independent research projects for a period of two months under the close mentoring of a faculty member. Both the student fellow and the mentor receive stipends. The fellow is not permitted to take other colleges courses during the summer and the faculty mentor is limited in their summer teaching responsibilities. Additionally, fellows who live at a distance from FSU are provided a residence hall room at not cost.

Celebration of Student Scholarship Event is held each April as a means of showcasing the research/creative activities of undergraduates from all FSU disciplines. Students supported by the Undergraduate Research or SURE Programs are required to submit abstracts for consideration while all student researchers are encouraged to participate. The event includes concurrent sessions of student presentations, a luncheon and guest speaker.

2 Undergraduate Research Day at the Capital

Nothing more effectively demonstrates the value of undergraduate research than the words and stories of the student participants themselves. Each year since 2004, Undergraduate Research Day at the Capitol takes place in the Capitol Rotunda during the legislative session. This event helps members of the State Legislature and Executive Branch understand the importance of undergraduate research by talking directly with the students whom these programs impact. Through media coverage it also brings research to general public. http://www.marshall.edu/urdc/

3 HEPC – EPSCOR

The State of West Virginia through the Research Challenge Fund provides $440,000 annually specifically for undergraduate research. These programs and funds are under the direction of WV EPSCoR (Experimental Program to Stimulate Competitive Research). They are:

Instrumentation Grants – This program provides $120,000 annually (up to $20,000/institution) to purchase scientific equipment for advanced undergraduate laboratories that will help encourage undergraduate students in West Virginia to continue careers in science, math, and engineering. This grant program is open to faculty from the primarily undergraduate 4 year colleges and universities (PUIs). WVU and Marshall faculty are ineligible.

Innovation Grants – This program provides $80,000 annually (up to $40,000/institution) to fund improvements in scientific equipment, curriculum, minor renovations, classroom instruction, delivery and pedagogy. The Innovation Program targets larger, more ambitious, cohesive, and/or more comprehensive innovations in laboratory/classroom settings that will encourage undergraduate students in West Virginia to continue careers in science, math, and engineering. These awards are only for PUIs; WVU and Marshall faculty are ineligible.

International Innovation Grants – This program provides $40,000 annually to support development of an international component in one or more STEM (science, technology, engineering, and mathematics) programs at a West Virginia PUI and to encourage STEM faculty and students in West Virginia to think globally about research, collaboration, grant opportunities, and exchange programs. Grant funds may be used for a variety of innovative purposes and activities including curriculum, scientific equipment, and travel.

SURE (Summer/Semester Undergraduate Research Experience) – This program provides $200,000 annually to help colleges and universities in West Virginia provide research experiences to undergraduates in STEM fields. Block grants will be awarded to selected institutions for the purpose of providing small research stipends to undergraduate students. Competition is open to all institutions of higher education in West Virginia.

WVEPSCoR Undergraduate Research Competition - To encourage undergraduate researchers, the Research Challenge Fund under the direction of WV EPSCoR will provide funding for awards to exemplary undergraduate researchers through an annual competition. Cash prizes will be awarded to the winners of the competition.

INBRE (IDeA Network for Biomedical Research Excellence) - The mission of the WV-INBRE, as part of the NIH Institutional Development Award (IDeA) Program and a project of the WVEPSCoR, is to establish a consortium among selected institutions of higher education in the State of West Virginia to enhance their capacity for educating and training their faculty and students in biomedical research. **Under the collaborative leadership of faculty at WVU Health Sciences Center and MU's Joan C. Edwards School of Medicine,** 15 PUIs in West Virginia receive focused research and multiple other out reach support. This is a federal grant (not state dollars) which currently provides over $3 million annually. Specifics on the consortium and details of outreach activities are available at **http://www.wv-inbre.net/.**

4 NASA Space Grant Consortium

The mission is to develop a statewide infrastructure that will enhance the state's competitiveness in aerospace research, education, and industrial activities. Specifically, the Consortium aims to capture, channel, and enhance the interests and activities of current and potential scientists and engineers in its member institutions (WVU and MU plus eight PUIs). The Consortium provides summer internship and research opportunities for students enrolled in science, math and engineering at one of the Space Grant affiliate institutions in West Virginia. In addition to the opportunities for internships at NASA facilities in summer of 2006, students will also have an opportunity to engage in research at some of the high tech companies in West Virginia. The following table provides a comprehensive summary of the level of undergraduate student research support provided in the current academic year.

	Number of Undergraduate Students	Scholarships, Fellowships & Internships	Research Sponsored Programs	Research Funds
Bethany College	7	$20,000	5	$12,000
Bluefield State College	10	$21,685	2	$12,000
Fairmont State University	15	$35,110	3	$45,000
Marshall University	28	$46,404	5	$136,873
Shepherd University	21	$25,800	2	$12,000
West Liberty State College	23	$20,000	2	$12,000
West Virginia University	42	$120,000	6	$166,290
Wheeling Jesuit University	6	$20,000	4	$12,000
West Virginia State University	10	$20,000	5	$12,000
West Virginia Wesleyan	12	$28,000	5	$72,000
WVU Institute of Technology	10	$20,000	3	$12,000
TOTAL	**184**	**$376,999**	**42**	**$504,163**

Additional details on undergraduate student opportunities are available at **http://www.nasa.wvu.edu/studentopportunities.html.**

5 West Virginia Academy of Science

The West Virginia Academy of Science (WVAS), an affiliate of the American Association for the Advancement of Science, is a non-profit West Virginia corporation organized in 1924 for the advancement of learning and scientific knowledge. Membership is open to individuals and institutions in all of the natural and social sciences, engineering, and mathematics. The WVAS Annual Meeting offers a venue for members and their co-authors to present oral or poster presentations. Undergraduate and graduate student presentations are explicitly solicited and are encouraged by setting a low student registration fee ($5 early and $10 regular). In addition, Institutional Members such as colleges can distribute up to 10 free student registrations. Further encouragement is provided by making cash awards for student presentations which vary in amount from year to year. In 2007, these awards were $75 each for the best oral presentation by an undergraduate and by a graduate student, and $50 each to the best undergraduate and graduate student posters. Undergraduate presenters are specifically identified in the program. There were 42 undergraduate authors or co-authors presenting 11 talks and 17 posters at the 82nd Annual Meeting on March 30-31, 2007, at Marshall University. By sponsoring the West Virginia Junior Academy of Science and its annual West Virginia State Science and Engineering Fair, the WVAS promotes interest in science among middle and high school students. Winners are supported to the Intel International Science and Engineering Fair. There are 81 students presenting 74 projects registered for the 2007 Fair. Over 400 students have participated since 2000.

6 NSF RII Grant

This 3-year NSF award, entitled "Next Generation Biometrics: Achieving Strength in Molecular Recognition and Transport", is a collaborative research and educational program involving WVU, Marshall, and WVSU. In the first six months, these three schools have created an extensive program for Education, Human Research Development and Outreach (EHRDO). The undergraduate elements include underrepresented minority (URM) retention programs (summer bridge activities for rising freshmen, peer mentoring, special "gatekeeper" courses, and mentored research projects), and targeted graduate student recruitment. Most of these activities will begin this summer.

