Stimulating High-Risk, High-Payoff Research

During the past two decades, many American companies focused their R&D efforts on safe, predictable short-term goals and incremental product improvement rather than on research that might lead to new technologies and products. Now a more entrepreneurial approach to technological research is emerging—fostered in part by the Advanced Technology Program (ATP), which is managed by the National Institute of Standards and Technology (NIST), an agency in the Department of Commerce.

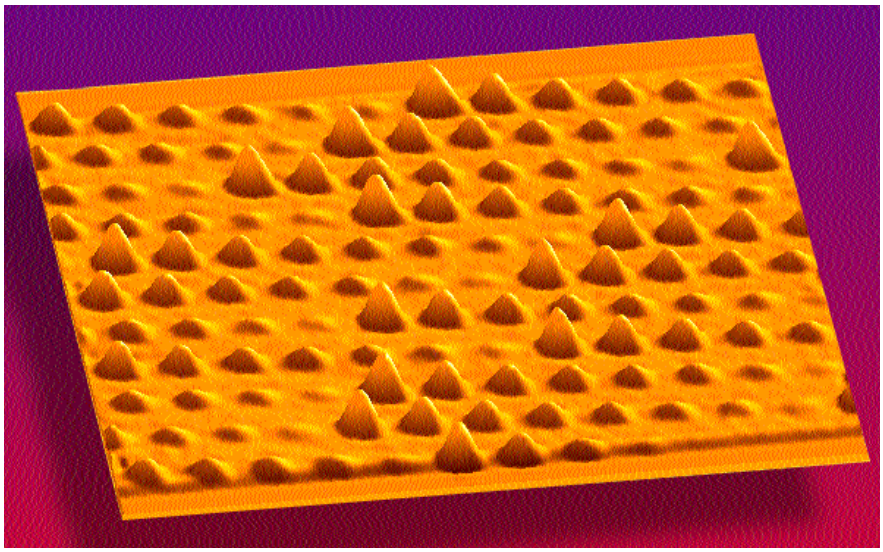

Figure 1. Calimetrics Inc. of Emeryville, California, used co-funding from ATP to create a new compact-disk data-storage technology. The lasers in current disk drives read tiny pits as 1, if present, and 0 if absent. Calimetrics' system uses pits of varying depths to code numbers from 0 to 8.

The Omnibus Trade and Competitiveness Act of 1988 authorized the program, which operated as an experimental effort from 1990 through 1993 and became a full-scale national program in 1994. The goal of ATP, headed by Lura Powell, is to stimulate high-risk research by the private sector into technologies that have the potential for significant commercial payoff. In particular, ATP offers financial assistance to projects that a company would otherwise scale down or fail to undertake because of the risks involved.

About 70% of the new ATP project awards go to small businesses. Indeed, NIST encourages small companies, including start-ups, to apply for ATP grants, and it offers assistance in planning research projects and in preparing grant applications. A small company can apply for an ATP grant by itself, or it can form a partnership with others to conduct the proposed research. Some companies turn to research institutes, universities, or government laboratories to carry out the research.

NIST currently lists about 300 active projects. Many grants run for three to five years and receive funding annually. Small businesses that win an ATP grant receive 50% of the project's budgeted cost, and large companies receive less, usually 40%. ATP funds cannot be used for product development. When a single company receives an ATP research grant, it must pay all indirect costs associated with the project. Some indirect costs are allowed for joint-venture projects.

In FY 1998, NIST received $192 million from Congress for ATP, and awarded about $82 million to 79 new industrial research projects, a larger number of awards than usual. In 1997, NIST gave out 64 ATP awards for new projects, and it expects to make a similar number of new awards in 1999. The amount of funding for new awards is set by Congress, but the final number of awards depends on the first-year funding requested by the selected projects.

ATP's total funding for FY 1999 is $203 million, of which about $66 million is scheduled for new projects. The remainder of the money goes to projects in progress, and a small portion pays administrative costs.

Proposals that won ATP awards in 1998 include research projects to develop a method for truly three-dimensional visualization using cross-beam volumetric display in an optical material (3D Technology Laboratories, Mountain View, CA, three years, $1.9 million); a new approach to digital video compression based on mathematical catastrophe theory and intelligent frame management (Physical Optics, Torrance, CA, three years, $1.6 million); low-cost, LED-based, solid-state lamps (Widegap Technology, Westlake Village, CA, and General Electric, Schenectady, NY, three years, $2.9 million); a smart microelectromechanical-system vibration sensor with wireless interface (Wilcoxon Research, Gaithersburg, MD, three years, $1.9 million); a DNA diagnostics chip (Caliper Technologies, Palo Alto, CA, three years, $2 million); and an adaptive learning system that allows educators to develop complex interactive software that modifies itself to meet the learner's needs (Real Education, Denver, CO, three years, $1.9 million).

