TRANSFORMING AMERICA'S SCIENTIFIC AND TECHNOLOGICAL INFRASTRUCTURE Recommendations for Urgent Action

> Project Kaleidoscope + 2006 Report on Reports II



SELECTIONS FROM THE 2006 PKAL REPORT ON REPORTS



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PROJECT KALEIDOSCOPE PHASE IV is supported by grants from

The National Science Foundation Directorate for Education and Human Resources Directorates for Biological Sciences and for Mathematical and Physical Sciences Directorate for Social, Behavioral & Economic Sciences— Office of International Science & Engineering

The ExxonMobil Foundation

The W.M. Keck Foundation

PROJECT KALEIDOSCOPE (PKAL) is an informal national alliance dedicated to: exploring and defining what works in undergraduate science, technology, engineering and mathematics (STEM); disseminating effective practices through workshops, institutes, publications, real and virtual networks; and supporting their widespread adaptation. January 2006

Dear Friends and Colleagues:

In 2002, PKAL presented its first *Report on Reports*, analyzing a selection of influential reports issued from the mid-1980's that had shaped efforts to strengthen undergraduate learning environments in science, technology, engineering, and mathematics (STEM) over a seventeen year period. The audience for that 2002 publication was primarily leaders taking responsibility for the quality of STEM learning in the nation's colleges and universities; the intent was to provide ideas and recommendations to inform and advance their work, and to spotlight the potential for collective action.

This 2006 PKAL *Report on Reports II* is modeled after its predecessor, with some significant differences:

- all of the nearly 20 reports cited, briefly or at length, have been issued in the last 36 months, reflecting an increasing concern at the national level and within academe about America's present and future capacity to be a world leader in innovating and applying scientific and technological advances to address critical societal problems. An array of groups that represent a broad spectrum of American society has expressed concern about this situation, including business and government groups, professional societies, foundations, academics, and private-public partnerships operating at the national level.
- the arguments and recommendations presented are "in their own voice," with short background statements to establish the context.
- the intended audience is the entire community of stakeholders: those responsible for budgets, policies and programs that affect research and education in STEM fields at the national, state and local level; those responsible for the quality of STEM research and education in America's educational institutions; those potential employers of STEM graduates; and all citizens in a society in which science and technology have a significant impact on most aspects of our lives.

PKAL's *raison d'etre* is strengthening undergraduate STEM. Yet from the reports cited here (and from the others that seem to be issued daily) what is urgently needed is fundamental change of the entire system. Short-term, piece-meal, sector by sector, underfunded and uncoordinated efforts will not move America confidently and creatively forward in the next, challenging decades of the 21<sup>st</sup> century.

We hope this publication helps to spark and inform such fundamental change.

Sincerely,

Jeanne L. Narum

Jeanne L. Narum Director

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### **EXECUTIVE SUMMARY**

### **RECOMMENDATIONS FOR URGENT ACTION**

#### Focus on students now in the pipeline

- support those students demonstrating promise for success in the study of science and mathematics as they enter into and pursue undergraduate studies
- give each undergraduate the opportunity for personal experience with inquiry-based learning that brings him or her to a deep understanding of the nature of science, the language of mathematics, the tools of technology
- extend research opportunities beyond the classroom and campus
- capitalize on and celebrate the growing diversity of students in American classrooms.

#### Focus on the future workforce

- connect student learning in STEM fields to the world beyond the campus, so students appreciate the relevance of their studies and consider careers that use the skills and understandings gained from study in these fields
- build regional collaborations of academe, business, and civic groups working to ensure a steady stream of graduates well-prepared for the 21<sup>st</sup> century workplace, as well as to be responsible citizens in our "flat world"
- respond to contemporary calls for interdisciplinarity by nurturing and rewarding faculty who make the kind of cross-discipline connections they hope their students will make.

#### Focus on innovation for the future

- be adventurous in exploring opportunities to strengthen student learning in the STEM fields and in piloting new ideas, tools, and approaches to keep the work of transforming student learning at the cutting edge
- set benchmarks (2010, 2015, 2020) against which action plans can be shaped and progress measured, at the local, regional, and national levels.

#### ◀

Ownership of student achievement must be community property, with wide involvement of all stakeholders. To cultivate ownership and accountability is to cultivate for the long-term.

—American Association for the Advancement of Science. A System of Solutions: Every School, Every Student. 2005

#### ◀

At the heart of interdisciplinarity is communication— the conversations, connections, and combinations that bring new insights to virtually every kind of scientist and engineer.

—National Academy of Sciences. Facilitating Interdisciplinary Research. 2004

#### •

Higher education must redesign itself.... Education must be engaging, flexible, and interactive. Forward-thinking institutions that can lead the way must pioneer innovative new efforts and become champions of redesign and learning.

