LOSING THE COMPETITIVE ADVANTAGE?

THE CHALLENGE FOR SCIENCE AND TECHNOLOGY IN THE UNITED STATES

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IN THE UNITED STATES

AeA, ADVANCING THE BUSINESS OF TECHNOLOGY

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ABOUT AeA

AeA, founded in 1943 by David Packard, is the largest high-tech trade association in the United States with over 2,500 companies representing all segments of the industry and 1.8 million employees. Currently, AeA has 18 offices in and around the United States, as well as offices abroad in Brussels and Beijing. Our primary purpose is helping our members' top and bottom lines by providing the following services: Access to Investors; State, Federal & International Lobbying; Insurance Services; Government Procurement; Business Networking; Foreign Market Access; Select Business Services; and Executive Education.

AeA's unique grassroots network promotes and represents the business interests of America's technology industry. We provide competitive products and services to our members and lead in education and advocacy on a variety of high-tech business issues. They include: Sarbanes Oxley Section 404 reform; RFID initiatives; broadband deployment; preventing harmful Internet privacy legislation; making the research and development tax credit permanent; seeking updated export controls legislation; working with U.S. trade negotiators to achieve high-tech industry negotiating objectives within new international trade agreements; limiting the government's regulation and taxation of the Internet; promoting education reform; lowering capital costs for emerging technology companies; and supporting human resource and immigration policies that ensure access to the most qualified and highly educated workers.

From the well known giants of the high-tech world to the next generation of dynamic, smaller companies, AeA's members create products that promote innovation and efficiency in virtually every industry and business sector in the United States and throughout the world. The impact of high-tech products on people's everyday lives is immeasurable. High-tech products keep people safer and healthier, enable them to be more productive at home and on the job, and contribute to a better quality of life. Whether it is medicine or national security, education or agriculture, environment or entertainment, the high-tech industry is omnipresent and is inextricably linked to the advancement of modern society.

For information about AeA and the high-tech industry, please visit our website at www.aeanet.org.

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FOREWORD

The United States stands at a critical juncture in confronting its future in science and technology. As the largest representative of the high-tech industry in the United States, AeA will always be the first to credit the unique factors that make the U.S. economy the envy of the world in creating the innovations that advance society. But AeA would be remiss if it were not also among the first to warn the government, the media, the general public, and the industry itself when a serious problem exists that warrants our collective attention.

We are slipping. Yes, the United States still leads in nearly every way one can measure, but that does not change the fact that the foundation on which this lead was built is eroding. Our leadership in technology and innovation has benefited from an infrastructure created by 50 years of continual investment, education, and research. We are no longer maintaining this infrastructure.

The obvious advantage of leading in any race – be it a sprint or a marathon – is having everyone else scramble to catch up; the less obvious disadvantage is not being able to see how quickly those behind you *are* catching up.

The United States is the proverbial frog in the pot of water, oblivious to the slowly rising temperature. When the Soviets launched Sputnik, it was more like being thrown into a pot of boiling water – and we reacted. Today we have to act without the stimulus of an overarching, mobilizing event. Just because the threat is less obvious, doesn't make it any less real.

The United States can no longer coast if we hope to continue our leadership in science and technology. We at AeA are not – as much as we'd like to be – idealistically convinced that we can change the world with a single paper. We don't believe all of the issues that challenge American preeminence can be solved with one simple cocktail of policy reform. But we do believe that confronting the issues threatening future U.S. competitiveness *can no longer be deferred*.

In this regard, the focus of our report is on the analysis of the problem. While considerable time and effort was spent preparing the recommendations at the end of this report, we are more concerned about recognizing the nature of the challenges ahead. We believe that once the debate is started, the solutions will become obvious.

Policymakers, industry executives, community leaders, teachers, and parents need to recognize that the world is changing and that we had better adapt to this increasingly competitive environment if we hope to remain at the forefront of the technology revolution.

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AeA, Advancing the Business of Technology

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President and CEO
AeA, Advancing the Business of Technology

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The dominance of the U.S. is already over. What is emerging is a world economy of blocs represented by NAFTA, the European Union, and ASEAN. There's no one center in this world economy. India is becoming a powerhouse very fast. The medical school in New Delhi is now perhaps the best in the world. And the technical graduates of the Institute of Technology in Bangalore are as good as any in the world. Also, India has 150 million people for whom English is their main language. So India is indeed becoming a knowledge center.

Peter Drucker
Fortune Interview, January 12, 2004[1]

The great benefits of globalization will accrue to countries and groups that can access and adopt new technologies . . . Those countries that pursue [policies that support the application of new technologies] could leapfrog stages of development, skipping over phases that other high-tech leaders such as the United States and Europe had to traverse in order to advance.

CIA's National Intelligence Council
Mapping the Global Future[2]

America needs to recognize that future innovation is not predetermined to occur in the United States. Even if we were doing everything right, we still face unprecedented competition from abroad.

AeA
Losing the Competitive Advantage?

EXECUTIVE SUMMARY

Losing the Competitive Advantage? explores the challenges the United States currently faces and, in many ways, is ignoring at its peril. Our purpose is to alert audiences that America's edge, particularly in science and technology, is increasingly at risk. AeA began this discussion in March 2004 with our report on offshore outsourcing. Our view then, as it remains now, was that offshoring is merely a symptom of a dramatically shifting global economy and the U.S. role within it. This report serves as a natural sequel, in that it addresses this big picture.

Many of the findings may sound vaguely familiar, even obvious; others may seem surprising. We analyze a number of competitiveness factors within these pages that, when taken in isolation as they so often are, would not necessarily constitute a crisis. But the interrelationship – the cumulative effect of these trends – makes the more compelling argument that the status quo is unsustainable, and that any reasonable person will see the need to act.

Even if the United States were doing everything right, the world still poses unprecedented competitive challenges. Ensuring future prosperity depends on decisions that move us forward today. As the legendary Wayne Gretzky once said, "I skate to where the puck is going, not to where it's been."[3]

In a rapidly changing global economy, the United States needs to address the implications of the following critical issues to prevent an impending slide in U.S. global competitiveness:

Economic Reforms Are Transforming Other Countries' Economies and Making Them Dramatically More Competitive

The United States has long urged the rest of the world to adopt free market principles. The good news is that many countries have now listened and represent new markets for U.S. products and services. Globalization has benefited no country more than the United States. But the bad news is, ironically, that many countries listened. They have entered the global economy and now aggressively compete against the United States – or soon will.

Other Countries Are Adopting and Utilizing Technology To Enhance Their Economic Growth and Competitiveness

These countries now invest heavily in their high-tech infrastructure and produce talented, highly educated workers and cutting-edge companies. **China graduates almost four times as many engineers as the United States** and offers lucrative tax breaks to companies conducting R&D there. India is pouring money into technology parks to lure back native talent and produce world class tech companies. South Korea has leveraged rapid technology diffusion to "leapfrog" into the global economy. **But the larger point is: a host of countries are catching up to the United States.**

U.S. Federal R&D Funding That Spawned So Many Technological Breakthroughs in the Twentieth Century Is Faltering

The Internet, MRI, the mouse, and GPS – to name a few – were born from federally sponsored research. R&D funding is vital in supporting innovation because it invests in the technologies that will advance society in the future. Unfortunately, R&D funding has declined over the last decade and a half and the priority has shifted to life sciences.

If U.S. Workers Are To Compete in a World Economy That Is Knowledge Based and Driven by Technology, the American Education System Must Improve Substantially

A highly skilled workforce is the lifeblood of any successful company, industry, or national economy. Regrettably, the American K-12 system is failing to provide the math and science skills necessary for kids to compete in the 21st century workforce, and the U.S. higher education system cannot produce enough scientists and engineers to support the growth of the high-tech industry that is so crucial to economic prosperity.

For the Past 60 Years America Has Been the Beneficiary of an Influx of Many of the Most Talented Minds on the Planet. That Period Could Grind to a Halt Given Restrictive Immigration Policy, Tremendous Opportunities Abroad, and the Perception of Not Being Wanted

Immigration policy post 9/11 has deterred foreign nationals from coming to the United States to study or work. They are choosing to go elsewhere and we lose when this happens. **Last year, foreign applications to American graduate engineering programs plummeted 36 percent. This is tragic because over 50 percent of doctoral engineering and math degrees awarded in the United States go to foreign nationals whose financial support makes many of these programs economically viable.** If we cannot graduate enough American workers, then we need to understand that keeping out foreigners is not the answer. **One out of five scientists and engineers in the United States are foreign born**. We cannot afford to lose their intellectual abilities, innovations, and ultimately, the hundreds of thousands of jobs they create.

INTRODUCTION

From the assembly line and airplane to the personal computer and Internet, many of the innovations that transformed the world in the twentieth century were born in the United States. The dynamic and entrepreneurial composition of the U.S. economy encouraged capital, labor, and creativity to flow efficiently to their most productive use. While many other countries insulated themselves from the global economy, the United States welcomed foreign direct investment, foreign students and workers, and competition onto its shores.

Following World War II, the majority of foreign governments supported uncompetitive industries, often attempting to manipulate the creation and direction of production. Meanwhile, the United States allowed for a flexible economy. It concentrated support on the factors of innovation by investing in a knowledge-based economy, funding research and development and scientific education.

The United States wisely has held on to many of the principles that created this success. The U.S. economy remains profoundly adaptive to change, and its flexibility in labor and capital markets is second to none. It continues to breed an entrepreneurial culture that the rest of the world envies and often tries to emulate.

The United States boasts a vibrant venture capital market with investors who are willing to support visionary, yet risky ideas and who play an active role through hands-on involvement. Not all ventures succeed, but that is the point; innovation flourishes best when people are allowed to fail. The ideas that do make it to the marketplace often produce benefits that far exceed their creator's intent.

The technological revolution of the 1990s created high-paying jobs, new products and services, new companies, and entirely new industries never dreamed of decades earlier. This directly resulted from the commitment by both the public and private sector to invest in new ideas, which helped make the United States the breeding ground for many of the scientific innovations of the twentieth century.

But that was yesterday. As the United States takes its leadership for granted, countries around the world have caught on and are catching up. While we begin to close our doors to the best and brightest minds, these talented individuals and the intellectual property and jobs they create here are lured elsewhere. As we cut funding for research and development (R&D) – a critical factor in the innovation that has driven our economy for a century – other countries are investing in R&D, scientific education, and high-technology infrastructure. While we continue to believe know-how and ingenuity are exclusive American brands, dozens of emerging nations are restructuring their economies and challenging our superiority. Americans may be surprised if the next revolutionary technology is produced abroad, but we should not be.

When one of America's strongest competitive advantages in the global marketplace is a knowledge-based economy, it does not bode well for the future when the United States neglects the infrastructure that supports its wealth creation. The irony is that the United States already has proven it can compete, but often needs fear to motivate it. In the 1950s, the Soviet Union challenged American leadership in technology by launching the world's first satellite, Sputnik. Americans feared the Soviets would use this space technology as a weapon. The United States met this challenge by launching a national program to improve math and science education, ultimately winning the space and technology race. In the late 1980s and early 1990s, fear abounded that Japan would become the world's dominant economy. U.S. businesses responded to the challenge by refocusing their efforts, adopting new technology, and innovating their products and processes.

America can certainly compete. It has the flexibility, pioneering spirit, and capital to win the race; but to do this America needs to recognize that future innovation is not predetermined to occur in the United States. Even if we were doing everything right, we still face unprecedented competition from abroad. Rather than face the new global economy unprepared, America needs to confront this competition head-on by supporting the innovation infrastructure. If we don't, America faces not just a continuing erosion of its manufacturing base, but also its lead in knowledge-based industries.