In addition, several 1998 awards went to projects in what NIST calls its premium-power focused program. These include a large grant to a joint venture for developing a lithium-ion battery with a new stable solid-polymer electrolyte that can be fabricated in ultrathin shapes (Ultralife Batteries, Newark, NY; Eagle-Picher Technologies, Joplin, MO; and Lockheed Martin Missiles & Space, Sunnyvale, CA, three years, $7.3 million). An award also went to a joint-venture effort to develop a supercapacitor with electrodes made of different materials fabricated from nanosize particles. US Nanocorp (North Haven, CT) heads this three-year, $441,000 project, which includes Eveready Battery (Westlake, OH), JME Inc. (Shaker Heights, OH), and Florida Atlantic University (Boca Raton, FL). These new supercapacitors are anticipated to replace batteries in wireless, computer, and heavy-duty applications such as power tools and electric automobiles.

PowerStor (Dublin, CA) has a three-year, $2 million grant to investigate metal oxide aerogel composites and new organic electrolytes for ultracapacitors with a rating of 3.5 V. Maxwell Technologies (San Diego, CA) also has a three-year, $2 million award to develop a modular building block for making ultracapacitors of any size and to research new electrolyte materials.

Two years ago, NIST altered ATP to encourage large companies to participate as partners in joint research ventures with other companies—large and small—and with universities, nonprofit research organizations, and government laboratories. Generally, a large company is one whose annual corporate revenues are high enough to include it in the Fortune 500 list, which in 1999 would be at least $2.721 billion.

The change is beginning to produce results. For example, Standard Microsystems, Xerox, Microcosm Technologies, Optical MicroMachines, Microscan Systems, and Maxim Integrated Products set up a $14 million joint venture to develop a standardized process for fabricating microoptical-electromechanical devices. Similarly, SDL, Adept Technology, RSoft, and Newport teamed together in a $6 million, three-year project to develop advanced fabrication techniques for photonic devices that will allow U.S. manufacturers to compete internationally in the emerging markets for high-volume, low-cost photonic products.

NIST instituted another change this year aimed at broadening the competition for new ATP awards. In the past, the agency solicited proposals annually in about six of its designated focused-technology areas and had one competition open to proposals from any technology area. The focused technologies eligible for ATP awards varied somewhat from year to year. In 1999, NIST is conducting a single large competition for the ATP awards. Proposals from companies will be categorized by technology area and assigned to one of several independent selection boards with the most suitable expertise. This change will ensure that each proposal is judged in competition with other proposals from the same area. It also may open the door for unforeseen technology developments.