-Business Higher Education Forum. A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education. 2005.

### INTRODUCTION

Barriers and challenges to changing the system:

- insufficient investment of resources to foster the professional training and education necessary to maintain a sustainable workforce that adapts to changing national dynamics
- organizational barriers that create competitive instead of cooperative environments among departments and organizations
- cultural differences between disciplines and agencies
- lack of innovative approaches in education
- scientific disciplines are too compartmentalized and tend to focus research on disciplinary interests
- hostility to 'disruptive' change to the status quo...can inhibit acceptance and support of new approaches.

—Adapted from National Institutes of Health, National Science Foundation, et al. Conference on Research at the Interface of the Life and Physical Sciences: Bridging the Sciences. 2005 The reports cited in these pages present specific recommendations for immediate action by one or many of the stakeholder communities: educational and business leaders, politicians and parents, staff of public and private funding agencies. The highlighted "calls to action" are one beginning point from which individuals and institutions can respond to the challenges expressed so clearly, particularly in the national reports in Part I. Some short-term benefits surely would accrue to students, science and society if the individual recommendations were adopted and implemented in 2006 by individuals, organizations, and institutions.

But the need for a transformation of the system that will be sustainable over the long-term is the real message of these reports. Collectively they press the point that the challenges are so pressing they require a direct, coordinated, and coherent response from the community of stakeholders. What they call for is the transformation of systems, whether the system is:

- a single STEM disciplinary department at a college or university looking to achieve a robust learning environment that ensures the persistence and success of all students
- institutional and national policies undergirding efforts to develop a strong and innovative cadre of 21<sup>st</sup> century S&T professionals in schools, academe, and the workplace
- institutional and national policies focusing on students: who they are, how they learn, and what their preparation is for leadership in an increasingly technological, global, competitive society
- networks of citizens working with public officials, business and educational leaders to ensure a robust pre-K-16 science/ mathematics (STEM) learning experience for all students— no matter their background or career aspiration
- regional partnerships of academic scientists and industrial partners introducing students to the world of the scientist/engineer as a means to motivate students to consider careers in an S&T field
- networks of leading scientists and engineers, across disciplinary or geographic boundaries, bringing 21<sup>st</sup> century science and technology into the undergraduate learning environment.

### NTRODUCTION

To achieve such transformed systems, we can begin by spotlighting, scaling-up and institutionalizing practices having documented success in building robust STEM learning environments for 21st century students, preK-20. Many examples of such programs and practices are described in the full body of these cited reports; other exemplars can be found in the work of pioneering agents of change around the country. That we do not have to begin with a blank slate is good news; the time is too short and the task too monumental to do otherwise. There are significant lessons learned from relevant reform efforts undertaken since the mid-1980's that offer direction as we respond to calls to build a nation of learners, a nation of innovators.

But building on what has worked yesterday and what is working today is not enough, if we are convinced that the authors of these reports are on target. The world of tomorrow they describe is already here. It is one in which the context of changing demographics, global competitiveness, scientific and technological advances (and more) calls for risk-taking initiatives to break systems apart and to put them together in ways that better serve students, science, and society over the next decade.

It is critical for each of us responsible for some small part of the larger system to understand how what we do affects the entire enterprise. Indeed, all of us making decisions— stakeholders with responsibility for individual parts of the system— about allocation and reallocation of public and private resources should be asking:

- does this initiative fit into America's emerging agenda to build a nation of learners, a nation of innovators, and a world-class science and technology workforce, and if so, how?
- can we evaluate the impact of this initiative, and thus, the return on our investment?

The broader vision of America's future presented in these pages is compelling, not only in responding to current challenges of an increasingly "flat world" in economic terms. Although the vision encompasses the character of the workforce and our relationship to global partners, at its core it speaks about "people." The vision is about the people needed to lead America with confidence into a future that, although uncertain, requires the same spirit of adventure, openness to discovery, and the agility and flexibility to deal with uncertainty as did past generations of leaders. How we respond to this 21<sup>st</sup> century economic and technological "Sputnik" will determine America's future. The need is for structural change, from the schoolhouse to the statehouse.... Fundamental change. Structural change. The educational system must not only be better. It must be different.

-Business Higher Education Forum. A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education. 2005.

Effective programs never stop asking basic questions about processes and outcomes: 'Are we doing the job?'

-Building Engineering & Science Talent. The Talent Imperative: Meeting America's Challenge in Science & Engineering, ASAP. 2004

### **CALLS TO ACTION**

1

We (all stakeholders) must plan and invest for the long-term, recognize the multifaceted nature of this problem, and come together across all sectors to form a new social and economic compact to promote a national innovationoriented culture.

