Nanotechnology Advisory Committee
Wednesday, September 22, 2004 1:30 p.m.
General Assembly Building, House Room D
Richmond, Virginia

The Nanotechnology Advisory Committee, charged with examining nanotechnology opportunities and obstacles for the Commonwealth, met for the second time on September 22, 2004. Members not present at the first meeting had the opportunity to introduce themselves and share their goals for nanotechnology in the Commonwealth. During this meeting, the Committee also received an overview of nanotechnology initiatives and the competitive landscape, and a briefing on the proposed Nanotechnology Accelerated Development Center in Northern Virginia.

Continuation of "Five Good Minutes"

At the first meeting, members of the Committee each took about five minutes to introduce themselves, speak about their background, their employer, any nanotechnology affiliation, and their goals for nanotechnology in the Commonwealth.

- Dr. Frederick Dylla is the Chief Technology Officer and Program Manager of the Free-Electron Laser (FEL) project for the Thomas Jefferson National Accelerator Facility. He ensures awareness of new and developing technologies that could be used to enhance or improve Jefferson Lab's (JLab) scientific program; and he leads JLab's Technology Transfer team to identify commercialization opportunities for Lab-developed technologies. As the FEL program manager, he is responsible for Jefferson Lab's Free-Electron Laser, a major initiative funded through the Office of Naval Research that uses Jefferson Lab's key technology (superconducting radiofrequency cavities) to produce high average power, coherent light. The lab recently undertook an $80 million project to build the world's most tunable laser. He noted that the Lab frequently interacts with Virginia universities and companies, an essential element of continued nanotechnology development.

- Dr. Richard Gregory is Professor and Dean for the College of Sciences at Old Dominion University. He has a background in organic electronics and material sciences. He sees a need for a focus in Virginia to allocate resources and provide funding to build areas in which the Commonwealth can succeed. One of the goals of a nanotechnology program should be to keep graduates from Virginia schools in the Commonwealth.

- Dr. Frank Gupton is an organic chemist and is the Technical Director in pharmaceuticals at B.I. Chemicals. He noted that there is a trend in the chemical and pharmaceutical industries of increasing levels of molecular complexity in new drugs, and nanotechnology can help to develop new catalysts in the future. Drug delivery systems are being developed to help better supply the active ingredients and a better understanding of the molecular level of the ingredients will help in the development. He sees nanotechnology as an enabling technology that applies to other systems to aid in better understanding.

- Dr. Dimitris Ioannou is a professor in the Electrical and Computer Engineering Department at George Mason University. He has a strong physics background, and works

closely with the graduate and undergraduate programs. He has been trying to tailor a curriculum to develop a graduate certificate program in nanotechnology, and has begun to offer a few classes this semester.

- Dr. John Noftsinger is the Associate Vice President of Academic Affairs for Research and Public Service and Executive Director of the Institute for Infrastructure and Information Assurance at James Madison University (JMU). He has a background in policy and experience in working collaboratively with other universities. JMU currently has several ongoing activities around campus that have caught the eye of industries. He suggested creating a Nanotechnology Commission much like the Governor's Biotechnology Advisory Board. He also suggested funding the Commonwealth Technology Research Fund, which has been instrumental in encouraging university collaboration. If funded, it could provide a vehicle for future collaborations. Dr. Noftsinger noted that JMU used the grant to work with George Mason University and obtain federal funding for the Critical Infrastructure Protection Project.

Nanotechnology: Achieving Leadership in Virginia

Dr. Lisa Friedersdorf, Director of the Virginia Nanotechnology Initiative, and Ms. Nancy Vorona, Vice-President of Research Investment at the Center for Innovative Technology (CIT), briefed the Committee on achieving nanotechnology leadership in Virginia. Their presentation focused on key questions that the Commonwealth must answer to establish leadership, provided an introduction to CIT's 2003 White Paper entitled "A Proposal to Establish the Virginia Nanomanufacturing Initiative," offered an overview of the competitive landscape of nanotechnology, and updated the Advisory Committee on Nanomanufacturing Initiative progress.