7 NSF REU (Research Experience for Undergraduates)

The Research Experiences for Undergraduates (REU) program supports active research participation by undergraduate students in any of the areas of research funded by the National Science Foundation. REU projects involve students in meaningful ways in ongoing research programs or in research projects designed especially for the purpose. For the current programs in West Virginia see **http://www.nrao.edu/students/ , http://wvvel.csee.wvu.edu/reu2006/,** and **http://www.as.wvu.edu/~dlederma/REU/index.htm**

RECOMMENDATIONS

After compilation and discussion of the information provided in this report, and in accordance with the statutory objectives of CURE, the members of the Consortium on Undergraduate Research and Engineering recommend the following actions, to be undertaken in each case by the appropriate components of the education, government, and industrial/professional communities:

To increase West Virginia's capacity for high-quality engineering instruction and research

- Increase the number and distribution of engineering STEM programs that promote critical thinking skills in the K-12 setting, which would include expanding and enhancing existing programs such as Project Lead the Way, Foundations in Engineering. In structuring and funding such programs, provide for long-term involvement with students and teachers to better assess program effectiveness and provide mechanisms for formal and informal coordination among programs.
- Consider revising the manner in which GPA is calculated for Promise eligibility to prevent penalizing students who opt to take higher level math courses.
- Support the development of alternate education and certification programs for teachers in math and science in order to meet the critical shortage areas, and to provide alternative pathways to teaching for STEM career professionals.
- Encourage and reward teachers with an interest and certification in STEM content areas with differential pay incentives that address the issue of market competition, similar to the approach taken by institutions of higher education.
- Support the expansion of AP and other virtual math and science courses to increase course options for students in schools without sufficient math/science staff.
- Explore and provide additional incentives for students to optimize their participation in the full range of available high school math courses, such as providing certificates for successful completion of an identified math curriculum.
- Create and maintain a forum for more meaningful interaction between and among the K-12, higher education, and professional communities to better define the needs of the STEM stakeholders at each level of the educational and early career process and to ensure smoother transitions for students at each step of the way. The forum should specifically include STEM teachers and higher education faculty in engineering and other STEM disciplines without a direct K-12 counterpart, as well as working engineers and scientists, in order to improve communication regarding the effectiveness of past and present approaches and the requirements for successful STEM careers.
- Support the implementation of the technology recommendations in the West Virginia Board of Education Comprehensive Report of Findings and Recommendations for Technology in order to integrate additional technology into STEM programs.

To increase access throughout West Virginia to high-quality STEM instruction and research opportunities

- To address the fact that engineering and related degree programs usually require more than four years for completion, focus a portion of the Promise scholarship program on STEM majors and increase the potential student support to five years for students who attain and maintain enrollment in these programs.
- Develop and support new positions at state institutions of higher education in engineering, math and science education to improve and enrich the first-year experience and to increase retention in these programs.
- Better prepare students for the future by enhancing current student design/capstone experiences to include undergraduate research at an earlier point in the baccalaureate curriculum, thereby expanding the focus on opportunities for advanced studies and providing students with enhanced critical thinking and learning skills

to adapt to an environment of rapidly changing technologies. Invest in such programs to make them more competitive with other opportunities for student employment, but maintain availability of co-op programs and similar internship opportunities in fields relevant to degree programs.

- Invest in the physical and intellectual infrastructure available to students by fully funding a statewide higher education research program that provides matching funds and incentives for growing the coverage and depth of research programs.

To stimulate economic development throughout West Virginia by increasing the number of professional engineers available to business and industry

- Stimulate interest of young people in training and careers in engineering and related disciplines by involving the professional and business communities in a more visible and engaged manner.
- Provide economic incentives for students to complete graduate degrees in engineering.
- Diversify the students who pursue education and careers and engineering by developing strategic initiatives focused on the recruitment and retention of traditionally underrepresented groups.

To stimulate economic development throughout West Virginia by increasing the number of professional engineers available to business and industry

- Stimulate interest of young people in training and careers in engineering and related disciplines by involving the professional and business communities in a more visible and engaged manner.
- Provide economic incentives for students to complete graduate degrees in engineering.
- Diversify the students who pursue education and careers and engineering by developing strategic initiatives focused on the recruitment and retention of traditionally underrepresented groups.

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[1] Authored by Gerald E. Lang, Sarah N. Denman, Galan Janeksala, and Jessika L. Thomas, with significant contribution from the engineering deans at West Virginia University, West Virginia University Institute of Technology, and Marshall University.

[2] The information on STEM programs and initiatives was compiled by Paul Hill, Vice Chancellor for Science and Re search, Higher Education Policy Commission, and John Putnam, West Virginia Department of Education.

[3] Provided by the West Virginia Department of Education.

[4] Compiled by John Weete, former Vice President for Research and Economic Development at West Virginia University, and Howard Aulick, former Vice President for Research at Marshall University, with assistance from faculty researchers at both institutions.

Appendix 1: Majors Available

Major	WVU	WVU Tech	Marshall
Pre-Engineering		X	X
General Engineering	X (first-year track)	X	
Engineering	X (first-year track)		X
Pre-Biometric Systems	X		
Pre-Computer Science	X		
Aerospace Engineering	X		
Biometric Systems	X		
Chemical Engineering	X	X	
Civil Engineering	X	X	X (WVU Tech classes offered on Marshall's campus)
Computer Engineering	X	X	
Computer Science	X	X	X
Electrical Engineering	X	X	
Industrial Engineering	X		
Mechanical Engineering	X	X	
Mining Engineering	X	X (with WVU, 1 add'l year after CE)	
Petroleum & Natural Gas Engineering	X		
Engineering Transfer Program			X
Safety Technology			X

Appendix 2: Students Currently Enrolled

1. Fall headcount enrollment of engineering students by program at WVU for 2003-2006.

Major	2006	2005	2004	2003
Aerospace Engineering	228	211	200	157
Biometric Systems	12	14	20	8
Chemical Engineering	67	67	82	73
Civil Engineering	167	164	148	132
Computer Engineering	191	196	216	227
Computer Science	15	16	19	14
Electrical Engineering	65	61	66	75
Engineering (freshmen)	473	440	410	499
General Engineering (freshmen)	360	347	362	254
Industrial Engineering	156	154	112	90
Mechanical Engineering	181	184	180	185
Mining Engineering	39	29	31	25
Petroleum & Natural Gas Engineering	72	58	52	46
Pre-Biometric Systems	20	12	8	27
Pre-Computer Science	46	59	46	55
Total	**2092**	**2012**	**1952**	**1867**

Note that the number of engineering majors at all levels by over 200 even though the number of freshmen has increased by only 80 over this period. This indicates increased retention rates in the engineering programs.

