The STEM Workforce Challenge:

the Role of the Public Workforce System in a National Solution for a Competitive Science, Technology, Engineering, and Mathematics (STEM) Workforce

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The STEM Workforce Challenge and the Role of the U.S. Department of Labor in a National Solution

Executive Summary

Science, Technology, Engineering, and Mathematics (STEM) fields have become increasingly central to U.S. economic competitiveness and growth. Long-term strategies to maintain and increase living standards and promote opportunity will require coordinated efforts among public, private, and not-for-profit entities to promote innovation and to prepare an adequate supply of qualified workers for employment in STEM fields.

American pre-eminence in STEM will not be secured or extended without concerted effort and investment. Trends in K-12 and higher education science and math preparation, coupled with demographic and labor supply trends, point to a serious challenge: our nation needs to increase the supply and quality of "knowledge workers" whose specialized skills enable them to work productively within the STEM industries and occupations. It will not be sufficient to target baccalaureate and advanced degree holders in STEM fields. Our nation's economic future depends upon improving the pipeline into the STEM fields for sub-baccalaureate students as well as BA and advanced degree holders, for youth moving toward employment and adults already in the workforce, for those already employed in STEM fields and those who would like to change careers to secure better employment and earnings.

The seriousness of this challenge has penetrated public and opinion-makers' consciousness—and government, industry, and education and training providers have begun to respond. NIH, NSF, and the Department of Education have been leading the federal effort. Industry associations, individual firms, foundations, and other organizations have identified and tried to fill gaps. State governments, too, are working to strengthen the STEM workforce pipeline. Much remains to be done, though, within government and across diverse sectors, to ensure that U.S. education, workforce, and economic systems rise to the STEM challenge.

The U.S. Department of Labor is already an important partner in federal efforts to strengthen the science, technology, engineering and math (STEM) pipeline. The U.S. Department of Labor invests about $14 billion a year in the nation's workforce system and in increasing the skills and education of our current workforce. In addition, the Department of Labor has begun investing regionally in ways that overcome typical fragmentation in planning and action among industry, government, non-governmental organizations, and education and training institutions.

The Department of Labor has the potential to play an even more important role in addressing gaps in the nation's approach to strengthening the STEM pipeline in three areas: 1) building the gateway to STEM careers; 2) enhancing the capacity of talent development institutions to produce more and better skilled STEM workers; and 3) catalyzing and supporting innovation, entrepreneurship, and economic growth. The leadership of the Employment and Training Administration is committed to—and stands ready to—contribute and collaborate to develop an overall national strategy around the STEM workforce pipeline and to improve coordination across federal agencies.

The STEM Challenge to U.S. Competitiveness and Growth

There is broad consensus that the long-term key to continued U.S. competitiveness in an increasingly global economic environment is the adequacy of supply and the quality of the workforce in the STEM fields. Scientific innovation has produced roughly half of all U.S. economic growth in the last 50 years (National Science Foundation 2004). The STEM fields and those who work in them are critical engines of innovation and growth: according to one recent estimate, while only about five percent of the U.S. workforce is employed in STEM fields, the STEM workforce accounts for more than fifty percent of the nation's sustained economic growth (Babco 2004). Opinion leaders and the public broadly agree that education in math and science is critical to the nation's future success. According to a recent Educational Testing Service survey, 61 percent of opinion leaders and 40 percent of the general public identify math, science and technology skills as the most important ingredients in the nation's strategy to compete in the global economy (Zinth 2006).

This engine of growth is increasingly precarious in today's global economy. The Business Roundtable (2005) warns that, if current trends continue, more than 90 percent of all scientists and engineers in the world will live in Asia. The Business-Higher Education Forum (2005) concludes: "Increased global competition, lackluster performance in mathematics and science education, and a lack of national focus on renewing its science and technology infrastructure have created a new economic and technological vulnerability as serious as any military or terrorist threat." The seminal National Academy of Sciences study, *Rising Above the Gathering Storm* (2006), argues that, absent a serious and rapid response, the U.S. will lose quality jobs to other nations, lowering our standard of living, reducing tax revenues, and weakening the domestic market for goods and services. Once this cycle accelerates, it will be difficult to regain lost preeminence in technology-driven innovation and its economic benefits.