THE UNITED STATES FACES HEIGHTENED COMPETITION AS OTHER COUNTRIES ARE CATCHING UP

- Other countries that have historically been followers are now becoming leaders.
- China now graduates four times as many engineers as the United States, the European Union graduates three times as many, and South Korea – with 1/6th the population – graduates roughly the same number as the United States.
- U.S. dominance in awarding science and engineering doctoral degrees, technology patents, and patent citations is slipping.
- Emerging economies are finding they do not have to be the initial inventor of a technology to take advantage of it. They are leveraging the rapid diffusion of advanced technologies to promote innovation and economic competitiveness.

For nearly five decades following the Second World War, more than half the world's population lived and worked outside of the free market system. The Soviet Union and Eastern bloc, China, India, and much of Latin America and Africa either eschewed capitalism entirely or flirted with socialist policies that stifled competition and rejected global integration.

By the close of the twentieth century, all that had changed drastically. The end of the Cold War transformed more than just the Soviet Union and Eastern bloc countries. It attacked the legitimacy of command and control economies everywhere, and promoted the benefits of the free market system.

China, India, Eastern Europe, the Asian Tigers, and other so-called emerging economies all have learned that the road to economic prosperity, wealth creation, and social development is through the free market. Russia and much of Latin America and Africa have started down the road towards adopting free market systems. However, they are not yet entirely convinced of the benefits of capitalism. Their economies fluctuate toward or away from free market principles depending on which interests control public policy.

The United States had long urged the rest of the world to adopt free market principles, preaching the benefits of transparency, open competition, foreign investment, economic flexibility, and technological innovation. As political barriers fell and countries undertook economic reform, the global marketplace began to become truly global.

The good news for U.S. business is that many countries listened. **No country has benefited more from globalization than the United States.** Economic forces have compelled other countries to open their markets, slash tariffs, accept foreign direct investment, buy U.S. products, and adopt U.S. technology. However, the potentially alarming news for the United States is, again, that many countries listened. Globalization also presents unprecedented challenges to American preeminence. As global economic cooperation proliferates, so too does global competitiveness. **Countries that have entered the free market system now aggressively compete against the United States – or soon will.**

Leaders in these countries also learned that competition and innovation go hand in hand. By liberalizing their markets, they recognized that to remain truly competitive they also must invest in the innovation infrastructure. These countries now produce talented, highly educated workers and cutting-edge companies, and they realize that technological development is a virtuous cycle. The more a country opens its economy, the more it adopts innovative products and services. With technology adoption, comes development. The more development it spawns, the more robust and competitive its industries become. Capital is drawn in. Intellectual property is created. Innovation takes hold. New products and services are conceived. Wages and living standards rise.

Other countries are taking advantage of this formula to advance their own societies and provide opportunities for their domestic companies to compete globally. Indian software programmers, Chinese components manufacturers, Taiwanese consumer electronics makers, and South Korean online game developers all have reaped the benefits of an active national government investing in the innovation infrastructure.

In development circles, this is called "leapfrogging." Most of the industrialized world needed nearly a century to provide 90 percent of its population with telephone service, mainly via copper lines to households. Many developing countries will accomplish this in a fraction of the time and cost because advanced wireless and satellite technologies allow nations to leapfrog over yesterday's technology by utilizing the latest innovations. The implications are far reaching

for U.S. competitiveness; the stagnant economy of yesterday could be the competitive rival of tomorrow.

Emerging countries are churning out more scientists, engineers, and technology workers to staff these nascent industries, while the numbers of students entering these fields in the United States has remained flat. The United States is cutting R&D funding while foreign governments are creating public-private partnerships to invest in R&D projects and persuade their brightest youth to pursue high-tech careers.

The implications are far reaching for U.S. competitiveness; the stagnant economy of yesterday could be the competitive rival of tomorrow.

U.S. policymakers, the media, and the public often underestimate the emerging competitive threat of nations like China and India. They believe U.S. companies flock to these destinations solely to exploit cheap labor. While partially true, this overlooks an additional fact; these and other countries increasingly offer skilled, educated, professional knowledge-based workers as well.

One needs to remember that the offshore outsourcing of software jobs did not begin because of the price of labor, but because of the drastic need for programmers to fix the Y2K problem in the late 1990s. The tight deadline involved and the lack of U.S. programmers forced companies to seek out all available skilled workers, wherever they could be found. And, while the current wage gap between a U.S. engineer and a Chinese or Indian engineer makes these developing countries attractive, this wage differential is narrowing, and skill sets will become the determining factor.

America no longer can rest on its laurels. The following statistics and anecdotes offer sobering evidence of the urgency with which U.S. policymakers must act.

Other Countries Place a Greater Emphasis on Educating Science and Technology Workers

❖ When examining the number of people graduating with bachelor degrees in engineering, the United States trails other countries. While the United States is the largest world economy and the fourth largest country by population, it only ranks sixth in the number of bachelor degrees awarded in engineering in 2000, the most recent comparable data available. China graduates almost four times as many engineers as the United States. Japan with less than half of the population of the United States, graduates almost twice as many engineers. South Korea – with 1/6th the population and 1/20th the GDP – graduates nearly the same number of engineers as the United States.[4] Some U.S. executives argue that Chinese engineers, in some cases, are not of the same caliber as American or European educated workers. But as China expands and increases technical education, the gap is closing, and closing fast.

❖ Interest in studying science and engineering in Russia has surged. Presently, six applicants compete for each available place in Russia, compared to just two or three in the mid-1990s. The largest demand is for science and math courses. Graduation rates for science and engineering degrees in Russia are up by 11 percent in 2004.[5] However, Russia does face challenges that are holding its universities back, including the high concentration of older professors, the lack of new teachers, and limited funding.

❖ On a country-by-country basis, the United States still leads in science and engineering doctoral degrees granted; however significant portions of these are awarded to foreign nationals. Also, when combined, the EU-15 graduated more S&E doctoral degrees than the United States. The recent addition of 10 new countries to the European Union has increased the integration, competitiveness, and ultimately, the availability of skilled labor in the EU.[6]

Worldwide Engineering Degrees Awarded by Country
2000 or most recent

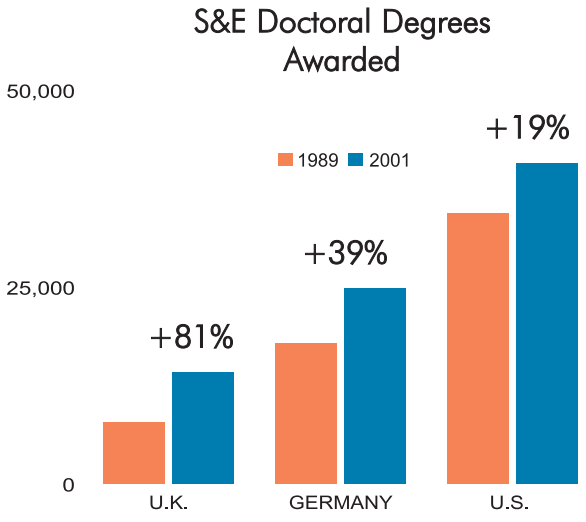
Rank	Country	Bachelor	% of World
1.	China	219,563	21%
2.	EU-15	179,929	17%
3.	Japan	104,478	10%
4.	Russia	82,409	8%
5.	India	82,107	8%
6.	**United States**	**59,536**	**6%**
7.	South Korea	56,508	5%
8.	Taiwan	26,587	3%
9.	Mexico	24,184	2%
10.	Poland	21,618	2%

Source: U.S. National Science Foundation

❖ Furthermore, the number of S&E doctoral degrees awarded in Germany and the United Kingdom is growing faster than in the United States. Between 1989 and 2001, S&E doctoral degrees in the United Kingdom grew by 81 percent, in Germany by 39 percent, and in the United States by 19 percent.[7]

As Other Countries Sharpen Their Focus on Science and Technology, the United States Risks Losing Its Dominance in These Fields

❖ One way to measure the ascendancy of S&E in other countries is to observe the origin of S&E articles in academic journals. Science and engineering articles in the United States grew by 13 percent between 1988 and 2001, hitting just over 200,000 in 2001, while in Western Europe the number of S&E articles leaped by



Source: U.S. National Science Foundation

Case Study – India

An Indian politician once asked Indira Gandhi: "Can the prime minister explain why Indians seem to thrive economically under every government in the world except hers?"[8] From the 1940s through the 1970s, India pursued socialist economic policies that discouraged foreign investment, stifled competition, and launched a mass exodus of its brightest citizens seeking opportunity abroad. Beginning in the 1980s and more dramatically in the 1990s, India reversed course by opening parts of its economy to the outside world, reducing the regulation that hindered business development, and investing in the factors of innovation. These reforms and investments have made India a potentially successful high-technology hub.

Four different parties have held power since 1991, each dedicated to a "Delhi consensus" of market reforms. India has eliminated the once famous "Permit Raj" that restricted market access by entangling companies in bureaucracy and charging over 100 percent tariffs on the majority of imports.[9] Tariffs have plummeted and inbound trade has skyrocketed. Domestic companies endured the growing pains of exposure to open competition and are now becoming globally competitive.

Once a regional vegetable products company, India's Wipro has expanded to become the global leader among offshore software service providers. Led by an Indian-born, Silicon Valley-trained former head of General Electric's medical scanner business, Wipro has achieved dominance by diversifying and integrating its services well beyond low value-added software coding. Like many Indian companies, Wipro realizes its low cost of labor advantage is fleeting; as education and income levels rise, eventually other emerging countries will seize the cost advantage. Wipro's goal is to remain a world class company by competing at the high end of the information technology value chain.[10]

India is now embarking on further reform to provide labor flexibility, freer flows of capital, and desperately needed infrastructure improvements. Public-private partnerships have invested in technical universities and communications infrastructure to create cutting-edge technology parks in places like Bangalore. This will only make India more competitive and alluring to investors and multinational companies. The highly skilled, Indian-born talent that once flocked to the United States is now returning home, turning America's brain drain into India's brain gain.

Case Study – China

As the inventor of gunpowder, rocketry, the compass, the printing press, and the mechanical clock, China historically has valued innovation. Because China was isolated from the rest of the world, these innovations did not spread as quickly as they later did in the West. But today, China is merging its culture of innovation with economic reforms that are opening its market to the world, and the world is taking note. China is already the world's manufacturing hub and now is moving up the production line to promote higher end technology firms, creating sobering competition for companies and workers around the world.

While it might seem that China has emerged virtually overnight as a serious competitor, China has undergone 25 years of economic reforms to adapt to a globally competitive environment. This modernization began in 1978 under the leadership of Deng Xiaoping, when the country first exposed its economy to international trade. Over time, the reforms eliminated most price controls, liberalized capital markets, adopted special economic zones, encouraged foreign investment, improved the infrastructure (with new roads, bridges, water, and sewer systems), and ultimately, raised the standard of living. In the early 1990s, China initiated the "Golden Bridge" project, a systematic plan to utilize the latest technology to create an integrated, digital economy.[11] It even began importing technology incentives from Silicon Valley, including stock options and R&D tax credits. Over the last several years, China's annual GDP growth rate stood between seven and nine percent.[12] Technology and innovation have been critical catalysts for this growth.

How Valued Is Innovation?