2. Engineering students by level and program at WVU Tech.

Major	First Time Freshmen	Freshmen	Sopho-mores	Juniors	Seniors	Total
Pre-Engineering	9	2	2	2	2	17
General Engineering	11		1	1		2
Chemical Engineering	6		5	4	13	22
Civil Engineering	13	3	15	11	23	65
Electrical Engineering	8	3	14	14	27	66
Mechanical Engineering	23	6	13	12	25	79
Computer Science	16	2	8	10	12	48
Computer Engineering	6	2	1	1	2	12
Aerospace Engineering	2	2	1	0	0	5
Electrical Engineering – Computer Engineering	2	2	2	1	9	16
Total	**96**	**20**	**62**	**56**	**111**	**332**

3. Engineering students by program at Marshall.

Major	Number of Students
Engineering transfer program	25
Engineering	69
Computer Science	68
Civil Engineering (Collaborative with WVU Tech)	29
Pre-Engineering/Pre-CS	54
	245

Appendix 3: Recommended First-Year Course Schedule

WVU

First Semester		Second Semester	
Course	**Credits**	**Course**	**Credits**
MATH 155 Calculus I	4	MATH 156 Calculus II	4
CHEM 115 Fundamentals of Chemistry	4	CHEM 116 Fundamentals of Chemistry or GEC Elective	3
ENGR 101 Freshmen Engineering Design	2	ENGR 102 Freshmen Engineering Design & Analysis	3
ENGR 199 Orientation to Engineering	1	PHYS 111 General Physics	4
ENGL 101 Comp. and Rhetoric	3		
GEC Elective	3		
Total Credits	**17**	**Total Credits**	**14**

WVU Tech

First Semester		Second Semester	
Course	**Credits**	**Course**	**Credits**
ENGL 101 English Composition I	3	ENGL 102 English Composition II	3
CHEM 115 Fundamentals of Chemistry I	4	HU/SS Elective	3
HU/SS Elective	3	GENE 111 Software Tools for Engineers	3
CHEE 100 Intro. Chem. Eng.	2	CHEM 116 Fundamentals of Chemistry II	4
MATH 155 Calculus I	4	MATH 156 Calculus II	4
TECH 100 Freshman Seminar	1		
Total Credits	**17**	**Total Credits**	**17**

Marshall

First Semester		Second Semester	
Course	**Credits**	**Course**	**Credits**
ENG 101 English Composition	3	ENG 102 English Composition II	3
MTH 229 Calculus 1	5	MTH 230 Calculus II	4
ENGR 107 Intro. to Engineering	3	ENGR 111 Computer Science for Engineers	3
Marshall Plan elective	3	CHM 211 Principles of Chemistry I	3
UNI 101 New Student Seminar	1	CHM 217 Chemistry Lab. I	2
Total credits	**15**	**Total credits**	**15**

Appendix 4: Attrition of Undergraduate Engineering Students

1. Number of students returning and attrition rates at WVU

Year	Major	First Year Student Census	+1 Year Census	Attrition Rate (1st-2nd year)	+2 Year Census	Attrition Rate (1st-3rd year)
2003	Eng	299	257		233	
	Gen. Eng	250	165		114	
	Overall	549	422	23%	347	37%
2004	Eng	270	190		139	
	Gen. Eng	258	142		96	
	Overall	528	332	47%	235	55%
2005	Eng	274	202		Not available	
	Gen. Eng	246	150		Not available	
	Overall	**520**	**252**	**52%**		

- Engineering (Eng) track is for freshmen ready to start first calculus course.
- General Engineering (Gen) track is for students behind in calculus.
- After 2nd year, students not eligible for transfer into a major must leave the College; some return but most matriculate into other WVU programs.
- Statistically, 2004 was a poor entering class based on entrance scores.
- An example, in 2004, 142 students continued into the sophomore year: 85 were still in Gen. Eng. and 57 moved into college majors. By the start of the junior year, 96 of the original cohort remained: 88 moved to majors and 6 continued in Gen. Eng. (unusual reasons).

2. Number of students not returning and attrition rates at WVU Tech

Year	First Year Student Census	+1 Year Census	Attrition Rate (1st-2nd year)	+2 Year Census	Attrition Rate (1st-3rd year)
2003	106	47	56%	31	71%
2004	121	59	51%	40	67%
2005	87	45	48%	Not available	

3. Number of years students were enrolled at WVU Tech before graduating in 2005-06

Number of Years	Number of Students	Percentage of Graduates
4 years	16	34%
5 years	25	53%
6 years	6	13%
Total	**47**	**100%**

4. Number of students returning and attrition rates at Marshall

Number of Years		Number of Students	Percentage of Graduates
2003	43	20	53%
2004	33	21	36%
2005	48	36	25%

Appendix 5: Student Qualifications for Success in Engineering Programs, provided by each institution

WVU

It is difficult to give a definitive answer because even students with very good high school GPAs and scores don't succeed in engineering programs. Much of the problems seem to result from the fact that students have not been challenged sufficiently in high school. Specifically, their lack of success is often due to their poor time management and study skills. High school students must learn and be challenged to:

1. develop stronger study habits;
2. work harder in high school, particularly in math and science courses;
3. learn to take exams regularly;
4. earn to manage their time;
5. have an entry ACT/SAT math score of at least 27/620, an ACT/SAT total score of 23/1070 and a high school GPA at least 2.5 to 2.75; and
6. understand there is a difference between Engineering Technology and Engineering degrees.

WVU Tech

To be successful, students must have

1. a good work ethic and attention to detail;
2. a strong background in algebra, trigonometry and geometry;
3. good reading and writing skills; and
4. some experience in a rigorous science class.

Marshall

Students must have strong math and science skills and good work habits to successfully complete a BS in engineering. Students also need to have strong reading and critical reading skills as well as experience in taking exams, particularly comprehensive ones.

Appendix 6: Factors that Inhibit Student Success, provided by each institution

WVU

While WV admission standards are quite reasonable, the rigor of an engineering curriculum, compared to other majors, usually is a deciding factor for students who leave engineering and computer science majors. The standards for completing coursework and/or degrees have been rigorously maintained, so retention becomes an even bigger issue. Reasons for leaving are quite varied (not all leave for poor grades) and difficult to summarize, but include:

1. poor grades and their effect on financial aid and scholarships,
2. students realizing engineering is not for them,
3. some students realizing they prefer a science field to engineering,
4. students not being willing or understanding of how hard they need to study,
5. high school not preparing some students for the academic rigors of college, and
6. the maturity level of the student.

WVU Tech

1. Poor abstract reasoning skills limit success in mathematics and science courses.
2. High schools generally do not prepare students for the work load or the need to study outside of class they will encounter in an engineering curriculum.
3. Some students enter engineering due to outside pressures (parents, etc.) when they really want to study some thing else. This limits motivation.
4. Students have a hard time relating classroom instruction in engineering to "real world" situations.
5. Students do not receive adequate high school preparation in mathematics.

Marshall

1. First and foremost is inadequate high school preparation, especially in mathematics.
2. Many students are not willing to put forth the effort required to be a successful engineering student.
3. Some students find a related major that more closely fits their career plans.
4. Engineering requires maturity, organization, and discipline. Many students right out of high school do not possess all of these.

