

# Challenge of Technological Competitiveness

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America's government, academia, financial, industrial interests must work as one to build seamless innovation process

Technology has assumed a paramount role in the world economy. It is our principal tool for creating new high value-added products and services for global markets, and for improving the productivity and quality of our manufacturing processes. The nations that use technology most effectively will enjoy the highest standards of living, new jobs, growing economies, and improved quality of life for their citizens.

In this regard, the United States is fortunate in having the world's most productive scientific and technological enterprise — vested in our universities, federal labs, industry research facilities, and the world's finest cadre of scientists and engineers. These unparalleled assets, and the enormous investments we have made in R&D, have allowed us to lead the world in scientific advances and in creating new technologies.

However, this lead alone has proven to be an insufficient competitive edge. Over the last three decades, at the very pinnacle of our technological achievement, we began to lose our leading competitive position in many high-technology markets, often in technologies that we pioneered — the VLSI, the microcomputer, machine tools, cable TV, robots, and industrial lasers, to name a few.

We have learned that our success in the laboratory by no means guarantees success in the global marketplace. Thus, our challenge, the one we must address now, is improving our ability to translate the technology we create in such abundance into world-class products and services.

We must concentrate on building a seamless, integrated system of innovation that moves technology swiftly from the laboratory to the marketplace, cycle after cycle — a commercialization machine if you will. This process must extend beyond the walls of the corporation to encompass the complex web of factors on which industry's ability to commercialize new technology depends.

## INTEGRATING GOVERNMENT POLICIES

Many factors that have a profound effect on the innovation process have nothing to do with technology per se:

- Economic, regulatory and trade policies.
- Intellectual property rights regimes.
- Investment flows.
- Industry structure.
- The business, management, and manufacturing practices employed by private firms.

Clearly, government and industry have important responsibilities in creating a system that will allow us to maximize our employment and use of technology for commercial objectives. The government must create an environment favorable to long-term investment, and in which the private sector's efforts to commercialize new technology can flourish.

For example, economic and tax policies affect the cost and availability of capital that businesses need for R&D, product development, and production. In this regard, the Bush Administration proposed a permanent R&D tax credit, capital gains tax reduction, incentives for savings to form a large pool of capital, and banking reforms that would encourage closer relations

between the users and providers of capital.

Government regulation can be a critical determinant of the time and money it takes to bring a new product to market. The President has fought for over a decade to remove the unnecessary regulatory obstacles that recumbent our innovation process. This includes reforms in the review process for new pharmaceuticals and biotechnology products, and antitrust reforms to encourage cooperative R&D. He also proposed amending our antitrust laws to allow for joint production ventures, and proposed reforms to our product liability system, which currently stifles innovation, reduces the availability of products, and increases product costs.

Our education system provides for labor force skills that play an important role in manufacturing productivity and quality. President Bush addressed this area by setting plans for revolutionizing our schools and improving our job-training system, and with record level investments in math and science education.

Federal R&D funding generates the pool of basic research that benefits all industries, and this Administration has made record-level investments.

Such measures, however, are only enabling actions. We must never forget that only industry possesses the wherewithal to manage the complex process of turning new technology into products and bringing them to the marketplace.

Assistant Secretary for Technology Policy, U.S. Department of Commerce, Washington, D.C.; paper presented at IES/USA 5-C Global Annual Meeting, October 1993.

## INTEGRATING THE PRODUCERS AND USERS OF ENABLING TECHNOLOGIES

One of today's competitive challenges involves the development, deployment, and commercialization of enabling technologies. These technologies are wealth producers because they are the building blocks with which many different industries will create new products and processes and improve existing ones. They will change profoundly how we live and go about our business.

It is becoming clear that U.S. industry cannot competitively commercialize enabling technologies using our traditional investment approaches and process of innovation.

Typically, these technologies are too complex, too expensive, and have too many applications for an entrepreneur or single company to develop and commercialize alone. Business investments can only be maximized — and in some cases investments may only be recouped — if the core technology is used in several applications, often in different industries.

In the competitiveness debate, some have suggested that an enabling technology's investment dynamics and potential to broad use justify a Federal financial role beyond the government's traditional role of supporting basic research and infrastructure programs. Yet, when we examined several case competitors closely, we identified a challenge that involves how U.S. industry is organized to manage the deployment and use of technology.

Today, competing in high-technology means going up against decentralized, vertically-integrated industrial-financial groups — such as Japan's industrial groups. This model of organization confers a strategic advantage when it comes to exploiting-enabling technologies. It integrates the producers and users of technology in a proprietary innovation process.

### ◀ Panel Resources ▶

Resources can be pooled quickly

and long-term risks shared. R&D costs can be spread over stages and diverse product lines. Such organizations are well-positioned to capture broad-based returns on an enabling technology's significant economies of scope. Inter-industry and inter-firm-cooperative relationships allow the introduction of new materials and components simultaneously in many different applications and markets. The above-stated product lines represent a viable internal market for the core enabling technology.

