

The Role of Government in Fostering Innovation

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The powerful role traditionally played by governments in fostering private-sector innovation is now expanding, and savvy companies are taking full advantage of a wide range of governmental support, both traditional and new.

In Japan, the Ministry of International Trade and Industry (MITI) sets industrial policy and supports Japanese industrial competitiveness through large-scale funding of selected high-priority advanced technologies. Similarly, the European Community and its member states support numerous cooperative research ventures. While the Airbus is perhaps the best-known of these, many others have been conducted under the umbrella of ESPRIT, EUREKA, and other collective public/private efforts. The European Community is also now beginning to use EC-wide standards both to stimulate innovation and to reduce risk.

Individual EC member states are also energetically fostering innovation. Scotland has been very active in a broad range of efforts to support innovation in the health care and medical products industry. Germany's Ministry of Research and Technology has made major investments in megaprojects that are deemed to be of strategic importance, such as magnetic levitation (maglev). Germany also has Prometheus, a public/private partnership designed to stimulate the introduction of intelligent vehicle/highway systems (IVHS) in Europe. The French government has invested heavily to support video and telecommunications innovations. In northern Europe and Scandinavia there have been significant government efforts to support innovation in environmental technology, food products, and packaging.

Another example of public/private partnership in Europe is Germany's Fraunhofer Institute for Manufacturing and Automation, which addresses organizational and technological problems in the manufacturing sector. This institute has extensive facilities to conduct research projects in manufacturing systems, such as image-processing, robot development, and computer networks. These research projects, initiated by small and medium-sized firms, receive 40 to 60 percent of their budgets from federal and state governments. Significantly, the results of the research are published only with the permission of the clients, allowing them to perform competitive research.

In the United States, despite strong resistance over the past decade to „industrial“ or „technology“ policy, there are also widespread efforts at all levels of government to foster innovation. The National Aeronautics and Space Administration (NASA) has long supported innovation and commercialization of technology. Other federal labs, particularly those of the Department of Defense and the Department of Energy, are now moving aggressively to make their resources available for cooperative research with individual businesses or industries. American companies are rushing to take advantage of the opportunities presented by the more than 700 national laboratories and 100,000 scientists and engineers now partially available to U.S. industry as a result of the end of the cold war.

The extensive and highly successful efforts by the U.S. government to sponsor innovation in the agricultural and health care sectors (through the agricultural extension and research services and through the National Institutes of Health) are now being put forward as models and expanded to support innovation and accelerated commercialization in manufacturing and other service sectors.

There is much support for innovation at the state and local levels in the United States and at the provincial level in Canada. Local as well as federal governments and private industry are supporting large numbers of manufacturing technology centers and technology extension services designed to foster innovation in small and medium-sized businesses. There are also numerous state- and province-sponsored public/private research institutes (such as the Massachusetts Microelectronics Center), as well as considerable state and local support for industry-sponsored research consortia. In addition, virtually every state and province has a network of support services for innovation and new ventures. In the state of Indiana, for example, the Corporation for Science and Technology funds research programs in the state, the Institute for New Business Ventures provides seed and venture capital to support new technology ventures, and the Corporation for Innovation and Development supports specific product development and commercialization efforts.

How Government Fosters Innovation

Governments can foster innovation four basic ways: by buying it, by reducing its risk, by collaborating on it, and by using standards or regulations to encourage it.

Buying Innovation. In many instances, the government's key role in fostering innovation is as the lead customer. The government itself acquires the required systems, products, and services, generally after following a prescribed procurement procedure that provides free competition. As very large and concentrated purchasers, governments have major opportunities to promote innovation. For example, the U.S. Postal Service and other

postal administrations worldwide have fostered innovation through their purchases of advanced long-life vehicles and advanced optical scanning technologies. In many countries, military and space agency procurement has triggered major innovations, including Teflon, advanced composite materials, and advanced sensor technology.

Departments of energy and public utilities have used procurement to foster innovation in nuclear power generation, solar and renewable energy technologies, and environmental technologies. In some cases, states and regions have also targeted specific areas of energy-related innovation to accelerate commercialization and business development within their regions (e.g., the solar industry in the Tennessee Valley, the electric vehicle industry in California, and the packaged nuclear plant industry in France).

Public health departments and hospitals have also led the innovation effort. In Canada, for example, there have been considerable efforts to use procurement to support innovation in health care products – particularly for the elderly – with the dual objectives of supporting lower-public-cost independent living for the elderly and supporting innovation in a nascent high-technology industry.

