Industry and Government-Laboratory Cooperative R&D: An Idea Whose Time Has Come

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There comes a time in the course of human events when streams of intellectual endeavor join together to form a mighty river. I believe we have reached such a time. Throughout the 1980s, as the U.S. international trade balance in high technology industries declined and then became significantly negative, increasing attention has been given to the ability of the domestic manufacturing industry to compete in world markets. During this same period our attention has also focused on the role our federal laboratories play in technological enterprise and, in particular, on the role some labs might play as their primary missions change or diminish in emphasis.

Together, these issues lead naturally to industry/government-laboratory cooperative R&D to enhance our domestic manufacturing enterprise. However, bringing these two ideas together to form an effective whole required the legislation of the last several years which authorized those laboratories to enter into cooperative research and development agreements (CRADAs) with individual companies or groups. CRADAs enable the laboratories to protect and manage intellectual property in such a manner as to ensure economic benefit to the domestic industrial participants and thence to the U.S. economy. At the forefront in utilizing these CRADAs are activities in materials science and engineering, particularly in the area of materials processing.

The recently published National Academies' study, *Materials Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials,* emphasizes processing as one of the areas of relative weakness in our system of materials R&D. This study and others which dealt with specific materials have focused our attention on the development of new materials and their actual utilization in manufacturing.

A common theme underlies the development path all materials follow. Research and development to improve the reliability and reduce the unit cost of materials innovations is a prerequisite for their wide adoption. This extensive R&D activity is far more expensive than that required to create new materials or to characterize them or understand their properties. This high development cost represents significant risk to the materials developer, who may not be able to capture all the economic benefit of such generic technology development. Strategies to spread these costs, and thereby lower the risk for each participant, are often key to the development of new materials or new processing technologies for conventional materials.

For 50 years the United States has pursued a successful strategy of risk reduction when the materials in question are related to national goals. Materials required for the mission needs of DOD, DOE, and NASA have been developed using the vast resources of the federal government to carry out development programs linking industry, university, and government-laboratory efforts. The current program to develop materials for the National Aerospace Plane is only the most recent of a series of major efforts, many successes of which have led to the popular rhetoric of "space-age-materials." One consequence of these years of effort is the creation of an enormous resource in talented staff and facilities at many of the national laboratories.

Our economic competitors abroad have recognized the need for risk reduction in materials development and have developed their own strategies to accomplish it. In Japan and Germany, relatively unburdened by defense development programs, these strategies have focused on commercial applications. While varied in detail, these strategies include some common elements: a government role in convening and encouraging industrial cooperation, often through shared funding mechanisms; pooling of industry resources to develop generic precompetitive technologies; and government laboratories with a clear mission to work with industries toward bettering the national economic well being.

Through the 1980s many who were unfamiliar with technological enterprise believed the United States could address most of its commercial technology development needs by "unleashing" the national laboratories and broadening their missions to include "technology transfer." Although significant, that vision is too narrow. While the laboratories are resource-rich, those resources are primarily the staff's know-how and special facilities. A specific, ready-made answer to an industry's needs, waiting "on-the-shelf" to be plucked off and used as is, is rarely found. What must be recognized instead are the commercial manufacturing industry's special requirements for low cost, high reliability, and high volume. These demands often lead to entirely different materials requirements and to entirely different process technologies than those used to satisfy government missions. Rather than pluck these items off the shelf, industry must work with the laboratory's technical staff to jointly develop the new technology required.

This joint technology development has now been sanctioned by the federal government through the Technology Transfer Act of 1986, which created the concept of the CRADAs between industry and government-owned/government-operated laboratories (GOGOs), and by its extension in 1989 to include the government-owned/contractor-operated laboratories (GOCOs). While the details differ somewhat for GOGOs and GOCOs), particularly regarding issues of employee rights and flexibility, CRADAs are similar at the two types of institutions. Specifically, the CRADA allows the laboratory to assign future intellectual property rights on an exclusive basis at the time of the initial contract, adding the economic incentive previously missing from the potential interaction between industry and these laboratories.

Materials processing appears prominently on the list of joint technology development activities at DOE laboratories and NIST. Among these efforts, the most visible so far have been those arising from the superconductivity resource centers at

Argonne, Los Alamos, and Oak Ridge National Laboratories, and from the Powder Atomization Consortium at NIST. Recently added to this list is the Specialty Metals Consortium coupled with Sandia National Laboratories. These activities share a common critical characteristic — industrial participation occurred at the outset in the planning stages and continued throughout the project. Laboratory staff and potential industrial partners worked out the research agenda as a team; they each brought resources to the table, including cash, intellectual capital and facilities; and they performed the research jointly, ensuring the most satisfactory mode of technology transfer from the outset. This mode of activity will see increasing emulation in the months and years to come as literally hundreds of CRADAs are in place or currently under negotiation.

Interestingly, a few years ago such cooperative ventures were thought to be inconsistent with the U.S. culture. "Experts" advised us that we had been brought up to excel as individuals and that competition was all we could understand. Somehow those great seers missed the point of our most popular games of baseball, basketball, and football. Organized cooperation by individuals, each striving to be the best at his/her particular job, is the essence of success in these games. This ability to cooperate for the common good is as much a part of our national psyche as is the drive for individual excellence. Admittedly, it has taken some time for Corporate America to recognize this reality, but under pressure from foreign competitors, many of our domestic industries have now entered the era of strategic partnering for the common good. Among the potential partners they find ready to cooperate are many of our federal laboratories.

Collaborative programs in precompetitive generic technology offer industry several advantages in addition to access to the know-how and facilities of the laboratories. High on a list of such advantages are spreading the risk and leveraging the capital investment of the individual partners.

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However, the most important benefit that can be derived from such a cooperative venture lies in the intellectual ferment often created in these activities. Commitment by a company, expressed through the assignment of company staff to participate in the R&D and to ensure the proper direction for the laboratory effort, will benefit the company in the long run as those staff members return to pursue application of the new technology at their home institutions. This is technology transfer at its most effective and elemental level.

Change is not without its consequences for the laboratories. One of the consequences of attention to the concerns and needs of commercial industry is a reculturalization of the activities and personnel at the federal laboratories. If the research agenda is to be jointly set, then communication with industry takes on a different and higher priority position on the list of activities of management and researchers alike. In the parlance of total quality management, it is critical that each participant in the enterprise know the customer of his/her productive efforts and work to achieve customer satisfaction. Also, freedom of communication within the laboratory may be impaired since laboratory scientists may gain personal financial benefit from their inventions (a minimum of 15% of royalty flow to the laboratory resulting from licensing of an invention must be shared among the inventors). Furthermore, maintenance of a core, long-term, underlying research activity is critical to the laboratory's health but may be threatened by a short-term development focus. Laboratory management faces the challenge of adapting to these changes and maintaining a balanced program while aggressively pursuing the new opportunities.

These are certainly exciting times in which we live. The technological and sociological changes required for a continuing successful economic enterprise in materials manufacturing are enormous, and the national laboratories working jointly with industry can now take their place in the vanguard of these changes.

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