#### **COUNCIL ON COMPETITIVENESS**

National Innovation Initiative Summit and Report: Thriving in a World of Challenge and Change. 2005

- 1. "The world is becoming dramatically more interconnected and competitive...
- 2. Where, how and why innovation occurs are in flux— across geography and industries, in speed and scope of impact, and even in terms of who is innovating.

The way forward is not to retreat or to re-trench. The way forward is to become more open, more experimental, and to embrace the unknown. We cannot turn inward, nor can we allow our institutions to become overly centralized, calcified and risk-averse.

... [T]he bar for innovation is rising. And simply running in place will not be enough to sustain America's leadership in the  $21^{st}$  century. Innovation itself— where it comes from and how it creates value— is changing." (*Pages 8 & 37*)

#### **BUSINESS ROUNDTABLE, ET AL.**

Tapping America's Potential: The Education for Innovation Initiative. 2005

"...Although numerous policy initiatives and programs are under way, none matches the coordinated vision, concentrated energy, attention and investment that emerged from the shock Americans faced when the Soviet Union beat the United States into space with Sputnik in 1957. We need a 21<sup>st</sup> century version of the post-Sputnik national commitment to strengthen [STEM] education. We need a public/ private partnership to promote, fund and execute a new National Education for Innovation Initiative. It must be broader than the 1958 National Defense Education Act because federal legislation is only one component of a larger, more comprehensive agenda.

...If we take our scientific and technological supremacy for granted, we risk losing it. What we are lacking at the moment is not so much the wherewithal to meet the challenge, but the will. Together, we must ensure that U.S. students and workers have the grounding in math and science that they need to succeed and that mathematicians, scientists and engineers do not become an endangered species in the United States." (*Pages 7 & 14*)

•

We must focus, as quickly as possible, on...areas that affect the choices made by students now in the pipeline.

# CALLS TO ACTION

#### THE NATIONAL ACADEMIES

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. 2005

"[S]hort-term responses to perceived problems can give the appearance of gain but often bring real long-term losses. It is useful to return to the implications of a flat world and of the exportation of the nation's jobs. [Our] report emphasizes the need for world-class science and engineering— not simply as an end in itself but a principal means to creating new jobs for our citizenry as a whole in this global marketplace of the 21<sup>st</sup> century." (*Page 1-16*)

#### **BUILDING ENGINEERING AND SCIENCE TALENT**

The Talent Imperative: Meeting America's Challenge in Science and Engineering. 2004

"The message is clear. Today's relentless search for global talent will reduce our national capacity to innovate unless we develop a science and engineering workforce that is second to none....

The barriers that stand in the way of broadening the participation of the underrepresented majority are built into our homes, schools, workplaces, communities, and psyches. Most would have fallen decades ago if they were not deeply embedded in our institutions and our behavior. The challenge of removing them goes beyond the reach of any group, organization, or economic sector. It is a shared task for which there is no single point of accountability. The piecemeal efforts upon which we have relied have opened up opportunities for thousands, but have not produced change on the scale that is required." (*Page 3*)

#### **BUSINESS HIGHER EDUCATION FORUM**

Building a Nation of Learners: The Need for Changes in Teaching and Learning to Meet Global Challenges. 2003

"In the future, the livelihood of the individual will be even more dependent on skills and education with the increased need for all members of the workforce to be better skilled, better educated, lifelong learners.... 60 percent of future jobs will require training that only 20 percent of today's workers possess.

The lifelong learning skills and attributes...leadership, teamwork, problem solving, time management, self-management, adaptability, analytical thinking, global consciousness, and communications need to be firmly embedded in teaching at colleges, including community colleges, and universities. When evaluating courses, programs, and styles of teaching, educators need to address questions such as: How do programs improve student leadership abilities? What kinds of multidisciplinary courses enhance analytical thinking? What learning experiences can help students become aware of global concerns and responsibilities? How can course requirements and exams enhance communications skills, both oral and written?" (*Pages 13 & 15*)

#### ◀

We must increase our investment in the talent pool that serves America's S&T workforce: scholarships for potential K-12 teachers; competitive scholarships for citizens who are undergraduate STEM majors on U.S. campuses; increased support for outstanding early career researchers.

#### ◀

We must scale-up practices recognized as succeeding in nurturing, deploying and retaining the talent of under-represented groups in STEM fields.

#### ◀

We must immediately support activities, that by 2010, give two generations of students the benefit of a higher education system that is more attuned to giving students the analytical skills, the learning abilities, and the other life-long learning skills and attributes needed to adapt to 21<sup>st</sup> century workplace realities.