Twice as many Chinese firms cite innovation as a top objective.

Percentage ranking innovation as one of top three goals:

Chinese companies	54%
U.S. companies	26%

Source: Based on survey results conducted by *IndustryWeek* and the Manufacturing Performance Institute

The good news is that a significant number of the new companies investing and building in China are American owned. These companies recognize the dual benefits of investing in China: access to low-cost, technically skilled labor and an enormous market of consumers with steadily rising incomes.

China admittedly is still in the early stages of penetrating high-tech markets with indigenous companies; but it has built a foundation and is progressing. In 2002, China surpassed the United States as the prime destination for foreign direct investment.[13] In 2004, it overtook the United States as Japan's largest trading partner.[14] By 2020, China's GNP is projected to be second only to the United States.[15] These macroeconomic trends are helping some companies forge new ground. Shanda Interactive is the largest company for online games in China with an average of 1.2 million users logged in at a time. It succeeded by tailoring its business model to thrive in a country where piracy is rampant and credit cards and e-commerce are rare.[16]

China also now graduates four times the number of engineers as the United States. Its native-born talent is returning home to exploit high economic growth rates and business opportunities that previously only could be found abroad. Many returnees not only have science and engineering skills, but also the management and entrepreneurial experience to create globally competitive companies. They will find an increasingly cooperative and forward thinking government, at both the national and local levels, willing to spur investment through tax incentives, research and development initiatives, and creation of technology parks.

Case Study – Russia

When the Soviet Union collapsed 15 years ago, Russian science and engineering were among the foremost in the world. The questions for the future became: to what purpose will these talents be refocused and how will such efforts be funded in the wake of the bankruptcy of the state-dominated economy? The following decade witnessed a painful transition to a market-based system with various attempts to privatize industry, root out corruption, and attract foreign investment into an economy where the rule-of-law was more an ideal than a reality.

Fifteen years later the results are mixed, but some high-tech companies have invested heavily in Russia. Likewise, indigenous firms have sprung up, exploiting highly educated scientific talent to compete in the global market for software and other high-technology services. Over the last several years, the Russian high-tech industry has grown by about 10 percent annually, and one U.S. executive sees remarkable similarities to where India was 10 years ago.[17]

With soaring oil revenues and pressure from interest groups, Russia now is investing more public funds into initiatives supporting scientific training, innovation, and high-technology growth.[18] These investments foreshadow an increasingly competitive economy, based on an incredibly talented technology workforce. The question for the future will be whether Russia continues the free market reforms begun in the early 1990s, or whether it reverts to command economics under the leadership of those who see free markets as a threat.

Case Study – Eastern Europe

Despite the old eastern bloc joke: "Capitalism is man exploiting man; communism is just the opposite," the former Soviet satellites vigorously embraced free markets when the Iron Curtain fell. Poland, Hungary, and the former Czechoslovakia, in particular, undertook a series of rapid reforms termed "shock therapy" that privatized dying industries, encouraged investment, and allowed competitive forces to flourish after 50 years of economic stagnation. Fifteen years later, these countries boast steady growth, high levels of foreign investment, profitable domestic companies, and membership in the European Union.

They have coupled these reforms with a dedication to their innovation infrastructure. As with Russia, the eastern bloc countries generated highly educated scientists and engineers even under communist rule. Built upon a long tradition of scientific inquiry, Poland has poured new investment into R&D, libraries, software, and scientific conferences. It invests public funds in nationally important R&D programs. These programs often originate from the private sector and are co-financed with foreign venture capital.[19] Hungary and the Czech Republic have followed similar paths, enacting high-tech friendly policies, investing public funds, and marketing their capabilities to tech firms throughout the world. The intense rivalry between these and other Eastern European neighbors to attract foreign capital has, in turn, made the entire region more competitive as each tries to promote its own Silicon Valley East.[20]

59 percent, surpassing the United States with 229,000 articles in 2001. The number of S&E articles in Asia more than doubled during this same period, with the number of articles in China quadrupling, albeit from a small base.[21]

❖ When examining the number of patents granted, the dominance of U.S. industry is slipping. U.S. corporations received 67 percent of all corporate U.S. patents between 1977 and 1988. However, the percent of patents awarded to U.S. corporations dropped to slightly more than half between 1988 and 2001, as patents granted to foreign corporations increased. Patents granted by the United States to applicants in Japan, Germany, Taiwan, France, the United Kingdom, and South Korea have increased over the past decade.[22]

❖ While the United States still dominates in the distribution of patent citations in S&E articles around the world, Western Europe is slowly gaining. In 1995, the United States accounted for 59 percent of all patent citations, Western Europe had 23 percent and Asia had 11 percent. By 2002, the number of patent citations attributed to the United States dropped by four percentage points to 55 percent, while Western Europe increased to 26 percent. Asia remained stable at 11 percent of the world's patent citations in S&E articles.[23]

Science and Engineering Articles by Country
1988 - 2001

Country	1988	2001	Percent Change
United States	177,700	200,900	13%
Western Europe	143,900	229,200	59%
Asia	51,800	113,600	119%
China	4,600	21,000	354%
India	8,900	11,100	25%

Source: U.S. National Science Foundation

> *"Rapid technological advances outside the United States could enable other countries to set the rules for design, standards, and implementation, and for molding privacy, information security, and intellectual property rights (IPR)."*
>
> CIA's National Intelligence Council
> *Mapping the Global Future*[24]

Rapid Technology Adoption and Diffusion Is Allowing Other Countries To Leapfrog

One irony about leading edge technologies is that you do not have to be the initial inventor of a technology to become a world class competitor. Emerging countries are catching up to – and in some cases surpassing – the United States in adopting and diffusing information and communication technologies to spur their economies.

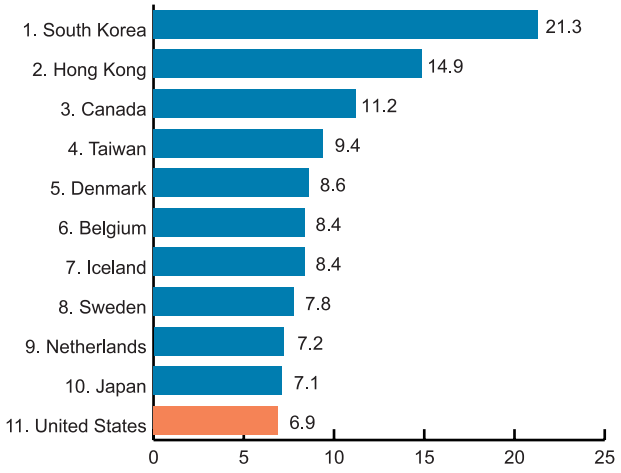
Throughout the twentieth century, the cost of land-based, copper wire phone lines remained prohibitively high for most developing countries, particularly in the hands of inefficient, state-owned monopolies. In the 1980s and 1990s, governments around the world privatized these industries and opened them to competition. This, combined with the development of highly advanced, lower cost technologies, has allowed countries to "leapfrog" from economic obscurity into the global economy.

This is true because technology diffusion is more than just penetration statistics. Diffusion plugs the entire nation into the economy. It connects consumers and producers more efficiently and in ways previously unimaginable. It promotes a more sophisticated, well informed, demand driven society that pushes companies to create innovative products and entirely new industries.

It is no coincidence that heavy public investment in the research and development that spawned computers and the Internet helped diffuse these technologies in the United States. This provided U.S. companies with the head start needed to develop innovative commercial uses for these technologies. To this day, the majority of leading computer hardware and software firms, as well as the largest online companies, are headquartered in America.

Certain countries have gained competitive advantages through rapid technology adoption and diffusion. National governments supported these efforts as a means to foster economic growth and development. Their indigenous companies then achieve first mover advantage in applications of the technology and reap the benefits as others scramble to catch up.

Broadband Penetration
Subscriptions per 100 Inhabitants
2002



Source: International Telecommunications Union

Two prime examples of this are broadband and cellular deployment. As illustrated below, these technologies are unique because the benefits of their diffusion are synergistic; they extend beyond their most direct application. If a U.S. competitor holds a strategic advantage in making plasma screen televisions, this may be a concern, but the effects are limited because it is not a networked technology.

The possibility that the next breakthrough technologies will be born abroad is ever more likely.

When a country builds highways, the economic benefits extend far beyond the profits made by the companies that laid the pavement. Commerce as a whole becomes more efficient. Broadband and cellular networks produce similar cascading benefits as more consumers are integrated into the economy and more companies vie to create applications for these networks.

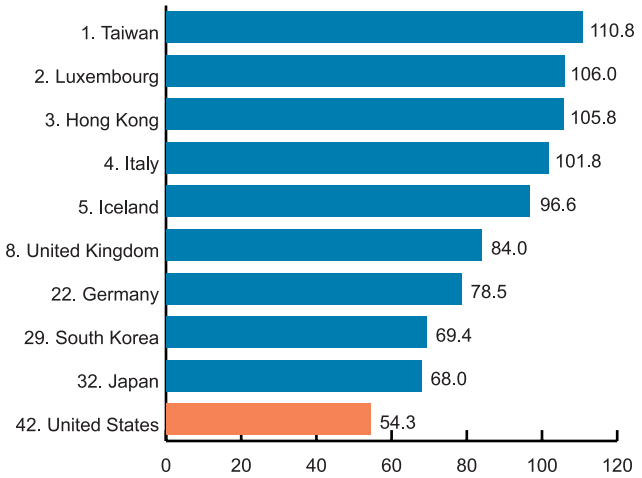
❖ The United States lags in the adoption of broadband access compared to select countries. The United States ranked 11th in the world in broadband penetration, with 6.9 subscriptions per 100 inhabitants in 2002, slightly behind Japan.[25]

❖ South Korea leads the world in broadband access, with penetration rates that are three times higher than in the United States – 21 subscriptions per 100 inhabitants in 2002.[26] Granted, many countries with higher broadband penetration rates benefit from higher geographic population densities, facilitating low-cost broadband penetration. However, third ranked Canada has similar urbanization densities as the United States but boasts almost double the penetration rate.

❖ Not only are South Korea and Japan ahead of the United States in penetration of broadband subscriptions, but also in its speed. Japan offered broadband access with 26 Mbit/second and South Korea offered 20 Mbit/second in July 2003, compared with 1.5 Mbit/second for the United States.[27]

❖ So South Korea has outpaced the rest of the world in broadband deployment. So what? How could this possibly threaten the United States? South Korea's rapid adoption of high technology allows it to do more than just brag internationally about having higher penetration rates than all of the world's great powers. Government investment in broadband rollout has transformed the domestic economy. The majority of South Korean citizens now access the Internet through low-cost, super high-speed connections.[28] This has locked producers and consumers into a seamless network that promotes innovation. South Koreans of all ages have developed a passion for online games, a service that only truly works over broadband connections. While such diversions might seem frivolous, the larger point is that *demand for a previously nonexistent service soared*. South Korean companies have used this domestic market as an incubator to further innovate

Cell Phone Penetration
Subscriptions per 100 Inhabitants
2003



Source: International Telecommunications Union

their games. **At the forefront of this innovation, they now have gained competitive first mover advantages in taking these products global as other countries deploy broadband.**

❖ Among worldwide cell phone penetration rates, the United States ranks 42nd, with over half the population subscribing to cell phone service in 2003. This positions the United States behind Kuwait and ahead of Jamaica.[29] The slower penetration of cell phones in the United States is due to, in part, a high-quality, low cost landline system.