For example, the Hitachi group — which generates nearly 2% of Japan's GDP — produces some 20,000 intelligent products in industries ranging from industrial and construction machinery, telecommunications, transportation equipment, home appliances, consumer electronics, analytical instruments, power tools, and auto parts. Think of the company's significant returns on its investments in advanced electronic technologies like semiconductors, and how quickly they can capture those returns and move on to the next generation technology.

How can the United States counter these advantages? One step we can take is forging close relationships between our producers and users of technology. In this regard, the Commerce Department is promoting a kind of partnership that we believe represents the next generation of consortia. This model has the potential to carry a technology from R&D through-commercialization in a proprietary organization structure.

Through our Strategic Partnerships Initiative, the Technology Administration will provide a neutral forum in which potential producers and users of enabling technologies can explore ways in which they might organize themselves. The goal is to spur the formation of teams of non-competitors that can integrate the entire process of innovation. For example, a new materials team might consist of a firm from each user industry, including aerospace, auto, appliances, construction, sporting goods, and marine products.

## INTEGRATING OUR SMALL BUSINESSES INTO LARGER STRUCTURES

These teams can also serve as a mechanism for integrating our world-class, small high-technology businesses into our larger industrial networks and structures.

Our entrepreneurial business sector is the envy of the world — a dynamic culture of innovation and creativity, and a major producer of outstanding technologies.

However, we have many valuable technologies embedded in these small, fragile firms, which often lack the manufacturing and marketing resources needed for full-scale commercialization.

The small business of entrepreneurship may not have its own choice but to just sell or license a technology to recoup investments in time and make some profit. They avoid the risks and investment in manufacturing, but forgo the profits of going to full-scale commercialization.

As a result, technology assets in these fragile firms are vulnerable to acquisition by our foreign competitors. In fact, the United States is a net exporter of technology as measured by patent licenses, royalties, and technology agreements. And Japan is our biggest customer. We feed raw materials into our competitors' commercialization machines, and I wonder what we live in the process.

To fully exploit our technology at home, we need partnerships that can tap the resources and manufacturing and marketing strengths of our large firms together with the creativity and dynamism of our small entrepreneurial businesses.

## NATIONAL TECHNOLOGY INITIATIVE

There are other structural problems that call for an integration solution. For example, in the United States the key elements of the innovation process — R&D, manufacturing, and capital — often reside in different institutions, each operating at arm's-length from one another with little coordination, let alone integration. This has led to an

innovation system that is too slow, too inefficient, and too ineffective for today's competitive environment.

To help meet this long-scale technology management challenge, the Bush Administration launched the National Technology Initiative—a coast-to-coast series of conferences designed to close the gaps between America's R&D organizations, US industry, and the financial community. By bringing these players together to discuss technology and competitiveness, the NTI is a forum for exploring ways to improve the innovation system as a whole. This is a step toward the coordination and integration that are essential for the timely commercialization of new technology.

#### LINKING-UP WITH THE LABS

A major focus of the NTI is how our firms interact with Federal laboratories. The Federal R&D system represents a wealth of knowledge, technology, facilities, and talent. However, the absence of strong ties between our Federal labs and industry often results in a failure to exploit the commercial potential of this rich national resource. Linking industry into the Federal lab system will help ensure that our firms are aware of potentially useful R&D and speed up the transfer and commercialization process. This will go a long way toward closing that time-consuming technology transfer gap. Cooperative R&D agreements are bringing our Federal labs into partnership with industry; more than 200 of them have already been established.

The NTI is helping to build these bridges by showcasing the lab capabilities, highlighting opportunities for technology licensing and cooperative R&D, and by having role models share their stories about using Federal R&D for commercial purposes.

#### THE FINANCIAL COMMUNITY'S KEY ROLE

We all know that developing technology is just the first step. Getting it off the drawing board and into the marketplace usually re-

quires substantial sums of capital. This is one of the biggest barriers to market entry, especially for our small firms.

In this country, most technology is financed through short-term, arms-length transactions, which can create an adversarial relationship between partners that depends on each other for success. In some regions, the financial community is linked into the innovation process so closely that you can barely tell where the hand ends and the company begins.

The NTI is designed to create a better understanding between businesses that need financing for technology and manufacturing, and those who provide capital for such investments. The NTI conferences are starting as a meeting ground for venture capitalists and investors. During some of the sessions, venture capitalists explain what they look for in a technology venture. And, role models who obtained funding for technology ventures share their experiences and lessons learned.

#### INTEGRATING THE MANUFACTURING ENTERPRISE

The third principal theme of the NTI is manufacturing. We often fail to fully appreciate the pivotal role manufacturing plays in the process of innovation; we have a tendency to focus our attention upstream, for example, at the invention stage.