The STEM education and workforce challenge is multi-faceted.

- *Many students never make it into the STEM pipeline, because of inadequate preparation in math and science or poor teacher quality in their K-12 systems.* Of the 2005 high school graduates who took the ACT test, for example, only 41 percent achieved the College Readiness Benchmark in mathematics and 26 percent achieved that benchmark in science (ACT 2006).
- *Many who are academically qualified for postsecondary studies in science and math fields at both the two- and four-year levels, don't pursue those programs: They might be dissuaded by disappointing postsecondary experiences, high tuition or demanding curricula and courses of study, relatively low salaries in STEM fields compared to other professions, or the lack of role models with whom they can identify (American Association of State Colleges and Universities 2005).* Whatever the reasons, trends in undergraduate and graduate enrollment in the biological, engineering, and physical sciences are troubling, as modest growth in STEM field degree graduates is being eclipsed by more dramatic growth in graduates from non-STEM programs (U.S. Government Accountability Office 2005).

- *The low engagement with STEM-related learning is particularly acute among minority, female, and lower-income students, who comprise a growing proportion of the total college-going public.* In the 2000 National Assessment of Educational Progress for twelfth grade students, about three out of four white and Asian students scored at or above basic level (which is far below proficient) on the math assessment, while fewer than half of Hispanics and under a third of African American students attained that level (National Science Foundation 2005).

Preparation for STEM success is one concern. Equally important are trends in the overall supply and employment of STEM field workers.

- *A large segment of the existing STEM workforce is approaching retirement age with the rest of the baby boomers.*
- *Women appear to be choosing non-STEM employment opportunities with increasing frequency.* According to industry data, for example, the percentage of women in the IT workforce declined from a high of 41 percent in 1996 to 32 percent in 2004, even as the percentage of women in the workforce as a whole remained steady at around 46 percent during that period (Information Technology Association of America 2005).
- *In addition, the reliance on immigrants for meeting employer demand for skilled STEM workers has become increasingly problematic.* In the wake of September 11, foreign immigration has become more complicated and visa processes have been tightened. In addition, as other countries expand their STEM-related economic growth, some who might have sought employment opportunity in the U.S. are able to find good jobs closer to home.

The STEM workforce pipeline challenge is not just about the supply and quality of baccalaureate and advanced degree earners. A large percentage of the workforce in industries and occupations that rely on STEM knowledge and skills are technicians and others who enter and advance in their field through sub-baccalaureate degrees and certificates or through workplace training. Competitiveness in STEM fields requires a focus on the skills and the supply of those involved in STEM fields from the most complex research and development and leadership positions to production, repair, marketing, sales and other jobs that require competencies built upon math, science, engineering, and technology knowledge. Getting more Americans ready for, interested in, and sufficiently skilled to be productive in STEM-related jobs will require attention to segments of the workforce that are often overlooked in STEM discussions: incumbent workers who need skill upgrading, dislocated workers who are trying to find new jobs in industries with a future, and individuals from groups traditionally underrepresented in STEM fields. The Department of Labor has an important role to play in this arena.

Responding to the STEM challenge will require a concerted and multi-faceted approach. No single agency can respond effectively. Tax, immigration, and innovation policies need to be reviewed through the lens of the STEM pipeline. Perhaps most important, education and workforce preparation policies need to be carefully reassessed.

This will require changes in: K-12 students' foundational preparation in math and science; improvements in access to and success in science, math and technology education and training both in our elite research universities and in the thousands of two- and four-year educational institutions that prepare most Americans for employment; stronger teacher and faculty training in the STEM disciplines; more effective linkages and economic signals between the education/talent development sectors and the employers who depend upon their graduates; better assessments of the quality of STEM-related education and programming; and strategies that expand and deepen workplace-based training and retraining for STEM workers at all levels.

No single sector of society can respond adequately in isolation from others. Much greater collaboration is called for: within the federal government; across different levels of government; and among the key business, government, and non-governmental institutions whose policies and practices shape the quality and quantity of the STEM workforce.

