Nanotechnology Advisory Committee
Wednesday, August 4, 2004, 1:30 p.m.
General Assembly Building, House Room D
Richmond, Virginia

HJ 120, adopted by the 2004 General Assembly, directs JCOTS to identify nanotechnology research and economic development opportunities for the Commonwealth and consider the efficacy of creating a statewide, comprehensive and coordinated strategy to secure additional federal research and development funds and to boost commercial activity in this fast-emerging sector. JCOTS created the Nanotechnology Advisory Committee to conduct this study and charged the Committee with examining nanotechnology opportunities and obstacles for the Commonwealth. This committee met for the first time on Wednesday, August 4, 2004. During the meeting, the Committee received a briefing on nanotechnology issues, and had the opportunity to share their individual backgrounds and views of nanotechnology.

Introduction to Nanotechnology

Dr. Robert Hull, Director of the NanoQuest Institute and Professor of Engineering, University of Virginia, presented an overview of nanotechnology. Nanotechnology involves the ability to engineer systems with components on length scales of one to 100 nanometers (a nanometer is a billionth of a meter). To put the size into perspective, a two-meter tall human is two billion nanometers tall and a pinhead is a million nanometers in diameter. Biological cells, like red blood cells, have diameters in the range of thousands of nanometers. Ten shoulder-to-shoulder hydrogen atoms span one nanometer, while DNA molecules are approximately two and a half nanometers wide. Individual atoms are up to a few angstroms, or up a few tenths of a nanometer in diameter. Properties and structures at these reduced scales often are different and better. The ability to make things smaller means that they are cheaper, lighter, and use less power to operate.

Nanotechnology has reached major importance today because scientists have developed the capabilities, such as computational, fabrication and measurement methods, to exploit materials, as well as an improved understanding of nanoscale biological processes. Through new techniques, they have been able to develop new materials and phenomena. Finally, they have been able to prove the impact of these new techniques on industries with tens of billions of dollars in annual sales, a major impact on the economy.

Money helps. In December of 2003, the federal government enacted the 21st Century Nanotechnology Research and Development Act (S.189) authorizing almost $3.7 billion in government funding for nanotechnology research and development (R&D). The legislation emphasizes the establishment of R&D Centers in academia and government. There are now over 50 institutes and centers dedicated to nanotechnology research. For example, the National Science Foundation has established the National Nanotechnology Infrastructure Network - comprised of 13 university sites that will form an integrated, nationwide system of user facilities to support research and education in nanoscale science, engineering and technology. Similarly, there are currently 15 government agencies with R&D budgets dedicated to nanotechnology. Opportunities exist for numerous industries such as electronics and optics, healthcare, the environment, energy, microspace, bio-threat detection, transportation, and national security.

These new abilities already have enabled the creation of smaller devices, a greater capacity for data storage, the creation of new catalyst materials and increased capacity on semiconductor wafers. Other existing applications include high performance sports equipment, specialized auto and aero components, polishing powders and slurries, stain-free fabrics, sun tan lotion and cosmetics, selective optical coatings (e.g., photographic film), telecommunications components, machine tools and corrosion and scratch resistant paints and coatings. To illustrate nanotechnology's potential impact on the world, if the aircraft industry had evolved at the same rate as the microelectronics industry in the last 25 years, a Boeing 777 today would cost $500, and circle the globe in twenty minutes on five gallons of fuel.

Major new opportunities exist for the Commonwealth in nanotechnology, such as the development of new methods for self-assembly of materials, based upon both biological and non-biological methods and the creation of new materials, methods, and instruments for harnessing sub-atomic properties. Opportunities also exist for the development of improved instruments and techniques for structuring and patterning materials at ever-increasing levels of precision and the ability to measure the three-dimensional structure, properties, and chemistry of materials down to the atomic scale, a sort of a “nano-GPS.” Researchers also will be able to take advantage of the interface between nanomaterials and biological systems, enabling widespread improvements in human health.

