Virginia Research & Technology Advisory Commission

Research & Development Strategies for the Commonwealth of Virginia

A Report of the Virginia Research & Technology Advisory Commission

November 2003

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November 30, 2003

The Honorable Mark Warner
Governor of Virginia
State Capitol, 3rd Floor
Richmond, VA 23219

Dear Governor Warner:

The final report of the Virginia Research and Technology Advisory Commission (VRTAC) Research Sub-committee is attached. The report is in response to House Bill 2760, which requires the VRTAC, in conjunction with the Secretaries of Technology, Commerce and Trade, and Education to develop strategies for research and development in the Commonwealth. It provides eight recommendations that can build human capital and meet a second strategy that encourages collaboration and partnerships for research and development in Virginia.

The VRTAC Research Sub-committee is co-chaired by Mr. J. Douglas Koelemay, from Qorvis Communications LLC, and Dr. Christopher T. Hill, from George Mason University, providing leadership from both private sector technology-based organizations and research universities in the Commonwealth. Their sub-committee has diverse representation from the universities, federal laboratories, and private sector technology and research organizations, whose membership is outlined in the study preface.

The Research Sub-committee considered strategy recommendations made recently by other Commonwealth research study groups as well as federal and state research priorities and existing assets. They then addressed the current economic position of the Commonwealth, and developed recommendations that provide the most affordable, realistic state-fostered research strategy, led by renewal of investment to human capital.

The report was presented to the full VRTAC membership for input to the draft, and subsequently for review and comment of the final recommendations. These eight recommendations provide mechanisms for expanding the Commonwealth's existing commitment to research and development in Virginia, and will result in a high return on investment in terms of economic development and enhanced competitiveness among other states and nations, for research driven technology from the public and private sectors of the Commonwealth.

Sincerely,

Mr. John Backus
VRTAC Co-Chair

Dr. John Noftsinger, Jr.
VRTAC Co-Chair

Report Attached

PREFACE

The VRTAC Research Sub-committee issued the report "Research and Development Strategies for the Commonwealth of Virginia" in response to House Bill 2760, issued by the Virginia General Assembly in request for VRTAC to develop strategies for research and development (R&D) in the Commonwealth. The report takes into consideration areas the federal government will emphasize in the next five years, the Commonwealth's R&D assets and capabilities, the current and future growth industries in the Commonwealth and develops recommendations for the means to strengthen the Commonwealth's position in global research and development competition. The legislative study was recommended in response to the December 2002 Report of the VRTAC Intellectual Property Committee's request to develop and implement a statewide strategic plan for R&D in the Commonwealth.

The VRTAC Research Sub-committee analyzed supporting reviews and research as a basis for the report. This analysis included Federal R&D priorities, Federal R&D dollars to Virginia, Virginia's R&D assets, growth industries of the future, Federal agency research strategies, SCHEV R&D findings 2002, the Governor's Steering Committee on Research Capabilities and Centers of Excellence 2003, and the Governor's Advisory Board for the Virginia Biotechnology Initiative 2002. Consideration was also given to Commonwealth Study Group Recommendations inclusive of the Virginia Biotechnology Initiative, the Steger Committee, the Center for Innovative Technology, and the Virginia Economic Development Partnership.

The analysis was developed and reviewed by the Research Sub-committee followed by discussion and information gathering with the full VRTAC Commission membership in September of 2003. The Sub-committee developed a final draft report, with final input from the VRTAC membership on November 20, 2003. This report is the final product of the Sub-committee and VRTAC membership.

