寄稿 1

The U.S. Innovation System: Leveraging Opportunities

Dr. Michael W. Chinworth
Director, Washington Office,
US-Japan Center for Studies and Cooperation
Vanderbilt University

Abstract:

The innovation system in the United States has been changed over the last 25 years to encourage greater competitiveness through more effective utilization of research and intellectual properties. There is evidence of increased research outputs, but a far more important transformation has taken place involving corporate and government participants in this reformed innovation system.

Companies and government research organizations have learned how to take advantage of changes introduced over the last several years for bringing innovations into the marketplace. Individual firms and sponsors of government research programs have become more sophisticated in leveraging the tools available to them for bringing innovations to the marketplace.

Tangible intellectual properties are exploited positively by companies in increasingly creative arrangements in the innovation system. This means that patenting plays a vital role in the overall innovation system. There are some concerns that the U.S. patenting system's effectiveness may slip by awarding patents less discriminately. There also are concerns that innovation in the United States will suffer if the patent system weakens due to lower standards and excessive workloads. Any changes introduced resulting from these concerns, however, must be made in the context of the broader innovation system.

This article summarizes changes made in the innovation system over the last thirty years and illustrates how companies are achieving tangible results by leveraging resources available to them in the innovation system. It addresses emerging academic and professional concerns about pressures on the U.S. patenting system, but argues that any potential adjustments in patenting practices must be made in the context of the broader innovation system.

The U.S. Competitiveness Decline and Changes in U.S. Innovation Policies

The U.S. innovation offers several "tools" to companies today as a result of changes made in policies and

practices from the 1970s through the 1980s. At the risk of over-simplification, that era was characterized in part by declining U.S. competitiveness in the face of rising Japanese technological and economic strength. Policymakers in the United States were dissatisfied with the returns on U.S. government R&D investment as well. U.S. programs and practices were seen as failing the economy as a whole by not producing innovations quickly or in sufficient numbers.

On the other hand, Japan experienced a economic boom, with predictions that it soon would become the world's largest economy. Its industries were perceived as dominant in the automotive, electronics and other key industrial sectors. These successes were attributed at least partly to superior technology development policies and practices. These included close and productive government-industry relations, targeted research programs, and policies that fostered technological spin-offs and spin-ons.

This led Congress and successive presidential administrations to approve several changes in the U.S. innovation system. Many of these changes were modeled on what the United States thought were common practices in Japan. The federal government sought changes that would provide both incentives and expectations of government research organizations and researchers who received federal funds. These changes covered two broad areas:

1. Research program structures, policies and practices; and,
2. Patent policies - specifically, changes in ownership of intellectual property rights.

Changes were introduced through a series of bills approved throughout the 1980s plus executive-level policy changes during the same time. [See Box 1 for titles of major bills approved at this time.]

Box 1: Legislation Affecting U.S. Innovation Processes and Practices, 1980-2000

- Stevenson-Wydler Technology Innovation Act (1980)
- Bayh-Dole University and Small Business Patent Act (1980)
- Small Business Innovation Development Act (1982)
- National Cooperative Research Act (1984)
- Federal Technology Transfer Act (1986)
- Omnibus Trade and Competitiveness Act (1988)
- National Competitiveness Technology Transfer Act (1989)
- National Cooperative Research and Production Act (1993)
- Technology Transfer Commercialization Act (2000)

Changes in Practices

Legislative changes allowed new forms of cooperative research and introduced incentives for individual researchers as well as research organizations to commercialize research results. These changes encouraged closer business-university-government ties and introduced more direct federal government interaction, especially with small businesses. These included:

Programs designed to foster industry-government research collaboration - These included cooperative research and development agreements (CRADA) that allowed joint research and other measures such as Work for Others and facility agreements that essentially permitted contract research of government research organizations by industry and other government offices.

New contracting processes aimed at accelerating introduction of new technologies - These include the expanded and more sophisticated use of Broad Agency Announcements (BAAs). BAAs allow government agencies to sift through thousands of development ideas rapidly and focus on a small group of promising ideas quickly. A small group of promising proposals are selected from thousands for accelerated contracting, speeding the introduction of innovations throughout the government.

Small business programs - These include the popular Small Business Innovative Research Program (SBIR) and the Small Business Technology Transfer Program (STTR). SBIR focuses on accelerated contracting of targeted research and development proposals while STTR encourages licensing of university-held technologies and patents.