The STEM Fields and the STEM Workforce Pipeline

Science, Technology, Engineering, and Mathematics (STEM) related fields are many and diverse. About 150 different college majors have been identified by the National Science Foundation as STEM majors. Equally diverse are the industries in which STEM jobs are critically important to growth and competitive success. Some of these industries are obvious: advanced manufacturing, biotechnology, chemical engineering, energy, actuarial science and health care all rely on high-level skills and education in the STEM fields in their workforce. Other industries may seem less obvious for their reliance on STEM knowledge and skills, such as construction, retail, transportation, and hospitality. But changing technology and expectations of the workforce in these industries make STEM knowledge important even in these industries. For example, mechanics in the trucking industry must deal with sophisticated computer technology in both diagnostics and repair procedures. In construction, the increased importance of math and technical knowledge on the construction site and in construction business offices has become an obstacle to entry into apprenticeship and other training programs for individuals who fifteen years ago would have easily found their way into those programs.

According to the U.S. GAO (2005), employment in STEM fields rose from an estimated 7.2 million to around 8.9 million in the years between 1994 and 2003—an increase of about 23 percent during a time when non-STEM employment rose by only 17 percent. The Bureau of Labor Statistics (2006) projects significant growth in the overall STEM workforce between now and 2014; of the 20 fastest-growing occupations over the coming decade, 17 will be in health care and computer fields.

The overwhelming majority of the last decade's expansion in STEM employment was in computer and math fields (78 percent) as opposed to science (only 20 percent growth) or engineering fields (no apparent growth). Getting sufficient numbers of individuals qualified for advanced education in STEM is one challenge; but connecting qualified and skilled workers to jobs in their fields is also problematic, particularly in science and engineering. A recent NSF report found that two-thirds of workers with science and engineering degrees are employed in positions that are only somewhat or not at all related to their educational expertise.

Current Responses to the STEM Challenge

The steady drumbeat of industry, government, and educators' warnings about the future of technology-based growth has led to important action by various stakeholders to address weaknesses in the pipeline into STEM occupations and fields in the United States.

Federal government: The federal government has taken a hard look at its own activities to support STEM and made efforts to coordinate and expand them. In October 2005, the U.S. GAO issued a report cataloguing and assessing the impact of federal programs designed to increase the number of students and graduates or to improve educational programs in the STEM fields. The agency found 13 different federal civilian agencies spent about $2.8 billion in fiscal year 2004 for over 200 different programs, mostly within the National Institutes of Health and the National Science Foundation. Although about half of the programs had evaluations as part of their investment, agencies reported little about the effectiveness of these investments. More recently, the National Science and Technology Council (2006) catalogued and issued recommendations for improving the impact of the federal investment in STEM education research, with particular focus on the Department of Education, NIH, and NSF, noting several ways that federal agencies can work together to ensure that gaps in STEM education research will be adequately funded and that research will be effectively disseminated to policymakers.

In his 2006 State of the Union Address, President George W. Bush announced the American Competitiveness Initiative. The Initiative promotes American innovation, emphasizes the need to increase the nation's ability to compete in the global economy, and promotes growth of the workforce's knowledge base, skill level, and use of technology. A week later, the budget act signed into law included an Academic Competitiveness Council chaired by the Secretary of Education and consisting of members of the federal government whose agencies have education programs in science, technology, engineering and mathematics. In FY 2007, Congress committed $5.9 billion to increase investments in research and development, strengthen education, and encourage entrepreneurship.

Industry: Industries and firms dependent upon a strong science and math workforce pipeline have launched a variety of programs that target K-12 students and undergraduate and graduate students in STEM fields. Industry associations that include the Society for Manufacturing Engineers, the American Chemical Society, the American Physical Society, the National Association of Manufacturers, and the National Science and Technology Education Partnership invest in STEM education initiatives that involve curricular improvements, career-focused websites, mentoring programs, scholarships, and other incentives and supports. Individual firms and their corporate foundations, including Raytheon, Bayer, and General Electric, have created outreach efforts of their own (Delaware Valley Industrial Resource Center and National Council for Advanced Manufacturing 2006).