Reducing the Risks of Innovation. The government can also help reduce the technical, commercial, and financial risks associated with industrial innovation. To reduce technical risk (i.e., the chance that effective solutions to problems being addressed will not be found), the government funds R&D programs and demonstration projects.

Under a project called PATH at the University of California, federal and state governments are providing funding for the development of advanced vehicle control systems as part of the IVHS program. Similarly, governments are providing R&D funding for maglev transportation systems in Japan, Europe, and the United States. In this case, the U.S. Department of Transportation (DOT) conducted a survey to determine whether the private sector would be willing to finance the development of an American maglev system to compete with the Japanese and German systems. When the response was generally negative, public sector funds were released.

Governments also fund demonstration programs that help to reduce not only technical risk but commercial and financial risks as well, while the private sector gets a much better idea of potential demand for the innovation. Examples include government funding for consumer equipment purchases to support the development of videotext services in France. Another way government can help reduce financial risk is through insurance liability caps. In the highly litigious United States, many innovations will not be commercialized unless some relief is provided on liability issues.

Collaboration on R&D to Support Innovation.

Governments facilitate innovation by collaborating on advanced R&D and product development, usually at the precompetitive stage but increasingly at the competitive stage as well. Often a government agency coordinates R&D efforts or innovative technology applications. For example, the two major public sector entities involved in the transportation area in the United States are the DOT and the Transportation Research Board (TRB), a unit of the National Research Council that serves the National Academy of Sciences and the National Academy of Engineering. The DOT and TRB coordinate dissemination of information on innovative concepts and practices in transportation systems, services, or infrastructure financing and development through conferences, publications, and symposia. As noted above, similar programs have long existed in the agriculture and health fields.

The U.S. government also provides funding and support for consortium research efforts such as SEMATECH (\$100 million matched by private industry) – efforts that have parallels in both Japan (through MITI) and Europe (through the EC). In addition, cooperative research and development agreements (CRADAs) are a relatively new tool that is now being used aggressively to accelerate innovation with collaborative efforts among the national labs in the United States and private businesses or industry consortia. Governments are also entering into collaborative agreements with their suppliers to develop new technologies and product applications and to share the costs and returns.

Using Standards or Regulations. Government regulations and standards serve as important barriers and incentives for innovation.

For example, efforts to accelerate innovation in broadband telecommunications capabilities and intelligent network services in the United States and Europe are being driven or held back primarily by government regulatory policy on rates and investments. Patent policy and health care regulation drives pharmaceutical and medical equipment innovation in most countries.

Electric vehicle technology and automobile engine technology are being driven by CAFE and ZEV regulations in the United States as regions recognize the dual benefits of environmental enhancement and economic development. Similarly, environmental, health, and safety regulations are driving numerous innovations in environmental technologies for power plants, automobiles, environmental clean-up, and recycling.

The Broadening Role of Government. Like it or not, believe in it or not, government agencies at all levels and in all parts of the world are broadening their roles and expanding their efforts to encourage innovation and enhance industrial competitiveness. They are partnering more closely with whole industries (e.g., SEMATECH) and with individual businesses. They are also providing more government resources: technical expertise from government laboratories, financial resources, targeted tax benefits for R&D and innovation, and access to government patents, as for example in the United Kingdom. They are loosening antitrust regulations and not only permitting but actively supporting the formation of consortia of otherwise competing firms. And they are aggressively purchasing more advanced technologies and providing purchase guarantees.

Many projects fall into more than one of these categories. For example, the recent agreement by the U.S. Department of Energy (DOE) to help Cray Research, Inc., develop software for its supercomputers exemplifies both close partnering and the provision of government resources. This move, a part of the National Technology Initiative, will help the firm with its rivals at the top end of computing power. At the same time, the project will attempt to transfer defense-based technologies supported by national laboratories to commercial uses in areas such as environmental modeling, material design, and advanced manufacturing. According to the agreement, DOE and Cray will share the costs of software development. Additional participants in the project will include two national laboratories (Lawrence Livermore in California and Los Alamos in New Mexico) and many private firms.