Appendix 7: Programs to Increase Retention, at each institution

WVU

The WVU College of Engineering and Mineral Resources treats all students admitted to the College as potential engineers and has established support programs that seem to have had some impact on helping freshmen get through the first year. WVU has developed the Freshman Engineering Experience to support students during their challenging first year as engineering students. During this first year the student complete two engineering classes designed to build their problem solving skills and introduce them to valuable computer skills both of which will be used and developed as they continue through any of the engineering programs offered by WVU. The first semester the student is exposed to working in a group on design projects for which they will develop both written and oral reports. One of the most important aspects for a graduating engineering student is strong communication skills and the fostering of these abilities begins now. The design projects are developed in such a way as to allow the student to begin using and recognizing the need for various software tools. The second semester further elaborates the students' ability to problem solve and develop designs through problems that require the use of a computer programming language in conjunction with some of the software tools introduced during the first semester. A small sampling of programs at WVU include:

1. splitting the freshmen year into two tracks, a calculus ready and a more general (non calculus ready) track to better prepare students to be successful by matching freshmen to their beginning math skills.
2. working more closely with the Math Department to develop more math intervention early in the semester,
3. instituting mandatory study halls until students demonstrate success in calculus exams,
4. providing engineering students with math recitation sections and peer mentoring (tutoring help is widely available),
5. using the E199 Orientation class to develop time management and study skills as well as to get students to think about their career and professional development,
6. raising required scores to test into math courses, and
7. requiring a C or better in 1st calculus to enter major.

Second year data are promising, but the program needs several more years of data collection and analysis to see the true impact on improving retention. The College continues to improve the freshman year experience by assessment of the program and using the feedback from students and instructors to make changes to enhance the first-year program. The changes made have been successful but are very expensive. The College continues to explore ways to intervene further before students encounter significant problems.

WVU Tech

1. A freshman course to provide more direct contact with entering students has been added to the curriculum. This seems to have helped give students a better understanding of what engineering is about, but does not seem to have improved retention.
2. Freshman student performance is closely monitored and intervention is attempted once it is apparent that a student is having problems. This has had limited success. Students in trouble often will not communicate with an advisor, possibly because of issues of pride and self-image.
3. In one department, the chair is advisor to all freshmen to assure that good advising is provided.
4. Every engineering department actively participates in TECH-100 (Freshman Seminar). Expectations of the departments are discussed and suggestions for student success are presented. In an effort to motivate the students, information about job opportunities for graduates are discussed and often, distinguished alumni are brought in to make presentations to the students.
5. Student organizations such as ASME, ASCE, IEEE, etc. are encouraged to recruit new freshmen into their organizations in an effort to get them involved in engineering student activities. This gets the freshmen associated with upper class students which should motivate them for success and provide avenues for advice when they encounter problems.

■ **Marshall**

1. Raising the minimum ACT Math scores required to take the freshman engineering course. Students not meeting the minimum criteria are required to complete an extra year of study that includes re-taking the equivalent of high school mathematics.
2. Additional mentoring opportunities are provided for freshman students.
3. A STEM outreach coordinator was hired to provide greater interaction with freshman students.
4. Individualized and group tutoring is available for students.
5. A study room is available for students to study individually and in groups.
6. A University required orientation class–UNI 101–is required of all Freshman and is college and often discipline specific.
7. Engineering programs across the state should consider joining forces to promote engineering programs in K-12 education, such as Project Lead the Way.

Appendix 8: Collaborative Engineering Programs in West Virginia

Engineering Transfer Group Agreement

The primary purpose of the Engineering Transfer Group Agreement is to permit students attending institutions that do not grant engineering degrees to obtain some or all of their first two years of engineering education at their school before transferring to either WVU or WVU Tech to complete their degree. The transfer group, consisting of representatives from each of the participating institutions (WVU Tech, WVU, Marshall, Potomac State College, Shepherd University, WVU Parkersburg, West Virginia Wesleyan, Southern West Virginia Community College, Wheeling Jesuit University, and Mountain State University), has developed a matrix showing the equivalent course numbers and names for all participating institutions. Using this matrix, advisors can easily determine which courses at any institution will transfer and apply toward an engineering degree at WVU or WVU Tech.

Representatives of each participating institution meet on a yearly basis to review the course equivalency matrix and to discuss curricular changes, the performance of transfer students, and other relevant issues. New courses which have been developed are reviewed for transfer credit approval. In order to maintain ABET accreditation, the degree-granting institutions must be able to verify that coursework completed by students prior to transferring is equivalent to the classes offered by the accredited institution. Final course review and approval is handled by the Associate Dean for Academic Affairs at WVU and the Dean at WVU Tech.

Two proposals to improve the transfer group agreement will be addressed during future transfer group meetings. In order to facilitate transferring credits for non-engineering courses, the requirements of the General Education Curriculum at WVU and the Core Curriculum at WVU Tech should be clarified for engineering students, advisors, and faculty statewide. This effort may result in courses offered at various institutions being pre-designated as GEC equivalents. Marshall University has also suggested that engineering courses be offered online or through other distance education delivery modes for students at institutions that are unable to offer similar courses due to low enrollment or the lack of qualified faculty. WVU will consider providing introductory engineering classes to students at other institutions if there is sufficient demand.

Civil Engineering program at Marshall with WVU Tech

Undergraduate students in the Civil Engineering program at Marshall complete a two year transfer program and then, instead of moving to a different institution, enroll in upper-division WVU Tech classes offered on Marshall's campus. This program provides students at Marshall the opportunity to complete a degree in civil engineering, but it has been criticized for the high per student operating cost of the program.

Civil and Mining Engineering program from WVU Tech and WVU
Students graduate from the four-year program in civil engineering at WVU Tech and then enroll as an undergraduate student at WVU. In one additional year, they are able to earn a second baccalaureate degree in mining engineering, which is awarded by WVU.

Physics and Mechanical Engineering from WV Wesleyan and WVU

Students complete three years at West Virginia Wesleyan and then transfer to WVU. They are able to complete an undergraduate engineering degree, most frequently in mechanical engineering, which is awarded by WVU. WV Wesleyan also grants credit to students for their work at WVU and awards them a B.A. in physics. The development of a similar program between Wheeling Jesuit and WVU is well underway.

Engineering Technology Program between WVU Tech and the Community and Technical College

WVU Tech collaborates with the CTC to advise students about associate and baccalaureate engineering technology programs, which are accredited by TAC-ABET. Through this agreement, students enrolled at WVU Tech can easily transfer into engineering technology programs at the CTC. The CTC offers both accredited associate degree (AS) programs and TAC-ABET accredited baccalaureate (BS) degrees in Electronic Engineering Technology or Engineering Technology.