# **COUNCIL ON COMPETITIVENESS**

NATIONAL INNOVATION INITIATIVE SUMMIT AND REPORT. 2005

### BACKGROUND

The Council on Competitiveness is a forum that sets an action agenda to drive economic growth, and for elevating national competitiveness to the forefront of national consciousness. In 2005, it convened a National Innovation Summit exploring the relationship between our nation's ability to compete in the global economy of the 21<sup>st</sup> century and to "unleash its innovation capacity."

The Summit's report significantly informs and advances discussions of key issues. Its most valuable contributions are: 1) to set "a nation of innovators" as the vision toward which efforts of all stakeholders can aspire; 2) to outline approaches for addressing the entire innovation "system," from the earliest educational opportunities to the range of public policies that lead to greater tangible support for students, for workers, and for the "entrepreneurial" community. oday, America finds itself at a unique and delicate historical juncture, shaped by two unprecedented shifts— one in the nature of global competition, the other in the nature of innovation itself:

- The world is becoming dramatically more interconnected and competitive. At the same time that economic interdependencies are growing, America is in the unfamiliar position of the world's sole superpower. It is important to recognize how novel this situation is historically, and what opportunities and dangers it holds— from rivals or potential rivals, to be sure, but perhaps even more from how we ourselves choose to handle this geopolitical reality.
- Where, how and why innovation occurs are in flux— across geography and industries, in speed and scope of impact, and even in terms of who is innovating. In many ways, the playing field is leveling, and the barriers to innovation are falling. Whenever such a shift occurs, there are always changes in how economies and societies work— including new ways of creating value and measuring success, and realignments of competitive advantage. In the 21<sup>st</sup> century, the pace of these changes will accelerate. To thrive in this new world, it will not be enough— indeed, it will be counterproductive— simply to intensify current stimuli, policies, management strategies and to make incremental improvements to organizational structures and curricula.

What will America do? Will we plan and invest for the long term, rather than just the next quarter, putting in place the talent pool, innovation capital and infrastructure necessary for continuing success throughout the 21<sup>st</sup> century? Will we recognize the multifaceted nature of this problem and come together across all sectors— business, government, labor and academia— to form a new social and economic compact?" (*Page 8*)

# **COUNCIL ON COMPETITIVENESS**

NATIONAL INNOVATION INITIATIVE SUMMIT AND REPORT. 2005

### RECOMMENDATIONS

- "Universities should promote an innovation-oriented culture while maintaining a commitment to creating new knowledge at the frontiers of research. This culture should seed traditional technical studies with new exposure to methods for creative thinking and translating ideas into commercial applications. Tenure and promotion policies should give weight to teaching creativity, inventiveness and innovation. These changes may require reassessments of organizational structures and learning environments.
- Academic institutions should develop curricula specifically designed to teach innovation skills and support major changes in innovation learning. They should expand the use of experiential learning.
- Innovation Partnerships need to be created to bridge the traditional gap that has existed between the long-term discovery process and commercialization. These new partnerships would involve academia, business and government, and they would be tailored to capture regional interests and economic clusters.
- States and universities should fund internships for innovationoriented students interested in experiencing local startup and small business environments.
- Universities and colleges— including community colleges— should establish curricula to teach innovation management skills to middle and senior managers from small businesses. States should create local and regional innovation synergies by providing incentives for interaction between small businesses and educational institutions and resources.
- The National Science Foundation should take a significant role in funding pilot efforts to create innovation-oriented learning environments in K-12 and higher education. It should also sponsor research into the processes involved in teaching creativity, inventiveness and commercialization in technical environments." (Page 27)



Source: American Association for the Advancement of Science. Investing in Human Potential: Science and Engineering at the Crossroads. Ed. Marsha Lakes Matyas, Shirley M. Malcom. Washington, DC.1991.

# **BUSINESS ROUNDTABLE, ET AL.**

TAPPING AMERICA'S POTENTIAL: THE EDUCATION FOR INNOVATION INITIATIVE. 2005

### **BACKGROUND**

►

Our goal is to double the number of science, technology, engineering and mathematics graduates by 2015. (Note: Therefore, the goal, by 2015, is 400,000 bachelor's degrees earned annually by U.S. citizens and permanent residents.) This report is a letter to "leaders who care about America's future." It is from fifteen of our country's most prominent business organizations that came together to challenge themselves and other leaders to work as partners toward a goal to double the number of science, technology and mathematics graduates from our nation's colleges and universities by 2015. As with reports from many peer groups, it suggests the challenges now facing America are similar in nature to those faced at the time of Sputnik— perhaps even more serious.