❖ Taiwan leads the world, with 111 cell phone subscriptions per 100 inhabitants.[30] This cell phone example is not only about penetration, but also about quality. Many of the leading countries also boast high quality next generation cell phone systems. Sweden, Finland, and South Korea all are home to globally competitive cell phone companies.

> *"[A] nation's level of technological achievement generally will be defined in terms of its investment in integrating and applying the new, globally available technologies – whether the technologies are acquired through a country's own basic research or from technology leaders."*
>
> CIA's National Intelligence Council
> *Mapping the Global Future*[32]

❖ **As the South Korean example illustrated, rapid technology diffusion often creates demand for innovative products and services.** Italy ranks fourth worldwide in cell phone penetration. As a result, Italian consumers have become highly sophisticated in demanding cutting-edge services. They want not only basic voice and data capabilities, but advanced chat, multimedia messaging, and real-time video streaming of soccer games. To achieve growth in such a saturated market, Italy's top cellular provider has met these local demands and now is aggressively expanding these services to customers in South America.[31]

WHY IS THIS A PROBLEM?

As other countries begin catching up to the United States in science and engineering, and as they leverage technology diffusion to promote innovation and enhance competitiveness, the possibility that the next breakthrough technologies will be born abroad is ever more likely.

U.S. policymakers need to recognize that the world has become a more intensely competitive environment in a relatively short period of time. As the CIA's National Intelligence Council recently reported, by 2020 China's Gross National Product (GNP) is forecast to become the world's second largest behind the United States, and India's GNP is predicted to match or potentially surpass that of all European countries. Even Brazil and Indonesia are likely to muscle their way into the top tier of world economies. The report states unequivocally that **"the greatest benefits of globalization will accrue to countries and groups that can access and adopt new technologies."**[33]

When assessing this new reality, we focus on the pervasiveness of change in the global economy. If you concentrate only on a particular emerging country, it becomes all too easy to extract a piece of data or to find that specific trend to reassure ourselves that there is nothing to fear. You might dismiss China's ascendancy as being built upon an unsustainable political system. You might console yourself that India will never become a world class power as long as vast pockets of its population cannot access modern infrastructure. Russia, you might argue, is one or two obstructive government interventions away from rejecting free market capitalism outright. And as for Eastern Europe, South Korea, or any of the other emerging countries? Their economies are miniscule compared to ours, you might argue. You might.

The problem is that these are just excuses that allow us to remain complacent. They let us overlook the bigger picture; all of these countries and dozens more are making unprecedented efforts to compete.

As such, policy needs to be directed toward initiatives that enhance the technological competitiveness of the United States in the future. Competing countries are now doing what the United States had done so well for decades – investing in future innovation. Many of the technologies the world enjoys today have been decades in the making. They often were born in the obscure environment of a federally funded laboratory and were later handed off to the entrepreneurs that could harness their commercial potential. As our competitors now borrow from this proven blueprint, the United States can no longer take its technological dominance for granted.

WANING COMMITMENTS TO R&D ARE THREATENING FUTURE INNOVATION

- SOME OF THE MOST REVOLUTIONARY INVENTIONS OF THE PAST CENTURY — THE INTERNET, MRI, THE MOUSE, DOPPLER RADAR, AND GPS, TO NAME A FEW — WERE BORN FROM FEDERALLY SPONSORED RESEARCH.
- TO A DANGEROUS DEGREE, THE UNITED STATES IS NOW TAKING FOR GRANTED ITS LEADERSHIP IN SCIENCE AND TECHNOLOGY.
- IN THE 2005 FEDERAL BUDGET CONGRESS CUT FUNDING — FOR THE FIRST TIME IN 16 YEARS — FOR THE NATIONAL SCIENCE FOUNDATION, THE LEADING PUBLIC SUPPORTER OF R&D.
- FEDERAL FUNDING PRIORITIES HAVE SHIFTED AWAY FROM TECHNOLOGY. IN 1981, HALF OF ALL FEDERAL R&D WENT TO TECHNOLOGY; BY 2003 THIS DROPPED TO ONE-THIRD.

At the end of World War II, the United States emerged virtually untouched by the physical destruction that ravaged Europe and Asia, vaulting it to the top of the world's power structure, both economically and militarily. Science and innovation proved integral to America's victory. Penicillin, the proximity fuse, and the atom bomb all played decisive roles in the war.

Scientific research enjoyed widespread popular support, which culminated in the creation of the National Science Foundation (NSF) in 1950, whose goal was "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes."[34] Since this time, the NSF, and federally funded research in general, have played a crucial role in the development of the U.S. military and economy.

Policymakers of the 1950s and 1960s understood that funding scientific and technological research represented an investment in the future and in national security. After the Soviet Union launched Sputnik, this funding became critical in fighting the Cold War. The United States realized that the only way to compete militarily with the Soviet Union was to enhance its technical capabilities and to "out innovate" them. This strategy required significant government involvement in funding technologies that would not elicit practical applications, quite possibly for decades.

R&D funding is vital in supporting innovation and the advancement of the technology industry, which bolsters the U.S. economy and even the military. President Reagan recognized this in the 1980s when he significantly increased R&D funding and provided the United States with a bold vision of achievement and advancement.

Consider what federally funded R&D has created and the time required for just two innovations: fiber optics and the Internet. Federal funding of solid-state physics and ceramics/glass engineering in the late 1960s created the knowledge base for widespread use of fiber optic cable in the 1990s. The Department of Defense began experimenting with the design of a decentralized file and data sharing network in 1969, leading to the explosive diffusion of the Internet 25 years later.

While critics of publicly funded R&D argued at one time that it was tantamount to "picking winners and losers," funding research does not necessarily favor a specific application or company proposal. It funds the ideas and unexplored fields that may generate specific innovations or commercial applications down the line. No one would argue that federal support for the Internet favored one product or company over another. This research laid the foundation upon which the marketplace later decided that, for example, Amazon.com had a sustainable business model while Webvan.com did not.

Innovation Resulting from U.S. Federally Funded Research

Innovation	Funder
The Internet	DARPA/NSF
Web Browser	NSF
Bar Codes	NSF
Fiber Optics	NSF
Routers	NSF
MRI	NIH/NSF
Doppler Radar	NSF
Speech Recognition	NSF/DARPA
Nanotechnology	NSF
Computer Aided Design	NSF/DARPA
Global Positioning Satellites	DARPA
The Mouse	DARPA

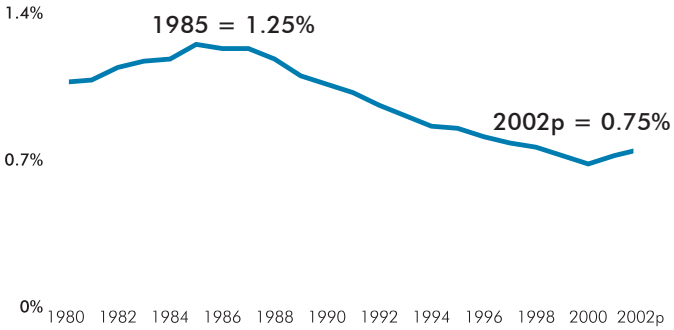
Note:

NSF = National Science Foundation
DARPA = Defense Advanced Research Projects Agency
NIH = National Institutes of Health

Unfortunately, U.S. research and development funding reached its pinnacle in the 1980s, and our focus on future innovations has been slipping ever since. With the end of the Cold War, federal funding commitments for R&D have declined, especially in engineering and physical sciences. In November 2004, Congress even cut the 2005 budget of the National Science Foundation by $105 million, the first cut in 16 years, despite the Bush Administration's proposed increase.[35]

The United States is neglecting the factors of innovation that have made us a world power. **These reductions in federal R&D spending will directly harm the competitiveness of the United States in the world economy.** As the following data indicate, the United States is slowly losing its lead in science and technology.

Federal Funding of R&D as a Percent of GDP
1980 - 2002p



Source: U.S. National Science Foundation

> *"Practical innovation more than anything else is the reason America achieved preeminence while other well-endowed landmasses lagged or failed. America's emergence from a rural backwater to a position of dominance is not to be explained by the access to physical resources or population, since Russia, China, Australia, Canada, Brazil, Argentina and South Africa were also richly endowed but failed to develop anywhere near as rapidly."*
>
> - Harold Evans
> *They Made America*[38]

R&D Funding by Federal Government Declines

The federal government is the primary funding mechanism for supporting basic research in the United States. Basic research serves to strengthen the innovative capacity of companies, increasing the capability of a firm to understand and absorb scientific and technical knowledge. While basic research plays an important role in building the foundation of technological advancement, it does not always lead directly to the creation of new products and services. As such, funding for basic research by industry is sporadic. Therefore, continued government support for basic R&D funding is necessary for continued advancement.

❖ U.S. federal funding of R&D has declined over the past two decades. It peaked in 1987 at $75 billion, and still was below this peak by 2002 at $71 billion, adjusted for inflation to 1996 dollars.[36]

❖ The decline of federal R&D funding is even more glaring as a percent of the U.S. economy. Federal R&D funding represented 1.25 percent of GDP in 1985, a full half percentage point higher than 2002 when R&D represented 0.75 percent of GDP.[37]

R&D Funding by Industry Slips During the Recession

❖ The recent recession has had a downward effect on R&D funding by the private sector. Industrial supported R&D fell by $8.4 billion, from $172 billion in 2000 to $163 billion in 2002.[39] This pull-back will affect the ability of industry to innovate and deliver new products and services.

❖ The federal R&D tax credit has served an important role in encouraging private industry to engage in R&D that might otherwise be cost prohibitive. It also supports risk taking because not all R&D ventures yield an immediate product. Although the tax credit was enacted in 1981, it has always retained "temporary" status and has in fact been allowed to expire twice.[40] This hurts companies' ability to plan for future R&D projects. In direct contrast, China's R&D tax credit is permanent, allowing companies to reduce uncertainty and plan investment decisions far into the future.[41]

❖ The good news is, the United States is moving in the right direction. President Bush has proposed in his FY 2006 budget to make the R&D tax credit permanent.

Federal R&D Priorities Shift Away from Technology

❖ Federal R&D funding has shifted away from technology – engineering, physical sciences, and math and computer science. In 1981, technology R&D represented 48 percent of the federal government's R&D and life sciences represented 36 percent. By 2003, these priorities had switched, with technology R&D at 32 percent of federal R&D funding and life sciences at 54 percent.[42]

❖ While it is commendable to support research that directly benefits the physical health of Americans – and such funding should continue – **technology R&D remains vitally important to the *economic health* of the nation. It creates many of the cutting-edge technologies that now bolster the economic and industrial strength of the United States.**

WHY IS THIS A PROBLEM?

These trends are undercutting the future of the U.S. technology industry and, ultimately, the U.S. economy. R&D offers far-reaching benefits that extend beyond the direct impact of discovery for the company or research institution.

Government investment plays an indispensible role in building the foundation of a knowledge-economy by investing in ventures, concepts, and ideas often years before a commercially viable product or service is available. As discussed, the Department of Defense and the National Science Foundation supported the Internet for over 20 years before it became commercially feasible and was opened to the public. The development of Magnetic Resonance Imaging (MRI) technology was based on 35 years of government funding through the National Institutes of Health, from 1955 to 1990. As a result, 60 million patients a year are grateful for such persistence.[43]

The U.S. government is supporting research into advanced materials by exploring the basic structure and properties of matter at the molecular, atomic, and even subatomic level. This research is the foundation of the nascent nanotechnology industry and has led to the creation of composite materials and high-tech ceramics. These materials already are critical components in such products as jet airplanes and cell phones and will play an important role in future innovations.

