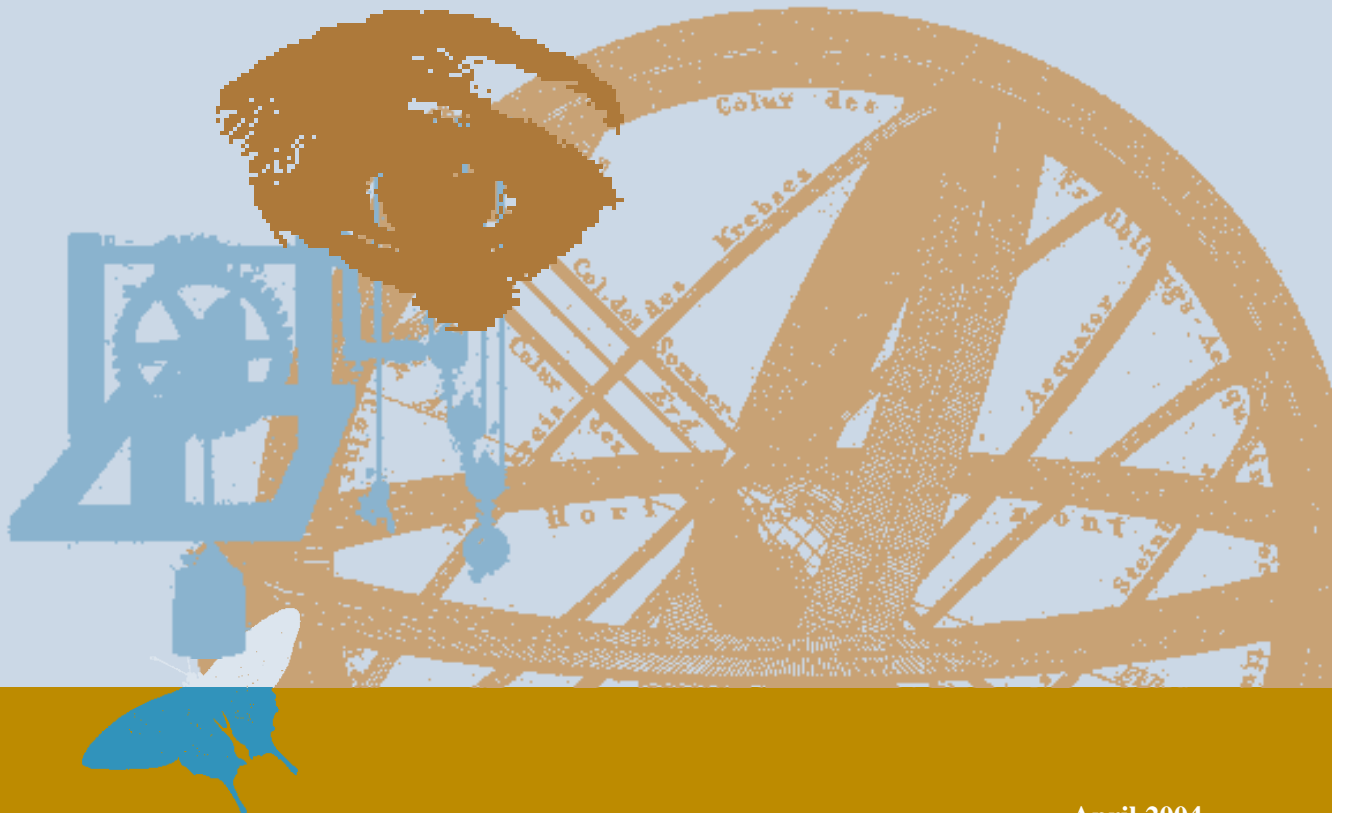




The Talent Imperative:

Diversifying America's Science and Engineering Workforce



April 2004



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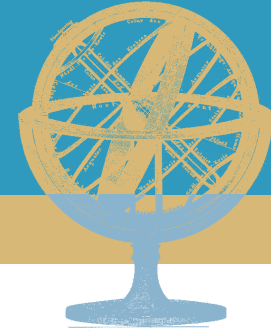
The national interest now calls for a far more robust effort to recruit and train a scientific and engineering workforce that reflects America's new demographic realities.



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 underrepresented groups.

This report is dedicated to the memory of Dr. Barbara Lazarus, a pioneer in the field of diversity research whose courage and optimism inspired all who knew her.





About BEST

BEST, an initiative of the Council on Competitiveness, was established as an independent, San Diego-based 501 (c)(3) organization in September 2001 at the recommendation of the Congressional Commission on the Advancement of Women in Science, Engineering, and Technology. Our mission is to spur action to build a strong, more diverse U.S. technical workforce. The nation's scientists, engineers, mathematicians and technologists comprise an indispensable strategic asset. Despite decades of effort, however, this pool of talent remains about three-quarters male and four-fifths white. The talent imperative we face is to prepare, attract and retain a larger share of all of our citizens in the technical fields that underpin U.S. economic strength, national security and quality of life.

BEST's objective has been to build a foundation for action through a two-year net assessment of best practices in pre-K-12, higher education and the workplace to increase the participation of women, African Americans, Hispanics, Native Americans and persons with disabilities in the science, engineering and technology professions. Three blue-ribbon panels have worked in parallel across the whole continuum of education and workforce development with the guidance and support of BEST's Board of Directors, National Leadership Council, Research Board and Project Integrators who are listed on the inside front and back covers of this report.

Based on available research evidence and the professional judgment of 120 nationally recognized practitioners and researchers, the assessment:

- Makes the case for national action to meet the U.S. talent imperative;
- Rates pre-K-12 programs that have research evidence of effectiveness or are worthy of investment in further research;
- Analyzes higher education and workplace exemplars;
- Distills the design principles that underpin effective programs; and
- Proposes an action agenda at the national and community levels engaging employers, educators, policy makers, professional societies and nonprofit organizations.

BEST will report its findings and recommendations to members of Congress in the spring of 2004.



401 B Street, Suite 2200
San Diego, CA 92101
(619) 615-2940
www.bestworkforce.org



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Acknowledgments

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Executive Summary

The Challenge for America's Workforce

America faces a talent imperative in science, engineering and technology that requires far more urgent public attention than it has received. The challenge is to prepare all of our citizens for opportunities in the technical fields that underpin U.S. economic strength, national security and quality of life. Creating a science and engineering workforce that looks like America will bring diverse perspectives to the drive for creativity and innovation, open vast new areas of economic opportunity for all of our citizens and better prepare the U.S. to meet the challenge of foreign competition.

The nation's scientists, engineers and technologists comprise an indispensable strategic asset. Although their numbers are small, their impact is enormous. The advances in technological innovation which they drive account for over half of U.S. long-term growth during the past 50 years.

For all its strength, the human resource base of U.S. innovation lacks bench-strength and diversity. Half of the technical workforce is over 40 and almost one-third of technical workers are over 50. Despite decades of effort, this workforce remains over 75 percent male and 80 percent white. A successor generation has shown declining interest in key fields — including mathematics, computer science, physical sciences and engineering — upon which future technological progress depends.

Meanwhile, the foreign-born share of the U.S. science and engineering workforce has jumped from 11.2 percent in 1980 to 19.3 percent in 2000. A common sense look at the surge in production of international talent and our growing reliance upon it — both off shore and at home — may point to a less secure, less prosperous future for all Americans unless we act decisively to develop and utilize our own human capital.

The national interest lies in producing a pool of homegrown technical talent that can reliably meet the long-term needs of the U.S. innovation enterprise by cultivating a much larger share of talent from underrepresented groups women, African Americans, Hispanics, Native Americans and persons with disabilities. Quantitatively, the largest numbers of future U.S. workers are concentrated in these groups. Qualitatively, a strong business case exists for inclusion: diversity creates a richer, more productive innovation environment.

The changes needed to broaden the base of the U.S. technical workforce are national in scope and generational in character. They encompass the foundational skills developed in pre-kindergarten through 12th grade, higher education, the workplace and the popular image of science and engineering careers. The challenge cannot be met one sector or one organization at a time.

Employers have a critical role to play to ensure the U.S. has the world's most talented, highly skilled and diverse technical workforce. Their full engagement and leadership is essential at all stages

of the science and engineering "pipeline." Their workplace policies and practices will determine whether underrepresented groups participate fully or remain at the margins in technical fields. Their commitment to developing a stronger, more diverse educational supply chain will make a telling difference. Bold action, the commitment of significant resources and accountability for results will be needed to ensure the United States meets the talent imperative.

The Stakes

The "quiet crisis" in developing and deploying American technical talent has not yet hit home with full force. Our economy has remained a location of choice in an increasingly integrated global economy, producing products and services that command a premium in the marketplace and support the world's highest standard of living. Looking forward, however, growing numbers of countries are on course to challenge U.S. technological dominance. The relentless move up the technological ladder has put the U.S. science and engineering workforce under the same competitive pressure that less skilled American workers have already faced.

Until a few years ago, the prospect that American firms would outsource large numbers of high-end, knowledge-intensive jobs serving the U.S. market seemed remote if not unthinkable. Now the calculus is changing. Pressures on the bottom line have triggered growing reliance on off-shore science and engineering options not merely as complements to, but also as substitutes for, U.S.-based operations.

The risks of inaction are high. While it is difficult to predict how labor markets will respond to U.S. demand for technical talent a decade or more from now, there will be a replacement need to fill the shoes of the current technical workforce, a structural need for talent in sectors where technological opportunities and demand for skilled workers are high, and a competitive need to sustain U.S. global leadership in innovation. Our failure to act on the talent imperative could:

- erode national innovation capabilities,
- increase the migration of high-wage science and engineering jobs overseas,
- dislocate the economy if inflows of international talent are reduced, and
- undercut public support for U.S. research and development.

Barriers to Progress

There is no one-size-fits-all explanation to an imbalance that has persisted in our nation's technical workforce, even as the overall workforce has become steadily more diverse in gender, race and ethnic composition. Those who stay away from science, engineering and technology, either by default or by choice, vary widely in background, life experience and income. In the final analysis, how-

Employers have a critical role to play to ensure the U.S. has the world's most talented, highly skilled and diverse technical workforce.

ever, two interlocking sets of barriers limit the participation of all underrepresented groups.

Upstream barriers in pre-K-12 and higher education thin the pool of workforce entrants. Most of this thinning occurs by the end of high school. The factors that remove students in droves from the pre-K-12 science and engineering feeder system — especially girls and underrepresented minorities — are widely recognized. They include unequal learning opportunities, social and cultural constraints, negative stereotypes of scientists and engineers, and a shortage of role models enabling students from underrepresented groups to see possible future selves in technical careers.

The process of weeding out continues in higher education, especially in the physical sciences and engineering. Selective recruiting, limited faculty commitment to teaching, lack of peer support, social bias and insufficient financial resources all have a differential impact on students from underrepresented groups. African American, Hispanic and Native American undergraduates leave technical fields in disproportionate numbers, while their ranks at the graduate level are miniscule. Women have increased their share of undergraduate and advanced degrees in technical disciplines, but the focal point of their interest continues to be the life and behavioral sciences. Their numbers in the workforce have actually declined in such high-potential fields as computer sciences.

Workplace barriers affect the hiring, retention, advancement and compensation of workforce entrants from underrepresented groups who opt for technical careers and seek to stay the course. Those who persist are shortchanged on virtually every measure of workplace success. Women and underrepresented minorities earn less, change jobs more often, advance more slowly and have less influence than white male counterparts in technical fields. These outcomes reflect a legacy of exclusion that runs deep. In today's context, the workplace environment that restricts the chances of underrepresented groups of getting a job, being retained and getting promoted is widely known as "the chilly climate."

The same core factors lower the temperature in industry, academe and government. Micro-inequities undermine an individual's sense of confidence in subtle, frequent and ordinary ways, often taking hold where target groups feel vulnerable. Social and cultural norms of the workplace may fail to accommodate the needs of women, underrepresented minorities and persons with disabilities.

Upstream and workplace barriers cannot be overcome in isolation. At the same time, transformational changes in the workplace will not occur without a greater inflow of technical talent from underrepresented groups. The end users of America's talent pool share responsibility for leadership in opening up the opportunity structure across the board. Therefore, science and engineering (S&E) employers must put their own houses in order by implementing effective diversity programs. They must reach beyond the boundaries of their own organizations to adopt business practices that encourage their partners and suppliers to make the same commitment. In sum, employers must support and invest in a stronger educational supply chain to produce the quality and quantity of workforce entrants needed to sustain U.S. technological leadership.

Exemplary Principles and Practices

The starting point for employers is a clear understanding of what it takes to make inclusiveness a norm rather than an exception in the S&E workplace. Today, more than 75 percent of Fortune 1000 companies, and 36 percent of all companies, have formal diversity programs, most started during the 1990s. The majority of federal agencies have such programs, and growing numbers of universities have begun to evaluate gender and racial/ethnic equity in faculty hiring and promotion.

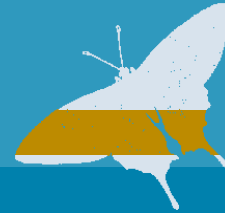
BEST's expert panel wished to look beyond these "average" programs, to identify and study the relative handful of science and technology-based organizations that have been nationally recognized for adopting exemplary policies and practices. Since publicly funded research on these efforts is virtually nonexistent and data are often tightly held in today's legal climate, the panel turned to diversity-related awards and "best to work for" lists to identify exemplary principles and practices. While these sources are by no means conclusive, they do provide some third-party validation of program effectiveness.

Starting with a systematic review of these sources, BEST's expert panel identified a pool of candidate exemplars and distilled from them a common set of design principles and implementing practices. These collective judgments, based on a wealth of professional expertise and personal experience, provide a strategic roadmap for implementing best practices.

Four fundamental principles underpin the headway that exemplary science and technology-based organizations have made in making diversity a norm in the workplace:

- **Sustained commitment to change.** Exemplary organizations seek lasting change through a comprehensive effort that starts at the top, but is ultimately embraced at all levels. The measure of sustained engagement is whether it lasts beyond the tenure of a particular CEO, university president or laboratory director.
- **An integrated organizational strategy.** Exemplary organizations recognize that stand-alone initiatives do not succeed. Instead, they make diversity a seamless part of the organization by incorporating the business case for diversity into the organization's mission, strategy, operating structure and culture to make it a seamless part of the institution.
- **Management accountability.** Exemplary organizations hold line managers at all levels personally accountable for meeting diversity objectives. They do so by setting high expectations, applying clearly defined metrics and rewarding outstanding performance.
- **Continuous improvement.** Exemplary organizations adopt regular cycles of planning, execution and evaluation of progress. In addition to hard metrics, many use employee surveys, focus groups, and personal interviews to determine what is working and identify problem areas.

These design principles comprise a package. Their impact hinges on strategies of implementation that enable an organization to earn a reputation as an employer of choice for persons from



underrepresented groups. Such employers demonstrate their commitment to S&E excellence and diversity not only through their recruiting, retention and advancement practices, but also by reaching beyond their own boundaries to pursue the goal of broader participation.

Organizations with exemplary **recruiting practices** create a competitive advantage by investing in long-term relationships with institutions that serve women, minorities and persons with disabilities. They also align the recruiting function with the responsibility and accountability of line managers with specific hiring needs.

Best-in-class **retention practices** strive to create an open and inclusive work environment through transparent policies and procedures; equity in compensation and promotions; employee affinity groups that provide networking, career development and support; and work-life programs that accommodate family needs.

Best practices in **career development and advancement** level the playing field for underrepresented groups through mentoring, formal training and development programs, early identification of high-potential employees and growth opportunities within the organization.

Exemplary **outreach** extends the commitment to science and engineering workforce diversity by influencing other organizations and building capacity in the educational supply chain. Effective initiatives recognize the value of community-based partnerships, apply leverage strategically and focus on results.

Recommendations

If the United States is going to meet the talent imperative, there is a pressing need to replicate and expand the strategies and programs that are most effective. Industry, government, academe and nonprofit employers must be fully engaged to move beyond piecemeal and uncoordinated efforts to achieve transformational change.

The key to driving change on a national scale is the creation and maintenance of appropriate incentives. We thus recommend a mutually reinforcing set of four mechanisms that can be employed by a coalition of government, business, and university networks.

1. A leadership commitment to excellence and inclusiveness in the U.S. science and engineering workforce, in the form of a standardized pledge along the lines of the Sullivan Principles.

A successful national initiative must start with visible leadership from the top. Signing a pledge to support S&E workforce excellence — and following up that pledge with concrete action — will send a powerful message within each workplace, and to other employers and key stakeholders involved in S&E education and workforce development. To encourage leaders in industry, academe, government, and science and technology nonprofit organizations to make a public commitment to diversity, the Workforce Panel has developed the BEST Leadership Commitment to Excellence Pledge.

2. A workforce leadership network to persuade others to take action and to provide a venue for sharing best practices.

A highly visible effort is needed to widen the circle of organizations committed to meeting the talent imperative. A workforce leadership network — composed initially of those diversity leaders who commit to the BEST Leadership Pledge — can play a vital role in persuading others to act by sharing their knowledge and successful practices with, peers, customers, suppliers and other stakeholder groups.

3. Well-documented workforce development toolkits, which encapsulate state-of-the-art, research-based best practices in a form that is readily budgeted, adopted and measured.

National models of S&E workplaces that are open and inclusive should be developed and made widely available to public and private employers of all sizes. Professional societies or other nonprofit organizations should act as honest brokers to provide employers with effective tools and the information necessary to implement successful S&E diversity programs.

