

Sustaining our National Capacity for Discovery and Innovation

Presented by
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Thank you, Dr. McKinnell¹, for the kind introduction. I am honored to be here, **today**, to address this distinguished group of business leaders.

As a nation, we are in the midst of two struggles. One is an international struggle against terrorism, which most see as an acute threat. The other is a struggle for sustaining our national scientific and technological capacity. And, while we are fully engaged in the one, we have been ignoring the other, which is directly related to the former, and, ultimately, may prove to be the greater.

This is not a new issue. In February of 2001, the U.S. Commission on National Security/21st Century (the Hart-Rudman Commission) released the third of its reports, "Road Map for National Security: Imperative for Change." It made five recommendations. The first was ensuring the security of the American homeland. The second was "recapitalizing America's strengths in science and education." The commission said that while we have enjoyed the economic and security benefits of previous investments in science and education, we now have crossed a line and are "consuming capital". The commission states that a lack of commitment to science and education poses

¹ Henry A. McKinnell, Jr., Ph.D., Chairman of the Board and CEO of Pfizer Inc.; Chairman, Business Roundtable.

“a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine.”

In discussing the national challenges we face, I will make two key points. One is the criticality of investment in research. The second is the urgent need to invest in human resources — the talent pool — to assure that we have the scientists to make the discoveries of tomorrow.

Scientific discovery and technological innovation have driven economies for centuries. In recent decades, it has fueled our national economic prosperity, and is the primary source of our global leadership. Consider air transportation, atomic energy, jet and rocket propulsion, other space technologies, communications, television, computers, semiconductors, microchips, laser optics, fiber optics — developments which have revolutionized life today, have spawned new industries, and have provided the underpinning of our economy and global preeminence.

These developments are the **direct** result of funded research in science and engineering, **and** the development of human capital. Scientific and technological progress is not inevitable — it is not self-perpetuating. Its momentum must be sustained by a steady infusion of talent and of resources.

History demonstrates that we do not know where the most significant future breakthroughs will occur. When the transistor was invented in 1947, *The New York Times* reported only that the device might lead to better hearing-aids. Instead, transistors are essential to almost every system or device manufactured today — computers, cameras, cars, spacecraft, missiles, and more. These achievements, **themselves**, were further driven by the rise of computer science and greater computational capability brought about by the marriage of quantum science and micro-fabrication techniques to develop microprocessors, nanoscale devices, integrated circuits, and more. These advances resulted from the nation’s investment in basic research, and the scientific compact between the federal government and research

universities, dating back to the post-WW II period when Vannevar Bush proposed this coupling.

But, we are at a critical juncture with regard to our support of basic research in the sciences. The war on terror, the uneven economic expansion of the last three years, and the federal budget deficit have weakened government resolve to invest in basic research in science and engineering. This is happening just when we should be investing **more**—not **less**. As the lesson of the transistor shows, the scientific breakthroughs of today become the transformative technologies of tomorrow.

Moreover, broad funding is important because science and engineering have become **multidisciplinary**. Contemporary research leaps traditional boundaries, as once distinct disciplines necessarily inform each other in order to achieve new breakthroughs. Moreover, as multidisciplinary teams collaborate, it is **less** likely that a line of inquiry will result in a scientific **cul-de-sac**, and more probable that it will open up new avenues to explore.

If someone asked you to design more effective and sturdy armor for soldiers, would you begin by studying the manipulation of matter at the molecular level? Probably not. And **yet**, researchers in nanotechnology — the practice of manipulating matter at the atomic or molecular level — have made great strides toward developing strong protective clothing for soldiers, in the form of “dynamic armor” which can be activated quickly on the battlefield.

The possible military and security applications of nanotechnology also include new medical treatments which could make battlefield medicine swifter and more effective.

Already, scientists at Johns Hopkins University have developed a self-assembling protein gel which can stimulate biological signals to quicken the growth of

cells. Using a combination of cells, engineered materials, and biochemical factors, the gel can replace, repair, or regenerate damaged tissues.