*Tapping America's Potential* emphasizes the need for partnerships geared for collective action, and commits the nation's business leaders to moving ahead now on this ambitious agenda for action.

"[T]o reach our goal of doubling the number of science, technology, engineering and math graduates by 2015, we must focus as quickly as possible in the years ahead on five critical areas that affect the choices made by students now in the pipeline.

- Build public support for making science, technology, engineering and math improvement a national priority.
- Motivate U.S. students and adults to study and enter science, technology, engineering and mathematics careers, with a special effort geared to those in currently underrepresented groups.
- Upgrade K–12 math and science teaching to foster higher student achievement.
- Reform visa and immigration policies to enable the United States to attract and retain the best and brightest science, technology, math and engineering students from around the world to study for advanced degrees and stay to work in the United States.
- Boost and sustain funding for basic research, especially in the physical sciences and engineering." (*Pages 10-13*)

# **BUSINESS ROUNDTABLE, ET AL.**

TAPPING AMERICA'S POTENTIAL: THE EDUCATION FOR INNOVATION INITIATIVE. 2005

### RECOMMENDATIONS

"[We] identified a core set of recommendations in a dozen recent reports that we can begin to initiate, even in this tight budget year."

- "Launch a campaign to help parents, students, employees and community leaders understand why math and science are so important to individual success and national prosperity.
- Create more scholarships and loan-forgiveness programs for students who pursue two-year, four-year and graduate degrees in science, technology, math and engineering (including students who plan to teach math and science, particularly in high-poverty schools).... Supplement Pell Grants for eligible students who successfully complete core academic courses in high school.
- Increase the retention rate of undergraduate [STEM] majors by expanding programs...that encourage college graduates to pursue fields outside of academia that combine science and/or math with industry needs.
- Encourage private sector involvement in consortia of industries and universities that establish clear metrics to increase the number of [STEM] graduates.
- Adopt curricula that include rigorous content as well as real world engineering and science experiences so that students learn what it means to do this work, what it takes to get there, and how exciting these fields are.
- Include incentives in the Higher Education Act and in state policies for colleges and universities to produce more math, science and engineering majors and to strengthen preparation programs for prospective math and science teachers.

All of these efforts should be driven by a commitment to inspire and educate a new generation of mathematically and scientifically adept Americans." (*Pages 10–13*)

### 2001 bachelor's degrees earned by U.S. citizens/permanent residents:

14,048 in physical sciences
4,001 in earth, atmospheric and ocean sciences
63,528 in biological sciences

11,256 in math

34,502 in computer sciences
17,986 in agriculturalsciences

55,003 in engineering

TOTAL: 200,324

-National Science Board. Science and Engineering Indicators. 2004

# **BUILDING ENGINEERING & SCIENCE TALENT**

THE TALENT IMPERATIVE: MEETING AMERICA'S CHALLENGE IN SCIENCE & ENGINEERING, ASAP. 2004

### BACKGROUND

►

BEST is a public-private partnership dedicated to building a stronger, more diverse U.S. workforce in science, engineering and technology by increasing the participation of under-represented groups. Its efforts reflect the growing realization that, historically, America has drawn upon a small segment of its population— and imported talent— to meet most of its needs for scientific and technological talent.

Further, as this traditional segment is ever-narrowing, BEST argues that the single most important test for American higher education over the next decade will be to develop "an emerging domestic talent pool that looks different from that in decades past." Unless it can do so, the primacy of American innovation will be lost, even as employers access international technical talent or move operations offshore.



EST has sought systemically those higher education programs that are "pockets of success where the talent of underrepresented groups is being nurtured, deployed and retained."

"Our greatest untapped resource: America's under-represented majority. Consider women, for example. They have emerged as the most educated segment of our society over the past quarter century, but a large number still view technical fields as off-limits. Image the infusion of knowledge and creativity if they were to choose science or engineering at the same rate that they have opted for business, law or medicine?

Or, take our burgeoning Hispanic population. Half of California's current kindergartners are Hispanic, yet the state's Science and Technology Council reports that only five percent of Hispanics who entered ninth grade in 1996 completed high school in 2000 fully ready to start college. What if that figure were multiplied 10-fold over the next decade? What could those kids, along with their African American and Native American classmates, bring to our innovation enterprise in 2025 and beyond?

Persons with disabilities, who comprise about 20% of our population, are another case in point. Technology is often their lifeline to a full and productive life. Think of what they could contribute if they had greater opportunities.