4. A national workforce excellence award, modeled on the Malcolm Baldrige Award, to recognize innovative practices and achievement in technical workforce development and diversity.

The success of the Malcolm Baldrige Award demonstrates that award programs can create powerful incentives for transformational change within organizations. A national-level award for commitment to S&E workforce excellence and diversity could have a comparable national impact. Like the Malcolm Baldrige award, the National award should be based on objective, measurable criteria that evaluate organizational performance on critical success factors.



Chapter 1



The Talent Imperative

Meeting America's challenge in science and engineering

If this nation is to thrive—economically, socially, politically—we must do all we can to ensure that all of our citizens are able to reach their full potential. Only then will we realize the full benefits to be found in a society peopled with different cultures, races and nationalities.

Charles M. Vest¹
President, MIT

The nation's pool of scientists, engineers, mathematicians and technologists comprise a strategic asset in which every American has a stake. Their numbers are small — about five percent of a total U.S. workforce of 132 million — but their brainpower and innovation are indispensable. Some focus on creating knowledge, while others translate this knowledge into new products, services and technologies. Resulting advances in innovation account for over half of U.S. long-term growth during the past 50 years.² Their work underpins our prosperity, national security and quality of life.

The reservoir of technical talent that counts for so much has taken decades to develop. It represents perhaps the single most important U.S. investment in human capital, with a yield dispersed across every sector of the economy and every region of our country. With good reason, America's capacity to produce technical talent is the envy of the world.

For all its strength, however, the human resource base that drives American innovation lacks depth and diversity. The nation's aging technical workforce draws from a narrow and decreasing segment of the U.S. population. A successor generation has shown declining interest in pivotal fields including mathematics, computer sciences, physical sciences and engineering itself. The nation's reliance on foreign-born talent — both at home and abroad — has increased dramatically in the past two decades.

These troubling trends, building gradually over many years, have produced a "quiet crisis" in the development of technical talent.³ The crisis stems from a cumulative failure to meet the country's demand for scientists and engineers from its emerging demographics, but it has remained quiet because American has yet to feel the pinch. A reckoning is bound to occur, however, due to the confluence of demographic change in the U.S. student population and our not keeping pace with a surge in international science and engineering (S&E) capacity. When this time comes, which could be less than a decade away, there will be no quick fix upon which to rely.

America's talent imperative is to attract and academically prepare a larger share of all of our citizens for science and technology careers. Above all, the nation must nurture, develop and utilize the women, minorities and persons with disabilities who comprise a majority of U.S. workers, but who make up a disproportionately small segment of the nation's current technical workforce.

The Persistent Underrepresented Majority

Several powerful forces are reshaping the U.S. workforce as a whole. Their day-to day impact is scarcely apparent, but their cumulative effect over the past two decades has been profound.

- Women are reaching higher levels of education and are participating in the workforce at higher rates than ever. From 1980-2000, women emerged as the clear majority pursuing bachelor's degrees, and accounted for more than half of the growth in the post-high-school-education workforce. At the same time, their share of total employment increased from 42.4 percent to 46.5 percent.
- The aggregate minority population is growing explosively. Led by a surge in Hispanic communities, it almost doubled from 1980-2000. This demographic wave has begun to hit secondary and higher education. African American high school graduates increased from 11.7 percent to 14.7 percent and Hispanic graduates from 4.2 percent to 10.9 percent, while total minority enrollment in higher education — including Asian Americans — jumped to 27.2 percent.
- The white non-Hispanic population remains the slowest-growing demographic component, increasing by 7.9 percent during from 1980-2000. During that period, the enrollment of white males at institutions of higher education declined from 39.5 percent to 30.3 percent.⁴

The convergence of these forces has produced an increasingly diverse workforce that today is comprised of about 40 percent white men, 35 percent white women and 25 percent minorities.⁵ The Hudson Institute projects that in 2020, the U.S. workforce will be 50 percent female and 31 percent minority.⁶

The changing composition of both the population and the total workforce is sharply at odds with a predominantly white male workforce in science, engineering and technology. Table 1-1 displays breaks down the percentage of the U.S. population and the technical workforce by gender, race and ethnicity in 1999 (the latest year for which data are available). It shows that white men made up almost twice as great a share of the S&E workforce as they do of the population, while white women are underrepresented in technical fields by about 50 percent. The underrepresentation of African Americans and Hispanics is even more pronounced: African Americans comprised 12 percent of the U.S. population, but held only 3.4 percent of the S&E jobs in 1999. Hispanics made up nearly 12 percent of the U.S. population in 1999, but were only 3.4 percent of science and engineering employment. Moreover, these demographic imbalances scarcely changed during the technology boom years of the 1990s.

Table 1-2 gives a more complete picture of underrepresentation, benchmarking participation in broad technical fields against the overall workforce. To summarize:



**Table 1-1
Percentage of the U.S. Population and the S&E Workforce
by Sex, Race/Ethnicity, 1993-1999**

Sex and Race/Ethnicity	Percentage of the U.S. Population		S&E Workforce	
	1993	1999	1993	1999
White men	36.3	35.2	66.2	63.2
White women	38.1	36.7	18.4	18.6
Asian men	1.6	1.8	6.9	8.4
Asian women	1.6	2.0	2.1	2.6
Black men	5.6	5.7	2.3	2.1
Black women	6.3	6.4	1.2	1.3
Hispanic men	5.0	5.8	2.1	2.4
Hispanic women	4.8	5.7	0.7	1.0
Native American men	0.3	0.4	0.2	0.2
Native American women	0.4	0.4	0.1	0.1

Source: CPST, data derived from U.S. Census Bureau and National Science Foundation

Note: Totals may not add to 100 due to rounding

- Women, who comprise almost half of the college-degreed workforce, make up less than 25 percent of the science and engineering workforce, regardless of ethnicity or race. They are most fully represented in the life sciences, but account for just 23 percent of physical scientists and 10 percent of engineers.
- African Americans and Hispanics both participate in the science and engineering workforce at rates far below their participation in the overall workforce. The participation of African Americans is highest in computer and mathematical sciences, while that of Hispanics is highest in engineering.
- Native Americans participate in the S&E workforce at a rate of one-third of their representation in the U.S. population. Native Americans are concentrated primarily in social

sciences, making up 0.3 percent or less of science and engineering professionals in other fields.

- Asians make up the largest ethnic group in science and engineering, comprising 11 percent of the workforce. Their largest representation is in computer-related fields and mathematics, followed by engineering. The majority of Asians in S&E occupations are male.
- Persons with disabilities, who make up about 20 percent of the population, are significantly underrepresented in technical professions despite advances in adaptive technology that could enable them to participate.

The nuances behind these numbers are important. African Americans and Hispanics

are underrepresented in the technical workforce even relative to their already small share of the pool of college-educated workers. The near-term outlook for increasing the numbers of African American, Hispanic and Native American advanced degree holders looks grim.

At the graduate school level, although minority enrollments have increased during the last decade, the numbers are still dismally low. For African Americans, Hispanics and Native Americans, fewer than 100 of each group received doctorates in science and engineering fields in 2001. During the period from 1981 to 1999, the top 10 Ph.D.-producing institutions graduated fewer than 100 African Americans and fewer than 200 Hispanics per institution during that time.⁷


The outlook is somewhat more encouraging for women, who increased their share of baccalaureate degrees in almost every broad field of science and engineering during the 1990s and earned

**Table 1-2
Proportion of Employed Scientists and Engineers in the U.S. by
Broad Occupation, Race/Ethnicity, Sex and Disabilities, 1999**

Sex, Race/Ethnicity and Disabilities	Total Occupations	All S&E Occupations	Computer/Information Scientists	Life & Related Scientists	Physical & Related Scientists	Social & Related Scientists	Engineering
White men	39.9	63.2	59.1	53.9	66.3	40.4	74.7
White women	34.8	18.6	19.7	29.5	18.5	46.1	7.2
Asian men	2.0	8.4	9.7	6.5	6.5	2.1	10.2
Asian women	1.8	2.6	3.9	4.5	2.8	2.0	1.3
Black men	4.9	2.1	2.4	1.1	1.9	1.8	2.1
Black women	5.9	1.3	1.8	0.8	1.0	2.9	0.6
Hispanic men	5.9	2.4	2.2	1.8	2.0	1.4	3.2
Hispanic women	4.2	1.0	1.0	1.4	0.6	2.8	0.4
Native American men	N.A.	0.2	0.1	0.3	0.2	0.3	0.3
Native American women	N.A.	0.1	0.1	0.1	0.1	0.1	0.0
Persons with disabilities	0.7	5.8	5.8	5.5	5.5	N.A.	5.9

Source: CPST, data derived from National Science Foundation, SESTAT and U.S. Census Bureau, Current Population Survey, March 1999, and NSB, 2002

Note: Totals may not add to 100 due to rounding.



The U.S. science and engineering workforce now feels the same kind of competitive pressure their colleagues in the manufacturing sector have felt since the 1960s.

almost 40 percent of the Ph.D.s in those fields in 2001. Still, much larger numbers of women have chosen life sciences over engineering and physical sciences. In the field of computer sciences, where demand is projected to grow much faster than other occupations, the number of women has actually declined from its high in the mid-1980s.⁸

In a nutshell, the United States is not on course to produce a future cadre of scientists and engineers that look like America. Although many committed organizations and individuals have worked for years to change the trajectory of underrepresentation, progress has been painfully slow. To remain on this course could imperil our economic and national security.

The Risks of Inaction

What are the risks in failing to meet the talent imperative? The dangers arise from global changes that have created great opportunities, but also subjected the U.S. economy to intense competitive pressure. Worldwide economic integration has brought more than two billion new consumers into the global marketplace, while at the same time opening up a stunning range of new choices for outsourcing, developing, producing and marketing goods and services.

Thus far, globalization has played to many U.S. competitive strengths. The nation with the world's deepest technology base, most productive workforce, and richest, most competitive domestic market has led the way in innovation. This position at the high end of the value chain has supported high wages, created national wealth and attracted some of the world's best technical talent.

Looking forward, however, U.S. technological dominance is certain to be challenged. The United States still has the strongest overall research capabilities, performing about one-third of the world's research and development, but other countries are developing both infrastructure and human capital to support world-class innovation. In the pivotal information sector, for example, Taiwan, the Republic of Korea, Ireland, Israel and India have emerged as global players overtaking both Germany and the United Kingdom in U.S. patenting activity.⁹

The nations that target U.S. technological leadership, both in specific niches and across the board, have made the development of science and engineering talent a top priority. Asian countries — China, India, Japan, South Korea and Taiwan — collectively have more than doubled their production of bachelor's degrees in the natural sciences since 1975, and quadrupled their number of engineering graduates.¹⁰ In addition, China is on course to match the U.S. production of advanced degrees in technical disciplines within a decade.¹¹

This relentless climb up the technological ladder has begun to equalize innovation globally. The U.S. science and engineering workforce now feels the same kinds of competitive pressure their colleagues in the manufacturing sector have felt since the 1960s. Against this backdrop of global competition, three risks to U.S. national interests loom if America does not act on the talent imperative.

Loss of National Innovation Capacity

The U.S. national interest is to produce a pool of U.S.-based technical talent that can reliably meet the long-term needs of our innovation enterprise. As a practical matter, those who can be counted upon to work in corporate or government research and development laboratories, or to teach in U.S. universities, are U.S. citizens and permanent residents.

It is treacherous, of course, to predict what the needs of the U.S. innovation enterprise will be. Quantitative projections of demand have been notoriously inaccurate; students and professionals react quickly to changing market signals; and unforeseen requirements can arise, as the nation learned after 9/11. What *can* be said with some certainty is that there will be:

- A *replacement need* to fill the shoes of the current technical workforce. Currently, about half of American S&E workers are at least 40 years old, about 28 percent are at least 50 years old, and about 12 percent are at least 55 years old.¹² Barring large reductions in retirement rates, National Science Foundation (NSF) predicts that retirements among science and engineering workers will dramatically increase during the next 20 years, as today's workers who are 40 and older move toward retirement.
- A *structural need* to meet demand for scientists and engineers in sectors where technological opportunities are likely to be high. The Bureau of Labor Statistics (BLS) projects that this need will be concentrated in computer-related occupations, which are enablers of innovation across much of the economy. BLS also projects significant structural needs in environmental engineering, computer hardware engineering, medical sciences and physical sciences.¹³
- A *competitive need* to sustain U.S. global leadership in innovation. To hold its own, the U.S. talent pool will have to be strengthened qualitatively and quantitatively over the next two decades. A common sense look at the surging production of international talent, especially in Asia, indicates that the United States cannot stand in place. Nor can it compete on wages, so it will have to compete on quality and productivity of U.S.-based technical talent. Empirical studies show that density of the S&E workforce is one of the core factors that equate with national strength in innovation.¹⁴

The underlying forces at work provide no assurance that these needs will be met. And while the NSF expects net production of scientists and engineers to fill the nation's replacement need, its overall estimates assume large increases in life sciences — a federal spending priority since the late 1990s — in which projected degree production exceeds estimated job openings by six to one.¹⁵

In the meantime, long-term declines in the key technical disciplines show no sign of being reversed. For example, bachelor's degrees awarded to U.S. citizens and permanent residents in computer science declined by more than 40 percent 1987 to 1996; by almost 25 percent in mathematics; by 21 percent in engineering.¹⁶

Underrepresentation in the workforce is now an economic issue.



Degrees in physical sciences have stabilized since the early 1990s at a level 30 percent below peak production a decade earlier (Figure 1-1).

These trends suggest that even if the U.S. does meet its overall replacement requirements, there is a significant risk of structural gaps in key fields. The United States is far off the peak degree production levels reached in the 1980s, notwithstanding the economic boom of the 1990s.

More fundamentally, America is not keeping pace with growth of international science and engineering capacity. The U.S. now ranks 61st out of the top 63 nations in its share of bachelor's level S&E degrees as a total of all bachelors' degrees awarded.¹⁷ Gaining ground on these critical shortfalls will require a national commitment to build capacity, as the country did to win the space race.

The best chance for America to increase the size and quality of its technical workforce is to cultivate a much larger share of talent from underrepresented groups. Quantitatively, the numbers are concentrated in these groups. Qualitatively, the inclusion of new perspectives can create a richer, more productive innovation environment.¹⁸

Without widespread commitment to educate the underrepresented majority in science and engineering, the U.S. will harvest only more of the same. This will lead to migration of S&E jobs overseas, loss of U.S. competitive advantage and less freedom of action in case inflows of international talent are curtailed reduced.

Overreliance on International Talent

The U.S. national interest is to attract the world's best science and engineering minds without crossing the line from enrichment to dependence. The continuation of current trends runs that risk.

The exceptional contributions of foreign-born scientists and engineers in all technical fields are beyond question. They date

back to the pre-World War II era, if not earlier, and have been documented by such measures as paper citations, authorship of "hot" papers and election to the national academies of science and engineering.¹⁹ More recent forces of globalization have changed the volume and character of talent arriving into the United States. The underlying forces at work in the production and deployment of scientists and engineers are plain to see. They have significantly increased U.S. reliance on international talent over the past two decades, while simultaneously reducing America's long-time advantage as the beneficiary of a one-way brain drain.

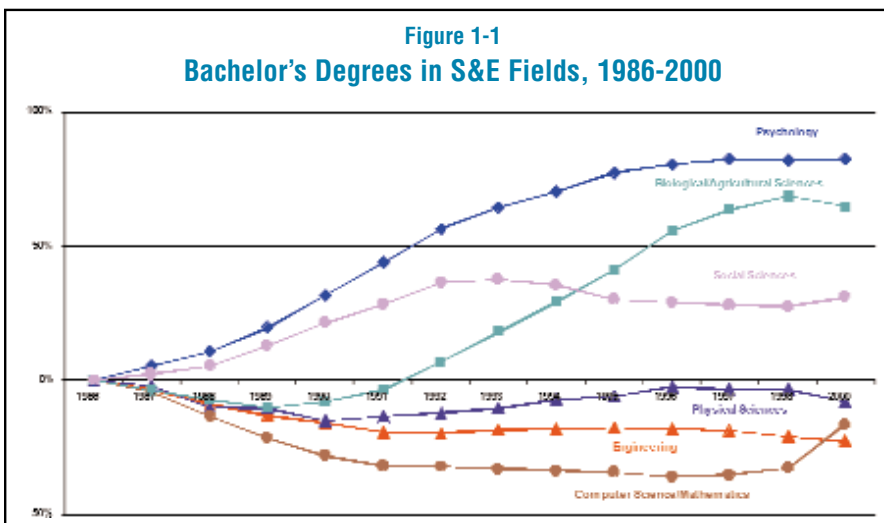
On the supply side, as the overall interest of U.S. students in technical disciplines flagged after the mid-1980s, thousands of willing counterparts from other nations applied for graduate training in American universities. Although countries of origin have shifted, the upward curve is intact. The percentage of foreign-born doctorate holders in the U.S. jumped from 18.3 percent in 1980 to 27 percent in 1999. In 2001, 56 percent of the Ph.D. degrees in engineering and 38 percent in the natural sciences were awarded to international students.²⁰

Table 1-3 puts the foreign student component of the degree pool in historical context, comparing by broad field and level of degree. Within the span of a single generation, the international share of the degree pool tripled in the biological sciences from 1985 to 2000; in the physical sciences it doubled; in the computer science, it quadrupled. A similar pattern holds at the master's level as well, particularly in the fields of engineering, math and computer science. In 2000, non-resident aliens earned more than 45 percent of the Ph.D.s and over 35 percent of the master's degrees awarded by U.S. universities in engineering (Figure 1-2).