The members of the VRTAC Research Sub-Committee are:

- Dr. Robert L. Ash, Interim Vice President for Research, Old Dominion University
- Mr. John C. Backus, Managing Director, Draper Atlantic Venture Fund
- Dr. James B. Blair, Interim Vice Provost for Research, Virginia Tech
- Dr. R. Ariel Gomez, Vice President for Research & Graduate Studies, University of Virginia
- Ms. Linda Hutson Green, VRTAC Executive Director, Center for Innovative Technology
- Dr. Christopher T. Hill, Vice Provost for Research, George Mason University
- Mr. Peter Jobse, President, Center for Innovative Technology
- Mr. J. Douglas Koelemay, Managing Director, Qorvis Communications, LLC
- Dr. Gary Kreps, Vice Provost, The College of William and Mary
- Dr. Christoph Leemann, Lab Director, Jefferson Lab/CEBAF
- Mr. Richard J. Martin, President, Noesis, Inc.
- Mr. Harris N. Miller, President, Information Technology Association of America
- Dr. John Noftsinger, Jr., Associate Vice President for Research and Program Innovation, James Madison University
- Mr. Thomas C. Pendergraft, Executive Director, Navy Naval Surface Warfare Center
- Mr. Robert Stolle, Executive Director, Greater Richmond Technology Council
- Dr. Ping Tcheng, VISINET, Inc.
- Dr. Marsha R. Torr, Vice President for Research, Virginia Commonwealth University
- Honorable Belle S. Wheelan, Secretary of Education, Commonwealth of Virginia

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A Report of the Virginia Research & Technology Advisory Commission

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EXECUTIVE SUMMARY

The Research Sub-committee of the Virginia Research and Technology Advisory Commission (VRTAC) reviewed the present research and development framework in the Commonwealth and evaluated its propensity to create economic opportunity within the existing structure. Strategies for consideration included areas the federal government will emphasize within the next five years, the Commonwealth's research and development (R&D) assets and capabilities, the current and future growth industries in the Commonwealth, and the means to strengthen the Commonwealth's position in global research and development competition.

The report is in response to legislation in House Bill 2760, which directed VRTAC, in conjunction with the Secretaries of Technology, Commerce and Trade, and Education, to develop strategies for research and development in the Commonwealth. All three respective Cabinet Secretaries are members of VRTAC, as well as the heads of research of universities, federal labs, two Virginia Delegates and a Virginia Senator, and private and public sector research and technology gubernatorial appointees who comprise the twenty nine person VRTAC membership.

The Research Sub-committee considered and debated broad ranges of R&D strategies and ultimately developed a series of recommendations that could be addressed without extensive budgetary considerations, due to the difficult economy. Drawing on recommendations from university research officers and the plethora of Commonwealth studies in recent years, the VRTAC concludes that the most affordable, most realistic state-fostered research strategy is one led by renewed investments in human capital. VRTAC makes eight specific recommendations that can build human capital and meet a second strategy that encourages collaboration and partnership.

Current recommendations include:

1. The Commonwealth of Virginia should assemble and dedicate resources necessary to attract and retain top researchers, research faculty and graduate research assistants at Virginia's colleges and universities. This strategy incorporates specific suggestions, such as a significantly more robust eminent scholars fund for science, technology and engineering and a new graduate research assistant stipend program.

2. The Commonwealth of Virginia should review and invigorate partnerships with local governments, economic development agencies and regional technology councils to improve the attractiveness of Virginia as a location for new private and non-profit research and development enterprises. This effort might include targeted investments in science, technology and engineering workforce development; in quality-of-life improvements; in tax and other business incentives specifically for R&D activity; in real time prospects/projects of opportunity information sharing; and in coordinated marketing initiatives.

3. The Commonwealth of Virginia should reestablish the strong foundation necessary to coordinate and integrate the teams, consortia and partnerships of the R&D future by funding its Center for Innovative Technology for at least $7.65 million annually, but preferably a baseline level consistent with annual appropriations made prior to the rounds of budget-driven cuts in the last two years. The Commonwealth also should monitor and analyze continuously the investments and initiatives of other states to remain competitive.

4. The Commonwealth of Virginia should ensure there are dedicated state research and investment funds in the existing Commonwealth Technology Research Fund (CTRF) to meet leverage and/or match requirements for the federal and private sector investments it is pursuing. Annual budget allocations should be set based on the projected federal and private investment targeted. Additionally, the Commonwealth should renew its commitment to seed R&D ventures in Virginia directly by investing $10 million annually in the existing Commonwealth Technology Research Fund (CTRF).