Federal R&D Funding by Field
Percent of Total Funding
1981 vs. 2003

	1981	2003
Technology	48%	32%
Life Sciences	36%	54%

Note: Technology = Engineering, physical science, and math and computer science

Source: U.S. National Science Foundation

When the government provides the foundation and funding for innovation, the U.S. economy benefits as businesses convert these innovations into new products, services, and, sometimes, new industries. Why would we want to stifle these advancements?

THE U.S. WORKFORCE IS INCREASINGLY UNPREPARED FOR THE 21ST CENTURY ECONOMY

- THE U.S. GOVERNMENT, PRIVATE INDUSTRY, THE MEDIA, AND THE GENERAL PUBLIC MUST CONFRONT THE CURRENT CRISIS IN TEACHING SCIENCE AND TECHNOLOGY TO OUR STUDENTS; IF WE DO NOT, OUR LEAD IN SCIENCE AND TECHNOLOGY IS AT RISK.
- U.S. HIGH SCHOOL SENIORS RANK AT OR NEAR THE BOTTOM IN COMPARABLE MATH AND SCIENCE SCORES WORLDWIDE.
- AMERICAN UNIVERSITIES ARE NOT GRADUATING ENOUGH SCIENTISTS AND ENGINEERS TO SUPPORT GROWTH IN THE HIGH-TECH INDUSTRY.
- FOREIGN NATIONALS WHO HAVE PREVIOUSLY FILLED THIS VOID ARE FINDING OPPORTUNITIES ABROAD AS BUREAUCRATIC BARRIERS KEEP THEM OUT OF THE UNITED STATES.

A highly skilled workforce is the lifeblood of any successful company, industry, or national economy. The United States historically has been the breeding ground for many of the world's most innovative companies, in large part, because it offered a diverse pool of talented, highly educated workers. **But evidence of a decline is surfacing, precipitated by three gathering trends: an increasingly ill-prepared domestic workforce; a steadily depleting stock of high-skilled and educated foreigners; and an aging population.**

Policies promoting the free flow of trade, capital, and knowledge can go only so far in creating an innovative, entrepreneurial environment. They are necessary – but not sufficient – conditions to attract cutting-edge industries in an increasingly global economy. Why? Because many other countries now offer similar incentives. As emerging nations integrate themselves into the rules-based system of global trade and investment, America's leadership in this realm is challenged.

> *"[W]e're falling behind. We're not keeping up with other countries in our investment in science and engineering. The science and math scores for our high school graduates are disastrous. We're underfunding research in the physical sciences, and we're lagging seriously on publications in these sciences. This is a problem for our economy, and we have to think about where we want to be 20 to 40 years from now."*
>
> - Susan Hockfield, *President, MIT*
> *BusinessWeek* Interview, October 4, 2004[44]

As countries liberalize capital markets, lower tariffs and other trade barriers, and pursue less interventionist regulatory policies, the tipping point in choosing where to locate the next cluster of innovation could be the education and skill level of the workforce. Silicon Valley remains an important location for technology companies, despite the high cost of living, because it offers access to qualified workers.

As the reaction to Sputnik attests, the United States, when motivated, has the capability to rededicate itself to improvements in the strategically critical fields of math and science. Congress responded to that threat by passing the National Defense Education Act in 1958. This legislation made available $1 billion – an astonishing figure for the time – to pay for college loans, scholarships, and scientific equipment for public and private schools, focusing on the study of math, science, and foreign languages.[45] This unprecedented, large-scale federal involvement in the realm of education sparked a dialogue for reforming school curricula and reshaping classroom materials and activities. The collaboration between classroom teachers and research scientists represented a fundamental shift in the educational process.

Today, the American educational system is in danger of reverting to the lax times of the pre-Sputnik era. Sadly, this is not a new phenomenon. America's "dirty little secret" is that the United States has frequently struggled to persuade sufficient numbers of its citizens to pursue highly technical careers.[46] It has been able to mask these deficiencies by welcoming the best and brightest foreign talent to come study, work, and explore new ideas and research fields in the United States. Not only has this bolstered U.S. innovation, it has created hundreds of thousands of jobs as these immigrants found companies on U.S. soil. It also produces benefits far beyond the economic realm. **Foreign nationals who return home with an American education tend to retain positive impressions of the United States as they become leaders in their own countries.**

Just when the competition for the brightest minds in the world has reached a fever pitch, the United States has raised the barriers and bureaucratic red tape to their admission. Understandable security concerns must be balanced against their consequences for long-term U.S. competitiveness. The State Department must work with Congress to allow more scientists, researchers, and engineers into the United States to complement the domestic workforce available for future innovation.

Because these highly skilled individuals are a critical link in the U.S. innovation infrastructure, policymakers must understand that reversing the long-held commitment to promoting immigration and cultural exchange is a national security risk itself.

Additionally, national policy needs to be viewed through the prism of education as a life long process, especially in a global economy that portends to be very different from that of the twentieth century. Through the high growth period spanning the 1940s to the 1970s, workers in all advanced industrial economies tended to follow linear career paths within a particular industry or even one company. In the more dynamic information economy, this trend could all but vanish.

> *"College will continue to be a good investment for a great many Americans in the years ahead. But with improvements in K-12 education, an expensive college education need not be the only way to obtain a middle class job."*
>
> - Richard J. Murnane & Frank Levy
> *Teaching the New Basic Skills*[47]

In the past, the skills workers learned were good for decades. Now, workers need to constantly adopt new skill sets. Increasingly, the success of an individual, a company, or a nation will be measured by how well they can adapt to new conditions and potential career shifts.

Formal education from kindergarten through college will remain crucial in preparing future generations of workers, but education will not end there. The flexibility of the American workforce has served the United States well, and it will have to become even more flexible. This will require creative solutions to stimulate continuous education and retraining programs to prepare workers and employers to compete in the knowledge-based economy.

This section offers the following statistical indications that U.S. education objectives need to be addressed and reexamined.

K-12 Education in Math and Science Is Not Up to Par

❖ The education of the workforce starts with K-12. Without a strong background in math and sciences, K-12 students will have trouble earning technology degrees and, ultimately, technology jobs. **In an information economy the majority of jobs – not just those specifically in high tech – require some grounding in science and math.**

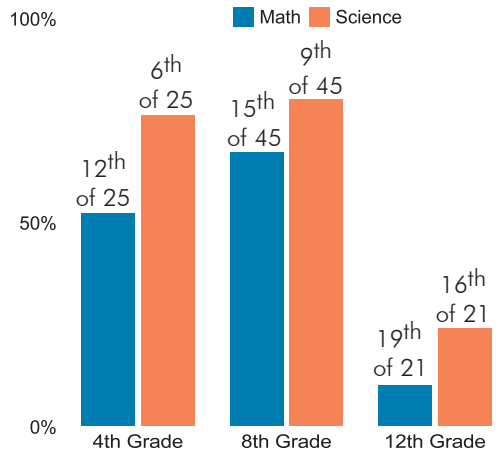
❖ While U.S. students in the 4th and 8th grades have improved their proficiency in math and science, they still have a ways to go. The National Assessment of Educational Progress (NAEP) reported that 32 percent of 4th graders and 29 percent of 8th graders tested proficient in math in 2003.[48]

❖ More troubling is that 12th graders perform even worse. The most recent NAEP data available for 12th graders show a decline in both math and science scores. **For example, the data show that 21 percent of 12th graders were proficient in science in 1996. By 2000, this number dropped to 18 percent,** according to the most recent data available.[49]

❖ When comparing U.S. K-12 students to their international counterparts, a similar trend emerges. **While U.S. students in the 4th and 8th grades score in the top percentile, 12th graders score at the bottom in math and science.**[50]

❖ U.S. 12th graders perform even worse when compared with their international counterparts in physics, ranking last among the 16 countries participating.[51]

International Rankings in Math and Science, U.S. as a Percentile of Total Countries



Source: Third International Mathematics and Science Study (TIMSS)

The U.S. Higher Education System Is Not Preparing Enough Students for Careers in High Tech

❖ The United States benefits from having many of the best colleges and universities in the world. However, just as the K-12 system is not preparing students for tech degrees, America's colleges and universities are not graduating enough tech workers.

❖ High-tech industry employment grew by 50 percent between 1990 and 2002. During this time, the number of engineering bachelor degrees awarded in the United States fell by six percent and physical science degrees grew by just three percent. The only saving grace for the tech industry was that math and computer science degrees grew by 41 percent during this same time. In part, this was due to the growth of the new Internet and Internet-related industries.[52]

❖ At the doctoral level, the growth rate slowed for engineering, as well as for math and computer science degrees. Doctoral engineering degrees grew by five percent between 1990 and 2002, and math and computer science degrees grew by nine percent, compared to a growth rate of 55 percent in engineering and 60 percent in math and computer science between 1985 and 1990.[53] However, as seen below, many of these graduate students are foreign nationals who may be forced to return home.

Higher Education Costs Are Outpacing Family Incomes

❖ Rising costs in higher education could further exacerbate these downward trends. According to a recent report by the College Board, a non-profit association of educational institutions, the average cost of attending a four-year public university (including tuition, fees, and room and board) jumped 7.8 percent or $824 in the 2004-2005 school year, to $11,354, adjusted for inflation. This follows three previous years of costs rising at similar rates.[54]

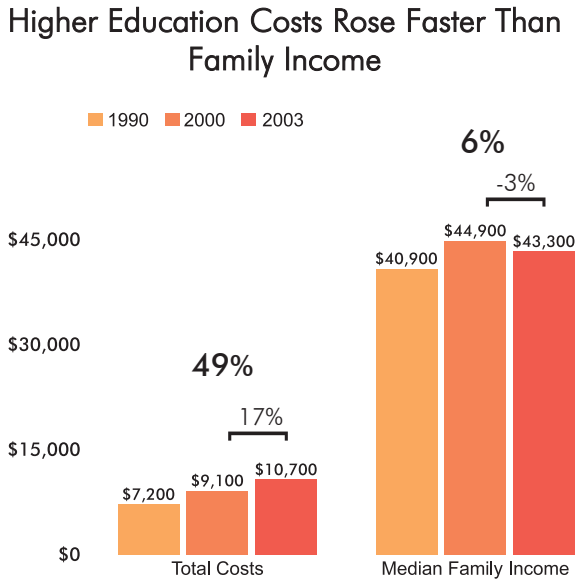
❖ Meanwhile, the burden on families to pay the costs of higher education has grown disproportionately. In 1990 the average total cost of attending a four year public university was $7,178 and the median family income was $40,865, both adjusted for inflation. In 2003, these numbers stood at $10,720 and $43,318 respectively, corresponding to a 49 percent rise in higher education costs but only a 6 percent increase in median family income.[55]

❖ The United States has historically recognized the value of promoting higher education for qualified young Americans whose academic merit is ample but whose financial resources are lacking. Federal Pell grants, money targeted for lower income students, have long served this purpose. Regrettably, the funding for this program has not matched the demand of increasing numbers of qualified applicants. In 1980-1981, a Pell grant covered 35 percent of the total annual cost of attending a public university. By 2003-2004, this had fallen to 23 percent.[56]

❖ In December 2004, the Department of Education announced a new formula for calculating financial aid that will eliminate federal Pell grant scholarships for an estimated 80,000 to 90,000 low-income students. On January 15, 2005, the President proposed a plan that will hopefully redress this issue by increasing Pell Grant funding over the next five years.[57]

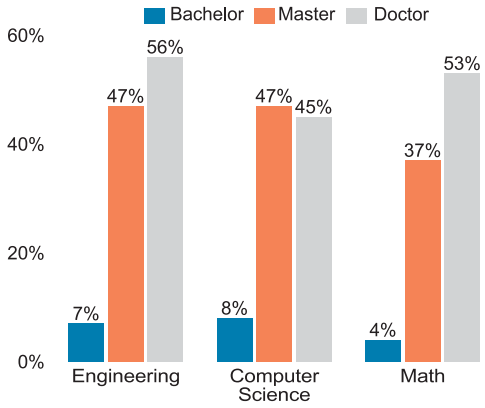
Foreign Nationals Are Critical to Our Educational System, Our Workforce, Intellectual Property Development, and Job Creation

❖ The lackluster growth in technology degrees is compounded by the fact that foreign nationals make up an important pool of qualified talent, yet U.S. immigration laws create barriers for these workers to stay and work here. If current policies are continued, foreign nationals will no longer provide this safety valve, and the United States will experience a brain drain as U.S.-educated foreign graduate students are forced to leave.