Appendix 9: Current Faculty by Institution and Department

Department		WVU	WVU Tech	Marshall	Total
Computer Science and Electrical Engineering (WVU)	Computer Science WVU Tech & Marshall)	33	3	4	46
	Electrical and Computer Engineering (WVU Tech)		7		
General Engineering (Marshall)				4	5
Mechanical and Aerospace Engineering (Mechanical Engineering at WVU Tech)		28	4		32
Civil and Environmental Engineering (Civil Engineering at WVU Tech)		15	5	2	21
Industrial and Management Systems Engineering		14		2	14
Chemical Engineering		12	3		15
Mining Engineering		6			6
Petroleum and Natural Gas Engineering		4			4
Extension and Outreach		1			1
Total Full Time, Tenure Track Faculty		**113**	**22**	**12**	**142**
Related engineering faculty/employees (includes adjuncts, visiting professors, non-tenure track faculty, research faculty, academic professionals, post docs, etc.; does not include classified staff or non-teaching administrators)		80	1 visiting professor	3 adjuncts	85
Total Faculty/Employees		**193**	**23**	**10**	**226**

Appendix 10: Potential Hires

1. Summary Table

	2006-07	2007-08	2008-09	Total
WVU	5	1	2	8
WVU Tech	6	2	3	11
Marshall	1	3	1	5
Total	**12**	**6**	**6**	**24**

2. Potential Hires by Year, Institution, Department, and Type

Department		2006-07						2007-08						2008-09					
		Resignations/ Retirements			New Hires			Resignations/ Retirements			New Hires			Resignations/ Retirement			New Hires		
		WVU	WVU Tech	MU	WVU	WVU Tech	MU	WVU	WVU Tech	MU	WVU	WVU Tech	MU	WVU	WVU Tech	MU	WVU	WVU Tech	MU
Computer Science and Electrical Engineering (WVU)	Computer Science (WVU Tech)		1										1						
	Electrical and Computer Engineering (WVU Tech)	1	2						1					1	1				
General Engineering (Marshall)																			1
Mechanical and Aerospace Engineering (Mechanical Engineering at WVU Tech)		1	1											1	1				
Civil and Environmental Engineering (Civil Engineering at WVU Tech)			1		1	1	1					1	2						
Industrial and Management Systems Engineering		2																	
Chemical Engineering															1				
Mining Engineering																			
Petroleum and Natural Gas Engineering								1											
Total Faculty		**12**						**6**						**6**					

Appendix 11: Concerns Related to Entry Salaries, Salary Inversion, Facilities, and Start-Up Support

1. Entry Salaries

WVU

WVU has offered much more competitive starting salaries in the last five years with the endorsement of the Provost. This has allowed the institution to recruit some very fine new faculty. Nonetheless, salaries continue to lag behind peer schools although the gap in salary offers to new faculty hires has been reduced. Offering nationally (or even SREB) competitive starting salaries will become an even greater challenge for CEMR because:

- a strong, growing market for new engineers will continue to emerge;
- baby boomer retirements will escalate the competitive situation;
- competition with industry to hire new PhDs continues to increase;
- the global marketplace is expanding the competition further;
- renewed interest in energy worldwide will continue to expand the market;
- U.S. citizens lack the desire to go to graduate school, so fewer PhDs are produced;
- more international students return home after completing PhD degrees; and
- higher starting salaries are causing salary compression at higher ranks, which may result in the loss of good faculty.

WVU Tech

Engineering salaries at WVU Tech are extremely low and almost noncompetitive with regard to attracting qualified new faculty. Starting salaries for new PhD faculty are, in some cases, less than starting salaries commanded by B.S. graduates. Only recently has WVU Tech been able to offer starting salaries approaching the 20th percentile CUPHAR salary.

Marshall

It is difficult to be competitive with peer institutions when trying to hire engineering faculty - especially when competing for female faculty. The institution is committed to support Engineering by working with the dean and chair to hire needed faculty.

2. Salary Inversion

WVU

Inversions are real and are beginning to evolve quickly as more new hires are made. They will only become more exacerbated as baby boomers retire and the global market continues to heat up. The College is seeing significant compression due to new hires at the Associate Professor rank. This causes concern about the loss of top performing Associate Professors, who are quite marketable to peers. Associate Professors are attractive to other institutions because they are established, have funding, and have developed strong research programs of interest, so the peer institutions do not have to start from scratch. WVU provides their training, and others reap the benefits. In fact, CEMR needs to be positioned to do some of this cherry picking instead of being the picked. The bottom line is that WVU cannot afford to lose the best faculty that has nurtured here and developed into strong faculty: they are the heart of the program as the baby boomers retire. Some will become the next national leaders in their profession and for the College. A similar problem exists for recently promoted professors who are at the top of their fields.

WVU Tech

Salaries within the College of Engineering at WVU Tech are very low and generally well below the 20th percentile CUPHAR salary. Faculty morale is already low because of the substandard salary structure and it is not uncommon for new faculty to leave after one to two years service due to this problem. Additional erosion of salaries would exacerbate the morale and faculty retention problems which are already causing difficulties in the college.

■ **Marshall**

Inversions have not yet been a challenge. The institution allows for a flexible merit salary policy and the College of Information Technology and Engineering is developing plan to adapt such flexibility. As the program and the college grow, this may become a challenge.

3. Facilities

■ **WVU**

CEMR has invested heavily in renovations of labs and classrooms over this decade to address critical needs.

- $23 million dollars have been invested since 2001.
- Most of the improvements have come from private gifts (60%), university matching support, and student fees, including a new facility fee initiated three years ago that is charged to all students.
- State support for equipment remains at $100k, the same as in 1979.
- This amount of state support is not even sufficient to maintain the college computer labs and classrooms, let alone replace equipment for labs.
- Operational costs have increased significantly with no corresponding increase in the CPI adjusted operational dollars provided by the state.
- Technical staff have continued to decrease significantly in number over the years, requiring faculty to repair and maintain labs.
- CEMR growth requires significant investment to increase space in order to offer a competitive engineering education and an exciting learning environment.

Engineering education is a very expensive education to provide. As a state, West Virginia must realize and come to grips with this fact, and then plan accordingly.

■ **WVU TECH**

Facilities provided to new faculty include a new computer and access to undergraduate teaching laboratories, which in some cases are quite antiquated.

■ **Marshall**

Dedicated and adequate engineering facilities - especially engineering lab space are crucial to a successful accreditation visit and a factor important to potential new faculty. In addition to current space, Marshall is preparing for new engineering lab space in the fall of 2008 and a new Engineering and Applied Technologies Complex in the first phase of development for the future.

4. Start-Up Support

■ **WVU**

WVU has become much more competitive in start up funding with peers.

- New hires are offered starting packages that they need to get their labs and research programs established.
- This program has enabled the university to recruit some new, very high quality faculty.
- WVU cannot sustain the cost for new hires, however, and the institution still needs to support replacements or new positions in order to remain competitive with peers in offering new programs.
- With competition to recruit new PhDs, WVU will fall further behind peers in the ability to offer reasonably competitive startup packages.

■ **WVU TECH**

The only start-up support offered to new faculty by WVU Tech is a one course per semester reduction in teaching load. The one course reduction is tied to expectations for significant grant activity. No monetary support is provided.

■ **Marshall**

So far, start-up funding has not been an issue with recent new hires.