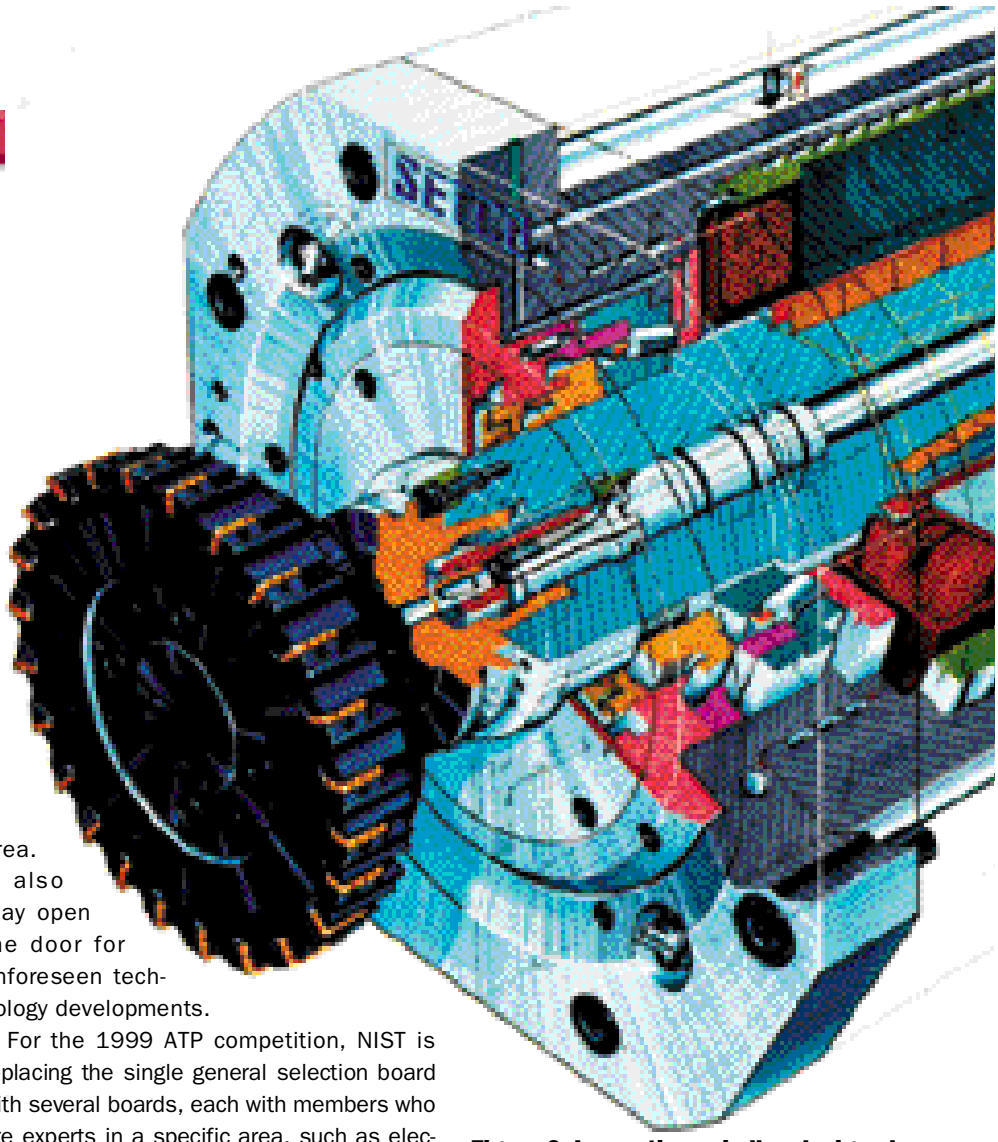

Figure 2. Innovative spindles designed in a project sponsored by the National Center for Manufacturing Sciences, Inc., and co-funded by ATP are smaller, faster, and more flexible than conventional designs, and could save millions of dollars in a wide range of industries.

For the 1999 ATP competition, NIST is replacing the single general selection board with several boards, each with members who are experts in a specific area, such as electronics or biotechnology. Projects are judged on their scientific and technological merits (50%) and on their potential broad-based economic merits (50%). The projects selected for funding will be assigned to the appropriate focused-technology management group within NIST.

New focused-program areas are set up as needed by NIST to manage groups of complementary projects. By managing a suite of interlocking R&D projects that complement and reinforce one another, NIST hopes to develop a synergy with high payoff potential. The focused programs seek to overcome major technology hurdles that are unlikely to be solved by an individual project. Current focused-program areas include catalysis and biocatalysis, selective membranes, digital data storage, component-based software, digital video, photonics manufacturing, microelectronics manufacturing, and motor-vehicle technology. The other ATP areas of interest are materials processing, composite manufacturing, premium-power technology, intelligent control of manufacturing, refrigeration, tissue engineering, DNA diagnostics, health-care information, and learning technologies.

NIST has structured ATP so that industry primarily sets the research priorities. The institute has developed extensive cooperative and consulting relationships with companies and industry groups to help it define the most promising areas for development and to evaluate research proposals. Experts are also drawn from government and universities.

Throughout the year, NIST sponsors a series of public meetings and workshops, each devoted to a focused program or to some aspect of managing an ATP project or joint venture. When a new focused program area is being considered, NIST holds work-