Meanwhile, growing opportunities in their home countries have led international students to make their commitments to stay in the United States more provisional than they once were. Half the scientists and engineers trained here return home.²¹ Those

who stay have transformed the American S&E workforce. For example, in 2001, 77 percent of our employed doctoral scientists and engineers were native-born, 13 percent were naturalized U.S. citizens and 10 percent were non-U.S. citizens, but only 2.9 percent of the employed doctoral scientists and engineers were non-U.S. citizens here on temporary visas. Overall, more than one of every five employed doctoral scientists and engineers were not native-born U.S. citizens. However, this varies considerably by field of doctorate:

- In engineering, slightly more than one of every four doctorates are naturalized



Source: National Science Foundation, Science and Engineering Degrees, 1966-2000

Table 1-3
Degrees Awarded in Selected Fields by Sex, Race/Ethnicity and Citizenship, 1985 and 2000

Gender, Sex and Citizenship	Bachelor's		Masters		PhD	
	1985	2000	1985	2000	1985	2000
Biological Sciences						
Men	19,725	26,370	2,349	2,499	2,178	2,276
Women	18,322	37,055	2,219	2,991	1,078	1,984
Foreign Nationals	4,277	9,559	474	738	424	1,239
Underrepresented Minorities	915	1,375	308	509	125	315
Physical Sciences						
Men	10,426	10,667	3,464	2,235	1,840	1,546
Women	4,811	7,382	1,119	1,288	347	422
Foreign Nationals	1,588	2,259	1,098	1,335	624	1,213
Underrepresented Minorities	780	578	237	267	60	131
Computer Science						
Men	24,690	26,914	3,667	5,028	189	372
Women	14,431	10,474	1,566	2,329	24	86
Foreign Nationals	2,116	2,879	1,709	6,491	89	356
Underrepresented Minorities	3,327	5,531	315	760	9	24

Source: CPST, data derived from National Science Foundation

U.S. citizen (25.8 percent), and an additional 18 percent are non-U.S. citizens (5.5 percent temporary visa holders).

- In computer science, 57 percent of employed doctorates were native-born, compared to 20 percent who are naturalized U.S. citizens and 23 percent who are non-citizens.
- In social sciences, more than four in five (82 percent) employed doctorates were native-born, while 10 percent were naturalized U.S. citizens and only 8 percent were non-U.S. citizens.²²

These supply side facts put the demand data in clearer context. The share of foreign-born science and engineering workers in the U.S. technical workforce increased from 11.2 percent in 1980 to 19.3 percent in 2000, reaching a total of 1.5 million.²³ A key swing factor has been U.S. industries' reliance on temporary work visa-holders when domestic talent has been unavailable or underutilized. The yearly limit on H-1B temporary work visas quadrupled during the 1990s to

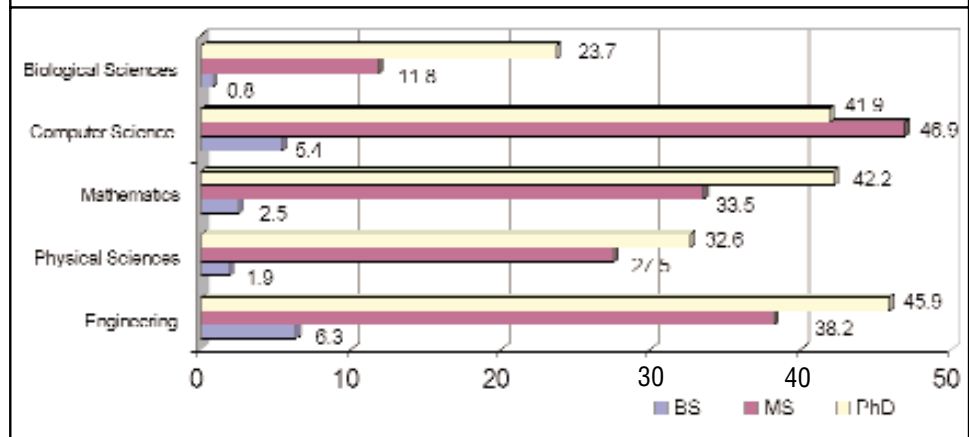
reach 195,000 — slightly more than half allocated to computer-related occupations and an additional 20 percent to other science and engineering fields.²⁴ Although the yearly quota has been cut back to 65,000 in 2003, demand for foreign workers in the information technology sector is widely considered to be structural and likely to rebound in a sustained economic recovery.

The potential vulnerabilities that will arise from excessive U.S. reliance on international talent are plain to see. What if the world's best and brightest no longer come to the United States or return home in growing numbers? What if a political backlash prompts Congress to reduce H-1B visa limits? What if national security concerns, which currently may lead to monitoring of students from 25 countries affecting about 10 percent of the Ph.D. student pool, result in restrictions that cut far more deeply into U.S. sources of supply? What if state-based challenges to affirmative action in college admissions and financial aid constrain

the enrollment of students in the underrepresented majority?

The most serious risk will arise if a rush to access global talent bypasses the United States altogether. Until very recently a few years ago, the prospect that American firms would outsource large numbers

Figure 1-2
Proportion of U.S. S&E Degrees Earned by Non-Resident Aliens 2000



Source: CPST, data derived from National Science Foundation



of high-end, knowledge-intensive jobs to serve the U.S. market seemed remote if not unthinkable. Now the calculus is changing. Although proximity to domestic customers, suppliers and research facilities remains important, pressures on the bottom line have triggered growing reliance on offshore science and engineering options — not as complements to, but as substitutes for, U.S.-based operations.

These risks cannot be waved off. The United States cannot allow ever-increasing reliance on international talent foreign-born talent to become business as usual without jeopardizing the national interest threatening national interests by diluting American technological leadership.

Loss of Public Support for U.S. Research and Development

The consistently high level of public support for science and technology reflects a broad understanding that all Americans share the benefits. Public support has translated into substantial public investment in research and development in many key sectors of the economy. It is hard to find any world-class industry that has not gained directly from such investment, whose unique contribution is to build a foundation of knowledge upon which the private sector can create new products and services. This has been especially the case in the life sciences and in fields linked to national defense.

Support for publicly funded basic research is not about to crumble, but it is potentially vulnerable to a changing electorate whose social and economic priorities do not square with the research and development community of scientists and engineers. The American public has long accepted that technical fields are highly selective; however, the country will not continue to accept that high-paying, high-opportunity fields remain closed — in appearance or reality — to the majority of American workers.

While S&E occupations may not be able to compete with business, law or medicine, they pay good salaries. In 1999, the median annual salary of employed bachelor's-degree recipients was \$59,000.²⁵ Moreover, science and engineering careers — particularly in engineering and computer science — have historically been a launching pad for entrepreneurial companies and careers in corporate management. Low levels of participation of underrepresented groups in these fields will restrict opportunities to enter the executive suite and boardrooms of technology companies, and technical leadership positions in government.

Should underrepresented groups conclude that they will remain long-term outsiders in science, engineering and technology, their elected representatives at the federal and state level will be less likely to champion research and development spending. This prospect is one of many reasons why the nation's leading research universities have been forceful advocates of diversity. All recognize that the composition of their own student bodies — and eventually their faculties — will be future litmus tests in the competition for scarce public resources. Sooner or later, government agencies that conduct or sponsor basic research will face comparable pressures.

The Leadership Challenge

The leadership challenge facing industry, government and academe is to solve this high-stakes problem for which there is no short-cut solution. While globalization has made international talent readily available, it will cost the U.S. heavily if the global card is played at the expense of developing and utilizing America's own human capital. Going global and investment in homegrown technical talent are not mutually exclusive options, but the trade-offs between them are real.

The best chance for the United States is to increase the size and quality of its own technical workforce by cultivating a much larger share of talent from its own underrepresented majority. The path to achieving this goal is not straight and smooth. The changes needed to broaden the base of the U.S. technical workforce are fundamental. They encompass the foundational skills taught from pre-kindergarten to the 12th grade, higher education and the workplace, as well as the popular image of science and engineering careers. Yet even as the U.S. Supreme Court has reaffirmed diversity as “essential to [the] educational mission,” it is clear that the politics of affirmative action are likely to grow more volatile at the state level. Race-conscious admissions processes will require even more attention to individual difference.²⁶ In sum, the stakes of meeting the talent imperative are high. Chapter 2 of this report highlights the barriers that have left large numbers of women, persons of color and persons with disabilities outside the technical workforce. Chapter 3 focuses on principles and practices that have enabled exemplary organizations to make progress on diversity goals. Chapter 4 presents a national blueprint for action to speed the pace of change.

The leadership challenge facing industry, government and academe is to solve this high-stakes problem for which there is no shortcut solution.



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Chapter 2

Barriers to Progress

Technical workforce remains imbalanced despite educational reforms

A revolution has taken place in the American workplace during the past several decades. The skills that command a premium have become increasingly knowledge-intensive and fluid. Frequent job change has become the norm. Continuous learning of new skills has become a necessity. The workforce itself has become steadily more diverse in gender, race and ethnic composition.

Why has the imbalance in the makeup of the U.S. technical workforce persisted of the face of such sweeping changes? Why is such a large segment of the population unprepared for or not attracted to the very disciplines that have transformed the world of work? Why are underrepresented groups so scarce in these fields, which have served as rungs of upward mobility for others?

Clearly, there are no one-size-fits-all answers. Workforce entrants are not fungible. Some are more or less able and willing to enter science and technology professions, change sectors or jobs, retool their skills or meet other demands. Those who stay away from science, engineering and technology, either by default or by choice, vary widely in background, life experience and income. Some who opt out are near-misses, while others would need years of additional preparation to enter a technical career. The forces that shape the preparation and motivation of women, African Americans, Hispanics, Native Americans and persons with disabilities affect each group in distinctive ways. In the final analysis, however, they limit the participation of all.

This chapter highlights two interlocking sets of barriers that limit the flow of underrepresented groups into the technical workforce. **Upstream barriers** thin the pool from which members of underrepresented groups enter the fields of science, engineering and technology. **Workplace barriers** affect the hiring, retention, advancement and compensation of those who opt in and seek to stay the course.

The limited supply of workforce entrants from underrepresented groups reduces the options of employers, leading to the familiar refrain, “there’s nobody out there” or “I can’t find any qualified candidates.” Those entrants who persist are short-changed on every measure of workplace success:

- **Turnover.** Women and underrepresented minorities change jobs more frequently and are more likely to exit the S&E workforce than white males. Women in industry, for example, leave science and engineering positions at twice the rate of men and at levels much higher than women employed in other sectors.
- **Wage disparity.** In 1999, the median salaries of women S&E professionals lagged men by \$14,000, with the same pattern holding across racial and ethnic lines.

- **Limited advancement.** Opportunities for underrepresented groups in academe and government have been especially limited by inflexible work environments, hierarchical management and late retirements.

- **Lower levels of influence.** Underrepresented groups are less likely to hold management positions in the science and engineering workplace and to have fewer subordinates when they do.

Of course stars have emerged in technical fields, but they represent the exception rather than the norm. There are not nearly enough success stories or role models to inspire those who would follow in their footsteps. The cycle will not be broken until increased supply is matched by increased opportunity in the workplace.

Upstream Barriers

Pre-K-12

The nurturing of technical talent takes a generation. Motivation, support, inspiration and confidence are as important to the making of a scientist or engineer as the mastery of content and the development of critical thinking skills. All of these essentials must fall into place, and the absence of any one of them can block the path forward.

Most of the thinning of the potential technical talent pool occurs by the end of high school. This attrition is much closer to being understood than solved. One core challenge is lack of preparation for large numbers of underrepresented minority students. Although those that gain foundational skills in mathematics and science grow as interested in technical disciplines as non-minority students, far too few are equipped to have the option to take the next step into higher education or the workplace.¹ A second challenge is the disinterest in technical fields of many who are prepared. The gender gap in pre-K-12 mathematics and science has now closed, but women are much less likely to pursue further study in such fields as computer sciences and engineering than men.² Studies show that many girls have opted out by the time they reach middle school.

The forces removing all students in droves from the science and engineering feeder system — especially girls and underrepresented minorities — are widely recognized. These forces can be summarized as follows:

Unequal learning opportunities. Economically disadvantaged students, who are disproportionately African American, Hispanic and Native American, start behind and stay behind. They are less likely than others to acquire the skills needed to put them on a path toward a technical career.

This path is clearly documented: early literacy; qualified, committed science and math teachers; access to technology in the classroom and at home; algebra by eighth grade; geometry and calculus in high school; availability of advanced placement courses; and knowledgeable guidance counselors. Achievement scores confirm how far out of reach these assets and achievements are to large numbers of underrepresented students from pre-school on.³

Social and cultural constraints. The most influential forces shaping education and career outside the classroom are family and community. However, these forces rarely steer students, particularly from underrepresented groups, toward science and engineering.

First, careers that are more understandable and visible look more inviting and accessible to parents and other family members. Second, science and engineering are still widely viewed as a professional domain for men, often depriving girls of an extra measure of encouragement that could spark or sustain their interest.⁴ Third, the academic demands of science and math put many low-income, less educated parents under pressure. Frequently they lack the knowledge, time or, in some cases, interest to support their children in pre-K-12 or the college admissions process. Fourth, the values of science are not embraced in all quarters. Some communities view its methods and goals as potential threats to deeply held beliefs.⁵

Skewed images of scientists and engineers. While Americans hold generally favorable views of science and technology, they lack a clear picture of what scientists and engineers do. If anything, the popular image of scientists and engineers is murky or not positive. Negative portrayals on prime-time television prompted the authors of one study to conclude, “the more people watch television, the more they think scientists are odd and peculiar.”⁶ An integral part of the image, also reinforced in the media, defines scientists and engineers as predominantly white males. This skewed image adds to the burden of attracting youngsters from all backgrounds to technical fields.

A shortage of role models. Role models play a pivotal part in spurring academic success and shaping career choices. The current composition of the technical workforce, however, limits the chances that students from underrepresented groups will find their possible future selves in science, engineering and technology. Starting with the pre-K-12 math and science teacher corps, this shortage of role models reduces the visibility and drawing power of technical careers for underrepresented populations.

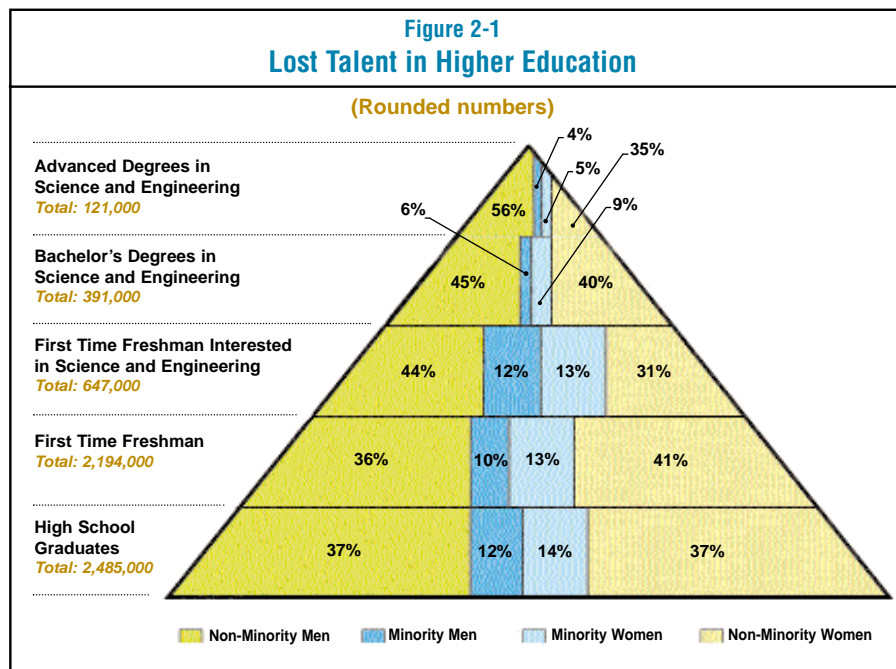
From a workforce perspective, these

barriers take a heavy toll. They reduce the earning capacity of those who fail to acquire foundational skills, impose significant costs of remediation and limit the pool of technical talent upon which U.S. employers can ultimately draw. The implication of these costs is profound. The talent imperative will not be met unless these employers become more actively and strategically involved in the pre-K-12 supply chain. But higher education is not without responsibility as well.

Higher Education

The United States sets the world standard in higher education, especially in science, engineering and technology. America’s research universities are at the nexus of the system, where they command national and international talent development, knowledge creation and innovation.

For the most part, however, underrepresented groups have participated in this success only at the margin. At every transition point, as Figure 2-1 shows, women and underrepresented minorities leave technical majors disproportionately.⁷ Even during the digital revolution of the past 20 years, undergraduate and graduate degree production has remained roughly constant in most technical disciplines, with the exception of life sciences. Underrepresentation at the faculty level has persisted, a legacy of its own stunted pipeline.⁸ On balance, more has stayed the same than has changed.