Liberalized policies on intellectual property rights allow government researchers in some cases to retain ownership of patented innovations. In theory, this provides incentives to work harder and bring innovations to market more rapidly.

With these incentives also came increased emphasis on accountability. The Government Performance and Results Act of 1993 (GPRA) requires all federal government organizations to develop long-term plans and objectives and report annually on fulfillment of those objectives. This includes research organizations such as the National Institutes of Health (NIH), one of the leading funders and performers of medical and biotechnology research in the United States.

Table 1 (below) illustrates the relationship among these programs and their various users. Additional information is provided in Appendix 1.

Table 1: U.S. Technology Development Programs and Tools

User Community / Program/Practice	*Government-Government*	*Government-Industry*	*Government-University*	*Industry-Industry*	*Industry-University*
Broad Agency Announcement (BAA)		✓			
Contract research	✓	✓	✓	✓	✓
Cooperative research and development agreement (CRADA)		✓		✓	
Work for Others	✓	✓			
Small Business Innovation Program (SBIR)		✓	✓		
Small Business Technology Transfer Program (STTR)		✓	✓		✓
Government Performance and Results Act (GPRA)	✓				

The Impact of Changes in Policies and Practices

Measurable results from these changes are evident. For example, patenting by most U.S. government agencies is increasing. While some new forms of research cooperation have lost their favor with industry, companies and other government agencies are taking advantage of the research opportunities introduced through such measures as CRADAs, Work for Others and straightforward contract research.

The more noticeable and perhaps important development from these changes is how companies - small businesses in particular - are leveraging research programs and practices to bring new technologies to both commercial and government markets. Companies increasingly use a variety of programs to build relationships across the government and build capabilities that result in new technologies and ventures.

This process is illustrated in Figure 1 (below). The illustration shows the experience of "FC, Inc." - a small contract research organization (the real name of the company has been altered for this illustration). The company specializes in fuel cell technologies, especially power management electronics.

Over time, the firm has developed relations with a variety of civil and defense government organizations, national laboratories, regional and national universities and other companies to bring innovative technologies to market. For example, beginning in 1991 and continuing to the present, the company received SBIR contracts from the U.S. Army, U.S. Navy, Defense Advanced Research Projects Agency (DARPA), the Air Force, National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF) to develop its technologies.