Disciplinary walls also have tumbled in clinical medicine, where physicists continue to develop new sophisticated MRI technologies. Recently, researchers at Duke and Harvard developed methods of making MRI "movies," providing sequential images of blood moving through vessels, and air moving through the lungs.

To develop these techniques, physicists have collaborated extensively with medical researchers and doctors. Thanks to breakthroughs like these, doctors can make better diagnoses, using safer, noninvasive tools.

Transformative technologies do not come with instruction books for use. We rely on the energy and creativity of scientists in both the public and private sectors to develop the tools and applications which change our world. Sustaining our national capacity for innovation means preparing the ground for the **next** transformative technology, by investing — in research **and** in the talent to make it happen.

But, who will **do** the science in the 21st century?

A variety of converging demographic and social factors are creating circumstances which may **preclude** or compromise an answer to this question. I liken the emerging situation to "The Perfect Storm." Allow me to develop the metaphor.

The phrase, "The Perfect Storm" is associated with meteorological events of October 1991, when a powerful weather system gathered force and, ravaging the Atlantic Ocean over the course of days, caused the deaths of several Massachusetts-based fishermen, and billions of dollars of damage. The event became a book, and, later, a movie.

Meteorologists observing the event emphasized the **unlikely confluence of conditions** which constituted a worst-case scenario, where multiple factors converged into an event of devastating magnitude.

A similarly unfortunate confluence of circumstances could arrest our national scientific and technological progress. The forces at work are multiple and complex. They are demographic, political, economic, cultural, even social.

First, the scientific and engineering workforce of the United States is aging. Half of our scientists and engineers are at least 40 years old, and the average age of workers with science and engineering degrees is rising. As a recent National Science Foundation survey states, “the total number of retirements among science and engineering-degreed workers will dramatically increase over the next 20 years. This may be particularly true for Ph.D.-holders because of the steepness of their age profile.”

An older work force is one factor. World events, including the terrorist attacks of September 11, 2001, and resulting adjustments in federal immigration policy, constitute another. Since 2001, visa applications from international students and scientists to come here to study, and to work have dropped.

Faced with new hurdles to students from other nations are choosing to study elsewhere. In addition, improving global economies are offering young scientists more job options at home, or elsewhere, and fewer of them are coming here, or staying, for employment, after they graduate from U.S. universities.

A recent survey by the Council of Graduate Schools has shown that 90 percent of American colleges and universities have seen a drop in overseas applications for Fall 2004. The overall number is 32 percent lower than the year before. Indeed, 31 of the 32 graduate schools with the largest international enrollments saw their overseas applications fall. The reduction is greatest in engineering and physical-science programs.

Against **this** backdrop, fewer young Americans are studying science and engineering. Graduate enrollment in science and engineering reached a peak in 1993, and despite some recent progress, remains below the level of a decade ago.

Some developing, and **developed**, nations are harvesting the fruits of long-term, concerted efforts to increase **their** domestic participation in science and engineering programs at the university level. According to the National Science Foundation, of 2.6 million first university degrees in science and engineering granted worldwide in the most recent academic year, 1.1 million were earned by Asian students in Asian universities, 800,000 were granted in Europe, and 600,000 in the U.S. In engineering, specifically, universities in Asian countries now produce six times as many bachelor's degrees as their counterparts in the United States.

Moreover, the proportional emphasis on science and engineering is greater in other nations than in the U.S. Science and engineering degrees now represent 73 percent of all bachelor's degrees earned in China, 45 percent in South Korea, and 40 percent in Taiwan. By contrast, the percentage of those taking a bachelor's degree in science and engineering in the U.S. remains at roughly 33 percent.

Individually, each of these four factors — an aging work force, fewer international students, more opportunities for scientists and engineers around the globe, and the lack of interest in science among U.S. students — would be problematic. In combination, they could be devastating. For the first time in more than a century, the United States could well find itself falling behind other countries in the capacity for scientific discovery, innovation, and economic development.

