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Meeting the New Challenge to U.S. Economic Competitiveness

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Collaboration among government, industry, academia, and labor succeeded in the 1980s. That coalition must act again.

The U.S. economy, seemingly a world-dominant Goliath in the mid- and late-1990s, now faces major structural challenges from a new cast of Davids. The nation confronts a host of new economic challengers led by India and China. The U.S. economy recently took an unprecedented path when it regained strength during 2003 and 2004 without creating growth in jobs. The manufacturing sector's share of the economy continues to shrink. The growing service sector, once considered immune to global competition, now finds that advances in information and communications technology have enabled global competition in low-skilled service jobs and the beginning of competition in high-skilled service tasks.

Underlying these shorter-term developments is a major demographic shift. Historically, the U.S. economy has relied on steady 1 percent annual population growth to provide additional workers and increased output. In the coming decades, the country will face a rapid expansion of the nonproductive population of seniors. Furthermore, the aging baby boomers are propped up by a network of entitlement programs generally indexed to inflation. The Social Security Trustees recently estimated that the Social Security and Medicare programs create an unfunded liability for the taxpayers of $72 trillion (in net present value terms)—a daunting sum compared to total national wealth estimated at $45 trillion. A debt on upcoming generations of these dimensions, unsupported by any anticipated revenue stream, is an unprecedented national problem and has strong implications for the nation's future ability to invest in growth.

This new economic landscape raises a question: If the current economy faces structural difficulties, what could a renewed economy look like? Where will the United States find comparative advantage in a global economy? This is a threatening process, and even if the United States finds a way to meet the challenge, the transition will inevitably create losers as well as winners.

The last economic war

In the late 1970s and the 1980s, the United States faced strong competition, especially from Japan, which was making a serious bid to become the largest economy in the world. This competition focused on the manufacturing sector, particularly consumer electronics, automobiles, and information technology (IT). The United States lost dominance in consumer electronics but salvaged its auto manufacturing sector, in part through bilateral trade arrangements that set import quotas on imported Japanese vehicles but allowed Japanese auto production in the United States. The U.S. industry's light truck platform, which was protected by tariff from foreign competition, became the basis for the next several generations of U.S. vehicle innovations: minivans, pickups, and SUV's. In information technology, the United States retained its

lead in advanced computer chips and software.
The United States benefited from the investments in science education in the Sputnik era and from major Cold War federal R&D investments. It explored public-private collaboration to bridge the gap between government supported research and private sector development. The most successful example was Sematech, which helped reverse the country's declining position in chip technology. The Defense Department's Defense Advanced Research Projects Agency (DARPA) came into its own as a unique organization focused on moving revolutionary technology from the research to the development stage, playing a crucial role in creating the Internet and promoting multiple generations of IT. New forms of capital support for innovation were developed, facilitating the birth of creative startup companies. The dramatic growth of the U.S. economy in the mid and late 1990s rode on the IT revolution that boosted productivity throughout the economy. Although excessive enthusiasm about IT fueled a stock market bubble, the gains in productivity were real and translated into widespread societal gains in real income across classes, record homeownership, and a decline in poverty rates.

The next war

The United States faces a very different competitive situation now. Consider how the China of 2004 differs from the Japan of 1980. Japan, like the United States, was a high-wage, high-cost, advanced technology economy. China is a low-wage, low-cost, advanced technology economy, a much more complicated competitive mix. Japan held an advantage in collaborative industry-government activities, whereas the United States excelled in entrepreneurism. China provides a good environment for entrepreneurs as well as wielding government power to capture advanced technology for use in its firms. Whereas Japan had a reliable legal and intellectual property system, China's legal system is a work in progress and its intellectual property regime is