Appendix 12: Activities Addressing Challenges

WVU

WVU has nurtured some strong engineering faculty and must develop the means to maintain them at the university. CEMR has tried to use a portion of the annual merit pool held by the dean to address salary compression and the inequities created by higher salaries for new hires. This salary has been used primarily for the high achieving Associate Professors but also for some newer Assistant Professors who are on a strong positive trajectory for promotion and tenure. Even over a six-year tenure track period there is significant salary compression, and this compression will increase due to the high demand for faculty in energy fields.

WVU TECH

1. Low enrollment. This is the greatest challenge faced by the College of Engineering at WVU Tech. The institution is attempting to meet this challenge by continuing efforts to recruit high school students by working closely with the recruiting office, holding Expos and open houses for junior high and high school students, cor responding with applicants via mail and personal phone calls, and using College of Engineering funds to offer a limited number of freshman engineering scholarships.
2. Maintaining functional facilities for undergraduate teaching. This is being met to the extent possible by judicious use of student fees allotted to the College of Engineering.
3. Retaining existing faculty and attracting qualified new faculty. The low salary structure dramatically impacts the institution's ability to recruit and retain faculty nationally and locally. The institution attempts to sell potential new faculty on the advantages of working at a small institution where undergraduate education is stressed.
4. Funding needs to be increased through external research grants and donations.

Marshall

The institution is supporting the efforts through new positions for faculty, start up research monies, equipment, and retention programs, supporting the ADVANCE grant and all STEM programs and proposals. The institution supports a staff position for a STEM recruiter who also works on retention efforts.

Appendix 13: Desired State Assistance

WVU

State involvement does not need to be exorbitant in cost, but it must be real in order to maintain a first class engineering education at WVU and WVU Tech. There needs to be:

1. investment from the state to provide new positions to the college along with the requisite startup funding;
2. investment in new faculty that is competitive with peer groups;
3. funds provided to assist with expansion and improvement of lab and classroom facilities in the College;
4. realistic increases for annual operating expenses for engineering programs;
5. some increase in technical staff to maintain and support engineering facilities; and
6. some increase in personnel salaries to address salary compression.

WVU TECH

The College of Engineering needs funds to increase faculty salaries to 80% of CUPA peers and an ongoing source of funding to modernize laboratory and teaching facilities.

Marshall

1. Establish and support a statewide STEM Outreach program to help in developing a better pipeline from the K-12 schools. Perhaps there could be established a Governor's STEM Academy at each of the three campuses each summer.
2. If not a Governor's STEM Academy, perhaps an Engineering Academy
3. Money for equipment, especially high ticket-needs
4. Collaborative research monies/support $500,000-1,000,000
5. Monies to support specialty hires that can participate in collaborative research and teaching.

Appendix 14: K-12/Higher Education STEM Partnerships

Program Name	Brief Description	Type of program	Field	Institution	Other Collaboration	Who Benefits	How many K-12 students benefit?	How many faculty benefit?	How long has program existed?	Funding	Plans for the future	Formal Evaluation	Student Tracking	Contact	Contact E-mail
21st Century STEM Academy	Focuses on collaboration with K-12 schools and counties to design a personalized and comprehensive professional development plan that focuses on improving students' understanding and achievement in science, technology, engineering and mathematics.	Teacher development	Science/ Technology/ Engineering/ Math	Marshall University		K-12 teachers			2 years	Verizon, West Virginia Department of Education; West Virginia Secretary of Education and the Arts; Wayne County Board of Education				Dr. Stan Maynard	maynard@ marshall.edu
Appalachian Collaborative Center for Learning, Assessment & Instruction in Mathematics (ACCLAIM)	Made up of five universities dedicated to improving mathematics teaching in the Appalachian region.	Teacher development	Math	Marshall University, West Virginia University		Teachers				NSF				Karen Mitchell	mitchelk@ marshall.edu
Appalachian Math and Science Partnership (AMSP)	Designed to help teachers in preK-12 schools in five counties (Braxton, Cabell, Mason, Mingo and Wayne) improve the performance of their pupils in math and science, and prepare them better for college-level courses for eventual careers in math, science and engineering fields.	Teacher development	Science/Math	Marshall University	University of Kentucky	preK-12 teachers				NSF					
Appalachian Rural Systemic Initiative (ARSI)	Provides instructional resources in mathematics, science and technology to students, educators and communities in economically disadvantaged counties.	Teacher/ community development	Science/Math	Marshall University		K-12 teachers/ communities				NSF				Carter Chambers	chambersc@ marshall.edu
Camp STEM	Encourages high school students to pursue an education in engineering, math and science. Students take part in lectures, demonstrations, field trips and experiments.	Resident program (one week)	Science/ Technology/ Engineering/ Math	West Virginia University Institute of Technology		10th-12th grade students								Dr. James Cercone	james.cercone@ mail.wvu.edu
Center for Educational Technologies (CET)	Using state-of-the-art educational technology, the staff of CET creates professional development programs, online curriculum, and various other tools and resources for teachers.	Teacher development	Technology	Wheeling Jesuit University											info@cet.edu
Classroom of the Future	Develops curriculum that improves mathematics, science, geography and technology education in ways consistent with national educational standards. These curricular supplements incorporate NASA expertise and datasets.	Teacher development	Scence/Math/ Technology	Wheeling Jesuit University		K-12 teachers			17 years	NASA					info@cet.edu
Coalfield Rural Systemic Initiative (CRSI)	Builds leadership capacity and improves teaching and learning among a cohort of 36 mathematics and science teachers by providing direct assistance and high-quality training. These teacher leaders have performed more than 10,000 hours of project-related activities outside their classrooms, including delivering high-quality professional development to teachers in their schools, mentoring new teachers, and leading improvement planning teams.	Teacher development	Science/Math		Rural school districts, higher education institutions, state departments of education and Edvantia	Teachers			5 years	NSF				Dr. Keith Smith	keith.smith@ edvantia.org