Foundations: Foundations, too, are investing in efforts to promote expanded enrollments and success in STEM education, particularly among groups traditionally underrepresented in these programs. Project Lead the Way operates in more than 1000 schools in almost all the nation's states, promoting pre-engineering courses for middle and high school students. The Alfred Sloan

Foundation has invested in a career information website targeted to pre-college, college, and early career professionals regarding STEM occupations and opportunities. The Bill and Melinda Gates and the Michael and Susan Dell Foundations have collaborated with the State of Texas on an ambitious new Texas Science, Technology, Engineering and Math (T-STEM) Initiative to create new T-STEM Academies across the state, establish a best practice network, and support other efforts to increase the number of young people who enter STEM postsecondary programs.

State government: According to a recent Education Commission of the States report, state governments are also beginning to respond. Some are raising graduation requirements in mathematics and science. Others have developed or imported pre-engineering curricula for high schools. Other areas for state action have included teacher training and recruitment, dual enrollment in STEM courses, real-world learning opportunities for students in science and technology courses, and grants to students who pursue STEM postsecondary programs and employment (Zinth 2006).

The entrepreneurial spirit that motivates these varied and vibrant efforts is impressive. But much more can and must be done. To date, these critical efforts at the national, state, and local levels have focused primarily on students at four-year universities and traditional high schools. If the pipeline for a qualified and flexible STEM workforce is to expand to meet the growing need, the nation must look to attracting and educating additional, less traditional pools of potential STEM workers: incumbent workers, dislocated workers, students working toward community college technical credentials, even students in alternative education settings who are trying to find their way back into the economic and educational mainstream. To tap these potential sources of new STEM employees, all the nation's talent development systems need to work in concert.

The Department of Labor, which coordinates a national public workforce development system and $14 billion of investments in workforce skills, is an important stakeholder and potential contributor to a robust national strategy for tackling the STEM workforce pipeline challenge. The Department's Employment and Training Administration is already deeply involved in supporting efforts to prepare more STEM workers. Its experience, capacity, and training and education assets puts the Department in a position to help the nation address this critical economic and security challenge—and to integrate its efforts to support innovation and growth with those of others in government, industry, and the education community.

The Department of Labor's Current Contributions to a Stronger STEM Pipeline

In seeking to help fill gaps in the nation's response to the STEM workforce challenge, the Department of Labor's Employment and Training Administration seeks ways to employ its infrastructure, capacity, investments, and initiatives for maximum impact. The Department's $14 billion of activities and investments in talent development is a significant asset. Moreover, the Department's unique commitment to regional workforce quality and economic growth strategies provides a powerful structure for collaboration and alignment across funding streams and public and private stakeholders.

Specifically, in collaboration with multiple agencies across the federal government, the state and local workforce investment system, and a wide array of strategic partners in the public and private sectors, ETA is committed to:

- **Building the gateway to STEM careers** by helping to prepare an educated, skilled STEM workforce in the context of its investments in preparing talent for economic development in regional economies;
- **Enhancing the capacity of talent development institutions** to produce more and better skilled STEM workers through investment of Department resources and through greater integration and alignment of existing public and private resources, so that more workers have access to postsecondary opportunities;
- **Catalyzing and supporting innovation, entrepreneurship, and economic growth** that can expand STEM employment opportunities.

Many of the Department's major initiatives are directly relevant to national strategies to improve STEM workforce pipeline outcomes. These include:

- *President's High Growth Job Training Initiative:* This initiative is ETA's foundation effort for engaging business, education, and the workforce investment system to work together to develop solutions to the workforce challenges facing high growth industries, including those industries with significant STEM-related employment. ETA identified fourteen sectors that are projected to add substantial numbers of new jobs to the economy or affect the growth of other industries or are being transformed by technology and innovation requiring new sets of skills for workers. The fourteen sectors are:
  - Advanced Manufacturing
  - Automotive
  - Construction
  - Financial Services
  - Geospatial Technology
  - Homeland Security
  - Information Technology
  - Transportation
  - Aerospace
  - Biotechnology
  - Energy
  - Financial Services
  - Health care
  - Hospitality
  - Retail

The initiative invests in national models and demonstrations in these sectors, many of which have high and growing concentrations of employment that is STEM-based. Initial investments have targeted the health care, biotechnology, advanced manufacturing, and construction sectors, among others.