notoriously lax.
China has adopted Japan’s technique of manipulating its currency to gain advantage. The strategy is to undervalue its own currency to stimulate exports and to buy U.S. government bonds to create leverage in U.S. policymaking. Japan was a national security ally, whereas China is a potential competitor. Competition with China will be both very different and far more complicated and demanding than was competition with Japan. On top of this, the United States faces new and growing competitive forces in India and East Asia as well as continuing strong competition from Japan. India is a particularly interesting challenger, because whereas China is pursuing a more traditional emphasis on manufacturing-led growth, India is pursuing the emerging global services market. Of course, the emergence of China and India can provide benefits to the U.S. economy. As they develop as markets, the United States should be able to sell goods and services to their consumers. But so far U.S. exports are dwarfed by its imports, and there is no evidence that this situation will change soon.
Not only are the competitors different than in the 1980s, but so are the markets that are in play. In the 1980s the competition was over manufacturing, but now most sectors, including services, face direct competition, and the increasing fusion of services and manufacturing is creating a new field of battle. The focus is shifting from machines, capital plant, and natural resources to talent and knowledge. The competition over quality has expanded to include customization, speed, and responsiveness to customer requirements. Whereas the best technology was once enough, it is now necessary to also develop an effective business model for using the technology. Trade discussions that were once limited to products now incorporate knowledge management and services. A skilled workforce is no longer a durable asset; workers must be periodically retrained to remain competitively productive. Whereas low-cost capital was once sufficient, success now requires first-rate efficiency in all elements of the financial system as well as the ability to recognize and tap intangible knowledge assets.

Is the United States ready for these new challengers and new challenges?

Economic growth and innovation

A school of economic theory that has developed during the past two decades argues that technological and related innovation accounts for more than half of historical U.S. economic growth, which makes this a far more significant factor than capital and labor supply, which are the dominant factors in traditional economic analysis. These economic growth theorists see a pattern shared by important breakthrough technologies such as railroads, steamships, electricity, telecommunications, aerospace, and computing. The new technology ignites a chain reaction of related innovation that leads to a surge in productivity improvements throughout the economy and thus to overall economic growth. The most recent example is the productivity boom that occurred in the mid-1990s following the IT revolution that spread through the manufacturing and service sectors.

The United States has been capturing talent worldwide for two centuries and must continue to do so.

Yet we are handicapped by this theory. Innovation may be the true growth god, but the details of this new religion have not been fleshed out. Whereas we have almost a century's worth of detailed data on the old gods—capital and labor supply—we have few metrics to understand the dynamics of innovation-based growth. We can look at some macro data, such as R&D spending and worker education where government plays a prominent role, but macro data are inherently misleading. We know that some R&D investments are more vital than others, as are some members of the workforce.

In addition, these macro factors are imbedded in a spider's web of other connected and supporting strands that make up a complex system. The federal government plays many innovation-related roles, such as in fiscal and tax policy, industry standards, technology transfer, trade policy, product procurement, intellectual property protection, the legal system, regulation, antitrust, and export controls. We have only a gestational idea of how to optimize this complex network to spur innovation. And that is only the public policy side. There is the even more complex private sector role in innovation as well as the interactions between the private and public sectors.

Despite the lack of innovation metrics, the underlying logic of growth theory is compelling. And if innovation is the big factor in growth—and therefore for much of national well-being—the nation has only one choice: It must innovate its way to continuing competitive advantage. The United States must increase the pace of innovation introduction to shorten the intervals between innovations. Behind this approach is an assumption that a country that leads in an innovation area can retain competitive advantage in that area for a period of time while it readies the next round of innovation introductions. In a deeply competitive globalized economy, the length of that advantage period can become progressively shorter, compelling an ever faster innovation flow.

It would be easier to promote an innovation revolution if we had the metrics and benchmarks to better understand a successful innovation process. A first step should be to energize business, public policy thinkers, economists, and data collection agencies to start identifying the data we need to make better policy judgments about effective innovation systems. However, given the magnitude of the competitive challenge, the country cannot wait for the results of a perfected innovation model. Enough is already known about the U.S. economy and federal policy to begin strengthening a few key links on the public policy side of the innovation chain: R&D funding, talent, organization of science and technology, innovation infrastructure, manufacturing, and services.