Minority = Black/African American, Hispanic and American Indian

Source: Joan Burrelli, NSF, based on 1999 Common Core of Data, U.S. Department of Education, National Center for Education Statistics (NCES); NCES, 1998 IPEDS Fall Enrollment Survey; UCLA Higher Education Research Institute, 1998 American Freshman Survey (estimate); and NCES, 1998 IPEDS Completions Survey



The much-studied barriers to increased participation in higher education are both institutional and attitudinal. First in students and again in faculty, they reinforce that science and engineering are not welcoming professions. In capsule form, their key components are:

Social bias and the lack of support groups. Negative faculty attitudes, including the stereotyping of students and the use of pedagogies that fail to recognize variations in learning styles, remain a fundamental contributor to the attrition of underrepresented groups. Although the value of peer support for underrepresented minorities has been demonstrated across the country, many universities have failed to institutionalize the practice for undergraduates, graduate students and postdoctoral fellows. Isolated students remain the most at risk. For faculty, alienation and distrust create a seemingly hostile work environment.

Flawed reward systems. Tenure systems based exclusively on research performance create no incentive to embrace the values of diversity. Teaching, mentoring and outreach will not be fully accepted until they are firmly embedded in the tenure process.⁹ In academe, slow employment growth, a reduction in the number of senior faculty positions and the relatively late retirement of many tenured faculty have limited opportunities for younger science and engineering professionals, particularly women and underrepresented minorities.¹⁰

Antiquated governance structures. The institutional changes needed to foster a university-wide culture of inclusiveness require committed leadership and strong incentive mechanisms. Decentralized management systems diminish the effectiveness of even the most committed leaders. Like most workplaces, academe has been a bastion of white males. Dominant cultural norms, often described as competitive, can be more accurately described as adversarial and non-collegial. Navigating this culture is especially challenging to women and minorities due to lack of access to unwritten rules, vague evaluation criteria by which performance is assessed and the closed networks in which business is sometimes conducted.

Resource constraints and inequities. Where one prepares for a career in science or engineering bestows a competitive edge. Institutions that educate the lion's share of minority populations are less well-endowed, with fewer state-of-the-art facilities and instrumentation. These shortcomings limit both faculty and student research experiences, in turn signaling a lack of readiness for subsequent high-tech work. Even at research universities, intra-institutional inequities take a toll. A prominent case was reported in the 1999 study of women faculty in science at MIT, which identified numerous inequities by gender, including salary, allocation of laboratory space and general treatment by faculty. This study spurred similar efforts at other institutions nationwide.¹¹

Inadequate outreach. A persistent "ivory tower" mentality blunts aggressive student and faculty recruitment. The best and brightest are expected to gravitate to science and engineering, yet competition from other fields and the student intelligence on attractive and rewarding careers undercuts this assumption.¹² The upshot is that many higher education institutions have failed to tap, both intellectually and interpersonally, many potential entrants to the science and engineering workforce.

These barriers have not stopped progress across the board.

BEST's assessment of what is working in higher education has identified and analyzed exemplars of best practice along the higher education continuum.¹³

In principle, the human resource costs of upstream barriers ought to give an extra incentive to employers to cultivate the relatively small number of professionals from underrepresented groups who enter careers in science, engineering and technology. In practice, the challenges of underrepresentation and the talent shortage it engenders persist and deepen in most workplaces.

Workplace Barriers

The forces that have limited diversity in the technical careers run deep. They reflect a legacy of exclusion that is more properly measured in centuries than decades. The scientific revolution itself had a defining impact on the culture as well as the content of science.¹⁴ The pioneer thinkers of the 16th century who helped shape the systems of thinking and institutions of modern science and technology viewed the objective of scientific inquiry as one of control. They established its mode as objective, detached and rational. This perspective, as many later commentators observed, overlooked the primary values and interests that connect women and less privileged groups to the pursuit of knowledge: family, community and beliefs.¹⁵

Moreover, the academies and universities that carried forward the scientific revolution in the 17th and 18th centuries excluded all but men of high social rank. The industrial age reinforced this division by creating a doctrine of separate spheres: man's place was in the public realm of production and woman's place was in the domestic, private domain. To the extent that women and minorities were allowed into the public sphere, they were segregated into the lower levels of labor.

In the United States, technical fields remained for men only until well into the 19th century. It was not until then that the first non-military coeducational engineering school, Rensselaer Polytechnic Institute, was founded, as were the first women's and historically black colleges.¹⁶ These latter institutions emerged as the most dependable source of diversity in science, engineering and technology in that era. Through recent times they have continued to prepare disproportionate numbers of women and underrepresented minorities for entry to the world of scientific work.

In today's context, the workplace environment that restricts the chances of underrepresented groups of getting a job, being retained and getting promoted is widely known as "the chilly climate." The same factors lower the temperature in industry, academe and government: micro-inequities that undermine an individual's sense of confidence; legal and policy frameworks that embed inequities in the workplace; and social and cultural norms that fail to acknowledge the differences of women, underrepresented minorities and persons with disabilities.

Micro-inequities. The types of behavior that undermine confidence in subtle, frequent and ordinary ways take hold in working environments in which the members of underrepresented groups feel vulnerable.¹⁷ The pattern can start early. During the 1980s, in the then-emerging field of computer science, a number of leading



universities reported that graduate student women felt neglected and rendered invisible in that field.¹⁸ The Wellesley College Pathways Project survey of women scientists provides additional examples:

“In many ways I feel I must perform at a higher level for the same recognition as my male colleagues.”

“There is a very strong tradition of an ‘old boys’ network’ where I work. The male colleagues I have seem to get more respect at meetings and more money and benefits not offered to me.”

“Women are not encouraged to do certain specialities such as surgery and cardiology, while they buttonhole us into pediatrics and ob/gyn.”

These micro-inequities have equal meaning for racial and ethnic minorities. The International Engineering Foundation Conference reported in 1998 that “people tend to share information, support, and encouragement with people who look like them.”¹⁹ Those who look different in a workplace that tends to replicate itself are more likely to suffer daily indignities and to be stereotyped into certain work areas. These micro-inequities have equal meaning for racial and ethnic minorities as well as for persons with disabilities. By the same token, persons with disabilities face a widely shared perception that they impose additional burdens on their supervisors, requiring extra help and different performance standards.

Micro-inequities do not fade on their own. They must be confronted in the workplace. The most favorable condition for doing so is when underrepresented groups reach critical mass within an organization. As these groups become more visible and less isolated, their increased leverage increases the chances of putting an end to subtle but pervasive demeaning behavior. Until then, however, such behavior remains an integral part of the chilly climate.

Legal and policy frameworks. Frameworks that put underrepresented groups at an institutional disadvantage go beyond daily personal indignities. The most egregious inequities were addressed by the 1964 Civil Rights Act, the 1972 Equal Opportunity Act and the 1991 Americans with Disabilities Act. Despite their far-reaching impact, these laws have not fully leveled the playing field in the technical workplace.

One well-documented area of persistent inequity is that of salary and benefits. A study of scientists at the National Institutes of Health, for example, compared matched pairs of male and female researchers who shared the same rank, advanced degree and years since degree. The results found that men earned an average of \$4,000 per year more than women. Self-evaluations by a number of universities revealed widespread differentials in recruiting packages, laboratory space and administrative support. While organizational policies did not cause these inequities, they allowed them to go unchecked.

The same permissive pattern holds for racial and sexual harassment. The Pathways Project survey noted above found that significant numbers of African American scientists felt that they were

deemed to be less intelligent, not as individuals but as a race. Half of all women doctors reported sexual harassment in medical school and on the job.

Policy failings of omission also pose obstacles. The business-as-usual assumption is that all workforce entrants have comparable organizational skills. As a result, organizations make no provision in policy for the possibility that working styles might differ by gender or minority group. Only recently have some technical organizations begun to put in place procedures to enable underrepresented groups to acquire the self-promotional skills to navigate successfully in a predominantly white male work culture.

Cultural and social norms. Underrepresented groups experience the chilly climate in a way that hits at home as well as at work. In fact, the inability of employees both to work and “have a life” in scientific fields often discourages the most committed woman and minority scientist or engineer. In 2001, a self-evaluation of diversity in science and technology at Harvard University underscored grave difficulties in a tenure system that demanded junior faculty work the hardest “during the time when many women and minority group members wish to start a family and feel that they must choose between a personal life and career.”²⁰ Researchers have also found that men are much more likely than their female counterparts to be married and have children.²¹

Some industries, including biotechnology, offer more reasonable work hours than academic careers. A study of persistence and advancement in the biotech industry, however, found that more flexible work arrangements are seldom exploited in a systematic way.²² For example, most biotech work is structured around interdisciplinary teams. Support work can thus be organized to allow scientists to schedule tasks to help each other. However, a traditional workplace culture persists that permits only the most well-established flexible policies to be practiced, such as maternity leave. This culture places a burden on all employees who place a high value on family life.

Two fundamental conclusions emerge from even a cursory review of workplace barriers. First, underrepresented groups are natural allies in eliminating the chilly climate. To be sure, each group encounters distinctive challenges in technical fields. Women of color face a number of pressures that are inherently different from non-minority women. The concerns of Hispanics, African Americans and Native Americans cannot simply be lumped together. By the same token, however, a number of shared behavioral and structural barriers confront all groups. A workplace with the flexibility and openness to respond to the needs of one group is more than likely to be welcoming for all. Second, underrepresented groups cannot change the culture of the workplace alone. If obstacles to progress were easily removed, America’s technical workforce would look a lot different than it does today. Committed leadership and support at all levels remain key to achieving diversity and making it work.

A relative handful of science and engineering-based organizations have gained national recognition for making real headway in attracting, retaining and advancing persons from underrepresented groups. Chapter 3 highlights a representative group whose principles and practices point the way for others.

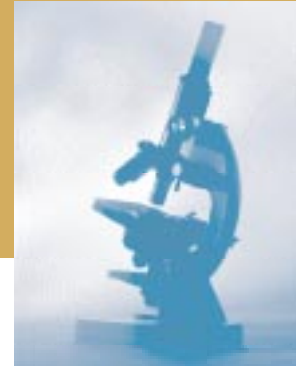


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Chapter 3



Principles and Practices

BEST distills four “design principles” of effective workplace practices that increase representation

Diversity initiatives that seek to break down the workplace barriers described in Chapter 2 have been launched in every sector of the U.S. economy during the past few decades. Today, more than 75 percent of Fortune 1000 companies, and 36 percent of all companies, have formal diversity programs – most started during the 1990s.¹ Survey data on federal agencies reveal that the majority have such programs, and growing numbers of universities have begun to evaluate gender and racial/ethnic equity in faculty hiring and promotion.²

Driven by market forces, as well as concern over potential legal liability, corporate employers with large science and engineering workforces have been at the forefront of developing and implementing diversity programs.³ The results of a 2001 survey of Fortune 1000 companies by the Society for Human Resources Management and *Fortune* provide a snapshot of the current diversity programs and practices of large U.S. employers as of 2001:⁴

- The most common components are recruiting efforts, followed by diversity training initiatives, education and awareness efforts, and diversity-related community outreach.
- Explicit promotion opportunities for women or minorities, cultural orientation programs or diversity-related conflict resolution are less common.
- About two in five organizations surveyed have systems in place for measuring managers’ performance on diversity-related goals.

The survey gives a picture of the “average” program. Setting the bar high, the BEST Blue Ribbon Panel on Best Practices in the Workforce (composed of about 120 nationally recognized S&E workforce diversity leaders from academe, government, industry and nonprofit organizations) sought to uncover and study the extraordinary: the exemplary practices and programs of science, engineering and technology-based organizations whose success in increasing the participation of underrepresented groups has been widely recognized. The panel’s ultimate goal was to extract dimensions of the most effective diversity programs that should become design principles for new or expanded efforts. This chapter highlights the panel’s approach and findings.

From its review of exemplary programs, the panel distilled four fundamental “design principles” that characterize successful S&E workforce diversity programs, and create the conditions that make successful program implementation possible. These principles are: sustained commitment; integrating diversity into organizational strategy; management accountability; and continuous improvement to achieve sustainability. The remainder of this chapter reviews exemplary programs and practices of S&E employers that illustrate these principles.

The BEST Evidence

The three expert panels assembled by BEST to identify what works in pre-K-12, higher education and the workforce faced the same task: how to identify and validate the effectiveness of programs developed to broaden the participation of women, underrepresented minorities and persons with disabilities in science, engineering and technology.

Each panel approached this task as rigorously as time, resources and availability of data allowed. Step one was to agree upon an analytical approach, recognizing the complexity and limits of using the same methods on groups as diverse as those underrepresented in technical fields. Step two was to create a national sample of programs by drawing upon the professional knowledge of the panelists as well as a review of the research literature. Step three was to apply specific analytical criteria to rate programs, giving targeted attention to third-party evaluation and research rigor as well as taking into account descriptive evidence generated by programs and, where appropriate, the judgment of the panel. Step four was to draw inferences from exemplary programs distilling a shared set of “design principles” that are not full explanations of effectiveness but a shorthand for what it takes to succeed.

None of the panels found the research base alone sufficient to draw conclusive judgments about what works. Moreover, the standards applied by BEST’s panels only begin to define what is effective, adaptable, affordable and deserving of further consideration as an intervention. These challenges speak to the need for hard thinking and real-world strategies about practices in the classroom, on campus and in the workplace. What seems exemplary warrants close scrutiny, subject to local constraints, goals, belief systems, opportunities, personnel and populations. The findings of the panels represent a starting point, not the last word.

With these caveats, BEST’s rigorous approach sets the bar high. Doing so will contribute to more informed decisions to meet an important and increasingly urgent national challenge. We do not ask that readers trust our evidence implicitly, but that they seriously consider our findings even as BEST and other committed organizations work to fill gaps in knowledge and translate our understanding of what works into action.



An Approach to Finding What Works

The BEST Workforce Panel faced several challenges in identifying and evaluating exemplary programs, including time limitations which prohibited original data collection and analysis, and a dearth of publicly available information about the results and impact of employer-sponsored S&E diversity programs.

While research and evaluation on diversity-related education interventions and outcomes is sparse, in the area of employer-sponsored diversity programs, publicly available empirical research is virtually nonexistent, even for large employers. If these programs have been formally evaluated, the results are typically proprietary and unpublished. Moreover, academic researchers — such as the Diversity Research Network, a research consortium studying the relationship between diversity and business performance — have found companies “reluctant to share their experiences or data, given the legal climate and the potential for litigation.”⁵

Lacking formal program evaluations or empirical studies from which to draw promising S&E diversity programs and practices for study, BEST’s Workforce Panel identified a pool of potential models from winners of national diversity-related awards and “best to work for” lists. For example, the Catalyst Award and the U.S. Department of Labor’s “Opportunity Awards” recognize corporate, academic, nonprofit and government diversity initiatives. The “best of” lists are published annually by *Fortune*, *Working Mother Magazine*, *Careers & the disAbleD*, *Hispanic Magazine*, *Diversity Inc.* and others. While the evaluation criteria and the rigor with which they are applied varies widely among them, these awards and “best of” lists do provide some third-party validation of the programs recognized.

To be as systematic and comprehensive as possible, the Workforce Panel selected for evaluation those programs and practices meeting the following criteria:

- Programs sponsored by science and technology nonprofits, universities, government agencies, and research and development intensive companies that have received the Catalyst Award or an Equal Opportunity Award from the U.S. Department of Labor within the past five years.⁶
- Programs sponsored by science and technology nonprofits, universities, government agencies, and research and development-intensive companies included in the Business Women’s Network “2002 Best of the Best” report.⁷
- Nominations from members of the BEST Workforce Panel.

This process produced 43 candidate programs that illustrate initiatives that work. Public information about each program was reviewed to determine longevity, evidence of institutional commitment and existence of demonstrable results. As a result, 25 programs were selected for further study. Available information about these 25 programs was collected and placed into a common format. With this information in hand, the 25 programs were assessed by a subset of the BEST Workforce Panel.

While the Workforce Panel’s search for promising programs and practices was systematic, and took advantage of networks in which panel members participate, inevitably it was not exhaustive. As a result, the programs and practices discussed in this chapter —

as well as the design principles mined from them — are based on the panel’s collective best judgment, drawing on their wealth of professional expertise and personal experience.

Design Principles for Excellence

While there is no “one size fits all” approach to increasing diversity in the science and engineering workforce, the Workforce Panel identified four fundamental principles that underpin the headway that exemplary organizations have made:

- Sustained commitment to change at every level of the organization.
- An integrated strategy that incorporates the business case for diversity into operating structure and culture.
- Metric-based accountability that holds all managers responsible for results.
- Continuous improvement to achieve sustainability based on internal and external benchmarks.

These features create the conditions that make implementing best practices possible within all organizations — private or public sector, large or small. Clearly, there are significant differences in culture and incentive structure in the science and engineering workplaces of industry, academe and government. However, just as the same kinds of barriers have slowed progress in all three sectors, so the same kinds of solutions must be fitted to the specific settings of each.

None of these design principles works in isolation. They comprise a package that advances one defining objective: to create a culture of inclusion and involvement within the organization. An inclusive culture is one in which the contributions of individuals are encouraged, welcomed and valued. The work environment is conducive to productive engagement of all participants, and all individuals are valued for their differences as well as their similarities.

Like other efforts to stimulate change, creating an inclusive organizational culture is a formidable task, and it is particularly difficult in the science and engineering workplace where, at its worst, the traditional science and engineering organizational culture is hierarchical, patriarchal and closed. Making real change requires institutional commitment with leadership from the top, backed by meaningful action. It requires closely linking science and engineering diversity to organizational strategy and holding management accountable for diversity performance. Making change permanent requires a commitment to continuous improvement.