Yet, manufacturing can be an enabler or a barrier. For example, the flexibility of manufacturing plays an important role in determining the cost of introducing a new product and, as a result, the willingness and ability of a firm to supply an existing product with a new or improved one.

If production facilities capable of making a new product are not in place, establishing them represents the major cost of innovation. This is why many new products are never marketed by the inventing firm and are instead licensed to another entity that has production capabilities. Of course, if the inventing firm does not reap the rewards from marketing the product, it is less able to fund its next round of

R&D. This often leads to a short lifespan for start-up companies.

Moreover, a technology is under way in US industry as traditional mass production gives way to a new manufacturing paradigm—a paradigm that can achieve the speed and flexibility needed to cope with rapid technological change and fragmenting global markets.

This new paradigm integrates the manufacturing process with new management methods, new technologies such as computerized, rated manufacturing, and with new partnerships, for example between our producer companies and their suppliers.

It has been standard business practice for a company to utilize a large number of suppliers, playing each off against the others to obtain the best price. However, such arms-length, adversarial relationships can have a detrimental effect: a supply that does not know when and how where its next need will come naturally responds with short-term planning and short-cuts, thinking about investments needed to stay competitive.

Moreover, the need for producing high quality on a just-in-time basis, tight ties with the need for bringing products to market with greater speed than ever before, requires an integrated producer-supplier work process. The development of materials, components, and process equipment provided by suppliers must be managed concurrently with product development.

This is a key process that propels those US firms that are at the forefront of implementing total quality management to occupy the winners of our Malcolm Baldrige National Quality Award.

So today, we see new partnerships replacing adversarial relations with suppliers; the sequential, top-down, over-the-wall approach to innovation, as well as hierarchical and functional organizational structures; Cross-functional partnerships—such as concurrent engineering and product development teams—to save not only the time it takes and the cost of bringing a new product to market.

Some believe that flexible networks and multi-discipline part-

ships will replace the hierarchy as the dominant form of organization. To quote Tom Peters, "Don't just destroy functional business — forget that you ever found the term functional organization... Old-fashion, slow-moving hierarchy is simply incompatible with new behaviors, lightning-fast competitiveness."

New partnerships are also being established between the company and the workers. Modern manufacturing methods rely on workers as knowledgeable, fully-integrated partners in the organization. They require a corporate culture and human resource practices that promote flexibility, long-term commitment, worker autonomy, and an increase in the range and depth of workers' skills.

The lack of trust, antagonism between labor and management that have plagued traditional manufacturing are detrimental to the cooperative relationships that underpin the modern manufacturing environment.

We do recognize that it is hard to abandon a traditional "way of business-life" in favor of one that is radically different, but many of our firms are taking on this challenge. The MIT conferences provide an opportunity for our companies to share their insights and experiences in making what is often a painful and difficult transition to modern methods and cooperative approaches.

#### INTERNATIONAL RULES OF THE GAME

I have discussed building a more effective system of innovation in the United States through cooperative relationships within the firm between the company and its employees, among firms and industries, and among our government, academic, financial, and business institutions.

However, our challenges do not stop at our country's borders. Many nations have made technology commercialization and the subsequent access to and control of high value-added markets the centerpiece of their national economic strategy. Nations are in the race as nations with very different economic environments and systems of innovation compete to deliver economic growth and security for their citizens.

Patience is on the rise because there are very real disparities among various nations' policies governing competition, trade, investment and, of course, intellectual property rights. In other, these disparities have created an uneven playing field.

A question now being posed by some is should we work with foreign partners and competitors to develop "international rules of the game." We at Cambridge are involved in several international initiatives to explore the disparities among various national systems of innovation and ways to reduce the disparities. These initiatives involve cross-

national innovation systems study with the OECD, and another study comparing the U.S. and Japanese systems. And, we are working with foreign partners to develop a framework for international R&D collaboration in response to the Japanese proposal for cooperative R&D in intelligent manufacturing systems of R&D. The latter process is serving as a "test-bed" for international rules of the game, and for developing new mechanisms for widespread domestic deployment of R&D results. Of course, the protection and equitable allocation of intellectual property rights are a major focus of these bilateral and multilateral initiatives.

In closing, many of the challenges we face are beyond a single company's — or even a single industry's — ability to address. They can only be answered through cooperation among government, academia, the financial community, and industry. America must work as a team to build that seamless innovation process — within the firm and extending beyond its walls — that can speed new products-to-market ahead of the competition.

America has the edge. We have unparalleled capabilities in science and technology. U.S. industry is the world's most diverse and productive manufacturing enterprise. And, our people are inventive and resilient. It is imperative that we find new and better ways to organize ourselves and put these world-class strengths and capabilities to work for us.