The Commonwealth must be able to answer several questions to establish itself as a leader in nanotechnology. It must review the opportunities that exist, understand the competitive landscape, and identify the influencing factors on development. Furthermore, it must decide whether leadership requires public sector involvement, and if so, whether this involvement includes the federal, state, or local levels of government. Finally, it must determine the steps it should take and when, be cognizant of the consequences of inaction, and review the benefits of strategic actions.

Nanotechnology is the next scientific and industrial revolution. It will play a key role in defense, homeland security, health care, information technology, transportation, and civil infrastructure. John Marburger, Director of the White House Office of Science and Technology Policy, has identified investments in nanoscale science and technology development as essential to winning the war on terrorism, securing the homeland, and strengthening the economy. Experts estimate that by 2015, the world market in nanotechnology will be $1 trillion, and that it will create 800,000 to 900,000 jobs in the United States, with 50,000 jobs in the Commonwealth. Currently, the public and private sectors are investing an estimated $8.6 billion in research worldwide.

The nanotechnology economy brings with it several challenges. First, it requires the ability to manufacture nanomaterials in sufficient volumes and at affordable prices. Second, it requires developing a trained nanomanufacturing workforce. These two challenges illustrate the current missing link in nanomanufacturing: the stage between research and commercial application.

Virginia already has extensive nanotechnology capabilities, including modeling and simulation, nanomaterials design and fabrication, electronically functional materials, carbonaceous materials, emerging technologies like fuel cells and quantum computing, nanobiomedicine, and nanomagnetics. In addition, Virginia's academic institutions are valuable assets, including several four-year colleges and research institutions, the Virginia Community College System, and its primary and secondary education system in grades K through 12. Examples of some of the work currently being performed in Virginia include Luna Innovations' nanomanufacturing facility in Danville, the development of fullerenes (large carbon-cage molecules; a fullerene cage is about 7-15 angstroms in diameter (that's around a billionth of a meter, or 6-10 times the diameter of a typical atom) known as Trimetaspheres at Virginia Tech, research using nanoparticles in neurosurgery at Virginia Commonwealth University and University of Virginia, and biochip research at Virginia Commonwealth University, University of Virginia, and Virginia State University.

In reviewing the competitive landscape of nanotechnology, the presenters shared that leadership in this field is up for grabs among the European Union, Japan and the United States. The United States provided $774 million in government research investments in 2003, compared with $650 in Western Europe and $800 in Japan. In addition, more than 30 countries have national nano activities and Japan currently is focusing on product development. Private venture capital firms also have invested $325 million in nanotechnology in 2003. The hubs of this investment tend to be in Silicon Valley, Boston and Texas. The top five start-up companies -- three in California, one in Texas, and one in Japan -- received about 22 percent of this venture capital. The private money is being invested in electronics and semiconductors (41 percent), nanobiotechnology (40 percent), specialty chemicals and nanomaterials (14 percent), and capital equipment and instrumentation (five percent), all areas of strength for Virginia.

In 2003, Virginia received over $20 million in NSF-supported NNI Research Awards, placing the Commonwealth tenth among states with this type of active support. California was first, receiving about $100 million. New York, Massachusetts Pennsylvania, Illinois, Texas, Wisconsin, Ohio and North Carolina round out the top ten. Between 1976 and 2004, Virginia received approximately 100 nano patents, in comparison to nearly 1300 in California. Currently, Virginia ranks 21st in the number of nanotechnology companies in the states. California ranks first in all categories.

There are currently 23 nanotechnology initiative and development centers in the United States, including the Virginia Nano Initiative. Other states have invested heavily in nanotechnology, including a commitment of $5 million per year for 20 years by Arizona for a Nano-bio research center. California has committed $100 million over four years for the California Nanosystems Institute. Illinois has committed $63 million to the Nanoscience Centers (a university collaboration). New York committed $50 million and $400 million over five yrs to the Nanoelectronics Center. Oregon committed $20 million over five years to the Oregon Nano-Micro Interface Institute. Pennsylvania and Texas have also made substantial state investments. The model for the investments ranges from university-state partnerships to corporate ventures.