America's Talent Imperative is to ensure we draw upon the strengths of all groups in science, engineering and technology. Innovation happens fast once all the pieces are in place." (*Page 2*)

BEST's Blue Ribbon Panel on Higher Education found common principles designed into the most successful programs it identified. They invite all stakeholders to "consider these as essential ingredients in any recipe for producing diverse talent for science and engineering:

# **BUILDING ENGINEERING & SCIENCE TALENT**

THE TALENT IMPERATIVE: MEETING AMERICA'S CHALLENGE IN SCIENCE & ENGINEERING, ASAP. 2004

### ESSENTIAL INGREDIENTS

#### Institutional leadership

 Leadership matters. Although passionate commitment to diversity may exist at any level of the campus, only commitment by the campus administration and senior faculty ensures that the values, goals and paths toward increased participation are essential to everyone's success.

#### Targeted recruitment

• Attracting the best available students and faculty from underrepresented groups is critical, but so is establishing and sustaining a feeder system from pre-K-12, undergraduate and graduate schools.

#### **Engaged faculty**

 The traditional markers of academic accomplishment, such as research productivity, do not replace ongoing commitment to diversifying successful student talent. Student outcomes are a critical measure of faculty performance.

#### Enriched research opportunities

 Extending research opportunities beyond the classroom, for example, by way of internships, connects students' experiences to the world of work, establishes mentors and presents career options.

#### Bridging to the next level

The path from grade school through university may be uneven for even the most privileged students. Successful programs to promote diverse student success build both the institutional relationships and the students' skills to enable them to progress through the educational system and envision career achievements.

#### Continuous evaluation

 Effective programs never stop asking basic questions about processes and outcomes: 'Are we doing the job?'" (Page 7)



Sources: U.S. Bureau of the Census, Current Population Survey, annual series; and U.S. Bureau of the Census, Projections of the Total Resident Population by 5-Year Age Groups, and Sex With Special Age Categories: Middle Series, 1999 to 2100, NP-T3, http://www.census.gov/population/www/projections/ natsum-T3.html

# Figure B: U.S. population 18-24 years old: July 1998 and projections to 2025

# THE NATIONAL ACADEMIES

RISING ABOVE THE GATHERING STORM: ENERGIZING AND EMPLOYING AMERICA FOR A BRIGHTER ECONOMIC FUTURE. 2005

### BACKGROUND

#### ►

The National Academies were asked by members of the U.S. Senate Committee on Energy and Natural Resources, with endorsement by Representatives of the House Committee on Science, to respond to the following questions:

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

H aving reviewed trends in the United States and abroad, the National Academies committee is deeply concerned that the scientific and technical building blocks of our economic leadership are eroding at a time when many other nations are gathering strength. They strongly believe that a worldwide strengthening will benefit the world's economy— particularly in the creation of jobs in countries that are far less well-off than the United States.

"History is the story of a people mobilizing intellectual and practical talents to meet demanding challenges. World War II saw us rise to the military challenge, quickly developing nuclear weapons and other military capabilities. After the launch of Sputnik in 1957, we accepted the challenge of the space race and landed twelve Americans on the moon and fortified our science and technology capacity.

Today's challenge is economic— no Pearl Harbor, Sputnik, or 9/11 will stir quick action. It is time to shore up the basics, the 'blocking and tackling' without which our leadership will surely decline. For a century, many in the United States took for granted that most great inventions were homegrown— electric power, the telephone, the automobile, the airplane— and were commercialized here as well.

We are less certain today who will create the next generation of innovations, or even what they will be. We know that we need a more secure Internet, more efficient transportation, new cures for disease, and clean, affordable, and reliable sources of energy. But who will dream them up, who will get the jobs they create, and who will profit from them? If our children and grandchildren are to enjoy the prosperity that our forebears earned for us, our nation must quickly invigorate the knowledge institutions that have served it so well in the past and create new ones to serve in the future.

The committee identified two key challenges that are tightly coupled to scientific and engineering prowess: creating high quality jobs for Americans and responding to the nation's need for clear, affordable and reliable energy." (*Pages 1-15 & 1-16*)

# **THE NATIONAL ACADEMIES**

RISING ABOVE THE GATHERING STORM: ENERGIZING AND EMPLOYING AMERICA FOR A BRIGHTER ECONOMIC FUTURE. 2005

### RECOMMENDATIONS

#### Talent Pool

 "Increase America's talent pool by vastly improving K-12 science and mathematics education." (Page 4-2)

#### Long-term Research

 "Sustain and strengthen the nation's traditional commitment to long-term basic research that has the potential to be transformational [in order] to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life." (*Page 4-2*)

#### **Attracting Students**

 "Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world." (*Page 4-3*)

"Although the committee was asked only to recommend actions that can be taken by the federal government, it is clear that related actions at the state and local levels are equally important for U.S. prosperity, as are actions taken by each American family." (*Page ES-7*)



# **BUSINESS HIGHER EDUCATION FORUM**

BUILDING A NATION OF LEARNERS. 2003

### BACKGROUND

#### ►

A nation of learners is one that effectively and efficiently helps students achieve proficiency in those basic, lifelong learning skills that transcend specific job categories. There is also a need to provide ongoing education and training tailored both to individual needs and workplace demands.