5. The Commonwealth of Virginia should continue to promote the Institute for Defense and Homeland Security, the consortium of university, industry and federal research and development partners launched in 2003, and to invest where possible to further the work of the Institute.

6. The Commonwealth of Virginia should form and fund aggressively new research consortiums devoted to life sciences and nanotechnology.

7. The Commonwealth of Virginia should encourage and reward those institutions of higher education making the most progress in expanding their R&D efforts in priority fields of inquiry in a collaborative manner by authorizing institutions to recover the 30 percent of indirect costs associated with R&D that is now credited to the general fund.

8. The governor and General Assembly should develop plans to convert into specific investments the results of the 2003 governor's initiative to identify the most promising R&D areas and programs in Virginia.

VRTAC stands ready to elaborate on the aforementioned recommendations as necessary to support the Governor and General Assembly in implementation of the strategies for ensuring the continued development of successful R&D in the Commonwealth of Virginia.

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Introduction

The innovation system in the Commonwealth of Virginia continues to evolve rapidly. Research increasingly is important to that system, particularly research combined with education in Virginia's universities. New, smaller private sector research efforts are replacing large corporate basic research laboratories. Both the National Institutes of Health and the Howard Hughes Medical Institute, now constructing a new research campus in Loudoun County, speak of reengineering the research enterprise. Public funding for research remains critical, including state funds for the university research infrastructure in Virginia, to match federal dollars and to attract top researchers and research enterprises.

As the State Council of Higher Education in Virginia (SCHEV) suggested in a 2002 assessment, [1] a strong research and development presence in Virginia can promote a stronger and more diversified economy, an attractive location for technology and high-wage businesses, higher incomes, a larger tax base, greater learning opportunities for college students, better healthcare, an improved quality of life and a higher standard of living. Despite a slowing economy in recent years, the federal government, private companies and non-profits, such as the Howard Hughes Medical Institute, continue to be major investors in research in the Commonwealth. Yet, the Commonwealth of Virginia has reduced state funds directly available for research and innovative entrepreneurship, cut budgets for state universities and Virginia's Center for Innovative Technology that provide indirect investment in research and kept faculty pay below peer institution averages.

Against this backdrop, the Virginia General Assembly asked the Virginia Research and Technology Advisory Commission (VRTAC) in HB 2760 to "develop strategies for research and development in the Commonwealth" and to consider "the areas the federal government will emphasize in the next five years, the Commonwealth's R&D assets and capabilities, the current and future growth industries in the Commonwealth and the means to strengthen the Commonwealth's position in global research and development competition."

The full text of legislation is at Appendix A.

VRTAC analyzed trends, assets and areas for growth in 2003 drawing heavily on reports previously submitted to the General Assembly and the governor and is pleased to submit this report.

[1] "Condition of Research at Virginia's Colleges and Universities," State Council of Higher Education in Virginia, 2002.

Survey of Federal R&D Priorities

A survey of federal research and development priorities is possible through a review of program documents and plans submitted to Congress or circulated publicly for comment from agencies such as the National Institutes of Health, the National Science Foundation, the Office of Naval Research, the Defense Advanced Research Project Agency, the Department of Energy's Office of Science, etc. Many of these agencies participated in the proceedings of Governor's Higher Education Research Summit on May 1, 2003.