To attain leadership, Virginia's mission must focus on the cost-effective manufacture of nanomaterials. The Commonwealth can reach this mission by building a foundation of collaborative research, a users network, and workforce development. The presenters recommended a research investment plan that includes a five-year, $140 million dollar investment model, including $40 million in year one for equipment, research and development, and workforce training, and $25 million per year during the remaining years.

In summary, Virginia can be a leader in nanomanufacturing. Success will lead to the creation of jobs and companies. However, the Commonwealth's role in this development is vital in providing seed funding and facilitating collaboration. However, time is of the essence for the emerging competitive national and international landscape.

Dr. Dylla argued that the report does not answer questions about the long-term return on investment and the short-term leveraged return for investments in nanotechnology. The Committee noted that the Commonwealth has already made substantial investments through the Center for Innovative Technology (CIT), the Virginia Economic Development Partnership (VEDP) and the educational institutions. According to the VEDP, companies want to know what the Commonwealth is doing in nanotechnology. Dr. Mattauch answered that question by reminding the Committee of the presence of venture capital and university research and technology transfer. He cautioned that the Commonwealth must beware of old research with a new name and avoid the trap of research for research sake. Whatever is developed must be commercializable to be worth the investment. He stressed that researchers must determine the industrial need and potential for their research and that Commonwealth must offer a highly skilled and ready workforce, a welcoming tax and incentive structure and a supportive legal structure to foster the necessary environment.

Nanotechnology Accelerated Development Center

Bruce Swenson, founder and co-Chair of the Northern Virginia Technology Council's Nanotechnology Committee briefed the Committee on a proposed Nanotechnology Accelerated Development Center (NADC) that would focus on prototyping. Of the three pillars of the nanotechnology ecosystem -- research, commercialization, and manufacturing -- the proposed NADC would focus on commercialization, the current weak link in the development of nanomanufacturing initiatives between the research lab and the marketplace. Commercialization involves converting research into a marketable, cost effective product. NADC would provide a physical lab and office facility, foster virtual networks and relationships, assist in developing a trained workforce, and provide demonstrations of nanotechnology capabilities.

The federal Nanotechnology Research and Development Act (S. 189) authorizes approximately $3.7 billion in funding over four years for research and development. Its goals include ensuring the position of the United States as a global leader in the development and application of nanotechnology, and accelerating the deployment and application of nanotechnology in the private sector, including start-up companies. The Act heavily emphasizes research and recognizes that development and commercialization are crucial next steps.

Twenty-one states have 48 nanoscience or nanotechnology initiatives and centers planned or underway. Thirty-three of these centers are university-based, five are in national laboratories, and 10 are state or city programs. A few states, such as New York, Oregon, and Texas have very robust initiatives underway. In addition, Department of Defense Initiatives are underway at the service, laboratory, and program levels. These initiatives have a strong emphasis on fundamental research, but little focus on customer needs, program requirements and possible nanotechnology solutions. Involvement with industry is typically indirect through partnerships with specific research centers or area initiatives.

A gap exists in transitioning basic research to a commercial market. Small businesses often lack the expertise and resources to transition basic research to the commercial market, while large businesses view nanotechnology as too high a risk. This gap complicates the development of nanotechnology products. As research transitions to the marketplace, the technology undergoes several evaluations and validations. Researchers initially create a proof of concept and validate it in the laboratory environment. Then, they must validate that concept as being relevant outside of the laboratory environment, and develop prototypes to show function in an operational environment. Until they can demonstrate that a product functional relevance, investors will consider any investments high-risk.