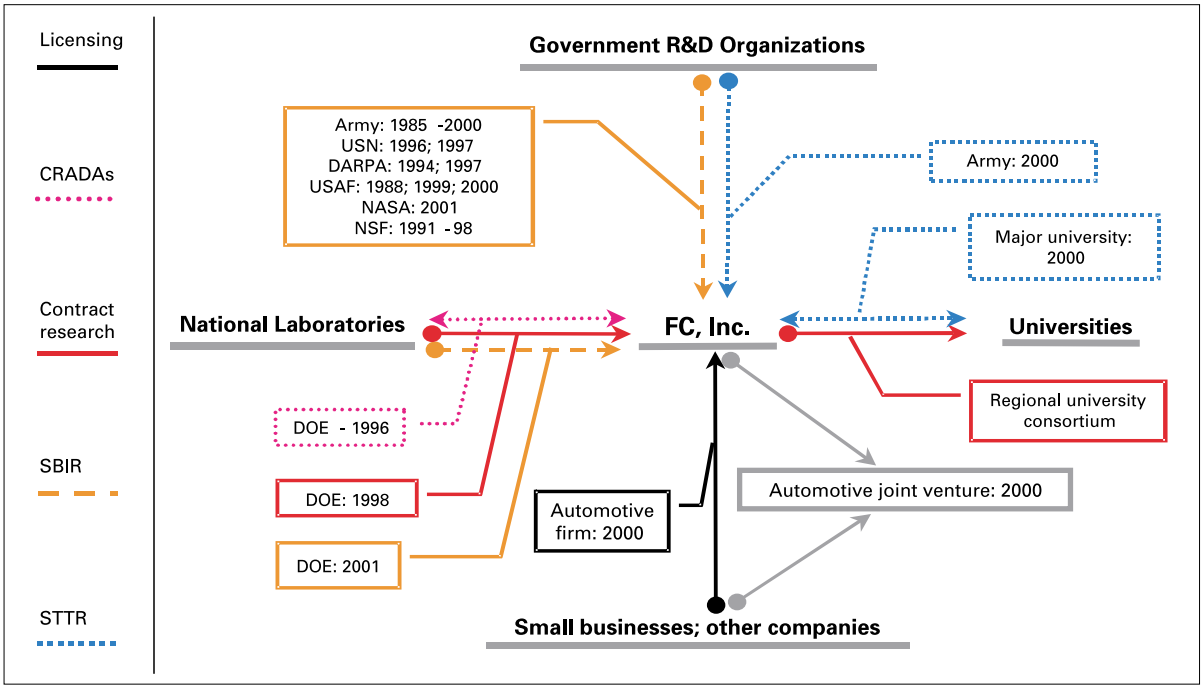

Figure 1: Experience of FC, Inc. in Leveraging Research Opportunities

Experience on one project contributed to successes in others. Although the contracts were separate, successive military contracts benefited from earlier work performed. Technologies also were dual-use: the NSF funds, for example, were used to miniaturize components for medical applications.

FC, Inc. utilized research avenues with national laboratories to establish proof of concepts for other fuel cell related technologies. A 1996 CRADA with one of the national labs established its qualifications and basic principles that led to a contract research award from the same laboratory two years later.

In keeping with U.S. government policy objectives, FC, Inc. utilized university ties in several ways. First, it commercialized patents held by a major university in 2000 for the U.S. Army. Second, it used contract research with other universities in its region to secure low cost, student researchers while identifying promising students for future employment with the company.

Many of FC, Inc.'s efforts culminated in an agreement with a large automotive firm that led to the formation of a joint venture with the same company to develop commercial vehicle fuel cell technologies.

It is important to note how various processes are linked with one another in this case. Although not indicated in the illustration, FC, Inc. has received patents resulting from much of the government sponsored research shown here, particularly the early stage SBIR contracts. It has helped commercialize patents held by other universities using the STTR program. Its contract research with national laboratories has helped it refine concepts that were later applied in other programs.

It also is important to note that this transformation has taken form over twenty years. The experience of FC, Inc. and other companies did not develop suddenly. It built over decades as incremental changes were introduced to the innovation system and as companies came to understand the benefits of these changes for them. Success stories from the changes introduced in the 1980s did not appear immediately. They emerged over time and through considerable trial and error.

Patent holdings are central to FC, Inc.'s ability to leverage the innovation process. However, no one program or aspect of the overall process stands out over the others. All elements are equally important in the company's strategy, as they are for thousands of other U.S. and foreign companies using similar strategies to commercialize technologies.

Emerging Concerns

While the results of these transformations generally have been positive, concerns in the U.S. academic and professional communities are emerging, particularly with the U.S. patenting system.[1] Among them:

1) For a recent overview of perceived deficiencies in the U.S. patent system, see Adam B. Jaffe and Josh Lerner, *Innovation and Its Discontents: How Our Broken Patent System is Endangering Innovation and Progress, and What to Do About It* (Princeton, NJ: Princeton University Press, 2004).

The quality of patents is declining - The sheer number of patents awarded annually is diluting the quality and value of individual patents. Examiners are so overworked by their growing caseloads that they increasingly award patents even in cases where claims are dubious. As the quality of patents declines, innovation also will decline.

Reforms are counterproductive - Reforms introduced in the 1980s have increased litigation rather than innovation according to some analyses. Well intended changes aimed at making it easier to secure patents have increased their numbers. Many patent claims overlap, contributing to a growing number of legal actions rather than fostering innovation.

Criteria for awarding patents is diluted - This is another quality issue but warrants separate treatment. There are concerns that patents increasingly are awarded to concepts and categories of dubious value.[2] For example, there is increased focus on the patentability of business practices. A broader fear is that the system itself is not able to keep pace with the tempo and variety of innovation.

The dimensions of the challenges facing the USPTO are illustrated in Figure 2 (below), which demonstrates the rising number of applications and new awards.