The American Association for the Advancement of Science, for example, summarized impact of federal R&D in Virginia as follows.[2]

- $4.9 billion in federal R&D in FY2000, 3rd behind California and Maryland
- Most due to DOD headquarters, while DOD industry funds actually subcontract out of state
- $1.5 billion to federal labs, including DOD labs, USGS headquarters, NASA Langley and Wallops Island Flight Facility
- $2.9 billion to industrial firms, including DOD and NASA contractors (most of it subcontracted)
- $251 million to FFRDCs, DOD FFRDCs in Northern Virginia (Mitre Corporation, Institute for Defense Analysis, Center for Naval Analysis, RAND Corporation), DOE Jefferson Lab in Newport News

The National Science Foundation summarized strategic priority areas as follows. [3]

- Biocomplexity in the Environment
- Information Technology Research
- Nanoscale Science and Engineering
- Mathematical Sciences
- Human and Social Dynamics
- Workforce for the 21st Century

The Department of Defense is pursuing research in a wide range of initiatives. [4]

- National Aerospace Initiative
- Power and Energy Technologies
- Advanced Surveillance and Knowledge Systems
- Directed Energy Weapons and Technology

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[2] "Federal Research and Development in the FY 2004 Budget," Kei Koizumi, American Association for the Advancement of Science, Governor's Higher Education Research Summit, May 1, 2003, Newport News, Virginia.

[3] "National Science Foundation: Context and Priorities," Michael Sieverts, National Science Foundation, Governor's Higher Education Research Summit, May 1, 2003, Newport News, Virginia.

[4] "Defense Science and Technology," Kenneth E. Harwell, Office of the Director, Defense Research and Engineering, Governor's Higher Education Research Summit, May 1, 2003, Newport News, Virginia.

- Materials Science and Nanotechnology
- Advanced Energetic Materials
- High Sensitivity Sensors and Radar

The National Institutes of Health have suggested new drivers for its research agenda.[5]

- Shift from acute to chronic diseases
- Aging population
- Health disparities
- Emerging diseases
- Biodefense (vaccines, therapeutics, diagnostics)

Included in the agenda suggested are new efforts in bioinformatics and computational biology, molecular libraries, nanotechnology and novel research methodologies.

The Department of Energy's Office of Science, which funds 40 percent of research in the United States in physical sciences recently released a plan for its future facilities to address the following scientific priorities.[6]

- Extending U.S. leadership in scientific computation
- Training the scientifically literate workforce for the 21st century
- Pioneering nanoscale science
- Employing genetic techniques to harness microbes
- Solving the mysteries of "dark energy"
- Promoting availability of fusion power
- Exploring the frontiers of understanding of nuclear matter (high energy and nuclear physics)
- Enabling advances in materials science

A recent memorandum[7] giving more detailed guidance to the heads of federal executive departments and agencies from the Director of the Office of Science and Technology Policy and the Director of the Office of Management and Budget suggests seizing "important opportunities for discovery and development while sustaining the basic R&D machinery needed for continued U.S. leadership in science and technology" as broad objectives for the federal government. Included as program guidance criteria are

- Sustain and nurture America's science and technology enterprise,
- Strengthen science, mathematics and engineering education,
- Focus on long-term, potentially high-payoff activities,

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[5] "National Institutes of Health," Anthony Demsey, Office of External Research, National Institutes of Health, Governor's Higher Education Research Summit, May 1, 2003, Newport News, Virginia.

[6] "Facilities for the Future of Science, A Twenty Year Look," Office of Science, U.S. Department of Energy (November 2003).

[7] "FY2005 Interagency Research and Development Priorities," John H. Marburger, III, Director, Office of Science and Technology Policy and Mitchell E. Daniels, Jr., Director, Office of Management and Budget (June 5, 2003).

- Maximize competitive, peer reviewed processes,
- Promote collaborations among agencies, industry, academia and states and
- Strengthen international partnerships.

Virginia R&D Assets

Virginia's assets in research and development have been well documented, most recently in a 1999 study by Virginia's Center for Innovative Technology for the Joint Commission on Technology and Science of the Virginia General Assembly.[8] Among the key findings of that report are the following.

- Virginia's science and technology assets as a whole and those specifically mentioned in this legislative resolution are key to supporting both existing and emerging technology-based industries in the state as they compete in the global economy. Most of these assets rely heavily on federal funding.

- Virginia's industrial performers are substantially more dependent on federal funds that are industrial R&D in other states.