Here are a few examples of the Department's STEM-related investments through this initiative: In the geospatial industry, for example, the University of Southern Mississippi is working with community colleges and industry partners to develop career ladders and apprenticeship training programs. In the advanced manufacturing industry, the Arkansas Department of Workforce Services focuses on training for technicians in such STEM-reliant fields as programmable logic controllers, plastics engineering, and robotics. The program includes a college, community colleges, the state WIB, and the state departments of Workforce Education, Economic Development, and Higher Education. In health care, the CVS Regional Learning Center is implementing pharmacy technician training programs for incumbent workers as well as people looking to enter the industry for the first time.

Community-based Job Training Grants: This relatively new competitive grants program, which builds upon the High Growth Job Training Initiative, is designed to improve the capacity of community colleges to train workers in skills needed by regional employers. It recognizes that many job opportunities of today and tomorrow require postsecondary education and training and that our community colleges will play an increasingly important role in developing the skills and talent of American workers. In 2005, $125 million in grants were made to 70 community colleges in 40 states. A second competition was conducted in 2006. Because the grants are targeted to the fourteen sectors defined above as having either high growth or high demand, many of these grants promote community college programs that prepare individuals for work in these sectors.

Northwest Iowa Community College is developing a biotech initiative that will combine a high school science curriculum component, an Associates Degree Lab Technician program for biotechnology careers, and a skills enhancement component for incumbent workers. Tanaka Valley College of the University of Alaska in Fairbanks is developing a set of curricula in technical skills needed in the state's energy industry that can be delivered in industry-based instructional sites with industry instructors. These funded programs involve multiple workforce partners including community colleges, local and/or state WIBs, businesses, trade associations, and K-12 education.

Workforce Innovation in Regional Economic Development (WIRED) is ETA's flagship initiative that focuses on the role of talent development in driving regional economic competitiveness, increased job growth, and new opportunities for American workers. The WIRED initiative is a regional initiative; it focuses on labor market areas that are comprised of multiple jurisdictions within state or across state borders, enabling Governors a unique opportunity to design and implement strategic approaches to regional economic development and job growth. Designed particularly for regions hard hit by global trade, dependent upon a single

industry, or recovering from natural disasters, WIRED emphasizes strategic partnerships to accelerate and support regional transformation linking economic development, workforce, and education systems. To date, twenty-six regions have been selected for participation. In many of these efforts, collaboration to catalyze talent development for STEM-related fields is at the core of the regional strategy.

The Northwest Florida Initiative is designed to create high wage high skill jobs in the target industries of aerospace and defense, life sciences, information technology, electronics engineering, and construction. The Denver regional strategy will focus on partnerships to address the "Colorado Paradox" of high in-migration of skilled and educated workers coupled with comparatively poorly-performing K-12 and higher education institutions in-state. The initiative will focus on raising standards in local educational institutions and reversing the current pattern. The California Innovation Corridor noted that it has the greatest concentration of potential innovation assets in the world; however it continues to seek to "Grow its Own" in order to meet the challenges of competing in the regional and global market as well as educating enough qualified technical workers to fill sectors of California's high-tech economy. This WIRED grant has a three-tiered approach: Innovation Support, Industrial Rejuvenation, and Talent Development.

National Emergency Grants and Dislocated Worker funds: An important component of the Department of Labor's portfolio is its responsibility to minimize the negative economic and employment impacts of dislocation from plant closings, regional employment shifts, and global competition. The Department provides funds that are spent for training and retraining services for dislocated workers, through the local and state public workforce system. The Department also makes available to local workforce investment boards National Emergency Grant funds for large group layoffs. While these resources are available for employees in all industries, the importance of STEM fields for American competitiveness and economic growth has led to increased allocation of these funds for STEM-related training and skill development. Funds have been used to train workers on new technologies, to enable them to earn industry certifications, and to provide entrepreneurial training and skills for workers interested in opening their own small businesses. An example of how these funds can support STEM pipeline activities: in the Merrimack Valley of Massachusetts, when Lucent Technologies laid off a large number of workers, dislocated worker and NEG funds were used to retrain STEM workers for employment in the defense and homeland security industries (Lazonick and Quimby 2006).

