2002 ACADEMIC-INDUSTRIAL WORKSHOP
REPORT

Diversifying the Research Portfolio:
Federal, Industrial, Academic Research Partnerships

October 27, 2002, Williamsburg, Virginia

Approximately 55 participants representing research careers in academia, industry and federal facilities gathered on October 27th, 2002, in Williamsburg, Virginia, for the 2002 Academic-Industrial Workshop, held in conjunction with the annual Industrial Physics Forum. Intended to stimulate dialog between industrial and academic leaders, and to the physics community as a whole, this year's workshop focused on diversifying the research portfolio through academic/industrial/federal partnerships. It was organized into three sessions, each followed by a roundtable discussion concerning the issues raised by the speakers. Since one of the principal goals of the workshop is professional networking, the small group discussions are designed to encourage interaction among the participants as they each offer their personal expertise and experiment with regard to several aspects of the research enterprise, and glean new insights from this exchange of perspectives.

As the keynote speaker, Arden Bement, director of the National Institute of Standards and Technology (NIST), gave a personal narrative comparing and contrasting the cultures of academic, industrial, and governemtn laboratories, as well as the responsibilities of different management levels. Despite the prevailing stereotypes and fundamentally different cultures of these three major employment sectors for physicists, Bement emphasized, "These differences should not divide us. Each employment sector has a unique role to play, and each is vital to the laboratory research enterprise."

To encourage positive interaction, he recommended fostering a sharpened focus on a well-defined vision and mission to ensure past success carries into the future. For example, in a vastly changed post-Cold War research environment, academia may need to undergo a cultural change to strike the right balance between pure and applied research, although training students will continue to be their lifeblood. Finding concrete ways to measure impact or return on investment is a key feature of this new environment.

Elements of a solid strategic plan for universities include deciding on criteria to guide research decisions, as well as which educational fields to emphasize. Above all, such plans "should lay out a clear roadmap for the university. Too many are overly vague," Bement said. Nevertheless, "Universities are not corporations—they're partnerships. And some flexibility is needed to adjust or reinvent itself as the climate changes. A good strategic plan must anticipate and welcome changes to avoid being blindsided or destabilized, which is what happened to industry at the end of the Cold War or the aftermath of September 11."

More than ever before, there is a need for synergy, and ways of leveraging R&D, particularly through interdisciplinary collaboration. "Self-sufficiency is no longer attainable and probably not desirable," said Bement. In fact, one of NIST's goals is to serve as a catalyst for collaboration

through such efforts as the Advanced Technology Program, which invests in early stage development of innovative technologies to bridge the gap between the research lab and the marketplace. Technology transfer is a key element in promoting synergies, although Bement emphasized that this is a dynamic, nonlinear process. Finally, all these disparate elements must be in alignment with each other, which requires a systemic approach to fostering unity of purpose without stifling innovation.

> ***The scientific community must recognize that organizational and technological complexity within the research enterprise will continue to increase and adjust accordingly. And while we need to disabuse the stereotypes of old sector cultures, we must recognize that diversity is still a strength and we must capitalize on that while being alert to opportunities for collaboration.***

The Industrial Viewpoint

The first session provided an industrial perspective focused on the issue of securing support and evaluating laboratory performance, and providing specific examples of research partnerships. Kenneth Hass, manager of physical and environmental sciences at the Ford Motor Company, drew on a complex systems perspective to describe his take on research management and partnerships, inspired in part by his recent sabbatical at the University of Michigan's Center for Complex Systems. He believes that the current dominant scientific and industrial worldview is incomplete and overly linear; traditionally reductionist instead of holistic; and mechanical rather than organic and evolutionary in its approach to the research enterprise. Specifically, the physics community holds that basic research leads to a reservoir of knowledge resulting in applied research that ultimately finds its way into technologies. "This implies a compartmentalized approach to a multi-dimensional problem," said Hass. "Real technology transfer involves multiple feedback and cross-fertilization; the process doesn't just flow one way."

This outlook has several implications for industrial R&D. First, progress is evolutionary, and hence the results are inherently unpredictable and uncontrollable. This means that the research community must pursue multiple pathways and gradually reinforce those that prove most promising. Since the environment is not static, the research enterprise must be able to evolve with that environment. Second, balance is critical. "People, ideas, customers, and partnerships are all important, and everyone's role is enhanced by understanding the overall context," said Hass. "We need to align incentives, time scales, and resources, and we need to be cognizant of the balance between risk and reward, cooperation versus competition, and exploration and creativity versus focus and discipline."