Principle 1: Sustained Commitment

Valuing science and engineering diversity starts with the complete and visible commitment by the organization’s leaders. This extends up to governing boards and chief executives, and down through the management ranks to all employees. Isolated programs do not produce such commitment. Only a comprehensive effort that is ultimately embraced at all levels — from the bottom up, as well as the top down — is likely to bring about lasting change. Indeed, the measure of sustained engagement is whether it lasts beyond the tenure of a particular CEO, university president or laboratory director.



To be sure, the chief executive plays a pivotal role in making the case for diversity to audiences within and outside the organization, and in ensuring management accountability for results. However, CEOs who succeed in driving change within an organization recognize that its culture extends beyond their personal reach. Lou Gerstner, who led **IBM**'s widely recognized gains in diversity during his tenure as CEO, suggests that while cultural change cannot be mandated, it should be encouraged by providing the conditions for transformation and inviting the workforce to change the culture.⁸

Other corporate leaders, such as Daniel Carp, CEO of **Kodak**, are their organizations' chief diversity champions. They communicate the importance of diversity, set goals and performance standards and monitor diversity performance. Several CEOs personally chair their organizations' diversity council or other governing body. Beyond such personal commitment, a number of large organizations have designated an influential senior executive, or established executive-level diversity councils, to lead diversity efforts rather than assign responsibility solely to the human resources department.

Governance Structure for Sustained Commitment

Lockheed Martin's Executive Diversity Council is chaired by its president and chief operating officer, and is composed of respected leaders from across the corporation. The council's mission is to advise and recommend strategic direction and policy to executive leadership to achieve Lockheed Martin's vision of an inclusive environment. In addition, Lockheed Martin supports 33 local diversity councils in its operating units, each of which identifies its own charter to support business unit objectives while aligning itself with the overall corporate diversity vision. The councils report to the senior management at their respective locations.

The National Institutes of Health (NIH) relies on a diversity council encompassing employees of different ages, races, genders, physical abilities, and sexual orientations from the scientific, administrative and blue-collar staff. The council, which reports to the director of NIH, leads and coordinates diversity efforts. Its outreach is enhanced by "diversity catalysts" in each NIH institute or center, at least 20 percent of whose time is officially allocated to these responsibilities.

In fact, the results of the **SHRM/For** *Fortune* survey mentioned earlier in this chapter also support the conclusion that housing diversity initiatives outside the Human Resources department increases their impact and influence. Organizations which did so invested on average four times more resources than organizations which did not.⁹

A few innovators have gone one step further, creating a panel of outside experts to advise the company on its strategy to integrate

diversity and inclusion in all aspects of the business. For example, **Kodak**'s panel, headed by former Deputy U.S. Attorney General Eric Holder, reports directly to **Kodak**'s chairman and CEO.

To encourage change, leaders need to use carrots as well as sticks. Celebrating diversity and rewarding significant achievement in diversity can be powerful drivers of change within an organization. For example, the **Department of Defense (DoD)**, which employs more than 47,000 persons with disabilities, created the "Secretary of Defense Trophies for Employing People with Disabilities." The trophies are brass cups that travel annually from winner to winner, as the top three organizations within DoD are recognized for leadership in employment of persons with disabilities. In addition, DoD each year recognizes employees with disabilities who make outstanding contributions to the DoD workforce.

Principle 2: Integrating Diversity into Organizational Strategy

Exemplary organizations recognize that one-time diversity efforts or stand-alone programs do not succeed. Creating real change requires framing a compelling business case for diversity and integrating diversity into the organization's mission, strategy, operating structure and culture to make it a seamless part of the institution. Ned Barnholt, CEO of **Agilent Technologies**, summed up this philosophy in a recent interview:

To achieve its potential benefits, diversity must be owned and driven at all levels of a company, especially by each and every individual. What's more, it must be seen as an inextricable part of any corporate culture. A company does not 'do' diversity — it must be a seamless part of the very definition of the company, its values and its mission.¹⁰

For any science and engineering diversity initiative to succeed, the employer must effectively communicate to all audiences why diversity initiatives will benefit the organization and all of its employees. Rather than creating special rights for certain individuals or groups, successful science and engineering diversity programs are designed to nurture and develop all science and engineering professionals.

The financial reasons for focusing on S&E workforce development are compelling: the high cost of replacing lost talent, the time required to educate new professionals on organization-specific processes and systems, the loss of productivity resulting from high turnover and increasing competition for high-demand skills in areas such as computer science and engineering. High employee turnover can increase an organization's labor costs by as much as 26 percent.¹¹

In addition, an essential part of the business case for diversity in technology-based organizations is the need to bring diverse perspectives to the drive for creativity and innovation. Participants in a recent workshop sponsored by the **National Academy of Engineering (NAE)** reinforced the positive relationship between diversity and innovation, concluding that "engineers with different ethnic, gender and cultural backgrounds bring a variety of life experiences to the workplace that, if wisely managed, can encour-



age creative approaches to problem solving and design.”¹²

NAE President William A. Wulf spoke to this point in his keynote address at the workshop:

*Collective diversity . . . is essential to good engineering. . . . Men, women, people from different ethnic backgrounds, the handicapped — each of them experiences a different world. Each of them has had different life experiences. I think of these life experiences as the ‘gene pool’ out of which creativity comes, out of which elegant engineering solutions come.*¹³

Exemplary organizations integrate diversity across all human

Integrating Diversity and Strategy

Pitney Bowes requires each business unit to create a diversity strategic plan annually based on its own unique qualities and characteristics. The plan must address five areas: communications and training, employee development, work-life balance, business diversity and community relations. The plan also must explain how diversity impacts its employees, customers, business partners and the community. Each business unit has its own Diversity Leadership Council, composed of employees at every level of the business unit, that meets regularly to assess progress toward goals. Each unit president and the unit management team are accountable for the unit’s annual ratings, which are then considered as part of the annual performance rating for the business unit.

Other leaders in science and engineering diversity have published their business cases on their web sites. A few examples:

Pfizer: “Diversity of thought is critical to reaching the most innovative, customer-focused solutions to the many issues, problems and challenges confronting our business. As such, it is the responsibility of every manager to value and secure diversity of thought in his or her work unit by employing and developing the highest-caliber individuals differing from one another culturally, intellectually and experientially, as well as by race, gender and other factors.”

Ford Motor Company: “Our understanding of diversity helps us serve our customers better. We find that well-managed, diverse work teams can outperform homogeneous teams in quantity, creativity and quality; that complex problems can best be solved by cross-functional teams typical of matrix organizations; and that people who work, live and learn in integrated settings develop stronger interpersonal communications and negotiating skills.”

Verizon: “We have established domestic and international Hispanic consumer populations as critical growth market segments. Verizon understands that to experience sustainable growth in its Hispanic markets, it must also develop business solutions to address its current and future workforce requirements. Hispanic purchasing power is over \$2 trillion and increasing every day. Verizon has recently engaged in business strategies to enhance the development and retention of its Hispanic employee base.”

resources functions, including recruitment, retention, work-life programs, employee training and development, mentoring, succession planning, awards and recognition, and EEO and legal compliance. But these standout organizations go even further, integrating diversity into strategic planning; communications, marketing and advertising; relationships with suppliers, vendors and customers; sponsorships, foundations and philanthropy; and community relations and public policy outreach.¹⁴

Creating Management Accountability

Bayer Corporation’s aggressive approach to management accountability helped it win a Catalyst Award in 2002. All of Bayer’s U.S. executive vice presidents have business targets for valuing diversity and cultivating an environment of inclusion. They develop annual action plans and report statistics for their divisions. Approximately 70 percent of their bonuses are based on meeting company objectives, and diversity and employee development are two of the four components measured. Bayer also monitors workforce statistics on employee demographics by level, function, retention and turnover, and uses them in annual evaluations of senior executives. Bayer distributes an annual cultural survey to help managers understand their employees’ points of view.¹⁵

Principle 3: Management Accountability

Exemplary organizations recognize that systems of accountability for diversity are necessary to achieve results. These organizations put systems in place to hold managers at all levels personally accountable for meeting diversity objectives. Responsibility for recruiting and retaining a diverse workforce typically extends well beyond the human resources department to line managers.

Leading organizations reflect these diversity goals in metrics that are well defined and clear to all employees. Successful organizations tie rewards for managers — such as merit pay and bonuses — to their personal achievement of diversity goals. These metrics frequently focus on:

- Representation of women and minority groups within the operating unit
- Representation of new hires
- Representation within applicant pool
- Promotion rates
- Pay equity
- Turnover rates
- Allocation of space and funds

Principle 4: Continuous Improvement

Exemplary organizations recognize that improving science and engineering inclusiveness is not a short-term or one-time effort, but a process of continuous improvement that contains regular cycles of planning, execution and evaluation of progress.

Many science and engineering diversity leaders begin with internal benchmarking exercises to understand their own strengths



and weaknesses, assess what is already working within their organization and determine what can be improved. This process helps them identify and prioritize problem areas, and sets a baseline against which progress can be measured. It also allows the organization to better understand barriers to the advancement of women and underrepresented groups. Benchmarking against other organizations, especially those that have received commendations for their diversity initiatives, also can be of great benefit.¹⁶ It is an opportunity to observe what works, and learn through the experiences of others.

Once internal strengths and weaknesses are known, the next step is to develop specific and practical solutions tailored to an organization's unique environment. Organizations frequently implement initiatives on a pilot basis prior to broad-based implementation. These initiatives are measured and evaluated to determine what works and what can be improved. It is important to measure how well systems are functioning, and to identify both the success and failure points, then follow through with corrective action where needed. Just like an engineering design project, a diversity program needs a feedback loop to ensure the desired results are being achieved.

Metrics for success of an science and engineering diversity program include the quantitative metrics discussed above, applied organization-wide, such as decreased turnover and increased representation of women and other underrepresented groups in executive and board positions. Metrics also should be developed to address micro-level inequities to help lead the organization toward a more fundamental cultural shift.

In addition to these quantitative metrics, many exemplary organizations use qualitative measures such as annual employee surveys, focus groups, personal interviews (particularly of employees exiting the organization) and affinity group evaluations to assess the success of their diversity programs. These surveys may seek to measure levels of employee satisfaction and optimism, perceptions about equity and objectivity in the career development process, perceptions about managerial effectiveness, intent to stay with the organization, and opportunities for, and barriers to, advancement.¹⁷

Measurement and Continuous Improvement

AT&T measures the success of its diversity programs using a combination of hard metrics and opinion surveys. It reported a decrease in employee turnover from 22 percent to 16 percent, resulting in \$20 million in savings, along with a substantial improvement in employee satisfaction.¹⁸

Practices that Work

The four design principles described above are not fully realized solutions. Their impact hinges on effective implementation strategies to recruit, retain, develop and advance scientists and engineers from underrepresented groups. Exemplary organizations combine these principles in a holistic approach to develop and

implement these strategies. Their overarching goal is to become and be known as an employer of choice.

What is an employer of choice? It is an organization that recognizes that its reputation is a significant factor in whether or not the organization can attract science and engineering talent. For example, in a recent survey by the **National Society of Black Engineers**, African American engineering students ranked advancement opportunity, job security, interesting work, training opportunities, work-life balance programs, diversity programs, and internship and co-op opportunities as the most important factors they consider when evaluating prospective employers.¹⁹

Exemplary organizations recognize that to earn a reputation as an employer of choice requires them to address a wide range of needs and interests of prospective (as well as current) employees. These organizations seek to demonstrate their commitment to science and engineering excellence and diversity not only through their employee recruiting, retention and advancement practices, but also by reaching beyond their own boundaries to pursue the goal of broader participation in the education and workforce supply chain. We touch on each practice in turn.

Targeted Recruitment

Competition for the best and brightest science and engineering talent is keen, particularly at the Ph.D. level and in high-demand skill areas such as computer science and engineering. Most large U.S. employers engage in some kind of recruiting effort to increase diversity within the organization, typically encompassing a number of basic elements:

- Provide diversity training to members of the recruiter team so that recruiters do not focus narrowly on academic achievement as the only selection factor.
- Recruit at colleges and universities with diverse student bodies, including Historically Black Colleges and Universities (HBCUs) and other Minority-Serving Institutions (MSIs).
- Develop candidates through internships, summer employment and cooperative work programs.
- Use alumni to recruit and conduct outreach activities.²⁰

Beyond these basics, standout organizations create competitive advantage through depth of commitment and quality of execution. In operational terms, recruiting strategies that work invest in long-term relationships with institutions that serve women, minorities and persons with disabilities; align the recruiting function with the responsibility and accountability of line managers with specific hiring needs; and build the organization's reputation as a good place to work.

Investing in long-term relationships Many science and engineering employers recruit at HBCUs and MSIs, and become involved with women and minority-focused student and professional organizations. But exemplary organizations do more. They invest significant time and resources in finding those organizations that best fit their needs and interests, and in developing long-term partnerships with those organizations. They do their homework to find educational institutions that produce the type of graduates they need — for example seeking out schools with extraordinary faculty



in a particular discipline — and then engage holistically with those institutions. This involvement may include serving on advisory boards, providing equipment or financial support, establishing scholarships or internship programs and collaborating on research.

At the same time, leading information technology companies seek to build long-term relationships at the individual level. Scholarship awards to high school seniors and junior college transfers from underrepresented groups are standard practice among committed firms. In addition, **Microsoft** and **IBM** are both widely known for their sponsorship of summer camps that help nurture the talent of middle and high school students.

Engaging line managers Recruiters perform several important functions, including representing the organization to prospective employees and building partnerships with universities, professional societies and student organizations. But it is the line managers who make hiring decisions and actually work with new entrants. Exemplary organizations develop strong working partnerships among recruiters and their line managers. This is particularly

important when developing internship and cooperative programs, in which the line managers will actually work with, mentor and hire the students participating in the programs. These mentoring relationships are extremely valuable in facilitating the intern's adjustment to, and growth within, the company when the intern joins on a full-time basis.

Recruiting employees with experience Many of the practices identified above also are useful in recruiting employees with experience. In addition, the following are successful practices:

- Recruitment activities at national professional conferences.
- Development of relationships with multi-cultural organizations.
- Recommendations from current employees.
- Instructing recruiters, referral and search firms to present a diverse slate of candidates for all positions.
- Providing financial incentives to recruiters and hiring managers.

Recruiting Practices

3M launched the Minority Engineering Scholarship Program (MESP) in 1986, targeting African Americans, Hispanics and Native Americans in technical fields. Since its inception, nearly 250 students have participated in this academic program. About half the scholars work for 3M when they graduate; most of the rest go directly to graduate school. Hands-on summer internships that go along with the MESP offer college students the chance to explore options in many of those areas. During these internships, most students work alongside veteran engineers who are often Ph.D.s. Because Native Americans are the least-represented minority in technical majors, 3M has put considerable effort into recruiting from that group. The company identifies top students and includes them in the program. When they arrive for their internships, members of 3M's Native American Network help them adjust to the corporate environment.

Hewlett Packard (HP) seeks to build strategic partnerships with a select group of institutions to ensure a supply of well-qualified and diverse graduates and encourage a strong university research environment. Such partnerships in 47 active-recruiting campuses, of which 20 are leading research institutions where HP has had long-term involvement and seven are historically Black Colleges and Universities or Minority Serving Institutions with similar long-standing ties. These two clusters of partners have a formal and continuing relationship with HP, including assignment of a university relations program manager, a college recruiting programs manager and a campus recruiting manager, as well as access to grant initiatives offered by HP's Philanthropy and Education Foundation.²¹

Faculty for the Future (FFF) is a website dedicated to linking a diverse pool of women and underrepresented minority candidates from engineering, science and business with faculty and research positions at U.S. universities. Academic employers

can post positions and review a resume database online. There are currently over 200 institutions registered with FFF, with over 230 job postings. The site provides an electronic forum with discussion groups focusing on topics related to faculty careers. FFF is administered by Women in Engineering Programs and Advocates Network (WEPAN) and is funded by the General Electric Fund.

The **Compact for Faculty Diversity**, now in its 10th year, is a regional coalition of New England, Southern, and Western boards of higher education to increase the number of minority students who earn Ph.D.s and become college faculty in fields in which they are most underrepresented. The program provides financial and academic support as well as personal guidance. Each region administers its own program for doctoral scholars with the goal of creating a state-based, self-sustaining funding mechanism. The Compact's doctoral scholars program supports more than 200 scholars, who attend 78 institutions in 23 states. The program has maintained a retention rate of almost 90 percent, and more than 70 percent of its graduates have begun academic careers.

In 1994, the Board of Directors of the **American Chemical Society (ACS)** established a Scholars Program to make \$5 million in renewable scholarships available over a five-year period to underrepresented minority students pursuing undergraduate degrees and careers in the chemical sciences. ACS Scholars are assigned a volunteer scientist-mentor and are helped to identify summer research experiences, many with corporate sponsors. To date, ACS has awarded approximately \$7 million in scholarships through its Scholars Program, and has an overall retention rate of 82 percent. Of the 505 program graduates, 399 have been tracked: 213 have entered graduate programs and 186 are in the chemical workforce. Of those who entered graduate school, 68 report being in Ph.D. programs and five have already received their Ph.D.

Hiring science and engineering professionals in academia can be particularly challenging due to the smaller pool of Ph.D.-level scientists and engineers who are underrepresented minorities or persons with disabilities. At the same time, many of the recruitment tactics identified above can be used. There are numerous tools being developed, such as the Faculty Recruitment Toolkit recently published by the University of Washington, to help search committees create diversity in the applicant pool by developing a more inclusive search process.²² One of the newest tools is the Faculty for the Future website, which facilitates posting job applications and resumes for academic positions.