In the area of technology transfer, a number of laws written over the past decade not only allow but also promote such transfer to the private sector. In the United States, the Stevenson-Wydler Technology Innovation Act (1980), the Federal Technology Transfer Act (1986), and the National Competitive Technology Transfer Act (1989) allow and encourage federal laboratories to enter into cooperative R&D with private companies, to license technology directly to them, and to provide private firms with direct access to the personnel, services, and equipment of federal laboratories to pursue joint efforts in technology development. For many national laboratories in the United States, the recent reductions in defense spending have created a sense of urgency. Cooperative arrangements play a dual role, both increasing private-sector competitiveness and providing a new mission for national laboratories. For example, the idea of using the national laboratories to help the American automotive industry become more competitive is currently being explored.

The Advanced Research Projects Agency (ARPA) has been involved in several innovative – and sometimes controversial – ways to foster private-sector innovations. For example, ARPA provided \$4 million to Gazelle Manufacturing, a private firm involved in making gallium arsenide computer chips for fiberoptic communications systems. This award was an investment under which ARPA became an equity partner, allowed to keep returns and use them on other projects. In effect, ARPA acted as a venture capital firm. ARPA has also pursued projects related to high-definition television (HDTV) as a „dual use“ technology for military and civilian applications.

Additional examples of technology transfer and novel ways of funding are provided by the National Aeronautics and Space Administration (NASA), which has backed more than a dozen industry/university partnerships known as Centers for the Commercial Development of Space. Using NASA funding as seed money, the centers are expected gradually to become financially self-sufficient as their university sponsors and industrial partners develop processes and technologies that can be used both in space and in earth-based applications. The centers deal with a wide variety of subjects: advanced materials, remote sensing, macro-molecular crystallography, crystal growth, space vacuum epitaxy, space automation/robotics, mapping, cell research, space power, and space propulsion.

Yet another form of industry/government partnering is exemplified by a collaboration of industrial organizations with the state of South Carolina, established in response to federal initiatives undertaken by the Department of the Navy. Under the authority and leadership of the South Carolina Research Authority (SCRA), several consortia of industrial firms are working on advanced technology development programs. The American Manufacturing Research Consortium – composed of the SCRA, Arthur D. Little, Battelle Memorial Institute, Grumman Data Systems, and Systems Engineering Analysis Corporation – is working under a \$93 million Navy contract for the Rapid Acquisition of Manufactured Parts (RAMP) program. RAMP's objective is to develop manufacturing technology capable of revolutionizing the way the Naval Supply Systems Command manufactures and delivers replacement parts. Its goal is to design, procure, test, and install computer-integrated systems that can process and manufacture several small-lot orders for new products daily. Aimed at developing the „factory of the future“ for the Navy, the RAMP technology is reducing the time spent waiting for spare parts by 90 percent – from 300 days and more to just 30 days.

The industry/government partnership represented by the association of the SCRA with its industrial partners has more than technology development as its operating objective. Like other industry/government partnership models described earlier, the RAMP program has technology transfer as a major goal. Once its technology is proven successful at the RAMP Test and Integration Facility in Charleston, South Carolina, the Navy intends to

introduce RAMP technology at the Charleston Naval Shipyard, the Cherry Point Naval Aviation Depot in North Carolina, and the Naval Avionics Center in Indianapolis. The Army has also expressed interest in RAMP technology and is looking at possible applications for activities in Anniston, Alabama, and Warren, Michigan. In addition, many defense and aerospace companies, including Westinghouse, General Dynamics, and McDonnell Douglas, have expressed serious interest in the technology and intend to participate in the technology transfer process. This venture exemplifies the potential for state government, federal government, and the private sector to work together to develop technology that is both immediately useful and transferrable.

Unlike the German government, which has actively promoted the formation of consortia of otherwise competing firms to perform precompetitive research – for example, the „Jessie“ consortium for semiconductor research – the U.S. government has generally looked askance at such consortia as potentially anticompetitive. Recently, however, Robert Bartholemy, project manager of the National Aerospace Plane (NASP), decided that the United States had enough competition without pitting American companies against each other. When the 1990 budget for NASP was slashed from \$427 million to \$254 million, Bartholemy won approval from the DOD Secretary to pull all contractors from the six competing teams into a joint venture in which individual firms have agreed to share data and to facilitate the transfer of technology to other industries.

Lessons for Managers

All these efforts represent a huge and growing public sector effort to support innovation and technology commercialization. They also raise some questions:

- What's working and what's not?
- What should governments do differently?
- How can business best avail itself of these opportunities?

What's working and what's not? The initiatives that are working best are those that have the closest ties to the market, those that represent win-win situations for both government and private industry, and those that involve the strongest interface between government and industry.