A federal and Commonwealth government-seeded prototyping center would bridge this commercialization gap, by assisting in the transition of research into an operational product. Goals of the NADC would be to create an industry-run center, support prototyping and accelerated development of nanotechnology, transition basic nanotechnology research to commercial markets, focus on industry and government needs in project development, and integrate with and support Virginia's nanotechnology research, development and manufacturing activities and resources. NADC would address basic research and customer needs to assist in developing a product useful to commercial and government markets.

NADC would lead to the development of innovative technologies, and would provide partners willing to assume a portion of the project risk. The Center would provide a venue to showcase Virginia nanotechnology research and development and potential applications. The intent of NADC is to achieve a threshold of credibility for innovations, with an emphasis on deliverables that reduces the risk for industry and government sponsors. NADC would also emphasize business development, with a focus on internships and training. The creation of new nanotechnology product lines would create in the Commonwealth and the nation.

Such a center would help to establish the Commonwealth's role across the full life-cycle of nanotechnology and would leverage investment in basic research and development. The center would make prototyping and demonstration capabilities available to the Department of Homeland Security, the Department of Defense, other government agencies, industry and academia.

A prototyping facility would provide instrumentation, staff and space in a facility in the Northern Virginia area. This location already is a hub for industry and corporate offices and leverages access to government agencies and markets. The facility would have the ability to work virtually

with other research and development facilities, and could serve as a model for other facilities around the country while establishing Virginia as a leader in nanotechnology.

The goal of NADC is to supplement the costs of the prototyping phase of development, and not the full life-cycle of the nanoproduct. In prioritizing a project, there must be an industry or government transition manager, and the project must have the capability to meet specific industry or government requirements. There must be an assessed return on investment and jobs from the follow-on product line. The estimated budget of such a center would include $20 to $30 million for infrastructure and $25 million annually to provide projects with $1 to 2 million per project for two to three years of funding.

Mr. Swenson concluded by arguing that the Nanotechnology Accelerated Development Center provides a mechanism to transition basic nanotechnology research to government and commercial markets. Furthermore, it allows and encourages a more prominent role of industry in the development and commercialization of nanotechnology. More importantly, it maintains the U.S. leadership and establishes Virginia leadership in the full life-cycle of nanotechnology -- research, development, prototyping, manufacturing, and commercialization -- defining the essence of a "The Nano-Commonwealth."

Such ventures are already underway and can draw and create opportunities. Mr. Smith warned that SUNY-Albany already has a prototyping facility and it does attract business opportunities. Dr. Mattauch warned that such a facility needs to demonstrate an impact and explained VCU's new initiative to achieve a multi-disciplinary program that combines the ability to visualize, create on a computer and produce a prototype with the precision of one-half of one-thousandth of an inch at a time.

Conclusion

The Committee concluded with a discussion of the various issues. One member shared an idea for a proposed nanotechnology network that would coordinate efforts in the Virginia, District of Columbia, and Maryland region to try to get the region into the top tier of competing for venture capital, chairs of university departments, and other essential elements.

The Committee agreed that the Commonwealth needs to publicize the existing infrastructure already in place in Virginia, to make it attractive as a destination to do business. Time is of the essence. Virginia needs to lay claim to a few initiatives, and take the lead. It already has many key elements relevant to nanotechnology development, such as university research, technology transfer, a welcoming tax structure, and industrial need. The key is to identify and be ready when opportunities arise.

The Committee questioned whether the Commonwealth has an adequate curriculum in place to develop a trained workforce. University representatives agreed such a curriculum is in place and growing. Delegate Purkey noted that all possible approaches to the nanotechnology questions include the need for a trained workforce. The approach to a trained workforce, however, includes not only research at four-year universities and graduate programs, but also a skilled workforce with hands-on training to operate manufacturing facilities. Furthermore, it includes

technical schools, two-year colleges, community colleges and the entire spectrum of education and training. The education question is much like the "chicken and egg" question -- students want to be trained in and go to areas where there appears to be career opportunities and money, but business will not develop and grow until there is a trained workforce. Until nanotechnology is well established, these opportunities will not be apparent.