Retention

Given the high cost of employee turnover, all employers have a strong financial incentive to improve their retention rates. Many organizations engage in a variety of basic activities to meet this objective, including providing diversity awareness training, development of performance management systems to focus performance evaluations on objective criteria, and developing competitive pay and benefits packages. Many of these activities are necessary to meet legal requirements.

Exemplary organizations go well beyond these basics, striving to create an open and inclusive environment in which employees are developed and nurtured. These exemplary activities include:

Creating organizational transparency Organizational transparency is defined as open communication regarding policies and procedures, such as those related to core competencies sought in employees, and standards for hiring, performance evaluation and promotion. In industry and government career pathways, skill sets and expectations for job advancement should be clearly defined and openly published. In academic institutions, requirements for achieving tenure and subsequent advancement should be well defined and clearly communicated.

Norms and cultural rules, once informal and known only by a few, are now being formalized and publicized. This practice helps level the playing field for employees who may not be part of insider networks. And in many leading organizations, “public” has taken on new meaning as information regarding policies and procedures now appears on the organization’s website, making it widely available within and outside the organization. Such information includes well-defined and communicated core competencies for promotion and written standards for performance evaluations, which make it more difficult for an organization to continue discriminatory practices, and give employees the information needed to help plan their career paths.

Open posting is becoming more widely used in organizations to increase the dissemination of information to all employees and remove the veil of secrecy which previously surrounded advancement practices. In some organizations, formal committees make performance and promotion decisions, increasing the transparency of — and confidence in — these employment actions.

Equity in compensation and promotions Leading diversity employers implement stringent controls to ensure that there are no pay inequities within their organizations based on gender, ethnicity

or disability. Practices include: developing fixed salary ranges for each position and ensuring that all individuals holding the same position are paid within that range; establishing fixed procedures for awarding merit-based raises and bonuses, such as tying bonuses to measurable performance criteria; and requiring second-level supervisors to approve bonuses and salary increases. In some organizations, the human resources department acts as a check on bonuses and salary increases that are outside the guidelines.²³ Some science and engineering diversity leaders conduct annual audits of their compensation practices to identify and correct any deviations from the stated policy.

Affinity groups Employee affinity groups, networks and resource groups have greatly increased in numbers and stature in the last few decades. Initially conceived as social support networks for groups of employees with common interests, they have greatly expanded their roles in the workplace. Affinity groups now frequently participate in recruitment and retention efforts, lead outreach and volunteer programs, serve as sounding boards for marketing, product development and business plans, and operate as liaisons between employees and management.²⁴

Affinity groups also frequently serve as effective career development resources for group members, providing, for example, an informal network that helps replace “old-boy” systems, as well as opportunities for mentoring and networking with influential colleagues.²⁵ The latter was identified as being particularly important to helping women of color advance, according to a recent study.²⁶

Affinity Groups

Ford works closely with 10 Employee Resource Groups (ERGs) including its Employees of African-Ancestry Network, Hispanic Network Group, Women in Finance and Parenting Network. These resource groups are formed by employees, but formally recognized and supported by the company. A senior Ford executive champions each ERG. Ford budgets \$8,000 annually for each group.²⁷

AT&T has eight affinity groups, including the Intertribal Council of AT&T, which gives special focus to the cultural development, career advancement and education of Native American employees, and Individuals with Disabilities Enabling Advocacy Link (IDEAL), which works to enhance understanding and remove barriers that impede the full development and productivity of employees with disabilities.

Intel has almost 20 employee groups, including the Women at Intel Network (WIN), which encourages women employees to achieve their full potential. In the U.S., there are almost 100 employee group charters. Employee groups support professional development, enhance people’s effectiveness at work and encourage improved teamwork and interaction.

Johnson & Johnson has eight employee affinity groups, including Help Our Neighbors with Our Resources (HONOR), which helps the company improve the company’s internal quality of life, and also reaches out to minority and disadvantaged communities.

Both employers and employees have a major stake in the success of affinity groups. In addition, the presence or absence of affinity groups is an important indicator of the level of maturity of an organization's diversity program. For example, affinity groups representing women cannot form until there is a critical mass of women in an organization.

Work-Life programs Work-life programs are a key component of any organization's strategy to increase retention of women and underrepresented science and engineering professionals. Several studies have documented the positive effect work-family programs have in reducing absenteeism and tardiness, and promoting employee retention. Work-life programs have particularly beneficial impact on retention of Latinas, who are more likely than other women to consider family commitments a barrier to their career advancement.²⁸

Achieving a work-life balance has become increasingly important to all workers. For example, a recent study shows that at least

Balancing Work and Life

IBM has initiated many work-life programs that have been emulated by others. IBM began a major global work-life initiative in 1998 with the creation of a Global Workforce Flexibility Project Office, supported by IBM's senior management team. One result is flexible work programs, which permit employees to begin their workday up to two hours before or after the location's normal start and stop times, providing a four-hour window of flexibility. When employees need to be away from work for an extended period of time, they may take a personal leave of absence for up to three years. Employees can reduce their work weeks for a broad array of personal needs such as dependent care responsibilities, "once in a lifetime" opportunities or other individual needs. Employees can perform their work at home or at another off-site location through a variety of telecommuting options. Meetings happen by phone, bringing together work teams from all over the world.

These flexible work arrangements are widely used within the company. In particular, senior level women have been successful while using these programs. Between January 1996 and December 1999, the number of women executives increased by 175 percent and the number of women-of-color executive increased by 235 percent.²⁹ Sixty-seven percent of IBM's global women executives are mothers, up from 40 percent in 1995.

Xerox, also a national leader in this area, recognizes that many outside factors influence work behavior. In response, the company's Work-Life Programs ensure that the workforce has the tools and flexibility it needs to achieve success, such as a dependent care fund, alternative work schedules, adoption assistance, mortgage assistance and partial pay replacement for leave under the Family and Medical Leave Act. Xerox also offers a childcare subsidy, a childcare resource and referral service, an employee assistance program and education assistance program.

70 percent of men between the ages of 21 and 39 want to spend more time with their families, and are willing to make career sacrifices to do so.³⁰ The needs of single parents, dual career couples and the expanding need for elder care have increased the non-work burdens placed on employees. The expanded ethnic, faith and cultural backgrounds of new science and engineering workforce participants require additional considerations and sensitivities for their full inclusion in the workplace.

Organizations that can assist in providing solutions to these concerns see improved morale, increased productivity and increased commitments to the organization by their employees. In-house daycare centers, flexible vacation/sick leave time, eldercare support and flex-time are all examples of programs that support employees in managing life's demands. Some large organizations have gone further, providing on-site services including pharmacies, dry-cleaning, food shopping and family-friendly cafeterias — all done in the interest of reducing the external burdens on their employees. Collaborations among organizations to provide such services in smaller communities have also proven successful in meeting the needs of employees.

Programs and services that assist employees in meeting their needs contribute to employer attractiveness and overall job satisfaction, and hence retention. In this increasingly competitive job market, flexibility and support can be the determinant factor in one's choice of employment.

Career Development and Advancement

To advance to senior leadership positions in the private sector, government and academe, science and engineering professionals need to develop a broad portfolio of technical and non-technical skills and be given a spectrum of opportunities. For example, in a survey sponsored by **Catalyst**, men and women engineers identified several factors needed for advancement in engineering careers, including management skills, high-visibility assignments, mentors, formal academic training and development programs.³¹ In addition, access to line positions with clear bottom-line impact is viewed by many as a key step to advancing to top leadership positions in the corporate world.

Recognizing that the lack of opportunity for advancement is the top reason women and underrepresented science and engineering employees leave, exemplary organizations have adopted a variety of programs to prepare underrepresented groups for promotion and advancement.³² Key program elements include:

Mentoring Mentoring — both formal and informal — is at the heart of most successful career development and advancement initiatives, and has been shown to have a significant impact on the professional development of employees. In recent studies, 69 percent of the women of color who had mentors have been promoted since 1998, compared to only 49 percent of those with no mentors.³³ And the more mentors a woman of color had, the greater number of promotions she received.³⁴

Mentoring often means something different at different points in an individual's career. Early on, mentoring helps new employees feel connected to their organization. Later, mentoring can help build the knowledge and skills needed for advancement. Even



executives in top positions, such as CEOs and university presidents, can benefit from peer mentoring. There are numerous models and programs available for mentoring, but to ensure success they should be tailored to the needs and culture of the organi-

Mentoring

Lockheed Martin incorporates mentoring in executive development, community outreach, summer internship and co-op programs, and new employee orientation. Its mentoring initiative — learning through others — is supported by a dedicated website on the company intranet with resources for mentors and mentees, including an on-line learning tool with courses on communication, coaching and career development. An executive mentoring program is designed to open up career opportunities for promising managers by providing a broader view of the organization. More than 2,100 managers currently participate in Lockheed Martin's executive mentoring program.

Procter & Gamble sponsors a highly unusual mentoring program in which mid-level women serve as formal mentors to senior-level men to help educate executives on the challenges women face in the P&G environment. The program is led by a steering committee of senior executives and an internal mentoring expert. This forum allows women to serve as a sounding board for the men, and allows the men to discuss gender issues in a non-threatening environment. Providing mid-level women access and exposure to senior executives is another benefit of the program.

Texas Instruments (TI) seeks to create a mentoring culture that goes beyond specific programs. The company's approach includes both formal and informal mentoring, as well as tools for "self-managed" mentoring. Formal mentoring can be sponsored by a business, function or diversity initiative. For example the Black Employees Initiative sponsors an annual educational symposium designed to encourage continuous learning and mentorship. Similarly, TI's Women's Initiative sponsors the Dallas MenTTium 100, a nationally acclaimed mentoring program to promote women's executive development.

Kansas State University's Mentoring Fellowships program, began in 1995 with the goal of helping women and minority tenure-track scientific and engineering faculty establish themselves in a chosen research discipline. Fellows receive \$6,000 annual fellowships and a tenured mentor in order to develop their research programs to a level that attracts extramural research funding (usually necessary to earn tenure in these fields).³⁵ Fellows graduate from the program upon receipt of substantial external funding. The program is demonstrating impressive results. Eligible female awardees, 17 of the 22 have achieved tenure, a level that compares favorably with male faculty, and five out of six faculty of color also have achieved tenure.³⁶

zation, and evaluated for their effectiveness on a regular basis.

Identifying and nurturing high potential employees One of the biggest challenges in increasing diversity in science and engineering leadership ranks is the assumption — usually unfounded — that there isn't enough talent in the pipeline. In most cases the talent is there. It just hasn't been identified and actively developed. Leaders in science and engineering diversity are making it a priori-

Growth Opportunities

Consolidated Edison (Con Ed) launched the Growth Opportunities through Leadership Development (GOLD) program in 1981 to develop future managers from under-represented groups. The program selects 20 percent of the company's college graduates for the program, based on their technical and communications skills and leadership potential. From 1997 through 2001, 55 percent of Con Ed's GOLD associates were minorities and 30 percent were women. The mentoring, senior management guidance and rotational assignments that comprise the program have achieved striking results. GOLD associates have attained high-level management positions including vice president for maintenance and construction, chief distribution engineer and general manager of substation operations.

Motorola has been nationally recognized for its succession planning and leadership development. The company maintains a list of three candidates for every key management position: an individual to fill the position in an emergency situation; someone who could be groomed for the job in three to five years, with a third spot reserved for a women or minority candidate. Motorola has also developed a system to develop "high potential" employees who eligible for fast track promotion. If such an employee leaves the company, managers are expected to explain why. These procedures have yielded significant gains. In 1997, Motorola had 40 women vice presidents, including seven women of color, up from two in 1989.

Verizon established a Development and Leadership Initiative (DLI) in 2001 to recruit, retain and prepare ethnic and minority candidates for leadership roles. Candidates with at least five years experience with the company are selected by their supervisors based on job performance and leadership skills. Hispanic employees piloted the DLI because of their link to Verizon's business strategy in Hispanic communities. The early success of the initiative, which led to an increase of Hispanic vice presidents from seven to 16, prompted the Hispanic Association on Corporate Responsibility to award Verizon its Best Practice citation in 2002.

The National Science Foundation's ADVANCE Program seeks to facilitate the advancement of women to the highest ranks of academic leadership. ADVANCE provides award opportunities for individuals and organizations through its Fellows, Institutional Transformation and Leadership programs.

ty to identify and prepare high-potential employees to assume senior leadership roles within the organization.

A key form of preparation is leadership development, a process by which individuals receive training and work experience to prepare them to assume increasing levels of responsibility within their organization. These experiences frequently include profit and loss responsibility, rotational assignments to learn about different functions, learning negotiation skills and dispute resolution tactics, and how to manage and motivate subordinates.

Some exemplary organizations have designed leadership and management development programs specifically for underrepresented groups. Others have designed programs to address the specific needs of underrepresented groups, but open those programs to all employees who are qualified.

Supply Chain Partnerships

Every organization with a long-term stake in broadening participation recognizes that it is part of an education and workforce supply chain. Opening up the opportunity structure in the workplace is only part of a solution that depends equally on expanding the pool of technical talent from which employers in every sector draw.

Supply chain partnerships look beyond immediate recruiting needs to build capacity in pre-kindergarten through 12th grade and higher education. The federal government has made an important national contribution in this area, although the efforts of funding agencies to increase the supply of work force entrants from underrepresented groups remain largely uncoordinated. Companies, foundations and universities have generally pursued more limited objectives.

Employers have a rich, and at times confusing, menu of options to build students' skills and confidence, stimulate interest in

technical careers and encourage universities to develop more diverse groups of students in science and engineering disciplines. The choices include: financial support for in-school, after school and summer programs; financial aid; equipment donations; competitions; hands-on research opportunities; mentoring and technical assistance. Any of these options can be pursued unilaterally or in concert with others.

Taking account of the findings of BEST's Blue Ribbon Panels on Pre-K-12 and Higher Education, as well as the experience of BEST's Blue Ribbon Panel on Workforce Diversity, exemplary supply chain initiatives reflect four shared features: community engagement, effective use of leverage points, capitalizing on stakeholder strengths and a focus on results.

Community Engagement

QUALCOMM forged a community-based partnership to improve the math performance of San Diego's lowest performing elementary schools. Joining forces with other employers, the San Diego Unified School District and San Diego State University, the partnership focused on giving teachers the knowledge and confidence to deliver course materials more effectively. Within two years, schools participating in the partnership registered the highest gains in California on standardized math exams.

DuPont applied the same partnership principles in Delaware, using its resources and convening power to introduce a hands-on science program in elementary schools throughout the state. Within two years, this program lifted scores on statewide science assessments across the board while at the same time eliminating the achievement gap between minority and non-minority students.

Investing in the Education Supply Chain

Employers have both an interest and a responsibility to play an active role in strengthening the nation's technical talent pool. In an era of limited resources, however, they must prioritize their activities and emphasize those investments are demonstrably effective and have the best chance of delivering measurable results.

Improve access to quality math and science preparation


Employers should support high quality pre-college math and science education for all students in their local communities and at the state level. Employers should adopt holistic, rather than piecemeal, approaches to counteract inadequate math and science preparation.

Stimulate interest in technical careers Employers should collaborate with other stakeholders in their communities to stimulate the interest of all children in S&E careers.

Create multipliers by engaging in partnerships Employers should partner with major national and regional organizations — such as the Boy and Girl Scouts, 4H and Junior Achievement — to add strong science and technology components to their existing programs.

Hold universities accountable Employers should hold universities accountable for producing more diverse technical talent by giving priority to recruiting for new S&E talent from those academic institutions who have accepted the BEST Challenge, and demonstrated a strong commitment to encouraging the full participation of women and underrepresented minorities in the S&E workforce.

Improve public understanding of science and technology and image of S&E careers The U.S. must make a national commitment to improve public understanding of science and technology, and create a positive and inclusive public image of scientists, engineers and technical professionals.



Community engagement Communities provide a natural framework for pooling resources and competencies because they bring together all of the key institutions and stakeholders who must be mobilized to develop more technical talent from underrepresented groups – parents, students, educators, civic groups and institutions, foundations, employers and the scientists and engineers.

Community-based initiatives are often most effective when they engage participants in active learning. Holding science competitions in schools, coupled with career fair information and workshops for families, is one such model. Providing the general public with information about the use of science and engineering in casual ways — an explanation of the physics used next to the roller coaster, or offering information on nature walks about the flora, fauna or topology of an area — provides science literacy that is more accessible to laymen and that is relevant to everyday life.

Leverage points Effective supply-chain partnerships seek leverage points that create multiple impacts. One such leverage point is

Leverage

Merck's nationally recognized Institute for Science invests deeply and for the long term in training teachers in school districts where the company has major research and manufacturing facilities.

HENAAC (Hispanic Engineer National Achievement Awards Corporation), draws upon its members as role models to support a widely acclaimed bilingual program — Viva Technology™ — to increase awareness of parents and middle school students of the opportunities in science and engineering careers. The program vividly communicates both the value and potential accessibility of these careers by awarding “doctorates” to all participants.

the professional development of pre-K-12 teachers, where corporations can have major effect. Another critical leverage point is parental engagement; outreach programs can help parents to see new opportunities for their children.

In higher education, the availability of financial assistance for low-income students creates a powerful multiplier. Work-study arrangements for these students, who are often compelled to work while taking a full-time academic schedule, can fill a critical gap by combining an earnings opportunity with meaningful research work.