Industry- or consumer-driven initiatives tend naturally to have the *closest ties to the market*. For example, the industry-driven consortia activities (e.g., SEMATECH) have been notably successful. Consumer-driven initiatives, such as green packaging or recycling, also have been quite successful, as have initiatives supported by regulatory compliance requirements (e.g., air bags and catalytic converters).

Initiatives that are further from the market – such as those driven by government laboratories looking for new missions or advanced space and defense programs looking for new commercial applications – have had patchy success despite the very high potential and generous funding.

Initiatives that have enjoyed the greatest *'win-win quotient'* are those that had the strongest near-term commercial potential, the strongest job-creation potential, or the greatest public purpose. Initiatives in health care have been especially successful, although cost-control pressures are now undermining some of their greatest win-win advantages. Initiatives in education still have great win-win potential if they can allay the fears of teachers' unions. Initiatives in environmental clean-up and recycling will also continue to be major beneficiaries of win-win scoring.

Initiatives with lower win-win potential are those involving technologies and innovations that have serious health or safety risk implications (e.g., nuclear power), environmental complications (e.g., natural resource exploitation), or relatively low commercialization potential (a current problem with electric vehicle research and innovation).

The potential for accelerated and enhanced innovation is greatest where initiatives involve *strong linkages between government and industry*, such as in the procurement area. Government purchases or purchase guarantees for advanced technology succeed with great regularity, as evidenced by the U.S. defense and aerospace industries.

Where initiatives involve weaker linkages, such as in provision of technical information, access to patents, or access to technical resources, success has been much more limited.

What should governments do differently?

Governments and private industry now accept that the government is a major player in innovation. The question is, where should the focus and balance be?

Since so many government activities are linked to innovation and commercialization, there is a major need for governments at all levels to look cross-functionally at how all their activities are influencing innovation in critical areas – whether explicit or implicit. Key leverage points need to be identified and enhanced so they can

be used more effectively in the future.

Although many government policies are justified on the basis of innovation and commercialization, other major policies are counterproductive in this arena (e.g., procurement policy in many cases). Governments need to develop explicit strategies and policy frameworks for ensuring consistent policy in support of innovation and accelerated commercialization.

Since so many government resources are now being expended in the name of innovation and support for commercialization, there need to be more explicit performance and impact measures and a more consistent assessment of the benefit of government expenditures in each area.

In the area of *procurement* (buying innovation), there needs to be increased flexibility that will allow governments to enter into the types of collaborative technology development efforts that businesses have been able to develop with their suppliers. Governments need to find ways to ensure fairness and level playing fields while getting much closer to their suppliers.

In the area of *seed funding, demonstrations, purchase guarantees, and co-funding* (reducing the risk of innovation), there needs to be a more consistent framework for measuring need, impact, and commercialization potential. Governments should embark on much more extensive and objective benchmarking of successes and failures to develop better guidelines for the future. Far too much money is being spent without the benefit of these benchmarks or of lessons learned.

In the area of *cooperative research and development agreements, consortia research programs, and other government/ industry partnerships* (collaborative innovation), it will be critical to find win-win situations (preferably market- and/or regulation-driven) where government and industry have complementary interests, in order to build the trust and respect that is now often lacking between government and industry researchers and administrators.

In the area of *regulatory policy* (standards to encourage innovation), the current trends toward more industry/ government collaboration on standards and to the increased use of standards to support innovation should be encouraged at all levels, but particularly in the merging computer and communications industries, in the transportation industry, the energy and utility industry, and the health and education sectors.

How can business best avail itself of these opportunities? The most important lesson learned from the successes and failures of past government efforts to support innovation and accelerated commercialization is that governments and businesses need to focus on win-win situations in which they can and do fully commit themselves to the success of new initiatives. Businesses need to take the lead in identifying areas where government procurement, collaboration, risk reduction, or standards would significantly accelerate innovation and commercialization.

Businesses also need to be more aware of the technical and financial resources that are available from government to support technology, product, business, or industry needs for accelerated innovation and commercialization. However, businesses need to enter into collaborative innovation ventures with the principal objective of making them successful, not merely exploiting available resources and programs.

In addition, businesses need to be more willing to experiment with new procurement initiatives or new regulations that can positively affect innovation. And businesses must find champions who will be best able to manage public/private initiatives involving vastly different cultures and reward systems. Finally, businesses need to be proactive overall in their dealings with government in areas of innovation and commercialization.

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