Ralph Cavin, vice president for research operations at the Semiconductor Research Corporation (SRC), echoed many of Bement's comments about the contrasts between industrial and academic cultures, and emphasized the common ground between them and their interdependency. Much of his focus was on SRC, which conducts university research on behalf of its member companies, placing significant emphasis on technology and knowledge transfer. While SRC has made many impressive contributions to the industrial technology base, it is currently facing significant challenges.

First and foremost, the semiconductor industry is radically and rapidly changing, particularly in the movement of manufacturing operations from within the U.S. to overseas sites. Second, there is a widespread flight of basic research from industry; for example, most companies no longer do internal CAD development. Universities are increasingly seeking to obtain intellectual property revenues from its industry-sponsored research. Finally, there are insufficient revenues for funding quality proposals.

> ***Cooperative research requires vigilance to address inevitable issues that arise in a dynamic environment, as well as a commitment by all participants to bridge established mindsets and cultures.***

Federal & State Support for Research

The second session focused on the various kinds of research efforts and available support, with particular emphasis by the first two speakers on large-scale research centers in academia through the National Science Foundation's Materials Research Science and Engineering (MRSEC) program. Two more speakers offered their perspective on federal laboratory research and collaborative efforts, with a particular emphasis on local venues in Virginia.

According to Thomas Weber, director of NSF's Division of Materials Research, the agency has three major strategic goals: promoting a diverse, internationally competitive and globally engaged workforce; promoting discovery across frontiers; and developing state-of-the-art tools and information bases. The MRSEC program is one of the building blocks for attaining these goals, granting six-year awards to establish materials research centers focused on a broad range of areas of expertise, with a total annual budget of $54 million. Based on the success of the program, Weber believes that MRSECs could provide a useful model for future academic/industrial collaborative research. "The products of modern materials research impact our economy and our everyday lives," he said. The centers address fundamental science and engineering problems in the creation of new materials. They also provide students with a highly interdisciplinary education that is prized by potential employers in industry, academia and government."

MRSECs share three major program goals: stimulate and support outstanding interdisciplinary research and education in materials; address fundamental complex materials issues; and foster partnerships across sectors. Specific features include Interdisciplinary Research Groups (IRGs) that address a major materials topic or area; active collaboration with industry and other sectors; education and development of human resources from pre-college to postdoctoral levels; and flexibility to develop new areas for "seed" projects.' Twenty-nine MRSECs support 373 postdocs, 950 graduate students and 448 undergraduates. For example, the MRSEC at the University of California, Santa Barbara's primary role is to support interdisciplinary research, training and education through the study of materials with chemical and structural complexity in which self-assembly and multiple length scales play an important role, with IRGS on biomaterial microstructures, solution synthesis of inorganics at molecular and atomic interfaces, mesoscopic macromolecular structures, and strongly non-equilibrium phenomena in complex materials.

Ellen Williams is the director of the fledgling MRSEC program at the University of Maryland, which has three IRGs focused on, respectively, (1) polarization dynamics in ferroelectric thin films; (2) surface nanostructures; and (3) metal oxides at high-spin polarization. The first is concerned with the development of new probe instrumentation, and hence there is a great deal of industrial collaboration, particularly in the area of memory storage. The second group studies the fundamental properties of nanostructures with instruments and techniques specifically developed for such characterization, while the third group is concerned with developing magnetic oxide materials for applications in sensors and magnetic memory storage.

UMD's MRSEC also has a strong educational outreach program. Williams believes that the lessons learned from those programs can be applied to knowledge to transfer and industrial outreach. UMD has a strong history of supporting commercialization of the research that comes out of its laboratories. "We need to work on making it easy and effective to make those vital technology transfer connections in a more timely fashion, commercialize new instruments and make sure students are aware of prevailing trends in industry," said Williams.

The newly established National Institute of Aeronautics (NIA) was created to foster a new kind of strategic partnership, according to Charles Harris, director of the NIA Management Office at the NASA Langley Research Center. NASA's budget has remained essentially flat for the last decade, yet its mission remains the same, and there are still ten field centers operating despite a one-third reduction in resources. When the International Space Station was approved by only one vote in 1993, NASA decided to reinvent itself, cutting back on basic research and focusing more on technology and fostering closer ties to industry.