Other major future impacts exist in the fields of electronics and computation; communications; data storage; energy storage, transmission and generation; health care; transportation; civil infrastructure; military applications and national security; and the environment. Emerging and future applications for the automotive and aeronautic industries include nanoparticle-reinforced materials for lighter, stronger bodies, nanoparticle-reinforced tires, self-cleaning and –repairing materials, electronics, and collision avoidance. In electronics and communications, applications include an extension of Moore’s law to thousands of times higher density, speed, lower power consumption and cost and the development of magnetic nanoparticle media. For chemical materials, they include improved catalysts, smart magnetic fluids for vacuum seals and lubricants, self-cleaning and –repairing surfaces, and adaptive surfaces. In health care, they include nanostructured drugs, gene and drug delivery systems targeted to specific sites in the body, biocompatible replacements, self-diagnostics, bone and tissue regeneration, and wound repair. Impacts on energy technologies include higher power density batteries, fuel cells, artificial photosynthesis, improved solar cells, improved fuel economy form lighter materials, and improved electronics. In manufacturing, they include super-hard and –tough cutting tools, ultra-precision engineering based on nanoscale microscopies, atomic-scale manufacturing tools and processes, nanopowders, internal sensors for fault detection and repair, and self-assembling materials. In space exploration, opportunities include lighter vehicles, improved energy generation, ultra-small robotic systems, in-flight sensing and repair capacity. For the environment, possibilities include reduced pollution through catalysis, nanostructured traps for pollutant removal, improved recycling, selective membranes for water filtering, and cleaner manufacturing processes. National security opportunities include detectors and detoxifiers of biological and chemical agents, improved electronic and optical systems, radiation-protected systems, harder coatings and bodies, camouflage materials, improved textiles, self-repairing materials, and in-battle medical care.

Economists estimate that the world market for nanotechnology will equal $1 trillion by 2015 and create 800,000 to 900,000 jobs. In Virginia, opportunities exist for partnerships in research, manufacturing, and education. Dr. Hull suggested that the Commonwealth can capitalize on existing research facilities and their expertise, lead educational programs, and grow its nanomanufacturing base. To capitalize on the possibilities, he stressed four issues that the Commonwealth must evaluate: (i) how these advances affect education at all levels (K-12, undergraduate, graduate, and beyond); (ii) how the Commonwealth can use nanoscience to educate and inspire society to be technologically literate; (iii)how it can encourage educational institutions to value and reward interdisciplinary programs; (iv) and how it can perform high-risk, high-cost research that will also benefit societies, or portions of societies, that cannot afford it. Finally, a real-life argument for focusing on nanotechnology is the sustainability of expected population growth over the coming decades.

"Five Good Minutes": Member Introduction

After the introduction to nanotechnology, Committee members introduced themselves, talking about their backgrounds, their employers, nanotechnology affiliations, and goals for nanotechnology in the Commonwealth.

- Dr. Richard Claus is Director of the Fiber and Electro-Optics Research Center at Virginia Tech. He focuses on making nanomaterials on a macro level. He suggests focusing on the key areas of teaching and education, research (including graduate research) to generate intellectual property, and outreach involving spinning off intellectual property and creating small companies.

- Steve Danziger is a Program Manager at BAE Systems and a member of the Northern Virginia Technology Counsel's Nanotechnology Committee. Having been involved for more than 20 years in many aspects of state-of-the-art semiconductor technology from engineering to executive management, he is currently integrating carbon nanotube technology to create an improved semiconductor memory device. His goal is to see increased involvement and investment in nanotechnology by established Virginia companies and further collaboration among government, academia, and private organizations to facilitate the commercialization of nanotechnology in Virginia. In addition, he would like to see a Virginia nanotechnology center of excellence established, involving several organizations.

- Charles Gause is the Vice President of Luna Innovations Inc.'s Danville Division, a company that specializes in commercializing research from the laboratory. Luna Innovations recently renovated an 1870s tobacco warehouse to create a state-of-the-art nanomanufacturing facility. He acknowledges Virginia's tradition of academic and industrial excellence as a means to aid in nanotechnology development efforts for current and emerging industries. He believes that issues critical to the growth of nanotechnology in Virginia include cost effective manufacturing of nanomaterials as an economic growth opportunity, development of a nanomanufacturing workforce, and a unified Virginia information exchange network for nanotechnology business development.