R&D funding. Measured as a percent of gross domestic product (GDP), federal R&D support has been in long-term decline; it is now only half of its mid-1960s peak of 2 percent of GDP. Federal support for the life sciences through the National Institutes of Health has been rising, doubling between 1999 and 2003 to nearly $28 billion. This means that the physical sciences have borne a disproportionate share of the federal decline.

This trend must be seen in the context of the upcoming long-term pressure on the federal budget created by tens of trillions of unfunded entitlement liabilities noted earlier. Within a decade these mandatory entitlements will begin to crowd out nondefense discretionary federal spending such as R&D. The current budget crunch and ballooning deficit caused by the reduction in federal revenue resulting from economic recession and tax cuts provide a preview of future budget debates. The budget process, the mainstay of congressional fiscal controls for three decades, has ground to a halt, and the appropriations system, a fundamental congressional process for well over a century, is systematically breaking down. Congress increasingly is politically unable to pass underfunded appropriations, so it throws them into massive, last-minute continuing resolutions. Federal budget deterioration, which will worsen with structural demographic and entitlement pressures, threatens the viability of our federal R&D capacity. We have an initial signal of that problem as annual appropriations for the National Science Foundation fail to meet authorized levels.

Industry R&D spending, which focuses on development, cannot substitute for the federal investment in research. Because the two components are related and interdependent, a decline in the robustness of federal research funding will have ramifications for the private sector's innovation performance, and future prospects for federal research spending are grim.

Effective political action will be necessary to change the current trend. Much can be learned from the life sciences, which have assembled a powerful mix of research institutions, industry, and grassroots patient groups working on a common R&D funding agenda. Federal life science research has increased five-fold since 1970. The physical sciences, despite steady deterioration in their research portfolios since the end of the Cold War, have yet to organize a comparable advocacy effort, and we cannot assume that they will.

Without a political movement to increase funding, the nation will have to choose between two strategies for making the most of declining research funds: random disinvestment or a conscious program of niche investment. Because the United States funds research through a wide variety of agencies and programs, the research budget is difficult to understand and manage. Many see this decentralized system as a strength, because it provides diversity and more opportunities for breakthrough research. However, given a growing pattern of research cutbacks, the fully decentralized system could result in what is essentially random disinvestment.

An alternative would be to focus research investments on the key niche areas likely to be most productive, focusing on research quality not quantity. The United States has funded science niches many times in the past, from high performance computing to the genome project to nanotechnology. However, this has always been done within an overall strategy of funding a broad front of scientific advance to guard against niche failures. If funding is not adequate to support research across a broad front, a niche strategy could be the best option. This is certainly not the ideal approach—indeed, it is potentially dangerous and risky—but it is preferable to random disinvestment. It will be made more difficult by the fact that the country does not have a tradition or mechanism for making centralized research priority decisions across agencies and disciplines.

Given the intensifying budget pressure and the political weakness of physical science advocacy efforts, the scientific world needs to start a frank discussion of research priorities and the painful sacrifices of quantity of research that will have to be made to maintain quality in key niches. The science community can begin preparing for this task by carefully studying the National Nanotechnology Initiative, which is the nation's largest current niche effort, to look for lessons on how best to organize multiagency and multidiscipline research efforts.

Talent. Growth economist Paul Romer of Stanford University has long argued that talent is essential for growth. His "prospector theory" posits that the number of capable prospectors a nation or region fields corresponds to its level of technological discovery and innovation. Talent must be understood as a dynamic factor in innovation. A nation or region shouldn't try to fit its talent base to what it estimates will be the size of its economy. Instead, its talent base, because of its critical role in innovation, will determine the size the economy. In the simplest terms, the more prospectors there are, the more discoveries and the more growth there will be.