To increase the effectiveness of learning, educators must provide more engaging, relevant content targeted to individual styles of learning and needs. Although some institutions of higher learning are doing this, as illustrated in other reports cited throughout, solutions must be scaled to a wider range of learning environments.

To achieve change on the scale needed, BHEF, a coalition of leaders from American businesses, colleges, and universities, recommends a bold new commitment to the nation's learning future— the creation of a Presidential Commission on Learning, comprised of representatives from Congress, the private sector, education, state and local government, and the relevant agencies in the executive branch. **H** igher education must redesign itself to meet the learning standards of today's world. Education must be engaging, flexible, and interactive. Forward-thinking institutions that can lead the way must pioneer innovative new efforts and become champions of redesign and learning....

The Challenge by 2010:

- Every campus will have redesigned its coursework.
- Every student will have access to individualized and customized strategies for his or her specific education needs.
- Every classroom on every campus will have access to the online and off-line tools that students need.
- Every graduate will be assessed not only on his or her academic achievement, but also on his or her skills....

Lastly, this effort requires a massive new investment in technology infrastructure that will allow U.S. colleges and universities to scale these learning solutions to a broad expanse of learning environments..

[We propose] that Congress create new regional centers of learning excellence that can specifically focus on improving and redesigning learning by:

- pushing the frontiers of learning science with new research
- exploring the role that the latest technology advancements can play in providing more effective learning techniques...
- disseminating the best models and methods to higher education and other institutions to put them into practice....

[T]hese centers would bring together the brightest minds from academia, the private sector, and government to search for new ways to further increase the effectiveness of learning. The centers will need to constantly look for and work with the most innovative learning models that pioneering institutions are developing." (*Pages 27 & 30*)

### **BUSINESS HIGHER EDUCATION FORUM**

**BUILDING A NATION OF LEARNERS. 2003** 

KEY CHANGES			
BHEF has identified five key changes that can help redes to produce graduates prepared for the 21 <sup>st</sup> century. Thes	sign education se include:		
<ul> <li>"focusing education on the lifelong learning skills ar needed for a nation of learners</li> </ul>	nd attributes		
• creating content that is challenging, motivating, and	l relevant		
<ul> <li>encouraging learning through more interaction and individualization</li> </ul>			
<ul> <li>increasing opportunities and access to education</li> </ul>	Figure D: Percenta	age of 24-year-olds wit	th first university
<ul> <li>adapting objectives to specific outcomes and certifiable job-related skills.</li> </ul>	degrees in natural	l sciences or engineer recent year	ing, 2000 or most
Change cannot happen in a vacuum. An undertaking of this magnitude can happen only through committed leadership at the highest level. To meet these goals by 2010, federal leaders must rise to this challenge, refocusing existing education and training efforts, and creating the new policies, priorities, and programs that will transform the United States into a nation of learners." ( <i>Pages 15 &amp; 29</i> )	0 Finland France Taiwan South Korea United Kingdom Sweden Australia Ireland Spain New Zealand Japan Netherlands Canada Switzerland Georgia Italy Iceland Israel Germany United States Kyrgyzstan Norway Czech Republic		

Source: National Science Board, 2004. Science and Engineering Indicators 2004. Two volumes. Arlington, VA: National Science Foundation (volume 1, NSB 04-1; volume 2: NSB 04-1A). Appendix Table 2-35.

Belgium Hungary Austria

# AFTERWORD

- What are the characteristics of a successful innovator?
- What are the characteristics of a life-long learner?
- What are the characteristics of a contributing and productive participant in the 21<sup>st</sup> century workforce?

These questions need to be on the table as we move toward realizing the visions described in these several reports, as they direct our continuing attention to the student, to the people affected by the systems we are attempting to transform. These reports also suggest how to answer those questions, as they talk about ensuring that students have access to the kind of learning experiences that give them the ability to self-educate over a lifetime, the skills of defining and solving problems, an understanding of intellectual depth, the capacity to work in and lead teams, and the willingness to take on and the knowledge to manage risks.

This *Project Kaleidoscope Report on Reports II, 2006* can be one tool for advancing and informing discussions within schools, colleges and universities, within disciplinary societies and educational associations, and in national, regional, and local gatherings of citizens, policy makers, and business leaders. It is intended to remind those already committed of the continued urgency of this work, and to alert emerging leaders about the critical challenges and opportunities facing our society. This PKAL publication also provides a set of benchmarks against which each of us can measure our progress— if, how, and where we are making a difference.