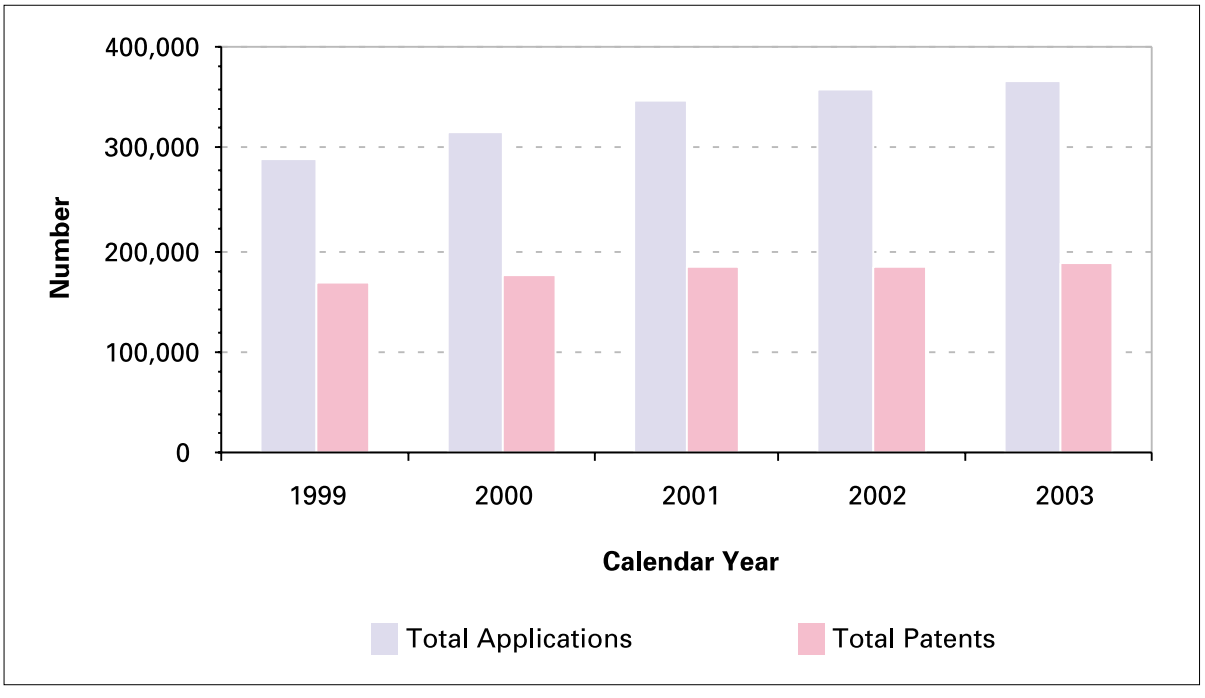

Figure 2: Total U.S. Patent Applications and Awards, 1999~2003

2) For example, see Jordan Paradise Lori Andrews and Timothy Holbrook, "Patents on Human Genes: An Analysis of Scope and Claims," *Science*, March 11, 2005, No. 307, No. 5715, pp. 1566-1567; and Eli Kintisch, "Case Probes What's Fair Game In the Search for New Drugs," *Science*, April 8, 2005, Vol. 308, No. 5719, p. 174.

Assessment

It is important to retain perspective in examining the benefits and drawbacks of the U.S. innovation system. Even though legitimate concerns existed at the time, it would be an overstatement to say that the innovation process was failing the United States thirty years ago. At the same time, it can be argued that current practices are an improvement over those from decades ago. Furthermore, changes have been incremental, building upon one another. Effects have been cumulative, and companies have learned how to leverage these programs effectively.

That should be the starting point for any discussion of reforming any elements of the innovation system. Generally accepted output measures for innovation have shown increases over the last ten years, despite constrained budgets at times. Programs such as SBIR are popular politically because of the support provided small businesses but more importantly for the results they have produced. Possible changes based on experience in those programs are being considered by the National Research Council (NRC) - an arm of the National Academy of Sciences (NAS) - but their wholesale elimination is not under consideration.

Potential problems facing various elements of the innovation system should not be ignored, though. Ironically, many academic analysts of the U.S. patent system are concerned that patenting has become so successful that the system is in danger of overwhelming itself.

In considering reforms of the innovation system, however, it is important to retain linkages among various aspects of the system while examining them individually. As the case of FC, Inc. indicates, research organizations increasingly are developing successful networks with one another by leveraging a variety of programs and tools. Any change in one program is likely to affect another.

Retaining the core elements of the present innovation system is the starting point for any consideration of future changes. The system has benefited the United States – and other countries engaged in the U.S. research base.