- Virginia receives a disproportionate share of its federal R&D funds from the Department of Defense (DoD) and NASA, two agencies whose budgets are shrinking or remaining flat.

- Existing science and technology assets must be nurtured over time, as they do take a significant period of time to develop before having a significant economic impact. They are, however, key to making Virginia a technology state.

- New opportunities to match Virginia's emerging technology assets with emerging industry sectors appear regularly. The State must be in a position to support the attraction and establishment of new resources.

A full listing of assets from that report are in Appendix B.

Since 1999 the Commonwealth has improved many of those assets and is adding new ones, including the Institute for Defense and Homeland Security (2003), the Janelia Farm Research Campus of the Howard Hughes Medical Institute (2003), Virginia Bioinformatics Institute, Institute for Nanotechnology in Virginia, Critical Infrastructure Protection Project, Corporation for Research Initiatives, Institute for Infrastructure and Information Assurance, National Center for Biodefense, Virginia Advanced Shipbuilding and Carrier Integration Center, Carillion Biomedical Institute and Centers for Nanoscopic Materials Design, Commercial Space Infrastructure, Magnetic Bearings, Electrochemical Science and Engineering, Coal and Materials Processing, Information Retrieval, Analysis and Management, Power Electronic Systems, Wireless Communications, Fiber and Electro-Optic Research and Polymeric Materials, among others.

[8] "Report on the Status of the Commonwealth's Technology Assets to the Joint Commission on Technology and Science of the Virginia General Assembly (January 1999).

Growth Industries of the Future

Growth industries by employment, sales and value are available in statistics from a variety of sources, but the Commonwealth has analyzed Virginia's potential as recently as 2002.[9] Virginia's Center for Innovative Technology at that time found the growth industries of the future for Virginia centered in information technology and telecommunications, aerospace, advanced materials and nanotechnology, biotechnology and advanced manufacturing. Within these broad sectors, specific strengths in Internet applications, communications security, pharmaceuticals, health diagnostics, lubricants and remote sensors were highlighted.[10]

The Virginia Economic Development Partnership (VEDP) is targeting nine industry sectors in its efforts to attract new business to Virginia, including aerospace, automotive, bioscience, electronics, financial services, food processing, information technology and telecommunications, microelectronics and plastics.

The VEDP targets reflect some of the top 25 manufacturing industries in Virginia, but not all. Cigarettes, shipbuilding, plastics products, newspapers, commercial printing, motor vehicle parts and accessories, organic fibers, wood household furniture, drugs, paper, radio and television communication equipment and search and navigation equipment all are on that list, which is included in Appendix C.

The U.S. Department of Labor[11] suggests that science and technology jobs will be among the fastest growing occupations and are projected to have the largest numerical increases in employment in this decade at every level of education or training.

- Veterinarians, pharmacists, chiropractors and optometrists (first professional degree)
- Computer and information research scientists, medical scientists, postsecondary teachers, biological scientists, astronomers and physicists (doctoral degree)
- Audiologists, speech-language pathologists, mental health and substance abuse social workers, substance abuse and behavioral disorder counselors, physical therapists (masters degree)
- Computer and information systems managers, medical and health services managers

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[9] "Strategic, Statewide R&D Recommendations for the Commonwealth of Virginia," Virginia's Center for Innovative Technology, 2002.

[10] By way of comparison, the Research Triangle Institute in neighboring North Carolina in 2003 identified eight emerging industries where the Triangle could become a world leader, including pharmaceuticals; finding and fighting biological agents and infectious diseases; advanced medical care, including genomics (gene manipulation) and proteomics (study of proteins inside cells); analytical instruments; nanotechnologies (engineering molecular-scale materials); pervasive computing networks (meshing wireless networks with computers than seamlessly integrate into users' lives); and informatics.

[11] U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2540, Occupational Outlook Handbook, 2002-03 Edition.

