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Why Not a Civil DARPA?

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In his campaign position papers, President-elect Clinton suggested that his administration would consider establishing a civilian version of DARPA (Defense Advanced Research Projects Agency), citing the agency's successful role in fostering a series of major technological breakthroughs. The newly chartered agency would "create new jobs for scientists, technicians and engineers; and develop and produce manufacturing expertise for state-of-the-art technologies and innovative new products."

Two additional proposals for similar federal agencies are also under consideration in Washington. One of these, recommended by the Carnegie Task Force, would transform DARPA into a National ARPA (NARPA) for the development of dual-use technology. The other, which emerged from an expert panel sponsored by the National Academy of Sciences, calls for a quasi-governmental Civilian Technology Corporation (CTC). The CTC would receive a one-time start-up grant from Congress and would be chartered to develop precommercial technology to introduce into the national technology base.

Despite their differences, all three proposals are based on the DARPA model—a strong-management approach in which a few elite technical managers operate relatively independently to seek out promising R&D programs and support them with government funds. While this management model worked well for DARPA in the early years, it was later changed irrevocably by congressional legislation. And even in its original form, it may never have been appropriate for promoting commercial R&D.

DARPA's Early Successes

DARPA was originally established as ARPA in 1958 in response to the Soviet Union's first Sputnik launch. (Its name and its position in DoD were changed in the 1970s, but its charter remained the same.) To keep its edge sharp, the agency was organized around a small group of experienced program managers recruited from defense contractors, the military, and universities. These managers were allowed to start, stop, and restructure projects—largely on their own initiative—so that they could respond swiftly to technical opportunities or setbacks. Talented young technical managers served for three to five years, returning to the private sector before they could become overcommitted to pet projects. By rotating managers in and out, the agency was able to keep a fresh perspective and preserve its ability to end unproductive projects and transfer funding to more promising ventures.

This management approach contributed to a string of successful innovations during DARPA's first twenty years: stealth aircraft, data packet switching, smart weapons, and treaty-monitoring sensors, to name only a few.

DARPA's Recent Problems

Unfortunately, the DARPA of today is not the DARPA of the 1960s and 1970s. Few recent projects have had the resounding success of the early ones. For example, DARPA's VHSIC (very high speed integrated

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circuits) and GaAs (gallium arsenide) projects did little more than help some defense contractors “stay in the game” during the 1980s. Most of the cost-effective cutting-edge innovations in the microelectronics field came from companies answering the demands of commercial markets, not from DARPA program managers.¹

Over the last twelve years, DARPA has become progressively less flexible and more bureaucratic. In the mid-1970s, Congress passed legislation to slow the “revolving door” between government and industry and to enforce competition in contracting. While these regulations were intended to reduce conflicts of interest, especially in Pentagon procurement, one of their side effects was to make DARPA less attractive to experienced scientists and engineers from industry and universities. As the influx of new managers and new ideas honed by nongovernment experience and close links to the technology community slowed, the agency’s capacity for innovation and high-turnover management fell off. DARPA became less able to identify (and thus cancel) troubled or failing programs; failures were glossed over and expectations were revised downward. X-wing aircraft, VHSIC, the national aerospace plane (NASP), and robotic ground vehicles are notable examples of programs continued for other than sound technological reasons.

In spite of these problems, however, DARPA has continued to enjoy strong political support on Capitol Hill. That support flows partly from the reputation the agency achieved in the 1960s and 1970s and the enduring misperception that DARPA is a small agency. (Its apparent size of 150 people is deceptive: it vastly understates the DoD-wide technical and contracting staff that DARPA routinely calls upon to do its detail work.) The support also stems from the fact that some DARPA managers have formed tacit alliances with influential legislators. Such deals let Congress manipulate DARPA’s research agenda and occasionally even steer projects to selected industries and universities. The result is often a misuse of DARPA research on projects that have little relevance to either military or civilian technology needs. The lighter-than-air airship developments in Oregon and Maryland, the Microelectronic Centers of Excellence in West Virginia, and the Super Computer Center in New York are three good examples.²

Even if the non-civil-servant CTC were developed as a way to sidestep congressional regulations, it would still not enjoy the rapid turnover of technical managers and the freedom from congressional interference enjoyed by DARPA in its early, most successful years.

Defense and Commercial R&D: Worlds Apart

Besides the fact that the original model for DARPA no longer exists and could not be duplicated with current congressional constraints, the DARPA model may not be valid outside the defense community. In the world of defense technology, the government is both the buyer and the seller. In the commercial world, the government is neither. This fundamental difference underlies a number of other critical distinctions between the worlds of defense and civilian R&D.