Other nations are not standing still. The forty leading developed economies have increased their science and engineering research jobs at twice the rate that the United States has. U.S. universities train an important segment of the science and engineering talent base of the nation's developing country competitors, and those nations are encouraging a larger proportion to return. Their own universities in many cases are also rapidly improving. China graduates over three times as many engineers as does the United States, with engineering degrees accounting for 38.6 percent of all undergraduate degrees in China compared to 4.7 percent in the United States. The United States now ranks seventeenth in the proportion of college age population earning science and engineering degrees, down from third place several decades ago.

Talent is now understood globally as a contributor to growth, and a global competition has begun. Yet, despite decades of discussion about the importance of educating more scientists and engineers, the percentage of U.S. students entering these fields is not increasing.

The technological opportunities of the coming century will require a different type of infrastructure, and government can play a role. The government has been active in education policy recently. The No Child Left Behind Act demands that schools demonstrate that their students are making adequate progress, which should help make science and math courses more rigorous. However, the legislation needs to be backed up with adequate funding if it is to succeed with its ambitious reforms. In addition, U.S. high schools need more programs focused on science and more magnet high schools focused on science.

Congress has passed “Tech Talent” legislation, creating a competitive grant program to encourage colleges and universities to devise innovative ways to increase the number of science and engineering graduates. Successful efforts could serve as models for programs implemented on a large scale. If the percentage of undergraduates receiving these degrees increases, it would create a larger pool from which to attract graduate students. By focusing on a later stage of science education, the Tech Talent program provides a potential shortcut to increase the talent base.

Because turning around the science education system will take at least a decade, the United States must continue to rely on a large number of foreign-born scientists and engineers. The United States has been capturing talent worldwide for two centuries and must continue to do so to maintain the robustness of its innovation system. One third of the U.S. citizens who have won Nobel prizes were born outside the country. It is thus cause for alarm that the number of visas granted to foreign students has fallen sharply since September 11, 2001. A recent survey of graduate schools showed a 32 percent drop in 2002-03 graduate school applications from foreign students, driven largely by a sharp increase in visa denials. A much more efficient security review system must be implemented, and scientists and engineers should be actively encouraged to stay. There are serious short- as well as long-term innovation consequences to this contraction of the talent pool, and it must be turned around promptly.

In addition, science and engineering education must change. The innovation system and process need to become a part of the curriculum so that students become motivated and prepared to play a role in innovation.

Organization of science and technology. The United States has had the same organizational structure for science since the 1950s. Until the recent creation of the Homeland Security Science and Technology Directorate, President Eisenhower's DARPA in 1957 was the last major new R&D agency. Yet the science and technology enterprise has grown far more complex in the past half century. Solo inventors have been largely replaced by complex organizational networks linking industry, universities, and government research agencies. A web of communication networks are now available for spreading, applying, and developing knowledge. Science and innovation are now collaborative activities that no longer heed disciplinary, agency, or sectoral boundaries. The nation's technology transfer mechanisms have not kept pace with developments in the generation of knowledge. The federal R&D system is a prisoner of its history even though changes in the way research is done demand changes in the way it is organized and managed. For example, NIH is now struggling with strains on a management system that remained unchanged even as its budget was quickly doubling in size.

U.S. federal R&D agencies need to take a searching look at whether they are optimally organized to contribute to innovation, consistent with their missions. The best innovation organizational models need to be explored and evaluated, performance metrics for innovation contributions need to be sharpened, and new approaches should be tested. The collaborative science we need for innovation demands new collaborative organization models. Therefore, we also need to look at past niche science initiatives to determine which cross-agency efforts have worked best and why. Legislation establishing a stronger coordination and budgeting role for the Office of Science and Technology should be considered to promote this organizational review.