Program Name	Brief Description	Type of program	Field	Institution	Other Collaboration	Who Benefits	How many K-12 students benefit?	How many faculty benefit?	How long has program existed?	Funding	Plans for the future	Formal Evaluation	Student Tracking	Contact	Contact E-mail
Communities Educating Tomorrow's Scientists (COMET)	An informal earth and space science program with the focus of learning science as inquiry. COMETS targets low-income, under-represented, and minority students at four community centers in Charleston. Involves students in the active collection and analysis of environmental data, better prepares students to succeed in secondary laboratory sciences, increases students' critical thinking skills, strengthens parental support for science education and promotes positive attitudes towards careers in science. Includes teacher professional development component.	Hands-on/Teacher development	Science	West Virginia State University	Kanawha County Schools, Bayer Crop Science Corporation, Clay Center for the Arts and Sciences	3rd-6th grade students/teachers	300 students/ 50 teachers			NSF					
Comprehensive Information Technology Education in Rural Appalachia (CITERA)	Designed to introduce students, teachers and counselors to careers and educational pathways in information technology, the program offers professional development by assisting teachers in becoming more knowledgeable, better equipped and less intimidated when it comes to incorporating IT skills and concepts into the daily curriculum.	Teacher development	Technology	Fairmont State University	Marion Co. Board of Education; West Virginia High Technology Consortium Foundation; The EdVenture Group	7th-12th grade teachers/students, guidance counselors	90 students and 20 teachers and counselors/year		2 years	NSF, ITEST	Expand program by offering it in the Wheeling and Charleston areas in 2007	Yes	None currently	Donna Peduto	dpeduto@edv-group.org
Engineering Career Day	Students attend hands-on workshops. Engineering firms, colleges and universities, the Army Corps of Engineers and other engineering organizations demonstrate various engineering careers. Scholarships are awarded.	Hand-on/ career exploration	Engineering	Marshall University	U.S. Army Corps of Engineers	High school students			14 years (incl. 2007)					Dr. Tony B. Szwilski	szwilski@marshall.edu
Engineers of Tomorrow	Focuses on attracting Appalachian high school students, particularly women and minorities, to engineering, math and science-related majors and careers. Provides mentorship of high school students by WVU engineering students. Offers high school teachers the tools they need to increase student achievement with kits comprised of problem-based engineering lessons specifically for math and science teachers.	Resident program (oneweek)/ teacher development	Science/ Engineering/ Math	West Virginia University	EdVenture Group					American Electric Power; Claude Worthington Benedum Foundation; NASA West Virginia Space Grant Consortium; NSF; Peabody Energy and PPG Industries				Dr. Gary Winn	gary.winn@mail.wvu.edu
Expanding Your Horizons	Career exploration activities in science, engineering and mathematics for young women. Corresponding program for parents and teachers.	Career exploration	Science/ Engineering/ Math	West Virginia University	Harrison County Board of Education, West Virginia Chapter of the Association for Women in Science	Middle school students(female)/ teachers/parents								Dr. Linda Vona-Davis	lvdavis@hsc.wvu.edu
Exploring Engineering: Academy of Excellence	Encourages students to explore engineering as a career by participating in hands-on engineering activities, touring engineering-related facilities and interacting with practicing engineers.	Resident program (one week)	Engineering	Marshall University	Appalachian Transportation Institute, Society of American Military Engineers Huntington Post, Learning for Life	Rising high school juniors	30 in 2006							Dr. William Pierson	pieson@marshall.edu
Fall Student Mathematics Symposium	The symposium is intended to motivate gifted students, to encourage potential scientists and mathematicians, and to provide an	Symposium	Math	West Virginia University	West Virginia Council of Teachers of Mathematics	High school students	28 in 2005		17 years (incl. 2006)					Dr. Mike Mays	mays@math.wvu.edu

Program Name	Brief Description	Type of program	Field	Institution	Other Collaboration	Who Benefits	How many K-12 students benefit?	How many faculty benefit?	How long has program existed?	Funding	Plans for the future	Formal Evaluation	Student Tracking	Contact	Contact E-mail
Fall Student Mathematics Symposium cont.	opportunity for students to interact with others having mathematical interests. It is directed to those students who have a strong interest in mathematics and a demonstrated ability in this area.														
Future Leaders of Our Watersheds (FLOW)	Program to improve watershed health (Brooke, Ohio and Marshall counties).	Hands-on	Science	West Liberty State College	Oglebay Park, West Virginia Department of Environmental Protection	9th-12th grade students								Zac Loughman	zloughman@westliberty.edu
Global Learning and Observations to Benefit the Environment (GLOBE)	A worldwide hands-on, primary and secondary school-based education and science program.	Hands-on	Science	Glenville State College, West Virginia State University, Fairmont State University, Alderson-Broaddus College, West Liberty State College's SMART Center	EdVenture Group; Institute for Scientific Research Inc.; Math, Science and Technology Consortium; Canaan Valley Institute; Glenville State College; West Virginia View; West Virginia State University; West Virginia Geologic and Economic Survey; Fairmont State University, Alderson-Broaddus College; West Virginia Conservation Agency; West Liberty College's SMART Center	Primary and secondary school students				NASA, NSF, EPA, U.S. Department of State				Todd Ensign	todd.ensign@ivv.nasa.gov
Governor's Honors Academy	Offers an academically rich environment for high ability/high achieving students in an institution of higher education.	Resident program (three week)	Science/Math	Fairmont State University	West Virginia Department of Education and the Arts	High school juniors	165/year		Founded in 1984	West Virginia Department of Education and the Arts	None currently	None currently		Sherry Keffer	skeffer@wvosea.org
Governor's School for Mathematics and Science	A summer residential program providing academic enrichment in the areas of science and math. The activities broaden students' understanding of the role of scientific research in society.	Resident program (two- or three-week)	Science/Math	West Virginia University	West Virginia Department of Education and the Arts, WVEPSCoR, West Virginia Department of Education	7th and 8th grade students	120/year		Since 2004	West Virginia Department of Education and the Arts, WVEPSCoR, West Virginia Department of Education				Sherry Keffer	skeffer@wvosea.org
Health Sciences & Technology Academy (HSTA)	Math and science program geared to minority and underrepresented students and rural communities. Brings students and teachers to campus each summer for clinic, laboratory, and classroom training and activities. The partnership also provides the infrastructure and support for community-based science projects mentored by teachers, health professionals, students and volunteer community leaders during the school year.	Summer program/ community program/ teacher development	Science/Math	West Virginia University, Marshall University, West Virginia State University	West Virginia Rural Health Education Partnership	9th-12th grade students/ communities/ teachers								Claire Bragonje	cbragonje@hsc.wvu.edu
Integrated Design for Geoscience Education (IDGE)	This project utilizes The GLOBE Program (see above) to increase scientific knowledge and to promote careers in the geosciences for at-risk students involved in the Upward Bound program	Hands-on	Science	West Virginia State University	NASA IV & V Facility Educator Resource Center, Fairmont State University	High school students				NSF					
June Harless Center Distance Learning Project	Offers classes to high school students in advanced subjects via ATM lines.	Distance learning	Science/Math	Marshall University		High school students								Dr. Stan Maynard	maynard@marshall.edu