"Tweaking" the patent system may be particularly challenging. Whatever changes are made, however, must improve, not alter, the basic changes introduced more than twenty years ago. Future changes must be introduced in consideration of all the elements of the innovation system, not just one.

The U.S. innovation system has revived in certain respects compared with several decades ago. It has done so in a measured pace over time and in ways that benefit the international community. Retaining that essence is the challenge facing policymakers who might consider future reforms.

Appendix 1: U.S. Technology Development Programs and Tools

Broad Agency Announcement (BAA)

- Government contracting process aimed at rapid identification of promising ideas for advanced technology development.
- Introduced in early 1980s to allow U.S. government agencies to identify potential suppliers of general needs quickly.
- Defined in Federal Acquisition Regulation 6.102 (d)(2)(i) as an "announcement that is general in nature, identifying areas of research interest, including criteria for selecting proposals, and soliciting the participation of all offerors capable of satisfying the Government's needs."

Contract research

- Direct contracting of a for-profit research company or non-profit research institute by another company or government agency.
- The research organization typically is hired to develop new technologies to satisfy a particular requirement or verify approaches toward larger technical problems.
- Contracting rules and practices have made it easier for government agencies in particular to contract directly with research companies.

Cooperative research and development agreement (CRADA):

- Established through the Federal Technology Transfer Act of 1986 for private sector companies; extended to government research organizations by the Federal Technology Transfer Act of 1986 and Executive Order 12591 of 1987. Handling of intellectual property rights clarified further by the Competitiveness Technology Transfer Act of 1989 and National Technology Transfer and Advancement Act of 1995.
- Allows private sector companies to enter into cooperative research at "pre-competitive" stage.
- Allows for the transfer of technology, knowledge and expertise from government laboratories to the private sector for further development and commercialization.
- Typically, a CRADA is a short-term research and development contract between companies or a specific laboratory and company, with a 50-50 cost share requirement.

Government Performance and Results Act (GPRA - 1993)

- Not specifically aimed at technology development, but it does apply to organizations in the government funding or performing research.
- GPRA requires agencies to set goals, measure performance, and report on their accomplishments. This includes research funding and performing organizations.
- Under GPRA, every major federal agency must now ask itself some basic questions:
    - -- What is the mission of the government unit?
    - -- What are the goals of the government office and how will they be achieved?
    - -- How can the government office measure its own performance?
    - -- How will the office use that information to make improvements?

- GPRA forces a shift in the focus of federal agencies away from such traditional concerns as staffing and activity levels and toward a single overriding issue: results.

Small Business Innovative Research Program (SBIR):

- Established in 1982; funded with agency set asides (2.5% of R&D budgets).
- Seed money provided in three stages with funding levels ranging from $75,000 (Phase I) to $750,000 (Phase III).
- Recipients must be small business (500 employees or less; cannot be owned by larger firm).
- Firm owner must be U.S. citizen and have equity share >50%; must meet other financial measures (income, others).
- Partnerships encouraged.
- Non-profit organizations cannot receive funds directly but are favored as partners.

Small Business Technology Transfer Program (STTR):

- Modeled on SBIR; pilot program established in 1992; first grants awarded in 1994.
- $300 million awarded between 1994-2002.
- Company MUST partner with non-profit R&D institution.
- STTR crafted as technology transfer program [SBIR focuses on technology development].

Work for Others

- Contract process that allows U.S. national laboratories to perform research for other government agencies or private sector organizations. Encouraged as a result of the Stevenson-Wydler Technology Innovation Act of 1980.
- The national laboratory is hired by another government organization much the same way as a private sector laboratory would be hired by an outside organization.
- Short term research usually is the focus but contracts can extend over a longer period of time.

profile

Dr. Michael W. Chinworth

1974	BA in Government and Modern Language from the University of Notre Dame.
1978	MA in International Affairs from Johns Hopkins University
1983-1988	Vice president of the Japan Economic Institute
1988-1990	Research Director, U.S.-Japan Program, Massachusetts Institute of Technology
1990~2000	Project Manager at Litton Industries, Information Systems Group
2000	PhD in Science and Technology Management from Cranfield University(UK)
2000~2002	Vice President, NAC International
2002-2003	Senior Analyst at the Decisive Analytic Cooperation
2004~	Director, Washington Office, US-Japan Center for Studies and Cooperation Vanderbilt University