Already we see some disturbing signs:

- ✍ The United States is losing its dominance in critical areas of science and engineering. The United States used to dominate in Nobel Prizes awarded to its scientists. That is down by a half.
- ✍ U.S. share of scientific papers published in major professional journals peaked in 1992, and has fallen by 10 percent.
- ✍ There has been a relative decline in the percentage of patents awarded to U.S. scientists, while Japan, Taiwan, and South Korea now reap one quarter of all **U.S.** patents.

The “Perfect Storm” need not unfold, however, if we draw on the talent extant in youth who traditionally have been underrepresented in science, engineering, mathematics, and technology. This means reaching out to minority youth and young women, who now comprise but a small portion of our scientists and engineers, yet in sheer numbers **together** comprise “the new majority” — the “under-represented” majority.

Consider this. In the last decade, the population of the United States grew from 249 million to just over 281 million. The non-Hispanic white population grew by roughly 3 percent, while the Hispanic population expanded by 58 percent, the Asian-American population by 52 percent, and the African-American population by 16 percent. The total minority population of the United States is now over 30 percent. When women are added to the mix, “the new majority” emerges.

Now, consider the demographics of higher education. By 2015, the nation’s undergraduate population will have grown by 2.6 million, with more than 2 million of those students being people of color. By 2010, more women than men will earn degrees at each stage of higher education, from associate degrees to Ph.Ds.

By contrast, the traditional science, mathematics, engineering and technology workforce is still nearly 82 percent white and 75 percent male. **Clearly**, there is a large demographic disparity between the scientific and technological workforce of the present, and the general college-educated population of the future.

To be sure, we have made some progress, but there is a long way to go. Women account for only 20 percent of college graduates who major in engineering. At the Ph.D. level, women are only 17 percent of those receiving an engineering degree, and only 24 percent of those receiving degrees in mathematics and computer science. This is well short of the level of participation we need in order to **replace** those who are retiring from our scientific workforce.

To arrest the “Perfect Storm,” identifying and analyzing the issue is a **first** step. But, we need a full-fledged **national** commitment to invest in research in science and engineering, to re-ignite the interest in science and mathematics of **all** of our young people, and to identify, nurture, mentor, and support the talent that resides in our “new majority” population. But, how do we encourage talented students to commit themselves to the sciences as early as middle school, to stay the often difficult course through high school? To find the means to attend the university, and continue through post-graduate work? To transition into the workplace, the laboratory, the design studio?

Some incentives necessarily must be financial. President Bush recently has voiced his approval for Pell Grants that especially aid low-income students entering the sciences. I would welcome an even more complete extension of this approach. This would require more economic support for such students, but also support for a broader socio-economic range of students (of all ethnic backgrounds), and at all educational levels, through graduate school (an example could be patterned on portable NDEA-like fellowships for graduate study in science and engineering).

Many of the corporations represented in this room, today, have programs in place which already are making a difference. Corporate foundations support education programs and participate in community mentoring, education, and employment efforts. Corporations provide job opportunities for scientists and engineers in research, design, and manufacturing, here and around the world. And, industry invests in collaborative initiatives with institutions of higher education in research and development and, also, help to identify and to support talented young scientists and engineers, and to foster their careers.

This spring, Business Roundtable President John Castellani discussed member company programs in testimony before the U.S. House of Representatives' Committee on Education and the Workforce. He discussed a Texas Instruments plan to build a \$3 billion semiconductor manufacturing facility to benefit research and development efforts at the University of Texas, and the United Technologies Employee Scholar Program, which rewards U.S.-based employees who complete an advanced degree with up to \$10,000 in stock.

He also noted the importance of partnerships such as the FedEx Institute of Technology at the University of Memphis, which houses a public-private collaboration for research focusing on breakthroughs in cancer, alcoholism, and artificial intelligence.²

But, while U.S. companies invest more than \$70 billion in job training, Mr. Castellani explained to legislators, that it will do little good to have American businesses compete successfully in the worldwide marketplace and to create good jobs at home if we do not have the scientists and engineers to fill them. Likewise, it will do little good to have our schools and universities produce highly educated graduates if companies are not creating jobs for those graduates to fill.