Source: College Board and U.S. Census Bureau

Percent of U.S. Degrees Awarded to Foreign Nationals
2002



Source: U.S. Department of Education

❖ Foreign nationals received over 50 percent of doctoral engineering and math degrees awarded and over 40 percent of doctoral computer science degrees awarded. These students represent the best and the brightest in their field of study, yet as foreign nationals, they need to navigate the complex immigration process to remain, and those not yet in the United States face even higher barriers.[58]

> *"Our immigration policy took a giant step backward because of fears associated with September 11. Making it hard for graduate students to come here does not make America safer. It makes us weaker."*
>
> - Roger McNamee
> *Venture Capitalist*[61]

❖ The limited growth of technology degrees in the United States and the high proportion of foreign nationals in master's and doctoral programs illustrate the importance of foreign nationals to companies and universities seeking qualified talent.

❖ **Foreign-born individuals represent one of every five scientists and engineers in the United States, accounting for over 1 million workers who contribute a tremendous amount of knowledge, talent, and innovation to the U.S. economy, ultimately creating hundreds of thousands of jobs.** This immigration keeps highly skilled workers in the United States.[59]

❖ Almost half of the Nobel Prizes awarded to researchers in the United States between 1901 and 1991 were won by foreign-born individuals or their direct children.[60]

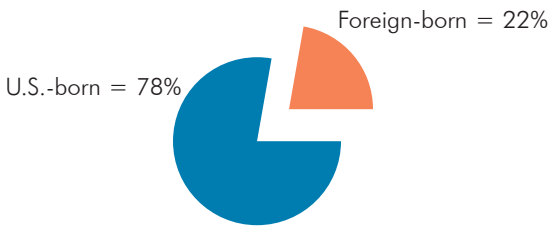
The United States Raises the Barriers for High-Skilled Immigration

❖ In the post-9/11 environment and during the recent recession, the United States has raised the barriers for skilled laborers entering the country. Fewer workers and students are applying for visas, and the rejection rates for those who do apply are higher. Student visas declined 27 percent between 2001 and 2003, a loss of 80,000. For those with specialized skills, the number of accepted visa applications also dropped by 27 percent, from 225,000 in 2001 to 165,000 in 2003. This means that 60,000 fewer high-skilled people entered the United States during this time.[62]

❖ **Outdated and overly bureaucratic immigration laws, the perception that the United States is less welcoming of foreigners, and heightened competition from foreign universities have lead to a decline of foreign nationals studying in the United States.** According to a survey by the Council of Graduate Schools, 88 percent of U.S. graduate schools reported an overall decrease in international student applications for the fall of 2004. Engineering and physical sciences suffered some of the largest decreases. Graduate engineering programs reported a 36 percent decline in the number of international applications.[63]

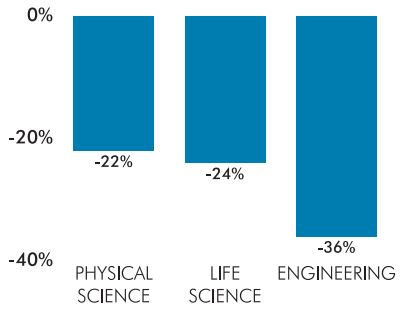
❖ These declines forecast not only an irreplaceable loss in available talent, but a financial shortfall as well. Loss of such significant revenue from foreign nationals jeopardizes the long-term viability of many U.S. science and engineering graduate programs.

Foreign-Born Individuals in Science and Engineering Occupations
2000



2000 data are the most recent available.
Source: U.S. National Science Foundation

Decline of Foreign Graduate Applications to U.S. Schools
2003-2004



Source: Council of Graduate Schools

❖ While it is understandable that 9/11 and a recession would make America more leery about immigration, policymakers need to be aware of the unintended consequences of this pull-back from the global workforce. These high-skilled and highly educated workers help create innovation, wealth, and more jobs. Immigrants helped found Intel, Sun Microsystems, Yahoo!, and Google – to name a few. **If we shut these people out of the United States, we only end up pushing the jobs overseas.**[64]

❖ In the United States, the bureaucracy and barriers to immigration continue to grow. H-1B visas are those reserved for high-skilled workers entering the United States on a temporary basis. The U.S. Citizenship and Immigration Services received enough H-1B visa petitions to meet their congressionally mandated cap of 65,000 for FY 2004 on February 17, 2004, meaning no new H-1B visa applications were available between February 17, 2004 and October 1, 2004.[65] In FY 2005, the congressionally mandated cap was hit on the same day that H-1B visas became available, October 1, 2004.[66] The issue is that after hitting the cap, no new H-1B visas are available. If a U.S. company needs a specialized worker that only could be filled by a foreign national, the company would have to hire the person in his or her native country, creating a foreign job instead of a U.S. job.

Visa Applications for High-Skilled Categories
2001-2003

	Applications	Percent Refused	Accepted
Exchange Visitors (J-1 visas)			
2001	279,500	7.8%	257,700
2002	278,600	10.5%	249,300
2003	295,600	15.9%	248,600
Other High-Skilled Work Visas			
2001	248,400	9.6%	224,600
2002	203,600	11.9%	179,300
2003	200,200	17.8%	164,600

Data are rounded.

Source: U.S. National Science Foundation

What Has Immigration Given Us?

Name / Title	Company	Employees	2003 Sales
Andy Grove Co-founder & Chairman	Intel	79,700	$30.1b
Vinod Kholsa Co-founder	Sun Microsystems	35,000	$11.4b
Jerry Yang Co-founder & Director	Yahoo!	5,500	$1.6b
Sergey Brin Co-founder & President	Google	1,600	$1.0b

Source: Hoovers Online

❖ Congress took a step in the right direction in November of 2004 by expanding the H-1B program by an additional 20,000 visas for foreign nationals who have received their master's or doctoral degree in the United States. It remains to be seen if this will meet the high skill needs of the U.S. tech industry, since the industry requested a number closer to 50,000.[67]

Other Countries Take Advantage of Immigration

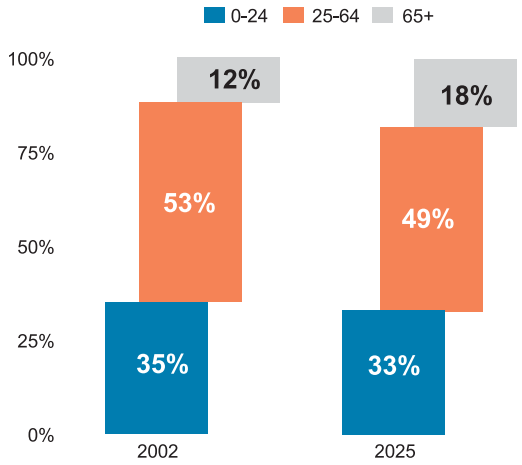
❖ Even if the U.S. immigration process were as efficient as it could be, the United States still faces unprecedented competition from abroad. Other countries are investing heavily in world class universities and fostering cutting-edge companies, taking a page from the development path of the United States. These rival universities and companies are aggressively competing for talented students and skilled workers. And more often than ever before, they are winning.

❖ In contrast to the bureaucracy of U.S. immigration, Japan took proactive steps to make it easier for highly skilled workers to immigrate, allowing employment and residency for an indefinite period. The number of foreign high-skilled workers in Japan grew by 10 percent, from 248,000 in 1999 to 274,000 in 2003. This is particularly telling for a country that has traditionally shunned immigration.[68]

Demographic Data Show an Aging Workforce with Implications for Science and Engineering

The United States, like most developed nations, will experience large demographic changes as the baby boom generation ages. Their retirement will create increased competition for skilled workers and exacerbate the future skilled worker shortages in the United States. Workers with the right skills in S&E will be in high demand.

U.S. Population by Age



Source: U.S. Census Bureau

As companies compete for talent, some will lose. The lack of available qualified workers will stifle U.S. innovation and advancement. It also could force businesses to devise alternatives to fill their workforce needs, including increasing their workforce in other countries – offshoring.

❖ The proportion of the U.S. working age population is shrinking. The percentage of Americans who are 65 or older will grow from 12 percent of the population in 2002 to 18 percent in 2025. This means that there were 4.4 people in the working age population (25-65) in 2002 for every retired person (65+); by 2025, this is projected to drop to 2.7. To maintain the same proportions in 2025 as in 2002, the United States would need 110 million more 25-64 year-olds in the population.[69]

❖ Similar demographic trends will also occur in the European Union and Japan. But these mature economies are unlikely to pose the greatest competitive threat to the United States in the coming years. Countries highlighted in this report – including many of the emerging economies in Asia – have younger populations.

WHY IS THIS A PROBLEM?

Other parts of the world exalt science and engineering. **In the United States, far too often, these are seen as careers for geeks and nerds.** This is tragic. This type of attitude embraces ignorance, and ignorance is poison to an economy that runs on technology and innovation. What we cannot figure out is: how is it not "cool" to create something that no one 10 or 20 years before had even conceived of? How is it not rewarding to look at a product, service, or procedure and say – with pride – that you were a part of its creation?

In educating our children, we would be wise to exalt the accomplishments of America's great inventors and innovators. Instead of enticing our children to pursue science and engineering with statistics about how hard the classes are or how likely they are to flunk out, educators would better serve themselves and our country by focusing on how scientists and engineers make life changing contributions to society. Instead of scaring freshman by telling them to look left, then right, and realize that at least one of those peers will not graduate, why not remind them that in this country one of those two – if not themselves – might just be the next Edison, Einstein, or Gates?

As long as American culture reinforces the stereotype that only geeks and nerds go into science and engineering, we should not be surprised when we cannot produce enough of these individuals to create the next wave of breakthrough technologies.

If we cannot shatter this stereotype and our native talent continues to steer clear of technical professions, then we need to understand that keeping out foreigners is not the answer. If we kept out Andy Grove, Intel might not be the company that it is today. If we kept out Sergey Brin, Google might not have been created here. How does this help the American economy? That is the problem, it doesn't.