Capitalizing on assets Standout collaborations build on the strengths of the partners. In many cases, this means inviting potential career entrants into organizations to take advantage of their technical and human resources.

A focus on results In today's resource-scarce environment supply chain partnerships must invest in initiatives that work and where necessary apply pressure to insure that commitments to diversity are honored. Exemplary organizations track recruiting, retention and degree completion for underrepresented groups in the institutions of higher education they support. Where needed, they make clear that upping the numbers of graduates and increasing

faculty representation are expectations of long-term partnerships with universities. To meet the national challenge, the measure of effective collaboration is in building capacity.

Results: Companies Building Capacity

Microsoft's High School Internship program was created in 1991 to open up long-term education and career opportunities for inner city youth in the Puget Sound area through summer employment in large corporations. The program tracks participating students through college, seeking to prepare and encourage them to pursue careers in technology. Nationally, Microsoft has invested more than \$160 million in recent years to stimulate increased interest among minorities and women in scientific and technical fields. Its pipeline initiatives include partnerships with national organizations, targeted scholarship and fellowship programs, and wide-ranging pre-K-12 awareness initiatives.

Capitalizing on Assets

NASA's Project ACCESS recruits high-achieving students with disabilities for internships at its centers performing research and aeronautical and space projects. The project has reshaped the attitudes of managers and staff regarding the capacity of these students to make substantial contributions.

The American Association for the Advancement of Science sponsors ENTRY POINT! — an employers' coalition that also provide internships in science, engineering and technology for students with disabilities. To date, this program has made more than 350 intern placements and has achieved more than a 90 percent success rate of alumni working in technical fields and pursuing degrees in graduate programs.

Bell Labs designed its Graduate Research Fellowship Program for underrepresented groups around its strongest asset — an on-site research and development experience under the guidance of research scientists and engineers. Beyond full tuition, fellowship participants spend an initial summer at Bell Labs on a research project establishing face-to-face relationships that provide encouragement and support throughout their graduate education.

Intel has invested more than \$700 million in education and training activities outside the company since its founding and contributed more than \$100 million in 2002 alone. The Intel Foundation, funded exclusively by Intel Corporation, supports programs that advance math, science and engineering education, promote women and underrepresented minorities entering science and engineering careers and increase the effective use of technology in education. Intel's initiatives include professional development, web-based resources and tools, science competitions, equipment grants, scholarships and fellowships, community computer learning centers and grants to support student achievement. The National Awards for Excellence in Science, Mathematics, and Engineering Mentoring recognize individuals and organizations that serve as models in developing the nation's human resources in technical



fields. Selection criteria are rigorous, requiring demonstrated results in number and diversity of students mentored to high school graduation, bachelors, masters or graduate degree levels; evidence that students who are mentored are successful in pursuing degree objectives; substantive achievements in changing the educational system to enable improved performance and advancement for underrepresented groups; and demonstrated innovation that is replicable. Institutions also must demonstrate institutional sustainability in structural changes or programs that are increasing student retention and/or graduation rates, and a quality of institutional life that fosters the establishment of viable networks that facilitate learning, contacts and career development. The

National Science Foundation administers the award program on behalf of the White House.

Reaping the Benefits

A diverse workforce will provide benefits to the workplace, the supplier, customer and workforce at large. Increased creativity, different perspectives, and greater breadth of experience will provide more potential solutions to any project, enhancing creativity, innovation and, in turn, competitiveness. In addition, organizations that can better reflect the populations they serve, for example in their products and services, will reap the benefits of increased business.

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Chapter 4

Recommendations

Employers' full engagement is essential to move beyond piecemeal and uncoordinated efforts into transformational change

The exemplary employers discussed in Chapter 3 are helping address barriers to participation of women and underrepresented minorities in the science, engineering and technology workforce, and bolstering overall technical workforce development. Yet despite these efforts, overall progress has been slow and uneven, with little, if any, improvement during the last decade. In 1999, the U.S. S&E workforce remained 76.3 percent male and 81.8 percent white.¹ Women, underrepresented minorities and persons with disabilities participated in the S&E workforce at approximately the same rates in 1993 as in 1999. In one area — computer science and engineering — women's participation in the workforce actually declined, despite an enormous increase in demand for computer scientists and engineers during this period.

A major reason for the glacial pace of change is that many of the efforts that have proved most effective — such as mentoring and leadership development — succeed one person at a time, requiring significant resources and years of support for each individual's career development. While these interventions reach many thousands of people nationwide, there is a pressing need to replicate and expand the strategies and programs that are most effective.

Employers have a critical role to play to ensure the U.S. has the world's most talented, highly skilled and diverse S&E workforce. Their full engagement and leadership is essential to move beyond piecemeal and uncoordinated efforts and into transformational change. Moreover, the challenge cannot be met one organization at a time. The technology business community, academe, government, and science and technology nonprofit organizations all must work together on high-impact initiatives designed to promote systemic change. Bold action, the commitment of significant resources and an effective system of accountability for results are needed to ensure S&E workforce excellence and diversity:

Several conditions must be met to make diversity a norm rather than an exception in the U.S. technical workforce:

- S&E employers must get their own houses in order by making the recruitment, retention, professional development and advancement of women, minorities and persons with disabilities a top priority within their own organizations. Although the practices of the exemplary employers discussed in Chapter 3 are a significant step in the right direction, only a handful of organizations have made the transformational changes necessary.
- S&E employers must reach beyond the boundaries of their own organizations to adopt business practices that encourage their partners and suppliers to make the same commitment. Systemic change will occur only when hundreds of employers and other key stakeholders embrace S&E workforce diversity

as a top priority. Today's diversity leaders must encourage others to join them.

- Employers must support and invest in a stronger educational supply chain to produce the quality and quantity of workforce entrants needed to sustain U.S. technological leadership.

The key to broad adoption of these conditions is the creation and maintenance of appropriate incentives. We **recommend** four mutually reinforcing mechanisms that can be undertaken by a coalition of government and business networks.

1. **A public commitment**, in the form of a standardized pledge along the lines of the Sullivan Principles, by the leadership of organizations involved in technical endeavors to contribute to the creation and nurturance of the future S&E workforce, focusing on broad outreach to all U.S. populations. This pledge is supported, enabled and incentivized by three additional elements:

2. **A workforce leadership network**, which provides incentive through recognition and peer culture, and provides a venue for sharing best practices.

3. **Well-documented workforce development toolkits**, which encapsulate state-of-the-art, research-based best practices in a form that is readily budgeted, adopted and measured.

4. **A national award for science and engineering workforce excellence**, similar to the Malcolm Baldrige Award, recognizing sustained achievement in equitable workforce development, which provides models of best practice and incentivizes excellence through recognition. Criteria are spelled out in Appendix 2.

The architecture of these recommendations, then, is a tripod in which an individual organization's pledge is supported and sustained by the network, toolkits and award, as sketched below:

We discuss each of these four elements in turn.

1. Commitment

Chief executives of technology-intensive companies, university presidents, state and federal officials, and leaders of science and technology nonprofit organizations and professional societies should make — or renew — a public pledge to create and nurture a diverse, highly skilled S&E workforce.

Successful programs start with visible leadership from the top, backed up by high-performance work systems and programs, financial resources and other types of support that permeate the



organization. Signing a pledge to support S&E workforce excellence and following up that pledge with concrete action will send a powerful message within each workplace and to other employers and key stakeholders involved in S&E education and workforce development.

To encourage leaders in industry, academe, government, and science and technology nonprofit organizations to make a public commitment to diversity, the Workforce Panel has developed the BEST Challenge, included below. A roadmap for achieving the BEST Challenge is at Appendix 1. It is based on the four principles of excellence described in Chapter 3: institutional commitment; integrating diversity into organizational strategy, processes and culture; management accountability; continuous improvement to achieve sustainability. In addition, the BEST Challenge covers specific S&E diversity practices adopted by exemplary organizations: targeted recruitment; retention efforts, including support for employee affinity groups and work-life programs; support for career development and advancement; and partnerships with customers, vendors and suppliers, educational institutions and community organizations.

2. Network

A workforce leadership network of committed public and private sector leaders should be established to persuade key stakeholders to embrace S&E diversity, and to share their

The BEST Challenge

As an organization which endorses the BEST Challenge to increase diversity and excellence in the science, engineering and technology workforce, we commit to following principles:

Publicly support the goal of diversity and excellence in the American science and engineering workforce within our company, among our peers and partners with whom we do business, and in the communities in which we operate.

Adopt and actively implement policies to promote excellence and diversity in our workforce, and to integrate our diversity goals into our overall business strategy.

Develop a system to communicate with internal and external audiences our policies to promote diversity and excellence in our science and engineering workforce.

Create an internal governance structure to ensure our diversity initiatives have meaningful leadership, visibility, sustainability, measurable goals and accountability measures.

Hold all levels of management accountable for living up to our goals for excellence and diversity in our science and engineering workforce by creating specific performance goals, formal measurements of progress and systems of reward.

Reach beyond our organizational borders to promote excellence and diversity in those partners with whom we do business and in the educational institutions that prepare our future employees and, to the extent possible, hold both accountable for achieving diversity goals.

knowledge and successful practices with, peers, customers, suppliers and other stakeholder groups.

Although many leading employers have made significant commitments to developing a diverse, highly qualified S&E workforce, and have implemented programs to improve the recruitment, retention, professional development and advancement of women and underrepresented minorities, these activities have not yet reached the critical mass needed for maximum impact. True systemic change will occur only if and when many more S&E employers and other key stakeholders embrace S&E workforce diversity as a top priority, and make numerous changes both large and small from business as usual.

A highly visible effort is needed to educate key leaders in technology-intensive companies, academe and government on the need for S&E workforce diversity, and persuade them to take action. A Workforce Leadership Network composed initially of those diversity leaders who accept the BEST Challenge can play a vitally important role in persuading others to act.

The most effective means of persuasion for each stakeholder in the American S&E workforce system will be economic self-interest. Leaders must be convinced that taking action to recruit, retain, develop and advance their S&E workers — including women and minorities — will benefit their organizations in tangible ways. As discussed in Chapter 3, reducing the cost of S&E employee turnover is one significant benefit.

Beyond articulating a compelling business case, encouragement to support S&E workforce excellence must come from all directions — the public, parents, students, educators, government officials, the private sector (including partners and suppliers), the media and other opinion leaders — to create a loud and clear call to action. Because the U.S. science and engineering educational and workforce development systems are so interdependent, the concerted action of one key stakeholder group can have great influence to persuade other stakeholder groups also to take action.

Specific activities of the S&E Workforce Leadership Network should include:

- Making public speeches about the importance of S&E careers and professionals to the U.S. economy and society;
- Communicating with the media and other opinion leaders about the S&E workforce challenge, including authoring opinion pieces, meeting with editorial boards, and making television and radio appearances;
- Participating in high-profile activities to encourage students to pursue S&E careers, and engaging in other efforts to reach out to students, teachers, parents, guidance counselors and others who influence students' career decisions;
- Communicating with peers, partners and suppliers to encourage them to accept the BEST Challenge and make S&E workforce excellence a top priority within their own organizations;
- Counseling small groups of peers on the lessons learned from their own diversity and workforce excellence initiatives; and
- Engaging in activities that help create an image of S&E professionals as open and inclusive to women and minorities.



3. Toolkits

National models of S&E workplaces that are open and inclusive should be developed and made widely available to public and private employers of all sizes. Professional societies or other non-profit organizations should act as honest brokers to provide employers with the right tools and information necessary to implement successful S&E diversity programs.

Once organizations make a commitment to create and nurture their S&E talent, many lack the expertise and tools needed to implement effective programs. Although there are many diversity consultants and for-profit organizations that help organizations develop and implement diversity programs, there is a need for an honest broker to provide employers with the right tools and information. Mechanisms also are needed to allow organizations to share information and ideas effectively among themselves, and employers need access to objective research and program evaluations to understand what works, where and for whom.

These needs could be addressed by creating a one-stop clearinghouse for quality information and tools to support S&E diversity initiatives, including the following elements:

Resources directories A single web portal should be created through which users can link to trusted, respected and reliable resources on all aspects of S&E workforce diversity. A trusted nonprofit organization should manage the portal and adopt neutral, objective standards for including materials and resources that are based on sound research, empirical and unbiased evaluation and have demonstrated measurable results.

Case studies of best practices Although some case studies of innovative organizational practices currently exist, a common framework for evaluating and reporting those case studies is needed. In addition, many currently existing case studies do not provide sufficient detail to offer useful guidance for others.

Toolkits and “how to” guides A few useful toolkits already are available. For example, Technology Workforce Partners, a nonprofit organization composed of many of the nation’s largest information technology companies, has published the *Leader’s Toolkit on Diversity*, offering step-by-step advice on all aspects of designing, developing and measuring internal diversity programs. The Society for Human Resources Management also offers *Finding Diversity: A Directory of Recruiting Resources* to help its members build diverse, capable organizations to create competitive advantage. The Department of Energy has developed *Diversity Employment and Recruitment Sources and their Recruitment Strategies: Building a Talented and Diverse Workforce* that provides resources for organizations seeking to recruit a more diverse group of S&E employees.²

4. Award

The federal government should create a national-level award program modeled after the Malcolm Baldrige Award to reward and encourage innovative practices in S&E workforce excellence and diversity.

The success of the Malcolm Baldrige Award demonstrates that such recognition programs can create powerful incentives for trans-

formational change within organizations. There is a need for a national national-level award for commitment to S&E workforce excellence and diversity. Although several diversity award programs exist currently, most are based on subjective criteria and opinion surveys, or may even allow organizations to nominate themselves and assess their own performance.

Like the Malcolm Baldrige award, the national award should be based on objective, measurable criteria that evaluate organizational

Applying the Principles of Supply-Chain Management to Diversity

Over the past decade, most major U.S. firms have driven down costs and improved quality by aggressively managing all links in their supply chain. The principle of supply-chain management can also be applied to the challenge of creating a strong and diverse science and engineering workforce. As purchasers of knowledge-intensive products and services from each other, users of the “product” of the educational system and investors in university-based research, employers can exert far-reaching influence by creating incentives for partners and suppliers to embrace workforce excellence and inclusiveness.

Effective supply chain operating principles should include the following:

- Federal agencies should place greater emphasis on diversity-related criteria in the merit reviews of research projects they fund. The National Science Foundation has led the way in this regard by announcing that proposals that fail to address its “broader impacts” criteria will not be reviewed. The expanded use of such criteria has the potential to drive systemic change within the research community.
- Companies have a comparable opportunity to reshape the landscape by making clear up front that diversity is one of the factors that affects their choice of R&D partners. An unambiguous signal that inclusiveness matters is bound to make a difference, especially in the face of tightening constraints on public sector research dollars.
- Government procurement processes should take fuller account of technical workforce diversity. Beyond providing opportunities to small business, and women- and minority-owned businesses, state and federal agencies will improve service to government by ensuring that all bidders have in place the workforce capabilities that meet world class standards and drawn upon a broad demographic base.
- Employers that accept the BEST Challenge should give preferred status to vendors and suppliers who do the same. By the same token, large organizations must play by rules in dealing with smaller suppliers. Smaller technology-intensive firms with significant numbers of employees from underrepresented groups can only flourish if their customers observe their own codes of fair conduct.



performance on critical success factors, including: institutional leadership and commitment; strategy development and implementation; work systems that enable S&E employees to achieve high performance; the quality of S&E workforce development opportunities; the quality of organizational metrics and systems of accountability; a commitment to evaluation and continuous improvement; levels of job satisfaction for S&E workers; and organizational productivity and financial performance. Draft award criteria are included in Appendix 2.

ENDNOTES

1. National Science Board. (2002, January). *Science and engineering indicators — 2002* (NSB-02-1, pp. A-3 to 102). Arlington, VA: National Science Foundation.
2. U. S. Department of Energy Office of Human Resources Management. (2002, May). *Diversity employment & recruitment resources guide*. [On-line]. Available: www.ma.mbe.doe.gov/pers/recsour.pdf. Also U. S. Department of Energy Office of Human Resources Management. (1999). *Recruitment strategies: Building a talented and diverse workforce at DOE*. [On-line]. Available: www.ma.mbe.doe.gov/pers/recstrat.pdf.

Better Teachers . . . Better Results

America cannot strengthen the technical talent pool without an ample supply of highly qualified, committed pre-K-12 teachers of mathematics and science. The challenge to build and maintain this group is a shared responsibility of government policy makers, educators, private sector leaders and parents.

Although research confirms that strong teachers make a defining difference in pre-K-12 student outcomes, their chronic shortage in mathematics and science hits underserved minority populations especially hard. More than 25 percent of America's current high school math and science teachers did not major or minor in the subject they teach. In high-poverty schools, that figure is nearly 50 percent.

This shortage reflects a classic mismatch between the importance of qualified teachers and the priority we place on creating a world-class U.S. mathematics- and science-teaching workforce. While there is no single solution to the problem, the component parts of a solution are widely understood.

First, we must recognize the social and economic value of teaching pre-K-12 mathematics and science with rewards that attract and retain highly qualified individuals whose zest for teaching and learning inspires students to attain high levels of achievement.

Second, colleges and universities must build a pre-service teaching corps competent in mathematics and science as well as pedagogies that are attuned to the learning styles of all students.

Third, employers must make clear to educators at all levels what knowledge and skills must be mastered in pre-K-12 to contribute to the U.S. innovation enterprise. Further, they must treat the teacher corps as an integral part of that enterprise, and be prepared to contribute to it.