Innovation infrastructure. Technology seeds have to land on fertile fields. Research progress must be coupled with an effective infrastructure to hasten the pace of innovation. For example, the

Internet thrived because it was introduced into a vibrant computer sector. For the Internet to continue to thrive, it will need to have a high-speed broadband infrastructure. The Department of Defense (DOD) is now building a worldwide Global Information Grid, an integrated fiber optic and wireless system including a dense satellite network that will provide the framework for the planned network centric defense system. Its effort to move all transmissions from all locations at fiber speed might pave the way for a civilian infrastructure able to capture the next generation of IT applications. As another example, research into greener energy systems will yield the desired benefits only if the underlying power and transportation infrastructure is able to integrate the new technologies. Infrastructure includes technology standards for new products, accounting standards that capture the value of knowledge-based enterprises, and technology transition systems that will smooth the introduction of revolutionary new developments such as nanotechnology into a wide array of applications.

Government has an historic role in supporting and encouraging infrastructure. Much of the economic story of the past two centuries revolves around government support of transportation infrastructure, from waterways to railroads to highways. The technological opportunities of the coming century will require a different type of infrastructure, and government can again play a role. Future needs are not obvious, so government has a responsibility to first assess likely developments and identify its infrastructure role. Competitive private sector solutions must be the preferred infrastructure mechanism, but where public missions are involved, government incentives should be considered to spur infrastructure markets.

Accounting standards that developed in the 19th century understandably emphasized fixed assets such as plant and equipment in measuring a corporation’s value. For the 21st century corporation, value resides not only in physical assets but also in talent, intellectual property, and the ability to launch innovation.

Measuring the value of those intangible assets is critical to making wise investment decisions. The European Union has begun a wide-ranging effort to develop new accounting measurement tools. Some on this side of the Atlantic have been working on this issue of valuing intangibles, but this effort needs to be expanded. The Securities and Exchange Commission and other federal agencies should spur the accounting profession, economists, and business thinkers to develop the new metrics needed for an innovation economy.

Manufacturing and services. Dazzling prototypes are not sources of profit. Reliable and cost-competitive products must be manufactured to reap the final reward of innovation. In the 1990s manufacturing comprised 16 percent of the U.S. economy but contributed 30 percent of U.S. economic growth. Manufacturing jobs on average pay 23 percent more than service sector jobs, but the United States lost some 2.7 million manufacturing jobs in the recent recession, and few of these have returned. In addition to providing a good salary, the average manufacturing job creates 4.2 jobs throughout the economy, which is three times the rate for jobs in business and personal services. As a result of the improved productivity of manufacturing workers, the sector's share of employment has fallen far faster than its share of GDP. Although manufacturing has continued to increase productivity since 2000, this hasn't translated into the economic gains we need. This is significant because manufacturing is a big multiplier. The Bureau of Economic Analysis indicates that some economic sectors have a "multiplier effect" where growth in one sector influences others; there is a 2.43 multiplier for manufacturing,compared to a 1.5 multiplier for business services.

Manufacturing remains the currency of the global economy. Selling high-value goods in international trade is still the way nations and regions become rich. However, the U.S. trade deficit in goods is exploding: It reached $482 billion in 2003 ($120 billion with China alone) and continues to grow—without causing significant public alarm. For perspective, remember that the nation agonized over a $22 billion deficit in 1981 and a $67 billion deficit in 1991. The argument that only the low end of manufacturing is leaving simply is not true; key parts of high-end advanced manufacturing are moving abroad.

Manufacturing is also a dynamic factor in the innovation process. Historically, manufacturing and the design and development stages of innovation have been closely interrelated and kept geographically close to each other. This is particularly true for newer advanced technologies such as semiconductors. When manufacturing departs, design and R&D often follow. In recent years, firms have been developing a combined production and services model, carefully integrating the two to provide unique products and services, and thus enhancing the importance of manufacturing.

Without a strong manufacturing base, it is difficult to realize economic gain from technological innovation.