CONCLUSION

In August 2004, Americans witnessed the startling defeat of the U.S. men's basketball team by both Puerto Rico and Argentina at the summer Olympics. Here was a sport the United States had always dominated, a game America invented. Yet, the team seemed unprepared to accept the possibility that a gold medal would not fall into its lap as a birthright. The Americans were shocked that players from other countries – many of whom had significant experience playing in the United States – had now closed the talent gap. The U.S. squad was woefully unprepared to compete against upstart teams who frankly played a more cohesive, team game. Many a commentator rationalized that at least this might serve as a wake-up call that times had changed and the United States better adapt and compete or it might fail to earn even a bronze medal in the future.

The realization that the United States no longer dominates internationally in basketball may bruise our national pride somewhat, but losing our competitive edge in the global business climate is far more devastating. Technological innovations have created entirely new industries and are largely responsible for the dramatic increases in productivity that help raise wages and standards of living.

The United States is not preordained to lead the world in economic or technological advancements. We achieved this lead over the last 60 years by focusing on those factors that made us highly competitive. We fostered a technically skilled workforce by educating American youth in math and science and by welcoming, not shunning, highly-skilled talent from around the world. We recognized that investment in research and development was critical in promoting technological innovation. And we understood that innovation – taken in its broadest sense as the open acceptance of change and new ideas – is what fuels our economy.

We are still in the lead, but it is a precarious one. Already other countries are challenging us in key technology arenas. If we don't act now to maintain our competitive edge, we should not be surprised if the next wave of breakthrough technologies is created abroad.

U.S. policymakers and industry leaders need to recognize that as we neglect our technology infrastructure – skilled labor, R&D, and a business friendly environment – many countries are adopting economic reforms and are directly competing with the United States for foreign talent, innovation, and technology products and services. Unless this realization hits home, American losses will not be confined to the basketball court.

AeA'S RECOMMENDATIONS FOR IMPROVING U.S. COMPETITIVENESS IN SCIENCE AND TECHNOLOGY

If *Losing the Competitive Advantage?* makes no other lasting impression, then we hope it underscores the urgency that America's capacity to produce the innovations of tomorrow relies on robust and visionary policy decisions today.

As representatives of many of the nation's innovators and entrepreneurs, we at AeA appreciate bold vision and long-term planning. At the same time, we are well aware that policy does not exist in a vacuum. We face significant obstacles in just recognizing that a problem exists. Compounding this, the current U.S. federal budget deficit constrains the type of policy vision that once challenged Americans to send a man to the moon. This requires a sea change in the way we formulate solutions.

Fortunately, we do not actually have to strive for something we have never done before. We merely have to rededicate ourselves to the policies and priorities that have historically sustained our economic growth. Budget deficits existed in the late 1950s when Congress enacted the programs that invested in education and helped win the space and technology race. Deficits existed throughout the 1980s when the federal government invested in the innovation infrastructure that spurred the technological advancements of the 1990s.

We realize the resources needed to fix this problem are not in abundant supply. But current fiscal shortfalls do not preclude enacting the policy initiatives advocated here, especially those with no significant budgetary impact. The cost of neglecting these investments is even higher: declining U.S. competitiveness in the world economy.

The approaching crisis did not sneak up on us overnight; it has evolved over the past decade and a half. We need to decide where we want the United States to be in the coming decades. If we hope to continue as the world's leading science and technology economy, we need to act now.

AeA dedicates itself to spearheading debate on the issues most critical to the advancement of high technology in the United States. We have stood among the vanguard in addressing offshore outsourcing, radio frequency identification, and the effects of corporate governance provisions on small- to medium-sized companies. We now call upon the Administration, Congress, the high-tech industry, and leaders in academia to act now for the future of U.S. competitiveness in a changing world.

While no country can totally control the forces governing world commerce, innovation, and competitiveness, the chances for success improve by being prepared. We can educate our domestic workforce, utilize the worldwide pool of skilled labor and knowledge, and rebuild a system that supports innovation and technology adoption. As competing countries do this, they will continue to close the gap, but this is not entirely to be feared. Nations that open their doors to free markets open their doors to U.S. products and services.

These trends can provide incredible benefits to the United States if we act appropriately. Every threat outlined in this paper is also an opportunity. In this context we propose the following:

I. SUPPORT HIGH-SKILLED IMMIGRATION

Lower Barriers for Immigration of High-Skilled Individuals

❖ As the number of foreign graduates in science and engineering continues to grow and as the number of foreign graduates inside the United States remains high, U.S. companies need to be able to draw on all of these graduates. Science and engineering graduates are the foundation of technology advancement and provide many positive external benefits to the company and country where they work.

❖ If companies cannot find enough qualified workers domestically and the barriers to employing foreign workers remain high, companies will go to where the workers are located.

❖ The United States also needs to decrease the bureaucratic and regulatory barriers delaying, preventing, and discharging high-skilled workers from entering the U.S. workforce. The U.S. government needs to invest in the technology and equipment to expedite the screening process, eliminating unnecessary delays. It also needs to change bureaucratic and burdensome rules that impede legitimate immigration such as deemed exported licenses for individuals. A deemed export is any release of technology or source code subject to the Export Administration Regulation to a foreign national within the United States. Such release is deemed an export to the home country or countries of the foreign national. Immigration is a critical component for maintaining a strong and vibrant technological workforce.

Give Green Cards to All U.S. Trained Master and Doctoral Students

❖ Accredited U.S. colleges and universities award 8,000 doctoral and 56,000 master's degrees in science and engineering to foreign nationals per year.[70] Instead of sending these people back to their countries, they should be given a Green Card to stay in the United States. These people will make significant contributions to the economy and workforce. The United States benefits by keeping them here.

II. ENGAGE PROACTIVELY IN GLOBAL TRADE MECHANISMS TO ENSURE OTHER COUNTRIES COMPETE FAIRLY

Promote Stronger Enforcement of Intellectual Property Protection Worldwide

❖ Intellectual Property is typically the core asset of any high-tech company. From patents and copyrights to software and trade secrets, intellectual property forms the basis of the knowledge economy. Far too often, foreign legal systems do not adequately protect the owner of these valuable creations, resulting in the loss of literally billions of dollars. The Business Software Alliance estimated that 36 percent of software worldwide was illegally pirated in 2003. This translates to a $29 billion loss in revenue. In China, this figure is 92 percent and the revenue loss is estimated at $3.8 billion.[71] Digital technology has made intellectual property theft that much easier on a wide scale. When foreign companies and consumers can steal this hard earned property, the profitability and, ultimately, the competitiveness of U.S. companies suffer.

Conclude the Doha Round of Global Trade Talks

❖ The United States economy has gained greatly from liberalization of trade worldwide and from the rules-based system facilitated by the World Trade Organization (WTO). The Doha round of trade talks broke down in the summer of 2003 as negotiations on agriculture and certain service sectors reached an impasse. As a result, the United States risks losing momentum in further opening global markets to U.S. products and services. While selected bilateral negotiations can produce beneficial results, a more comprehensive approach to trade is still needed. U.S. trade representatives must continue to work with developing countries to achieve broader global integration. Additionally, while much has been gained by welcoming countries like China into the WTO, only through constant vigilance can the United States, and the U.S. high-tech industry, ensure that countries abide by the rule of law.

III. CHAMPION DRAMATIC IMPROVEMENTS IN THE U.S. EDUCATIONAL SYSTEM

Alter the Attitudes of Young People Towards Careers in High Tech

❖ Educators, parents, and business leaders need to promote the benefits and rewards of pursuing a career in science and technology. All too often, these careers are seen as the domain of nerds and geeks, instead of inventors and leaders. Our attitudes even discourage people from these fields by promoting how hard they are instead of how rewarding they can be. The United States would benefit tremendously from a series of industry-sponsored public service announcements exalting science and technology careers.

Improve Math and Science at K-12 Level To Adequately Prepare the U.S. Workforce and Provide Students with the Necessary Background for Degrees in Science and Technology

❖ Today's workforce needs more technical skills and ability than ever before. From doctors to mechanics and lawyers to manufacturers, technology touches all occupations, requiring more advanced skills. Only those with the proper background and education will succeed in this highly technical environment.

❖ To increase the number of science and engineering students, the United States first needs to provide all students an adequate foundation in math and science. This situation is similar to 1958 when President Eisenhower mandated a national program to improve math and science education, following the launch of Sputnik. The U.S. needs a "son of Sputnik" mandate today.

❖ The No Child Left Behind Act took a bold stab at reforming the U.S. educational system. But this is only a first step. Congress only partially funded NCLB. We need to fully fund it.

❖ We also need to drastically improve the academic ability of our 12th graders. It is appalling that less than 20 percent of our kids graduate high school proficient in science. We should strive to achieve a goal of at least 30 percent of our 12th graders testing proficient in math and science within five years.

Create the Human Capital Investment Tax Credit To Promote Continuous Education

❖ As this paper has argued, an educated workforce is crucial for the United States to maintain its competitive advantage in high technology. In addition to policies aimed at the K-12 level and at colleges and universities, policymakers need to recognize the value of on-the-job training and continuous education programs for enhancing the skill set of the American workforce.

❖ Companies often lack incentives to invest in educating and retraining workers as they risk losing that return on investment if the worker subsequently leaves the firm. By providing human-capital investment tax credits, the U.S. government can encourage companies to retrain workers by reducing or eliminating out-of-pocket costs. At the forefront of technology innovation, companies are often the best predictor of what skills will be most valuable in the future.

❖ Continuous retraining, education, and skills acquisition ensure that fewer technology workers will find themselves suddenly displaced with no skills to participate in the constantly shifting high-tech industry. Furthermore, society would benefit from the continuous education of workers, which also increases productivity and decreases downtime between jobs.

IV. SUPPORT RESEARCH AND DEVELOPMENT

Promote Federal Funding for Basic Research

❖ Basic research is the pure study of a topic for the sake of knowledge, as opposed to searching for a specific development or product. As such, basic research is the foundation on which innovation and advancement occur with tremendous externalities that can yield benefits beyond the research itself. Because basic research generally involves the most uncertainty and is the least likely to foster immediate commercial value, businesses are reluctant to fund basic research initiatives. The federal government needs to fill this void and continue to provide support for all fields of basic research.

Increase Funding for the National Science Foundation, Specifically for Physical Sciences, Engineering, and Math and Computer Science Research

❖ While federal funding for physical sciences, engineering, and math and computer science research has slowly increased, the majority of new funding supports life sciences research. Federal research in the physical, engineering, and math and computer sciences needs to have the same level of funding commitment as life sciences. R&D breakthroughs in these fields increase the economic and industrial strength of the United States. As examples in this paper illustrate, this ultimately benefits the American people.

❖ The National Science Foundation Authorization Act of 2002 authorized the doubling of the NSF budget by 2007. Instead of doubling the funding for the NSF, Congress in November of 2004 cut funding. The United States needs to make good on its plan to increase the NSF budget to $9.8 billion by FY 2007.[72]

Increase Grants and Funding for College and University Research To Support Academic R&D and Facilitate Graduate Education

❖ An essential component to supporting universities, undergraduate and graduate programs, and students is the funding of academic research. The money spent on R&D in higher education helps spur innovation and product development. In addition, research money provides graduate students the funding they need to attend school, helping to make graduate programs more affordable. Furthermore, the federal government should advertise that this money is available, just as the military advertises for recruiting.

Make the R&D Tax Credit Permanent

❖ Companies play a critical role in funding and performing research and development in the United States. Many U.S. trading partners and developing countries – including China – offer more generous and permanent R&D tax incentives than the United States. Enactment of a strong, permanent U.S. R&D tax credit will encourage private R&D investment and will provide companies with long-term certainty in their tax planning, something that is lacking in our current system of temporarily renewing the tax credit. We are encouraged by the recent Bush Administration proposal in the FY 2006 budget to make the R&D tax credit permanent.