The U.S. government, trade associations, and a variety of other organizations are funding many programs which partner the public and private sectors to address the issues. Two years ago, the National Science Foundation and the U.S. Department of Education launched the Mathematics and Science Partnership Program, which helps to support needy school districts, which are implementing cutting-edge programs to improve teaching and learning in our K-12 public schools. Each program is the collaborative effort of one or more institutions of higher education, school districts and, frequently, regional and local corporations. These programs touch hundreds of thousands of students each year. The business component of these partnerships is

² Castellani testimony, March 11, 2004, available on Business Roundtable Web site.

critical, as it provides internship and mentoring opportunities, which is just as important for teachers as it is for students. Many teachers in advanced subjects find it difficult to keep up with the latest developments without business involvement.

Where can we go from here? What road map can we follow? What more do we need to do? For recommendations, I would look, first, to BEST—Building Engineering and Science Talent, a public-private partnership, dedicated to building a stronger, more diverse workforce in the science, engineering, and technology fields. BEST recently coordinated three high-level, blue-ribbon panels to identify the best practices for increasing the participation of women, under-represented minorities, and persons with disabilities in these fields at three critical points—pre-K-12, higher education, and the workplace.³ I was honored to lead the higher education panel. Representatives of several Business Roundtable corporations also participated, including leaders from Hewlett-Packard, IBM, Lockheed Martin, Merck, and Pfizer. Many of us here today have a stake in making these recommendations become a reality.

BEST examined the efforts undertaken by a range of U.S. corporations throughout the 1990s to improve the diversity of their workforces. Today, more than 75 percent of Fortune 1000 companies and 36 percent of all companies have formal diversity programs.⁴ The report found four guiding principles which comprise a successful diversity effort:

First, a sustained commitment to change. Only a comprehensive effort which is ultimately embraced at all levels—from the bottom up, as well as the top down—is likely to bring about change which will endure beyond the tenure of a particular CEO. Lockheed Martin's Executive Diversity Council is chaired by its president and chief operating officer. It supports 33 local diversity councils in each of its operating units, which write their own charters aligned with the corporate diversity vision.

³ "A Bridge for All..." BEST February 2004

⁴ Ibid.

Second, integrating diversity into organizational strategy. Creating real change requires framing a compelling business case for diversity and integrating it into an organization's mission, strategy, operating structure, and culture. For example, Ford Motor Company links its diversity initiative to improved customer service. Ford diversity leaders say "complex problems can best be solved by cross-functional teams, and that people who work, live, and learn in integrated settings develop stronger interpersonal communications and negotiating skills."⁵

Third, management accountability. Organizations which succeed at diversity programs tie rewards for managers, such as merit pay and bonuses, to their personal achievement of diversity goals. Metrics frequently include promotion rates, pay equity, and representation of the underrepresented majority among new hires, in every operating unit, and within the applicant pool.

Fourth, continuous improvement. As with any successful organization-wide effort, continuous improvement is a critical factor and begins with internal benchmarking to determine what already is working and what can be improved. They, then, study the efforts of other similar organizations, and develop specific and practical solutions tailored to their unique environments.

One recommendation from BEST struck me as particularly appropriate for this audience. BEST suggests that the federal government create a national-level award program, modeled after the Malcolm Baldrige Award, to reward and encourage innovative practices in building the science and engineering workforce. The Baldrige Award has demonstrated that recognition programs can create powerful incentives for organizational change.

⁵ Ibid.

As you know, companies that compete for the Baldrige Award undergo a relentless process of self-scrutiny—analyzing their missions, goals, strategies, processes, and implementation efforts within every pocket of their organizations. The effort of trying to win a Baldrige Award has transformed many corporations from good to great. BEST recommends that the science and engineering version of this national award should evaluate organizational performance with regard to diversity based on a number of critical success factors. These include: institutional leadership and commitment; strategy development and implementation; work systems that enable scientists and engineering employees to achieve high performance; the quality of organizational metrics and systems of accountability; and finally, the levels of job satisfaction for science and engineering workers.