Fourth, public and private sector partnerships must build teacher capacity through mentoring and role modeling. Through these in-service activities the real life experiences of scientists, mathematicians and engineers can enrich both the professional development and classroom effectiveness of the pre-K-12 teacher corps.

Appendix 1

The BEST Leadership Pledge for Technical Workforce Development

As an organization which endorses BEST's national call to action for diversity and excellence in the science, engineering and technology workforce, we commit to following principles:

- Support the goal of diversity and excellence in the American science and engineering workforce within our company, among our peers and partners with whom we do business, and in the communities in which we operate.
- Adopt and actively advocate policies to promote excellence and diversity in our workforce, and to integrate our diversity goals into our overall business strategy.
- Develop a system to communicate with internal and external audiences our policies to promote diversity and excellence in our science and engineering workforce.
- Create an internal governance structure to ensure our diversity initiatives have meaningful leadership, visibility, sustainability, measurable goals and accountability measures.
- Hold all levels of management accountable for living up to our goals for excellence and diversity in our science and engineering workforce by creating specific performance goals, formal measurements of progress and systems of reward.
- Reach beyond our organizational borders to promote excellence and diversity in those partners with whom we do business and in the educational institutions that prepare our future employees and, to the extent possible, hold both accountable for achieving diversity goals.

Guidelines to Implement the BEST Leadership Pledge

The BEST Leadership Pledge represents the principles which we believe underlie meaningful success in accomplishing the goals of excellence and diversity in the science, technology and engineering workforce. Because implementation can promote or hinder the achievement, what follows are a set of suggested specific practices an organization can adopt to advance its diversity goals.

Public support the goal of diversity and excellence in the American science and engineering workforce within our company, among our peers and partners with whom we do business, and in the communities in which we operate.

1. Participation Participate actively and publicly in a Workforce Leadership Network to promote excellence and diversity in our workforce, and to integrate our diversity goals into our overall business strategy.

2. Communication Develop a system to communicate with internal and external audiences our policies to promote diversity and excellence in our science and engineering workforce.

3. Management strategy Create a business case that embeds diversity into broader organizational strategy. This should include, in as specific terms as possible, a discussion of the benefits the

organization has or can expect to accrue as a result of employing a more diverse workforce, e. g. reduced turnover, broader perspectives in the innovation enterprise, etc.

- Recognize and celebrate the achievements of women, underrepresented minorities and persons with disabilities in science and engineering careers in the organization.
- Support and work closely with employee affinity groups to enhance recruitment among women and underrepresented minorities, raise the internal profiles of existing women and minority S&E professionals, and mentor younger colleagues inside and outside the organization to increase their chances for success.
- Use all available means to disseminate the organization's goals and accomplishments, including websites and company publications.
- 4. Governance** Create an internal governance structure to ensure our diversity initiatives have meaningful leadership, visibility, sustainability, measurable goals and accountability measures.
 - Designate high-level councils, working groups or other senior-level teams to lead S&E workforce strategy development and implementation, coordinate and integrate efforts across the organization, and measure results.
 - Review and regularly update our policies on hiring, retention and advancement to eliminate barriers which may impede the professional progress of science and engineering professionals, with special attention to those which may have unequal and detrimental impact on women and underrepresented minority employees.
 - Create greater career advancement opportunity for all S&E professionals, including women and underrepresented minorities, by adopting flexible policies such as promotion on a technical, rather than management, track, or by stopping or delaying the tenure clock.
 - Create or expand formal mentoring programs based on proven design principles.
 - Offer continuing education and training to keep all S&E workers at the forefront of their disciplines.
 - Support the work/life balance needs of the science and engineering workforce with family leave, child care, elder care, flex time, job sharing, telecommuting and volunteering.
- 5. Accountability** Hold all levels of management accountable for living up to our goals for excellence and diversity in our science and engineering workforce by creating specific performance goals, formal measurements of progress and systems of reward.
 - Create clear and transparent procedures for promotion and advancement of all employees, including those in our science and engineering workforce.
 - Create systems of reward and recognition within our organization to encourage individuals and operating units to



Appendix 1 (cont'd.)

value diversity and create a culture of inclusion.

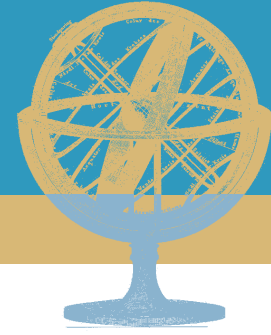
- Incorporate diversity and excellence goals into the performance agreements of senior executives.
- Tie some portion of executive compensation to progress on workforce excellence and diversity.

6. Leverage Reach beyond our organizational borders to promote excellence and diversity in those partners with whom we do business and in the educational institutions that prepare our future employees and, to the extent possible, hold both accountable for achieving diversity goals.

- Actively support organizations that focus on developing

science and engineering talent in schools and universities, and among practicing professionals.

- Develop recruiting and mentoring partnerships with Historically Black Colleges and with Minority Serving Institutions.
- Offer internships, co-ops and scholarships for women, underrepresented minorities and persons with disabilities who are pursuing science and engineering careers.
- Build awareness about S&E careers by reaching out to K-12 students, emphasizing the particular needs of girls, underrepresented minorities and children with disabilities.



Appendix 2

Criteria for a National Award for Science and Engineering Workforce Excellence

Applicants must describe how their organization meets each of the following criteria:

Institutional Commitment

Leadership

- Describe how senior leaders guide your organization with respect to promoting S&E workforce excellence, including measures to recruit, retain, develop and advance your S&E professionals of all disciplines, ages and educational levels.
- Describe both formal and informal programs for education and training.
- Describe how senior leaders communicate and reinforce the importance of S&E workforce excellence.
- Describe your organization's system for building diversity in your S&E workforce.
- Describe how senior leaders review organizational performance with respect to diversity in your S&E workforce.

Social Responsibility

- Describe how your organization addresses its responsibilities to the public, ensures ethical behavior and practices good citizenship with respect to increasing the quality and diversity of the American S&E workforce.

Strategic Planning

Strategy Development

- Describe how your organization establishes its strategic objectives with respect to improving the recruitment, retention, development and advancement of S&E professionals, including women, underrepresented minorities and those with disabilities. Describe how these strategic objectives enhance your competitive position, overall performance, and future success.
- Describe your strategy development process.
- Describe your key strategic objectives and your timetable for accomplishing these objectives.

Strategy Implementation

- Describe how your organization converts its strategic objectives for promoting S&E workforce excellence, including diversity objectives, into action plans.
- Summarize your organization's action plans and related key performance measures.
- List the S&E goals for your organization's future performance with respect to diversity in your S&E workforce on these key performance measures or indicators.

Human Resources Development

Work System

- Describe how your organization's work and jobs enable S&E employees and the organization to achieve high performance.
- Describe how compensation, career progression and related workforce practices enable S&E employees and their organizations to achieve high performance.

Employee Learning and Motivation

- Describe how your organization's S&E employee education, training, and career development contribute to high performance.
- Describe how your organization's education, training, and career development build employee knowledge, skills and capabilities of women, underrepresented minorities and those with disabilities in the S&E workforce.

Employee Well-Being and Satisfaction

- Describe how your organization maintains a work environment and an employee support climate that contribute to the well-being, satisfaction and motivation of all individuals, including women, underrepresented minorities and those with disabilities in the S&E workforce.

Partner and Supplier Relationships

Encouraging Partners/Suppliers to

Embrace S&E Workforce Excellence

- Describe how your organization reaches out to partners and suppliers to encourage them to promote S&E workforce excellence, including creating opportunities for women and underrepresented minorities to pursue S&E careers.
- Describe the performance measures used by your organization to measure the effectiveness of efforts by partners and suppliers.

Science and Engineering Pipeline

Increasing the Number of Those in the Pipeline

- Describe how your organization reaches out to girls, underrepresented minorities and children with disabilities in the communities in which it operates, to interest them in pursuing S&E careers.
- Describe the relationships your organization has built with institutions of higher education of all types to increase the number of women, underrepresented minorities and those with disabilities pursuing S&E careers.

Appendix 2 (cont'd.)

- Describe how your organization facilitates women, underrepresented minorities and those with disabilities in pursuing S&E careers.

Relationships with S&E Professional and Student Organizations

- Describe how your organization builds relationships with S&E societies, particularly those with focus on women, underrepresented minorities and those with disabilities, to increase their number pursuing S&E careers.
- Describe also how your organization determines the satisfaction of these societies with respect to your efforts to promote S&E workforce excellence.

Measurement, Analysis and Knowledge Management

Measurement and Analysis of Organizational Performance

- Describe how your organization measures, analyzes, aligns and improves its performance data and information related to S&E workforce excellence (including diversity) at all levels, and in all parts of your organization.

Information and Knowledge Management

- Describe how your organization ensures the quality and availability of needed data and information related to S&E workforce excellence (including diversity) for employees, suppliers, partners and customers.
- Describe how your organization builds and manages its knowledge systems relating to S&E workforce excellence and diversity.

Results

Organizational Effectiveness Results

- Summarize your organization's results in the recruiting and retaining, and the career development and advancement of S&E professionals, including women, underrepresented minorities and persons with disabilities. Provide detailed information of the measures of effectiveness your organization uses, and describe your organization's performance with respect to each measure.
- Summarize your organization's improvements in retaining women, underrepresented minorities and those with disabilities in your S&E workforce.
- Summarize your organization's improvements in developing your S&E professionals, including women, underrepresented minorities and persons with disabilities.
- Summarize your organization's improvements in advancing the careers of S&E professionals, including women, underrepresented minorities and those with disabilities.

Financial Results

- Summarize how your organization's investment in your S&E workforce had impact on your company's financial results.

Outside Recognition

- Describe the outside recognition your organization has received for its efforts to create a diverse, high-performance S&E workforce.





BEST Blue Ribbon Panelists

Best Practices in Pre-K–12 Education

Alfred Berkeley (Panel Co-Chair)
Former Vice Chairman
NASDAQ

Shirley Malcom (Panel Co-Chair)
Head, Directorate for Education
American Association
for the Advancement of Science

Eugene Garcia (Expert Leader)
Dean, School of Education
Arizona State University

Allan Alson
Superintendent
Evanston Township High School

Raymond V. “Buzz” Bartlett
President and CEO
Council for Basic Education

Muriel Berkeley
President
Baltimore Curriculum Project

Manuel Berriozábal
Professor, Mathematics
University of Texas at San Antonio

Susan Brady
Director, Education Programs
Merck Institute for Science Education

Costello Brown
Professor of Chemistry
California State University Los Angeles

Patricia Campbell
President
Campbell-Kibler Associates

Douglas Carnine
Director, National Center to
Improve the Tools of Educators
University of Oregon

Elizabeth Cohen
Professor Emerita
Stanford University

Mike Cohen
President
Achieva, Inc.

Anthony Colón
Vice President
National Council of La Raza
Center for Community Educational
Excellence

Jacquelyne Eccles
Chair
MacArthur Foundation Research
Network on Successful Pathways
through Middle Childhood

Charles Eilber
President
Charles Eilber Associates

Stephanie Fanjul
Director of Student Achievement
National Education Association

Yolanda George
Deputy Director and Program Director
Directorate for Education and Human
Resources Programs
American Association for the
Advancement of Science

Kris Gutierrez
Professor
UCLA

Rebecca Herman
Senior Research Analyst
American Institutes for Research

Anthony Jackson
Vice President, Strategic Development
and Communications
The Galf Institute

Julia Lara
Deputy Executive Director
Council of Chief State School Officers

Leon Lederman
Nobel Prize Winner
Physics

Sharon Nelson-Barber
Director, Culture and Language
Education Program
WestEd

Babette Moeller
Principal Investigator
Education Development Center

Andrea Prejean
Senior Professional Associate in Science
and Mathematics
National Education Association in
Student Achievement

Linda Rosen
Consultant, former Math
and Science Advisor
U.S. Department of Education

Larry Rosenstock
Principal and CEO
High Tech High, San Diego

Barbara Schulz
Consultant, Science Education
Partnership
Fred Hutchinson Cancer Research

Diane Siri
Superintendent
Santa Cruz County Office of Education

Marshall Smith
Program Director
The Hewlett Foundation

Virginia Stern
Director
Project on Science, Technology
and Disability
American Association for the
Advancement of Science

Sam Stringfield
Principal Research Scientist
Johns Hopkins University Center
for the Social Organization of Schools

Louise Sundin
President
Minneapolis Federation of Teachers

Mary Catherine Swanson
Founder and Executive Director
AVID

Shelly Wolff
President
National Society of Women Engineers

Best Practices in Higher Education

Shirley Ann Jackson (Panel Chair)
President
Rensselaer Polytechnic Institute

Willie Pearson, Jr. (Expert Leader)
Chair, School of History, Technology and Society
Georgia Institute of Technology

Margaret E. Ashida
Director, Corporate University Relations
IBM

Walter E. (Skip) Bollenbacher
Professor of Biology
University of North Carolina
at Chapel Hill

Salvatore "Tory" Bruno
Vice President of Engineering
Lockheed Martin's Space Systems

Jane Zimmer Daniels
Program Director
Clare Booth Luce Program for Women
in Science and Engineering
The Henry Luce Foundation

Cinda-Sue Davis
Director, Women in Science
and Engineering Program
University of Michigan

Alfredo de los Santos, Jr.
Research Professor
Hispanic Research Center
Arizona State University

Mary Frank Fox
Professor, School of History,
Technology and Society
Georgia Institute of Technology

Judy R. Franz
Executive Officer
American Physical Society

Angela Ginorio
Associate Professor
Department of Women's Studies
University of Washington

Evelynn M. Hammonds
Associate Professor, History of Science
Massachusetts Institute of Technology

Robert Ibarra
Office of the President
University of New Mexico

Alex Johnson
President
Cuyahoga Community College

Sandra Johnson
Executive Director
National Consortium for Graduate
Degrees for Minorities in Engineering

Wayne Johnson
Executive Director
Worldwide University Relations
Hewlett-Packard

Kenneth Maton
Professor & Chair
Department of Psychology
University of Maryland

Lionel "Skip" Meno
Dean, College of Education
San Diego State University

Carol B. Muller
Founder and Executive Director
MentorNet

Ken Pepion
Executive Director
Harvard University
Native American Program

Clifton Poodry
Director, Minority Opportunities
in Research Division
National Institute of General Medical
Sciences

James H. Stith
Director, Physics Resources Center
American Institute of Physics

Dan Sullivan
Corporate Executive Vice President
of Human Resources
QUALCOMM

Orlando L. Taylor
Dean, Graduate School of Arts
and Sciences
Howard University

Isiah M. Warner
Professor & Chair
Chemistry Department
Louisiana State University

Melvin R. Webb
Director, Program for Research
Integration and Support for
Matriculation to the Doctorate
Clark Atlanta University

Best Practices in the Workforce

Dan Arvizu (Panel Chair)
Senior Vice President
CH2M HILL Companies, Ltd

Paula M. Rayman (Expert Leader)
Professor
University of Massachusetts

Linda Cubero
Strategic Program Director
EDS

Harold Davis
Vice President
Preclinical Safety Assessment
Amgen, Inc.

Allan Fisher
President and CEO
iCarnegie, Inc.

C. Michael Gooden
President and CEO
Integrated Systems Analysts



Mike Guyton
Vice President of Administration
Oncor Group

Paul Hanle
President
Biotechnology Institute

Thomas Kochan
George M. Bunker Professor of
Management
Sloan School of Management, MIT

Margaret "Penny" Lane
Former Director, Program on
Diversity in Engineering
National Academy of Engineering

Catherine Mackey
Senior Vice President
Global Research and Development
Pfizer, Inc.

Vivian Pinn
Director, Office of Research
on Women's Health
National Institutes of Health

Joyce Plotkin
President
Massachusetts Software
and Internet Council

Lura Powell
Director
Pacific Northwest National Laboratory

Una S. Ryan
President and CEO
AVANT Immunotherapeutics, Inc.

Robert L. Shepard
Founding Executive Director
Science and Engineering Alliance

Ray Smets
President
Sniffer Technologies
Network Associates

Katherine Tobin
Taylor Nelson Sofries Intersearch

Claudette Whiting
Senior Director of Diversity
Microsoft

Charla K. Wise
Vice President of Engineering
Lockheed Martin Aeronautics Company

Project Integrators

Cathleen A. Barton
U.S. Education Manager
Intel

Suzanne G. Brainard
Executive Director
Center for Workforce Development
University of Washington

Daryl E. Chubin
Senior Vice President
National Action Council
for Minorities in Engineering

Manuel N. Gomez
Vice Chancellor, Student Affairs
University of California, Irvine

Joyce Justus
Chair Emeritus, Department of Education
University of California at Santa Cruz

Shirley M. McBay
President
Quality Education for Minorities

Anne Pruitt-Logan
Scholar-in-Residence
Council on Graduate Schools

Carlos Rodriguez
Principal Research Scientist
American Institute for Research

Sue Rosser
Dean, Ivan Allen College
Georgia Institute of Technology

Claibourne D. Smith
President
Delaware Foundation for Science
and Math Education

Wanda E. Ward
Deputy Assistant Director
National Science Foundation

William Washington
Director, Program Development
Lockheed Martin Corporation

Lilian Shiao-Yen Wu
Chair, Committee on Women
in Science and Engineering
National Academy of Science

BEST Staff

John Yochelson
President

Anne Crossway
Executive Vice President

Brenda Sullivan
Communications Director

Robb Henderson
Research Associate

Wanda E. Ward
Chief Advisor 2001-2002

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