V. PROMOTE TECHNOLOGY DIFFUSION

Provide Industry the Incentives To Promote Broadband and Cellular Penetration

❖ Countries like South Korea and Italy have realized enormous competitive advantages by investing heavily in broadband and cellular deployment. Just as the interstate highway system dramatically increased the efficiency and productivity of the U.S. economy half a century ago, so too can efficient communications networks have the same positive effect today.

❖ Broadband and cellular diffusion also foster competitive advantages by creating demand for cutting-edge products and services. As examples in this paper illustrate, it is no coincidence that countries with high penetration rates have produced globally competitive companies.

VI. IMPROVE THE BUSINESS CLIMATE IN THE UNITED STATES

Reform Section 404 of Sarbanes-Oxley

❖ While there are many worthwhile provisions in Sarbanes-Oxley and the intent is laudable, many small and medium-sized companies have serious concern with Section 404 and the expense of the internal control reporting requirements. Small and medium-sized companies are disproportionately burdened by Section 404, and these provisions need to be examined to ensure a proper balance between accountability and bureaucracy.

Address the Rising Costs of Health Care for U.S. Business

❖ The dramatic rise in health care costs for U.S. businesses, particularly over the last three years, has put these costs in a new spotlight. The future of health care and the health care debate will now have to incorporate the reality that these health care costs for U.S. companies could greatly undermine their international competitiveness. Many foreign competitors do not incur these costs. Whatever options this debate considers, it must be cognizant of the impact of American competitiveness on the world stage.

Reward Risk Taking by Supporting Stock Options

❖ No industry has benefited more than the high-tech industry from the use of stock options. Stock options provide employees with a direct link to the growth and profitability of companies. They also are an essential tool for attracting and retaining the best workforce, especially for small businesses and start-ups who do not always have the capital to compete on salary alone.

❖ Already China and India have learned from the successful use of stock options in Silicon Valley and are using it to attract and retain businesses and employees.

❖ The current regulatory efforts to expense stock options put significant burdens on American companies, with a direct effect on their bottom line. The regulation will force many companies to end their stock option plans for the rank-and-file employees, the primary recipients of stock options. It also puts American companies at a disadvantage when competing with foreign companies that can offer this incentive package.

Stop Raiding the U.S. Patent and Trademark Office for General Funds Revenue

❖ Patents play an integral role in the new knowledge-based economy. Patents help protect and identify ownership of innovation. An efficient patent system helps reward individuals and companies that are on the forefront of the technology revolution. Unfortunately, the current U.S. patent system is broken. The U.S. Patent and Trademark Office (PTO) lacks sufficient numbers of patent examiners and attorneys to process all the incoming patent applications. The average time required to secure a patent is two to three years, a delay that ends up stifling innovation.

❖ Currently, the fees collected from patent applications are diverted to the general treasury. Instead of siphoning this revenue away from the PTO, these fees, or some portion thereof, should remain with the PTO. Consequently, as the number of applications increases, PTO revenue would rise proportionally and it could hire more examiners and attorneys to process these additional applications. Expediting the process will help unlock the creativity and drive of inventors, and mitigate the risk that competing countries will issue the initial patent.

VII. HOLD A SPUTNIK 2005 SUMMIT

The Decline of U.S. Competitiveness Needs To Be Addressed at a Sputnik 2005 National Summit

❖ We call upon federal and state policymakers, the U.S. business community, educators, workers, and anyone else dedicated to U.S. competitiveness to convene a national summit. This summit would focus on strategies to improve U.S. competitiveness across the spectrum of issues addressed in this paper. This includes K-12 education, higher education, worker training and retraining programs, research and development funding and priorities, immigration policy, technology diffusion, the domestic business climate, and the implications of other countries' adopting free market principles and utilizing advanced technologies. This summit should put forth concrete proposals to be implemented by the Administration, Congress, and other key groups, such as academia, school boards, parents, teachers, and the business community.

NOTES

The following is an extensive, but by no means exhaustive, list of sources for the research conducted to produce this paper. We have provided citations for all instances in which we used specific data, quotations, or material that could be primarily attributed to one or two sources. The analysis of historical and economic trends, the current state of the global economy, and the benefits derived from technology result from research spanning a multitude of sources not necessarily cited here.

1. Peter Drucker, Interview by Brent Schlender, "Peter Drucker Sets Us Straight," *Fortune*, January 12, 2004.
2. National Intelligence Council, *Mapping the Global Future* (Central Intelligence Agency, December 2004), 11. Available at: http://www.cia.gov/nic/NIC_globaltrend2020.html.
3. U.S. National Science Foundation, *America's Investment in the Future* (2000), 1.
4. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), Appendix 2-33; and *IMD World Competitiveness Yearbook* (2004).
5. Jason Bush, "A Renaissance For Russian Science," *BusinessWeek*, August 9, 2004.
6. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), Appendix 2-36.
7. Ibid., Appendix 2-38.
8. Quoted in Fareed Zakaria, *The Future of Freedom: Illiberal Democracy at Home and Abroad*. (W.W. Norton & Company, 2003), 53.
9. Arvind Panagariya, "India's Economic Reforms: What Has Been Accomplished? What Remains to Be Done?" (ERD Policy Brief Series, Asian Development Bank, November 2001).
10. "An American in Bangalore," *The Economist*, February 6, 2003.
11. For more information on China's "Golden Projects" for development, including the "Golden Bridge," go to: http://www.chinagate.com.cn/english/147.htm.
12. *IMD World Competitiveness Yearbook* (2004).
13. News Release, "China and India Jockey for the Top Most Attractive Foreign Direct Investment Destination Globally While the U.S. Is Challenged by These Rapidly Evolving Economies," A.T. Kearney, October 12, 2004.
14. Paul Blustein, "China Passes U.S. In Trade With Japan," *The Washington Post*, January 27, 2004.
15. National Intelligence Council, *Mapping the Global Future* (Central Intelligence Agency, December 2004), 11.
16. Daniel Roth, "In Search of China's Bill Gates," *Fortune*, October 4, 2004.
17. Steve Chase, President of Intel Russia, quoted in "Russia joins tech-worker game," *SiliconValley.com*, November 21, 2002.
18. Olga Kharif, "Russia: Playing Catch-Up in Tech," *BusinessWeek*, March 4, 2003.
19. U.S. National Science Foundation, "An Overview of Science And Technology Reform in Central and Eastern Europe 1990-1993" (Report No. 67, December, 1993).
20. James Niccolai, "Hungary: The Silicon Valley of Eastern Europe?" *CNN.com*, March 17, 2000.
21. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), Appendix 5-35.
22. Ibid, Appendix 6-10.
23. Ibid, Appendix 5-52.
24. National Intelligence Council, *Mapping the Global Future* (Central Intelligence Agency, December 2004), 35.
25. ITU World Telecommunications Indicators Database.
26. Ibid.
27. Ibid.
28. Michael Kanellos, "South Korea's digital dynasty," *CNet*, June 25, 2004; and John Borland and Michael Kanellos, "South Korea leads the way," *CNet*, July 28, 2004.
29. ITU World Telecommunications Indicators Database.
30. Ibid. Count based on number of subscriptions. In many countries it is common for people to own multiple "SIM" cards, each of which is considered a subscription.
31. Eric Sylvers, "In Italy, a 'love to talk' feeds cell phone bonanza," *International Herald Tribune*, April 28, 2003.
32. National Intelligence Council, *Mapping the Global Future* (Central Intelligence Agency, December 2004), 35.
33. Ibid, 11.
34. The First Annual Report of the National Science Foundation, 1950-51.
35. Robert Pear, "Congress Trims Money for Science Agency," *The New York Times*, November 29, 2004.
36. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), Appendix 4-6.
37. Ibid, Appendix 4-1 and Appendix 4-6.
38. Harold Evans, *They Made America*, (Little, Brown and Company, 2004), 11.

39. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), Appendix 4-6.
40. R&D Credit Coalition and the National Association of Manufacturers, *America's Future: R&D* (2004).
41. China National Tax Affairs Bureau. Available in Chinese at: http://www.chinatax.gov.cn/print.jsp?code=200309241006475384.
42. U.S. National Science Foundation, Science & Engineering Indicators - 2004, Appendix 4-34.
43. Harold Evans, *They Made America*, (Little, Brown and Company, 2004), 442.
44. Susan Hockfield, Interview by William C. Symonds, *BusinessWeek*, October 4, 2004.
45. Rodger W. Bybee, "The Sputnik Era: Why Is This Educational Reform Different From All Other Reforms?" Prepared for the Symposium "Reflecting on Sputnik: Linking the Past, Present, and Future of Educational Reform" (Washington, DC, October 4, 1997); and G. Pascal Zachary, "Why terrorism isn't reshaping technology," *San Jose Mercury News*, February 29, 2004.]
46. Fareed Zakaria, "Rejecting the Next Bill Gates," *Newsweek*, November 29, 2004.
47. Richard J. Murnane and Frank Levy, *Teaching the New Basic Skills: Principles for Educating Children to Thrive in a Changing Economy* (Free Press, 1996), 35.
48. U.S. Department of Education, National Center for Education Statistics.
49. Ibid.
50. International Association for the Evaluation of Educational Achievement, Third International Mathematics and Science Study (TIMSS).
51. Ibid.
52. U.S. National Science Foundation; and AeA, *Cyberstates 3.0* and *Cyberstates 2002*.
53. U.S. Department of Education, National Center for Education Statistics.
54. The College Board, *Trends in College Pricing* (2004).
55. Ibid; and The U.S. Census Bureau, *Income, Poverty, and Health Insurance Coverage in the United States* (2003).
56. The College Board, *Trends in College Pricing* (2004).
57. Michael A. Fletcher, "Bush Proposes $500 Boost for Student Aid," *The Washington Post*, January 15, 2005.
58. U.S. Department of Education, National Center for Education Statistics, *Postsecondary Institutions in the United States: Fall 2002 and Degrees and Other Awards Conferred: 2001-02*.
59. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), 3-36.
60. Immigration Policy Center, *In Focus*, August 2004, Volume 3, Issue 3.
61. Interview with Roger McNamee in *BusinessWeek*, October 11, 2004.
62. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), 3-37.
63. Council of Graduate Schools, "Council of Graduate Schools Survey Finds Widespread Declines in International Graduate Student Applications to U.S. Graduate Schools for Fall 2004," Press Release, March 2, 2004.
64. The Alliance for a Competitive Workforce, *Passport to Prosperity*, (2004).
65. U.S. Citizenship and Immigration Services, Press Release dated 2/17/04 (rev. 2/19/04).
66. Patrick Thibodeau, "H-1B visa cap for FY '05 already reached," *Computerworld*, October 4, 2004.
67. Patrick Thibodeau, "Congress ups H-1B visa cap by 20,000," *Computerworld*, November 22, 2004.
68. Japan Ministry of Justice. Available in Japanese at: http://www.moj.go.jp/TOUKEI/DB/nyukan06.xls.
69. U.S. Census Bureau.
70. U.S. National Science Foundation, *Science & Engineering Indicators* (2004), Appendix 2-25 and 2-27.
71. Business Software Alliance, "First Annual BSA and IDC Global Software Piracy Study" (July 2004).
72. National Council for Science and the Environment, "President Bush Signs NSF Doubling Act into Law," December 19, 2002.

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