- Daniel Gonzalez is Executive Vice President and Managing Principal of Scheer Partners, Inc., a regional commercial real estate consulting firm that specializes in advising biotechnology, technology and microelectronics firms. He is also a member of the Northern Virginia Technology Council and Governor Warner's Biotechnology Advisory Board. He is interested in creating a sound strategy to capitalize on the convergence of technologies to benefit the overall economic development of the Commonwealth.

- Dr. Robert Hull is the Charles Henderson Professor at the University of Virginia, Director of a program on "Nanoscopic Materials Design" that is funded by the National Science Foundation as part of its Materials Research Science and Engineering Center (MRSEC), and Director of the University of Virginia Institute for Nanoscale and Quantum Engineering, Science and Technology. He believes that a key focus should be winning nationally competitive Center awards within state universities. These programs demonstrate excellence, generate substantial follow-on funding, help build infrastructure, will help build a nano-economy in Virginia and will greatly enhance external perceptions. A key strategy is developing partnerships across institutions, thus enhancing the pool of talent and facilities. State funding can help greatly in building the infrastructure to enable us to compete against the nation's leading institutions on a level playing field.

- Dr. Philip Lane practices Intellectual Property law with McGuireWoods and has a Ph.D. in Chemistry. A key question for him is whether the Commonwealth is protecting what it is developing. For developments in nanotechnology to attract business to the Commonwealth, the intellectual property resulting from it must be protected.

- Dr. Dennis Manos is the CSX Professor of Physics and Applied Science at the College of William & Mary. He serves as the Vice-Provost for the College, with primary responsibility for research, graduate, and professional study. His interest in nanotechnology began with work on soot formation in the late 1970s, and his current research includes plasma processing techniques, production of field emission devices from patterned carbon nano-structures, development of clinical diagnostic methods for identification of diseases by analysis of serum and tissue protein and peptide markers, and computational methods for enhancing very large data streams. The College is part of the part of the consortium that operates the Applied Research Center in Newport News, which has been in full operation since 1998 and has aggregated university resources to initiate collaborative research. He reiterated William & Mary's firm commitment to continued work in this important area and its willingness to invest in developing shared infrastructure to bring this promise to reality.

- Dr. Robert Mattauch is Dean of the School of Engineering at Virginia Commonwealth University. He initiated semiconductor device work at the University of Virginia in 1966, and by the time he left the program boasted 11 Ph.Ds. and 47 graduate students. He explained that the development of inorganic crystalline semiconductor materials reduced the size of satellite dishes from 14 feet to 14 inches, while transforming them from analog receptors to digital and led to the development of collision avoidance radar. Advances have reduced the energy required for magnetic storage by a factor of ten million (10^7), and led to the development of polymeric surfaces that can detect toxins and the growth of veins and tissues that are 100th the width of a human hair using bioscaffolding. He emphasized that the Committee must focus on stimulating

and growing nanotechnology manufacturing. This focus requires a careful balance of university research and industrial input and support. He warned that the Commonwealth must be wary of research "chameleons" who rename their work to correspond with the latest highly funded area of research. True nanotechnology involves research at such a micro level that the properties of the material change and not merely macro research on the micro level.

- Scott McNeil is a scientist at Science Applications International Corporations (SAIC)'s Systems Integration Department. Through his association with SAIC, he has worked with the Nanotechnology Cancer Lab and the National Cancer Institute. He believes that it is critical for the Committee to address and define what it wants to accomplish with nanotechnology.

- Victor Peña is co-Founder and CEO of nanoTITAN, Inc., company that develops software for nanotechnology companies. He is a member of the President's Council of Advisers on Science and Technology and its Nanotechnology Technical Advisory Committee, co-Founder and Steering Group Member of InanoVA (VNI), and co-Chair and co-Founder of the Northern Virginia Technology Council's Nanotechnology Committee. His goal is for the Committee to produce a business plan of policy and legislative actions for the Governor and legislators that identifies actions and resources in the Commonwealth that are necessary to build a nanotechnology economy. This plan should include a SWOT analysis (a SWOT analysis involves a scan of the internal and external environment assessing strengths, weaknesses, opportunities and threats), funding requirements and sources, academia, K-12 education, federal and state resources, tax incentives, technology transfer streamlining, attracting nanotechnology businesses to the Commonwealth, public relations, and promotional conferences. He suggests that the Committee should exercise systems engineering and life cycle principles in this endeavor.