As already pointed out, DARPA relies extensively on the enormous DoD infrastructure. A civilian agency would have to be much larger, more self-contained, and less efficient than DARPA. Many of DARPA’s best program managers have been military officers with an intimate knowledge of their own “product line.” A civilian agency would be hard-pressed to attract a core of experienced technical/managerial experts who have comparable familiarity with their markets. DARPA has also had access to a vast intelligence system that gathers information about potential adversaries—their technologies, their organization, and their operations planning. No civilian equivalent exists.

A government agency for commercial R&D would also have to deal with contentious issues never faced by DARPA. How will it handle the ownership of intellectual property rights, the use of tax revenues to selectively enhance private enterprise, and the question of whether the government has the ability or the right to pick winners in the nondefense arena?

Perhaps the most important difference between the two worlds is their markets. Whereas the defense market is relatively simple and predictable, the commercial technology market is complex and uncertain. According to Professor David Teece of the Walter A. Haas School of Business, University of California at Berkeley, “There is no arena in which uncertainty is higher and the need to coordinate greater than the development and commercialization of new

¹Anna Slomovic, *An Analysis of Military and Commercial Microelectronics: Has DoD’s R&D Funding Had the Desired Effect?* RAND, N-3318-RGSD, 1991.

²In *The Technology Pork Barrel* (Brookings, 1991), Linda R. Cohen and Roger G. Noll demonstrate how politics can subvert federal

efforts to develop new civilian technologies. They analyze six case studies—the Supersonic Transport, the Applications Technology Satellite Program, the Space Shuttle, the Clinch River Breeder Reactor, Synthetic Fuels from Coal, and the Photovoltaics Commercialization Program—and conclude that none of them was successful.

technology."³ This uncertainty arises from the impossibility of determining future actions of competitors, future preferences and characteristics of the marketplace, and the trajectory of technological development.

The Need for a New Organizational Model

The need for coordination as a way to deal with uncertainty should be considered in all organizations, including DARPA. But that need is particularly important in the world of commercial R&D. Internal coordination creates and maintains links among the R&D, manufacturing, marketing, and planning staffs. External coordination links staff to customers, suppliers, and even competitors, as well as to scientific data bases, research reports, and new developments worldwide. It also promotes an information flow from those who will ultimately use the targeted innovations. In many cases, these users synthesize the necessary information and suggest the optimum direction or conception for an innovation. Organizations that stress coordination—i.e., have few internal or external boundaries and a culture characterized by sharing, cooperative attitudes—appear to be the most conducive to promoting the innovation needed to respond to marketplace uncertainties.

The fact is, however, that little is known about the dynamics of innovation and the organizational structures that best promote those dynamics. It is far from clear what organizational, managerial, and incentive factors distinguish successful, innovating firms from unsuccessful ones.⁴ Even "the emerging literature on the economics of organization has yet to deal with matters of innovation."⁵

Thus, while most experts agree that the linear model of innovation (the sequential process of scientific research, technological change, and commercialization) is dead, the national policy implications of the most promising theoretical alternatives—organizational learning and the network model of innovation—remain largely unexplored. Since current business literature strongly supports the value of networked learning and coordination in promoting innovation, it would be unwise to pursue a national policy without first examining the connections between organizational

design and external links and the promotion of innovation. Careful studies should be carried out to determine how these two factors impact innovation success.⁶ Failure to do so could lead the government to commit itself to an agency designed after an old model that shows little promise of fostering the breakthroughs and developments sought by the new administration.

Is a Federal Agency the Answer?

It is clear that government can provide R&D incentives through taxation policy and by increasing the availability of venture capital. What is less clear is whether a federal agency can do better, particularly an agency facing the unpredictability of the commercial market without the benefit of the vast defense community supporting DARPA, and without the freedom of action and the expertise that led to DARPA's successes in its early years. Consider as a benchmark the alternative of spending \$5 billion over several years (the same amount of money that a federal agency might dispense) on a series of high-technology, sector-specific mutual and venture funds. Such an investment would put new capital into the technical companies that are generating new jobs, new ideas, and new commercial products. The portfolio managers, with strong performance incentives, would be insulated from congressional micromanagement. If the companies prospered, dividends would flow into the national treasury and ultimately to the taxpayers. Perhaps the best test of any proposed agency is to ask how it would improve on this approach.

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³David J. Teece, "Competition, Cooperation, and Innovation: Organizational Arrangements for Regimes of Rapid Technological Progress," *Journal of Economic Behavior and Organization*, 18, 1992, p. 17.

⁴See Nathan Rosenberg, "Critical Issues in Science Policy Research," *Science and Public Policy*, December 1991, pp. 335-342.

⁵Teece, p. 15.

⁶The subjects of these studies should be quasi-governmental enterprises such as SEMATECH, the National Center for Manufacturing Sciences, and the Software Productivity Consortium; private joint research efforts such as the Microelectronics and Computer Technology Corporation; and successful, innovating firms such as 3M, Xerox, Apple, Raychem, and Sony.

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