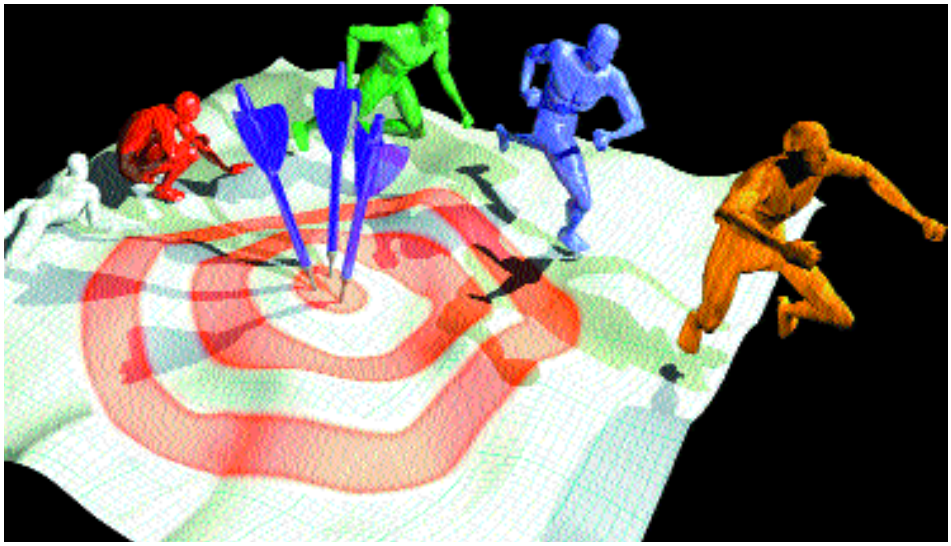

Figure 3. A tool kit of software components being developed by Aesthetic Solutions of Aliso Vieja, California, which received a cost-shared ATP award in 1995, may cut dramatically the time required for building virtual reality environments.

shops at appropriate industry and association conferences to solicit ideas and comments about the technology and ATP's role.

Benefits of ATP

NIST tracks the benefits of ATP projects for the participating companies and for the economy as a whole. Because it is still too early to measure the full economic effects, NIST is experimenting with macroeconomic models for projecting outcomes.

Several microeconomic case studies of individual projects show that the research has led directly to commercial production. For instance, in 1991 Cree Research (Durham, NC) received almost $2 million in co-funding from ATP for a two-year project to develop an improved process for growing large silicon carbide (SiC) wafers. Cree succeeded in doubling wafer size and significantly reducing defects in SiC crystals, which are used as the substrate for its blue LEDs (see *The Industrial Physicist, 9/97*, pp. 16-18). As a result, the yield of LEDs went up and production costs dropped. Cree's blue LEDs are used in a wide range of products, from car dashboards to giant full-color displays in stadiums. Cree also sells raw SiC wafers to the semiconductor industry.

Studies have identified other benefits. ATP encourages companies to pursue more high-risk research than they would otherwise, and surveys reveal that the program is spurring increased industry investment in R&D. ATP also is catalyzing cooperative R&D. Nearly four-fifths of the companies that completed at least one year of work under ATP reported that collaborations helped to achieve goals.

Small companies, particularly start-ups, find that winning an ATP project award not only provides them needed funds to conduct research, but also makes them more attractive to private investors. Even for well-established companies, winning an ATP award gives them leverage for additional financing.

Accepting an ATP award carries with it a commitment to early commercialization. Some companies benefit from direct interaction with NIST laboratories, and some from cooperative research with other companies and partners such as universities, government laboratories, and institutes. Participation in ATP often results in improved management of R&D.

In joint ventures, the partners benefit from exposure to different approaches to technology development. ATP's support of joint ventures is designed to promote industrial R&D alliances, both horizontally among competitors and vertically between customers and suppliers.

Companies incorporated in the United States keep the intellectual property rights, such as patents and copyrights, for improve-

ments and discoveries resulting from ATP-funded research. The federal government reserves the right to a royalty-free, nonexclusive license for government use of the new technologies developed with the aid of ATP funds. This right, however, is rarely invoked. Universities and nonprofit research organizations cannot claim title to the intellectual property developed with ATP funding, but they may receive royalties.

The failure rate of ATP projects is low. NIST has had to cancel only a few projects because it became clear that support was no longer justified. Some companies cancel projects in their early stages because of changes in their own research priorities or because new technological developments render the goal of the project obsolete. Some joint-venture projects fail because the partners disagree about how to conduct the research or share intellectual property rights.

Applying for ATP funds

NIST publishes notices of ATP competitions in the *Commerce Business Daily*, and accepts proposals only in response to its published solicitations. Companies may obtain information about current ATP competitions directly from the NIST Web site (www.nist.gov/atp) or by calling 1-800-ATP-FUND. An ATP proposal preparation kit with detailed instructions can be requested at any time. The deadline for the 1999 ATP competition is April 14.

NIST holds two public conferences each year, one in the East and one in the West, to provide general information about ATP and tips on preparing proposals. In addition, NIST holds spring and fall ATP meetings that provide multiple workshops on research in selected focused-technology areas, an exhibit of technology in development, and a session on how to prepare proposals.

Companies may submit abbreviated pre-proposals at any time. NIST will examine pre-proposals and provide feedback to applicants about the suitability of the research project. NIST recommends that companies submit pre-proposals at least two months before the annual deadline so that applicants will have time to incorporate the agency's recommendations into their formal proposals.