Developing new talent in science and engineering also will require finding new ways to teach. We must educate our students to work **between** disciplines, in order to reach new innovative aspects of science, engineering, and technology.

We must examine pedagogical approaches and learning styles. We must understand the cognition patterns of students who grew up on VCRs, MTV, video games, and instant messaging, and devise ways of organizing pedagogy to enable them to use their skills and perspectives in yet more creative ways. Information technology can take us beyond classroom walls, offering students the kind of interactive, experiential learning to which they have become habituated, in ways which enhance their analytical abilities and specific knowledge.

Simulation of physical phenomena, gaming technology, tele-presence and tele-immersion — the ability of geographically dispersed sites to collaborate in real time — all are pedagogical tools that can help us in this task.

The diversity of "the new majority," is more important than one might realize, not only because this is where the talent of the future resides, but because diversity is a valuable asset in and of itself.

It is no accident that for, perhaps, 150 to 200 years the United States has been a global leader, or that this nation has been the source of so much that is visionary, transformative, new.

Immigrants — new Americans — coming for decades to our shores, from all parts of the globe, brought (and, still bring) with them a unique determination to improve their lives and an eagerness to participate, and to contribute. Here, they have pooled their vastly differing talents, wide experiences, unique ideas, differing perspectives, and distinct cultures. This diverse mix, this great “smelting pot,” has been the crucible from which has poured a great array of world-changing discoveries, innovative technologies, life-sustaining initiatives, transformative ideas.

A profitable alloying does not occur in isolation. **Valuing** diversity is a requirement. Corporate America already has embraced diversity as an essential asset, not only as good business in a competitive global marketplace, but also to produce the vanguard of creative ideas and innovative discoveries they must have to remain competitive.

We **now** need the leaders of business and industry to raise the visibility of the quiet crisis at top management forums and roundtables, like this one, **and** with our political leaders. We must refresh the social compact which Vannevar Bush proposed in his report to President Harry S. Truman, entitled “Science the Endless Frontier,” nearly 60 years ago. That compact, between government and the scientific community, led to the golden age of research and innovation which produced the economic security, military strength, medical and pharmaceutical advances, and the prosperous life style our nation enjoys today.

We need public and private sector partnerships directed at solutions, not just in the boardroom, but at **every** level of government, business, and education.

The United States has all the essentials needed for continued success—elements which have sustained us for decades:

- ~~✍~~ We have the most sophisticated educational system in the world.
- ~~✍~~ We have a well-developed science infrastructure.
- ~~✍~~ We have a financial system providing ready access to venture capital and a long tradition of investment in entrepreneurial projects.
- ~~✍~~ We have government structures designed to support and invest in the scientific enterprise, and government policies which encourage investment and entrepreneurship.
- ~~✍~~ We have a history and tradition of collaboration between the public and the private sector.
- ~~✍~~ We have a thriving, diverse culture of risk takers—a culture tailored to innovation, where a variety of ideas are welcomed and viewpoints sought.
- ~~✍~~ We have a long history of taking great risks for great rewards.

We cannot take these advantages for granted. We cannot expect that we will necessarily **forever** remain **THE** predominant player in the world. But we **must** remain **A** (if not **THE**) predominant player. This will rest upon all the advantages we now enjoy, but it fundamentally will rest upon people.

We need **strong** leadership to engage our national will, creating a national strategy to address the competitiveness of our national science and engineering enterprise. We need **collaborative** leadership to make sustainable change across the spectrum of systems including K-12 education, higher education, and the corporate workplace. We need **committed** leadership to engage governments at each level—federal, regional, state, and local—to **embrace** a national strategy to seek out the talent pool within the new demographics, **and** to find new ways to ignite the wonder and excitement of discovery in our youth to foster their interest in and commitment to the challenge of becoming a scientist or engineer, and to provide the means for them to achieve their dreams.

Ours is a history which gives us much to draw upon and which tells us that we did this before, and we can do it again.

Thank You.

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