The talent erosion in the manufacturing base is a particular concern. Economist Michael Porter of the Harvard Business School has argued that if high-productivity jobs are lost to foreign rivals, long-term economic prosperity is compromised. John Zysman of the Berkeley Roundtable on the International Economy believes that manufacturing is critical even in the information age, because advanced mechanisms for production and the accompanying jobs are a strategic asset whose location can make a nation an attractive place to create strategic advantage. Without a strong manufacturing base, it is difficult to realize economic gain from technological innovation. Because technology innovation and manufacturing process innovation are closely linked, the erosion of the manufacturing base will affect the innovation system. To avoid the “hollowing out” of manufacturing, action will be needed on a range of policies from trade promotion and enforcement, to tax policies to encourage new investment, to programs for improving worker skills, to DOD efforts to ensure strategic manufacturing capability. Innovation in the manufacturing process, however, might be the most important:

The United States will be able to achieve comparative advantage in critical manufacturing sectors only if it updates the process, substituting productivity for our higher costs. The nation needs a revolution in manufacturing that taps into developments in distributed manufacturing, desktop manufacturing, simultaneous inspection and production, small-lot production that is cost-competitive with mass production, and the use of new materials and methods for practical fabrication of devices and machines at the nano scale. Overall, the country needs new intelligent manufacturing approaches that integrate design, services, and manufacturing throughout the business enterprise. Because DOD would be a major beneficiary of the corresponding productivity gains, because it has long played an important role in this field, and because it has a huge strategic stake in keeping advanced manufacturing leadership in the United States, it makes sense for DARPA to take a lead in R&D for 21st century manufacturing processes and technologies. DOD's Mantech programs could support pilot projects and test beds for evaluating prototypes and results in the defense industrial sector.

The nation needs innovation in services as well as manufacturing because we now face global competitiveness there, too. Services dominate our economy, yet we perform comparatively little services R&D. We need a new focus on services innovation to retain comparative advantage, so that we are ready for the upcoming global services challenge.

From analysis to action

In the 1980s, when the United States faced significant competitive challenges from Japan and Germany, U.S. industry, labor, and government worked out a series of competitiveness policies and approaches that helped pave the way for the nation's revitalized economic leadership in the 1990s. In the mid-1980s President Reagan appointed Hewlett Packard president John Young to head a

bipartisan competitiveness commission, which recommended a practical policy approach designed to defuse ideological squabbling. Although many of its recommendations were enacted slowly or not at all, the commission created a new focus on public-private partnerships, on R&D investments (especially in IT), and on successful competition in trade rather than protectionism. This became the generally accepted response and provided the building blocks for the 1990s boom. The Young Commission was followed by Congress's Competitiveness Policy Council through 1997.
These efforts were successful in redefining the economic debate in part because they built on the experiences, well-remembered at the time, of industry and government collaboration that was so successful in World War II and in responding to Sputnik. Those are much more distant memories in this new century, but we should revisit the Young Commission model. The private sector Council on Competitiveness, originally led by Young, has assembled a group of leading industry, labor, and academic leaders to prepare a National Innovation Initiative, which could provide a blueprint for action. Legislation has been introduced in the Senate to establish a new bipartisan competitiveness commission that would have the prestige and leverage to stimulate government action.
The U.S. economy is the most flexible and resilient in the world. The country possesses a highly talented workforce, powerful and efficient capital markets, the strongest R&D system, and the energy of entrepreneurs and many dynamic companies. That by itself will not guarantee success in a changing economy, but it gives the country the wherewithal to adapt to an evolving world. Challenges to U.S. dominance are visible everywhere. Strong economic growth is vital to the U.S. national mission, and innovation is the key to that growth. The United States needs to fashion a new competitiveness agenda designed to speed the velocity of innovation to meet the great challenges of the new century. Once that agenda has been crafted, the nation must find the political will to implement it.

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