Interagency Aerospace Revitalization Task Force: In the last session of the 109th Congress, H.R. 758 was passed and signed by the President. This new legislation, which originated in the House Committee on Commerce, Science and Transportation, establishes a new Federal Interagency Aerospace Revitalization Task Force intended to develop a strategy for the federal government for aerospace workforce development. The legislation appoints the Assistant Secretary of Labor for Employment and Training as the Chairperson of the Task Force. This is further evidence that Congress has identified the critical role workforce development plays, and therefore the Department of Labor, in ensuring that one of the nation's most important STEM related industries has a stable, high-skilled job pipeline necessary to compete globally in this highly competitive industry.

InDemand Magazine: InDemand Magazine is a quarterly publication that the Employment & Training Administration produces to connect today's students with the careers of tomorrow. It is available on CareerVoyages.gov and each issue explores careers in a different high growth industry. It provides students, as well as guidance counselors, parents and teachers, with interesting and relevant information and tips about career opportunities; education and the skills needed for various jobs; and how to help students build successful futures. There are opportunities for young people in fields ranging from art to math, from sports to science, and from design occupations to the trades.

These and other Departmental efforts—including youth employment funding under WIA, WIA adult worker programs, the longstanding registered apprenticeship system, and faith and community-based organization programs funded by ETA—give the Department an opportunity to address serious gaps in the nation's STEM workforce pipeline strategy and to augment and help integrate investments available through other federal and other public and private sources.

A Call to Action: Toward a Pro-Active Response to the STEM Challenge

The Department has embraced the beginnings of an action agenda that, in collaboration with other stakeholders and investors, should help to: expand the pool of potential STEM workers; strengthen the gateway for non-traditional populations into STEM careers; ease the transition for dislocated or transitioning workers into STEM fields; and integrate national, state, regional, and local efforts into a more powerful set of partnerships and coordinated strategies.

Some specific contributions that the Department can—and does—make to this agenda include the following:

Building the Gateway to STEM Careers: Labor Department programs can promote alternative learning models in STEM education; support the development of career awareness materials highlighting employment in high growth, high demand STEM industries; establish a framework for defining competencies and skills essential for 21st century STEM workers; and explore the use of technology-based learning for STEM competencies.

Enhancing the Capacity of Talent Development Institutions: Labor Department investments can support community college efforts to train workers for STEM occupations; develop competency-based apprenticeship and internship models in STEM fields; promote the professional development of teachers, recognizing education as a high growth industry; and strengthen the public workforce system's capacity to support employer commitment to developing a skilled STEM workforce.

Catalyzing and Supporting Innovation, Entrepreneurship, and Growth: The Department's activities can accelerate the development and success of emerging and leading growth companies through access to resources, expertise, and private sector networks; invest in entrepreneurship and intrapreneurship talent development strategies; and assist entrepreneurs in finding and strengthening the skills of their workforce as their firms grow.

These kinds of investment priorities can provide important leadership and address gaps and opportunities that currently constrain the nation's ability to generate sufficient qualified and prepared workers for the STEM fields—from the most skilled research and technical scholars to the production, service, and technician-level employees who are so critical to industry health and growth. These investments will have even greater impact if they can be linked effectively with the investments of other stakeholders, starting with other federal agencies (particularly the Department of Education, NIH, and NSF) and extending to industry, foundations, and state governments across the nation.

The time is now for coordinated efforts to seed innovative new ideas, incubate the most promising of these initiatives, and scale demonstrably successful programs to strengthen the STEM pipeline. The Department of Labor's Employment and Training Administration is committed to partnering with others in the public, private, and not-for-profit sectors to achieve this critically important goal. The future well-being, security, and prosperity of the nation depend upon our collective success.

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