"We are not following the Langley model, which is populated mostly by academics and their grad students and postdocs, who are the next generation workforce," said Harris. The new model features shared resources and risks; joint ownership of intellectual property; creating synergies; and the role of the government is as a collaborative partner, not as a traditional boss with a heavy-handed approach to oversight. "We want to be a strategic partner in R&D, but we will also have an educational component through the granting of degrees from various universities," he said. "And we will commercialize intellectual property and foster technology transfer. Economic development is definitely one of our goals…Our survival depends on innovation, and we expect to develop interdependencies with new institutes over time; we can't succeed without each other."

Closing the session was Daniel Manos, director of the College of William and Mary's Center for Plasma and Photon Processing, part of a collaborative research effort with the Applied Research Center (ARC) consortium. Part of ARC's function is to develop new models for collaboration between the various sectors of the research enterprise. The building houses both offices and labs, with occupants hailing from universities, federal laboratories, industry and small start-up companies, economic development organizations and venture capital firms. It provides a multi-disciplinary and technically diverse environment, as well as aggregated equipment with dedicated technicians. ARC is greatly needed in the region, according to Manos. Virginia currently ranks 39th in the country in R&D expenditures as a fraction of state gross domestic product, and state salaries have been frozen for two years; there has been no other significant

infrastructural investment on the scale of ARC. Manos concluded with a quote by Harold Furth, originally aimed at the Department of Energy, but relevant to ARC's predicament: "The python does not kill by crushing its victim overnight. It simply takes out the slack."

> ***Technological R&D in the private sector is driven by today's global economic realities, with an increasingly rapid pace of technological change. Partnerships and collaborations between industry, academia, and government and other laboratories enables the sectors to share the high development risks of innovative new technologies with potential commercial applications, and also collectively reap the rewards.***

The Academic Response

An academic response to the discussions of the day was provided during the third and final invited session. Mark McDermott, a professor of physics at the University of Washington, described the current academic environment from the perspective of a *Research I* institution, as classified under the Carnegie scale. First, research support is mostly federal, and while faculty can still determine their own research directions on physics grounds, they are more likely to take federal interests into account. Nevertheless, "Some of the best research is the result of good physics instincts, where the faculty followed their noses to the most challenging and interesting physics, not the money," he said. The modern academic environment is also more dynamic and less static, but while fields of expertise may change, "good faculty are agile and able to adapt." Collaboration tends to be more external than internal, with use of off-campus facilities on the rise. The research tends to follow physics "fashions" -- the most recent hires at UW have been in carbon nanotubes, string theory and nuclear physics -- and fundamental experiments are often of long duration. New faculty are often recruited by "poaching" from other institutions.

Diandra Leslie-Pelecky, an associate professor of physics at the University of Nebraska, provided the perspective of early career faculty, drawing on her own experience in the field of condensed matter physics. In particular, she sees a shift in the academic research paradigm away from single-investigator, single discovery grants in one's own field of expertise, to multi-disciplinary, multi-investigator group grants with industrial and national laboratories, as well as coordinating research activities and grant proposals with education, outreach and teaching responsibilities. These additional tasks can be quite burdensome to early career faculty struggling to meet growing expectations of them. There are also disproportionate demands on women and minority faculty to participate in various outside activities due to the greater demand for diversity on committees, national boards, and other bodies. The University of Nebraska has benefitted from an aggressive administration that espouses prioritization and has instituted changes in the reward structures to take these changes into account. Leslie-Pelecky suggested supplying new hires with an orientation list on the mechanics of getting starting in academia, as well as a mentor, and perhaps even advice on balancing career and family.

Breakout Groups: Consensus and Summary

At the end of the day, participants split into their small breakout groups, and were asked to boil down the discussions a few main points. While responses varied from group to group, there was general consensus on numerous issues. First, participants reiterated the point that universities, industry and government labs share common problems, and recognized the need to continue to promote collaborations between the three sectors and emphasize common goals in research and education. Second, academic institutions need to engage in effective strategic planning to ensure proper rewards and incentives, while remaining flexible enough to identify and explore new opportunities. Any new model should include mentoring of new faculty, and some felt that a post-tenure review at universities would be helpful, although an appropriate metric for evaluation would need to be developed. Finally, early career faculty simply need more time to meet the additional demands on their time. Specific suggestions included setting up an early sabbatical program for young faculty, as well as a one-semester leave from teaching in order to get their research programs up and running.

The fourth Academic-Industrial Outreach Workshop will be held on Sunday, October 26, 2003 in San Jose, CA. The focus of the workshop will be undergraduate research.