(work experience plus bachelors or higher degree)

- Computer software application engineers, computer software systems engineers, network and computer systems administrators, network systems and data communications analysts, database administrators (bachelor's degree)

- Computer support specialists, medical records and health information technicians, physical therapists assistants, occupational therapists assistants, veterinary technologists and technicians (associate degree)

The Occupational Outlook Handbook Table also is included in Appendix C.

Research Strategies

Different drivers of research suggest leading investments in human capital or individuals, in institutions, in new collaborative mechanisms or partnerships or in facilities and equipment. The National Science Foundation (NSF), for example, uses a simple model as a part of its strategies to connect

- What NSF invests (time, money, knowledge and skills, partner resources) with

- What NSF invests in (research, education, equipment and facilities – individuals, institutions, collaborations, core, priority areas, large facilities, infrastructure and instrumentation) with

- What NSF investments produce (people – competitive science and engineering workforce; ideas – discovery and knowledge; tools – state of the art S&E infrastructure) and with

- What NSF investments lead to (prosperity, security, health and welfare, environmental quality, international leadership and human understanding). [12]

Utilizing this model, NSF currently is proposing three core strategies – develop intellectual capital, integrate research and education and promote partnerships. Proceeding with these strategies drives investments in core research and education activities of single investigators, small groups, centers and early career faculty and students. Virginia Tech's 2003 success in linking 1,100 Apple G5 computers together to create the world's fourth fastest supercomputer (at a cost $5.2 million, less than one-twentieth the cost of comparable supercomputers), for example, was led not by the most senior faculty, but by Srinidhi Varadarajan, an assistant professor of computer science, with NSF support.[12]

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[12] "GPRA Strategic Plan, FY2003-2008," National Science Foundation, Draft 3.1 (NSB-03-70), June 5, 2003.

[13] The machine, assembled in 10 days by 165 students and faculty members, can handle 17 trillion operations a second. It will be used for research in chemistry, aerodynamics, nanoscale electronics and other academic fields. Virginia Tech Intellectual Properties unit is working out licensing and patenting issues as part of a plan to offer a "supercomputer kit."

NSF also intends to identify and support research in priority areas – bio-complexity in the environment, human and social dynamics, information technology, mathematical sciences, nanoscale science and engineering and 21st century workforce needs.

Dr. Charles W. Steger, President of Virginia Tech, summarized four research goals for Virginia in the report of the Governor's Steering Committee on Research Competitiveness and Centers of Excellence early in 2003.[14]

- Attract and retain world-class researchers.
- Build more research space.
- Eliminate barriers to R&D in academic settings.
- Provide focus, sustain investment, and encourage collaboration.

Each of these goals require additional state funds for direct investment, for indirect investment through state universities, Virginia's Center for Innovative Technology and other entities and for incentives to encourage and attract additional private sector R&D investments. The final point requires a shared vision, a consensus to act and a commitment to the long-term.

Similarly, a 2002 report of the Governor's Advisory Board for the Virginia Biotechnology Initiative[15] suggested Virginia build on the strength of its growing technology business sector, its ability to attract federal R&D dollars and its ranking of 3rd among states in SBIRs. Four foundational areas underpin research success, the report suggested, including

- Access to financial capital,
- Human capital,
- Facilities and infrastructure and
- Intellectual capital.

Recommendations

VRTAC focused first on the strategy recommendations made recently by other Commonwealth study groups. Very useful were the four areas explored by the Advisory Board for the Virginia Biotechnology Initiative in 2002, i.e. improving access to financial capital, attracting and retaining human capital, investing in facilities and infrastructure and facilitating the commercialization of intellectual capital. The advisory board initially discussed capital formation and funding issues, including proposals to invest state funds in private venture capital funds targeted at biotechnology, begin a loan and lease guarantee program for public authorities to finance facilities for small to medium-sized biotechnology companies and create a Virginia biotechnology commercialization loan fund to be used by university tech transfer officers to cover costs associated with commercial potential, assessment of patentability, etc. The group also recommended starting an eminent life sciences scholar program.