Program Name	Brief Description	Type of program	Field	Institution	Other Collaboration	Who Benefits	How many K-12 students benefit?	How many faculty benefit?	How long has program existed?	Funding	Plans for the future	Formal Evaluation	Student Tracking	Contact	Contact E-mail
Junior Science and Humanities Symposium	High school students who have completed a research or engineering project can present their work to compete for regional scholarships and, for the top two presenters, national scholarships. Also includes hands-on labs and other activities.	Symposium	Scence/Math/ Engineering	West Virginia Wesleyan College	U.S Depts of the Army, Navy and Air Force	High school students			42 years (incl. 2007)					Dr. Jeanne Sullivan	wvjshs@wvwc.edu
LEGO Sensors City	Educational resources for students, parents, and teachers--related to remote sensing, robotics, and earth and space science.	Hands-on	Engineering	Marshall University	Appalachian Transportation Institute	K-12 students/teachers								Linda Hamilton	hamilton@ marshall.edu
Online College Courses in the High Schools Program	Gives high school students the opportunity to enroll in challenging freshman courses.	College courses	Science/Math	Marshall University		High school students								Pat Campbell	campbelp@mar-shall.edu
Online Physics Teaching Specialization	Multi-institutional collaboration to develop a largely online physics teaching specialization.	Teacher development	Science	Fairmont State University		K-12 teachers				NASA				Florin Bocaneala	fbocaneala@fair-montstate.edu
RockCamp I	An introductory session that serves as a springboard for participation in advanced field-oriented sessions (see below). A team of geologists and science educators introduces teachers to the most recent developments in geology content and teaching strategies.	Teacher development	Science	West Virginia University	West Virginia Geological and Economic Survey	K-12 teachers			Founded in 1992	West Virginia Geological and Economic Survey				Tom Repine	repine@geosrv.wvnet.edu
RockCamp II	This five-day residency session begins with participants being provided with the resources needed to learn more about the geology of their home counties. They begin introductory planning and organizing a six-hour workshop and day-long local field trip for peers. This work is done after participants return home. These teachers-sharing-with-teachers experiences provide interactive forums fostering ideas that enhance science education.	Teacher development	Science	West Virginia University	West Virginia Geological and Economic Survey	K-12 teachers			Since 1994	West Virginia Geological and Economic Survey				Tom Repine	repine@geosrv.wvnet.edu
RockCamp III	Provides participants with a chance to see the geomorphology, tectonic, structural and stratigraphic geology of the New River. Each participant was required to develop an activity that would allow them to share some portion of their experience with their students.	Teacher development	Science	West Virginia University	West Virginia Geological and Economic Survey	K-12 teachers				West Virginia Geological and Economic Survey				Tom Repine	repine@geosrv.wvnet.edu
RockCamp IV	Participants compare and contrast the geology of West Virginia with that of New England. They explore tectonics, metamorphic and igneous rocks and glacial features.	Teacher development	Science	West Virginia University	West Virginia Geological and Economic Survey	K-12 teachers				West Virginia Geological and Economic Survey				Tom Repine	repine@geosrv.wvnet.edu
Science on Wheels Project	This mobile science lab will provide enhanced on-site educational opportunities for integrated, relevant and hands-on science experiences. The lab will have the capability to improve both the content and methodology of science instruction in grades 4 through 8 in the counties of Cabell, Lincoln, Logan, Mason, Mingo, Putnam and Wayne.	Mobile science lab	Science	Marshall University	Appalachian Transportation Institute	4th-8th grade students/teachers				Toyota USA Foundation				Dr. Bill Carter	bcarter@marshall.edu

Program Name	Brief Description	Type of program	Field	Institution	Other Collaboration	Who Benefits	How many K-12 students benefit?	How many faculty benefit?	How long has program existed?	Funding	Plans for the future	Formal Evaluation	Student Tracking	Contact	Contact E-mail
Search Committee for Recognizing Excellent Students (SCORES)	Academic festival/competition with more than 120 contests.	Competition	Science/ Engineering/ Math	Marshall University		High school students			29 years					Margaret Brown	brown27@marshall.edu
State Mathematics Field Day	Mathematics competition	Competition	Math	Marshall University	NASA West Virginia Space Grant Consortium; West Virginia Council of Teachers of Mathematics	4th-12th grade studetns			32						
STEM Initiatives Enhancement Program	Goal is to advance STEM workforce development through a hands-on summer camp to teach students scientific data collection techniques and the science necessary to interpret data. Includes one-week workshop for teachers and a statewide research program. Video conferencing equipment will be purchased and distributed to 45 West Virginia high schools to allow Glenville State College faculty to present workshops and work directly with science teachers and students.	Summer camp/ workshops	Science	Glenville State College		High school students/teachers	Up to 50 students at thecamp/ hundreds of students through video-conferening		New 3-year grant	NASA ($3.7 million)	Continue to expand science faculty involvement with K-12	None currently	To be developed	Dr. Kevin Evans	kevin.evans@glenville.edu
Washington Gateway Academy	A one-week residential, pre-college program intended to encourage students to think about, plan and prepare for college. Includes a science and mathematics component. The program is designed for underachievers who are performing between the average and high academic performance range.	Resident program (one week)	Science/Math	Shepherd University		8th grade students	Approx. 100/year		17 years	Shepherd University	yes		None currently	Shepherd University Career Development Center	jobweb@shepherd.edu
West Liberty State College SMART Center	Science and mathematics workshops	Workshops	Science/Math	West Liberty State College		K-8 students								Robert Strong	strongro@wlsc.edu
West Virginia Handle on Science	This project offers a comprehensive, systemic five year science education reform initiative for 49 schools in the five West Virginia Northern Panhandle counties (Brooke, Hancock, Marshall, Ohio and Wetzel). All of the approximately 625 K-6 teachers will receive professional development focusing on inquiry-based teaching strategies, content fortification, and alterative assessment using exemplary curriculum materials including STC, FOSS, and INSIGHTS modules refurbished at West Liberty State College's SMART-Center Materials Resource Center. The long-term goal of the project is to raise the level of scientific literacy of elementary school children.	Teacher development	Science	West Liberty State College		K-6 teachers		625		NSF				Robert Strong	strongro@wlsc.edu
West Virginia Math/Science Partnership (MSP) Grants	Designed to improve student academic achievement in mathematics and science by improving teacher content knowledge and skills in these areas. Partnerships between	Teacher development	Science/Math		West Virginia Department of Education	K-12 teachers				West Virginia Department of Education				John Putnam	jputnam@access.k12.wv.us

Program Name	Brief Description	Type of program	Field	Institution	Other Collaboration	Who Benefits	How many K-12 students benefit?	How many faculty benefit?	How long has program existed?	Funding	Plans for the future	Formal Evaluation	Student Tracking	Contact	Contact E-mail
West Virginia Math/Science Partnership (MSP) Grants cont.	high-need school districts and the science, technology, engineering and/or mathematics faculty in institutions of higher education are at the core of these improvement efforts.														
West Virginia State Science and Engineering Fair	This science, math and engineering competition offers high school researchers an opportunity to present their work and earn scholarships.	Competition	Science/ Engineering	Marshall University	West Virginia Academy of Science; U.S. Army, Navy and Air Force; Dow; Denvir Consultancy; DuPont Washington Works; Spectroscopy Society of Pittsburgh; WVEPSCoR	High school students			54 years (incl. 2007)	U.S. Army, Navy and Air Force				Dr. Marcia Harrison	harrson@marshall.edu
Science Education Courses	These science education courses are designed to help boost the number of certified science teachers in McDowell County schools.	Teacher development	Science	Concord University	McDowell County Schools				1 year					Dr. Joseph Allen	allenj@concord.edu
Math and Science Workshops	Workshops in math and science for teachers in Randolph, Barbour and Tucker counties.	Teacher development	Science/Math	Davis and Elkins College		K-12 teachers			Approx. 8 years	Improving Teacher Quality Grants Program				Dr. Sharmi Roy	sbr@davisandelkins.edu