- Dr. Mark Shuart has worked for the NASA Langley Research Center since June 1977, and currently is the Director of Structures and Materials. The Langley Research Center is widely recognized for its technical expertise in aerospace. As part of that capability, the NASA Langley's structures and materials organization has been identified as the Agency's Center of Excellence in that discipline. The structures and materials organization participated in orbiter tile research in the early 1980's, helped analyze the Challenger accident and return the Shuttle to flight and assisted the National Transportation Safety Boarding in the accident investigation for American Airlines 587. The Structure and Materials organization includes more than 250 researchers working in facilities valued in excess of $400 million, and the products of their research have found numerous aerospace and non-aerospace applications.

- Robert Smartschan is a partner with the law firm of Kaufman & Canoles. As the founder of the firm's Technology Ventures Group, he helps clients protect business assets under intellectual property laws and concentrates on technology licensing and transfer, and similar matters. He is a member of the Board of Directors for the Hampton Roads Technology Council, and serves as General Counsel to the Hampton Roads Technology Incubator, a facility whose mission is to nurture early stage high-tech companies into profitable industry leaders. Mr. Smartschan is interested in the developing nanotechnology as a viable contributor to Virginia's economic expansion, especially in the Hampton Roads region.

- Richard Smith is the President of Nanotechnology Network, co-founder of the Nanotechnology Policy Foundation, and Principal in Nanoverse, LLC, a nanotechnology commercialization firm. The Nanotechnology Network was created to foster collaboration among Maryland, the District of Columbia, and Virginia and develop a regional nanotechnology initiative. The Nanotechnology Policy Foundation fosters public dialog about the societal implications of nanotechnology and hopes to become an "honest broker" for the public, policymakers, and the press. Nanoverse focuses on commercializing intellectual property developed by universities, though currently none in Virginia, in the fields of health and medicine, energy, and homeland security.

- Dr. Sharon Smith is the Director of Advanced Technology for Lockheed Martin Corporation, a member of the Northern Virginia Technology Council, and a member of the Board of the NanoBusiness Alliance. At Lockheed Martin, a developer and integrator of technology, she focuses on applications for homeland security and defense. For the growth of nanotechnology in Virginia, she considers facilitating the interactions between local government, academia, large corporations and small businesses to be most important. The Commonwealth must address educating the current and future workforce and establishing financial incentives for nanotechnology start-up companies.

- Bruce Swenson is Founder and co-Chair of the Northern Virginia Technology Council's Nanotechnology Committee and a systems engineer at the Science Applications International Corporation (SAIC). He emphasized the cross-disciplinary nature of nanotechnology and the need for cross-regional cooperation. The Commonwealth must acknowledge that nanotechnology is capital intensive and requires multi-disciplinary collaboration as well as shared equipment and expertise, and its strategy should include facilitating collaboration on the state, federal, and international levels. Virginia should focus on developing the entire spectrum of nanotechnology, from research to prototyping to manufacturing. The Commonwealth's strategic position (proximity to a large government customer base) can encourage companies to establish a presence here.

- Dr. Usha Varshney is Acting Director of the National Science Foundation's (NSF) Electrical and Communications Systems Division. NSF is an independent federal agency that helps set and advance the national agenda for research and education in science, mathematics, engineering and technology. The agency supports basic research and education through the grant mechanism based on peer review. For FY 2004, the Foundation funded research and education in nanoscience, nanoengineering and nanotechnology with $253 million; the President authorized $385 million for FY 2005.

- Charles Wieland is a co-founder of the Atlantic Nano Forum, an organization created to facilitate the training of patent examiners in nanotechnology. He is also a partner at the intellectual property firm of Burns, Doane, Swecker & Mathis, LLP in Alexandria. Mr. Wieland would like to find more ways to encourage universities and federal labs to spin-off nanotechnology based companies in Virginia.

The Next Step

After the introductions, Delegate Purkey asked the members to identify legislative obstacles to reaching the Committee's and industry's goals.