The 2002 *Report on Reports* presents valuable perspectives on the past, present, and future of undergraduate programs in mathematics, technology, and the various fields of science and engineering.

For one, we see a remarkable consistency of vision in these seventeen years of reports— one that is not modest and that calls for more than tinkering around the edges. The vision is of an environment in which all American undergraduates have access to learning experiences that motivate them to persist in their studies and consider careers in these fields; it is of an environment that brings undergraduates to an understanding of the role of science and technology in their world. It is a vision that calls for attention to practices and policies that affect shaping the curriculum and building the human and physical infrastructure to sustain strong programs. It is a vision that calls for collective action.

—Project Kaleidoscope. Recommendations for Urgent Action in Support of Undergraduate Science, Technology, Engineering, and Mathematics. 2002

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<sup>1</sup> *Tapping America's Potential* is a collaboration between the following prominent business organizations: AeA, Business Roundtable, Business-Higher Education Forum, Computer Systems Policy Project, Council on Competitiveness, Information Technology Association of America, Information Technology Industry Council, Minority Business RoundTable, National Association of Manufacturers, National Defense Industrial Association, Semiconductor Industry Association, Software and Information Industry Association, TechNet, Telecommunications Industry Association, U.S. Chamber of Commerce

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### ACKNOWLEDGEMENTS

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Project Kaleidoscope is supported, in part, by the National Science Foundation under Grants #0314006, #0341516, and #0532090. Any opinions, findings, conclusions or recommendations expressed are those of the grantee and do not necessarily reflect the views of the National Science Foundation. http://www.nsf.gov/

roject Kaleidoscope began in 1989 with support from the National Science Foundation to outline an agenda for reform of undergraduate programs in science and mathematics. From the beginning, Project Kaleidoscope (PKAL) has taken a kaleidoscopic perspective, giving attention to all facets of the undergraduate learning environment— what is learned, how it is learned and where it is learned. PKAL's initial report, What Works: Building Natural Science Communities, was presented at the first PKAL colloquium at the National Academy of Sciences in 1991. Since that time, nearly 4,500 individuals from over 850 colleges, universities and professional organizations have participated in one or more of PKAL's NSFsupported workshops or other PKAL activities. A significant focus of PKAL is fostering leadership within undergraduate STEM. With support from the ExxonMobil Foundation, PKAL is identifying and supporting faculty with responsibility for leadership on their home campus and at the national level; there are over 1200 PKAL Faculty for the 21<sup>st</sup> Century, representing campuses across the country. Support for local leadership teams also comes through a consultant program supported by the W.M. Keck Foundation. The PKAL web site is a significant vehicle for dissemination about the work of all dedicated to building and sustaining a strong undergraduate STEM community in the service of students, science, and society.

Special thanks to: David F. Brakke, Dean of the College of Science & Mathematics— James Madison University; Judith A. Dilts, Associate Dean of the College of Science & Mathematics, Professor of Biology— James Madison University; James R. Gentile, President—Research Corporation; Melvin D. George, President Emeritus— University of Missouri; Daniel L. Goroff, Vice President, Dean of Faculty— Harvey Mudd College; Ishrat M. Kahn, Professor of Chemistry— Clark Atlanta University; C. Gary Reiness, Dean of Mathematical & Natural Sciences, Professor of Biology— Lewis and Clark College; Frank G. Rothman, Provost and Professor Emeritus— Brown University; J. B. Sharma, Professor of Physics— Gainesville College; Susan R. Singer, Professor of Biology— Carleton College; and Daniel F. Sullivan, President— St. Lawrence University.

Thanks to: PKAL DSEA\* colleagues James Brown, American Chemical Society; Amy Chang, American Society for Microbiology; Ida Chow, Society for Developmental Biology; Carla B. Howery, American Sociological Association; Mary M. Kirchhoff, American Chemical Society; Jay B. Labov, National Research Council; Susan Musante, American Institute of Biological Sciences; Abraham Parker, American Institute of Biological Sciences; Irelene P. Ricks, American Society for Cell Biology; Tina H. Straley, Mathematical Association of America; and Jodi Wesemann, American Chemical Society.

\*DSEA is the Disciplinary Society and Educational Association Alliance

#### And to:

- The National Science Foundation Directorate for Education and Human Resources—Division of Undergraduate Education, Directorates for Biological Sciences and for Mathematical and Physical Sciences, and Directorate of Social, Behavioral, & Economic Sciences—Office of International Science & Engineering.
- The ExxonMobil Foundation
- The W.M. Keck Foundation



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