[14] Report of the Governor's Steering Committee on Research Competitiveness and Centers of Excellence, 2003.

[15] Report of the Governor's Advisory Board for the Virginia Biotechnology Initiative (2002).

Subsequently in 2003, the advisory board has made more specific recommendations.[16]

- Form Biotechnology Macro Partnerships that would draw upon $20 million in Commonwealth funds and debt annually to fund five such partnerships representing $100 million over ten years. These partnerships include an estimated $8 million each to recruit eminent senior faculty with relevant critical expertise through a Commonwealth Life Sciences Fellow program.

- Authorize a $100 million bond issue to fund nine distinct research facilities.

- Establish a Virginia Life Sciences Capital Access Fund of $45 million to leverage up to $135 million for Virginia companies.

- Establish a revolving Virginia Biotechnology Commercialization Loan Fund with a one-time investment of $3 million.

The so-called Steger Committee produced a series of recommendations that suggest research strategies for Virginia to articulate the value of university research on the economic well-being of the state, to more vigorously pursue federal R&D dollars, to increase partnerships among institutions and with industry and to build a robust Commonwealth Technology Research Fund. The committee also recommended a new graduate research assistant stipend program.

In collaboration with VRTAC and with Virginia's colleges and universities, Virginia's Center for Innovative Technology has developed a series of priority recommendations for its own operations as it transitions away from sole reliance on state appropriations funding. CIT suggests in its FY2004 operating plan[17] that it will focus on research consortia and entrepreneurial technology ventures. Among its recommendations are the following.

- Strengthen Institute for Defense and Homeland Security.
- Establish nanotechnology research consortium.
- Establish life sciences research consortium.
- Establish baseline funding for Virginia's Center for Innovative Technology that supports VRTAC, research consortia, SBIR/STTR/ATP programs, early stage technology company development, regional technology company extension services.
- Increase state capitalization of the Commonwealth Technology Research Fund.
- Create a Commonwealth Technology Investment Fund to allow state match for federal funds sought for research consortia.
- Create Broadband Expansion Program to allow state funding match for private sector development projects in underserved areas.
- Create Overhead Relief Program for research in targeted areas (defense, homeland security, nanotechnology, life sciences).

VRTAC also took note of emerging recommendations from other studies it has underway, including expanding VEDP's mission to include the "gazelle" class of fast-growing technology

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[16] Governor's Advisory Board Report, Biotechnology Initiative (November 14, 2003).

[17] Operating Plan, Fiscal Year 2004, Virginia's Center for Innovative Technology, July 9, 2003.

companies, directing CIT to implement a public awareness campaign on entrepreneurial support and mirroring the work of the advisory board on biotechnology with a similar dedicated effort for nanotechnology.

But VRTAC could not ignore barriers to all these recommendations, including the likelihood of very modest state resources available for direct investment by the Commonwealth (current estimates show a $1.5 billion potential deficit for FY2005), the reluctance of the Virginia Retirement System to pursue alternative investments, the choices of the General Assembly to make tax cuts a higher priority than targeted technology-driven economic development incentives, the unlikelihood of another bond issue for research university facility development for years (bonds authorized in 2002 have yet to be sold) and continuing fiscal pressures for the Commonwealth.

Reluctantly, VRTAC concluded that Virginia is not likely to succeed in the short- to medium-term through research strategies requiring significant new state investments in institutions, facilities, infrastructure and equipment. Moreover, VRTAC notes that as general economic conditions improve in the United States, financial markets and the private sector will provide more investment capital to Virginia enterprises and entrepreneurs, even if Virginia does not approve new tax, loan, capital access, commercialization or other incentives. Such investment capital will not necessarily flow, however, into research areas considered as priorities by Virginia or in such a manner as to maximize new company, new sales or new job creation returns on investment in Virginia. The relative shortage of incentives offered by the Commonwealth, however, remains of great concern to VRTAC and still will pose a competitiveness problem for Virginia vis-à-vis other states, regions and foreign countries. And for Virginia to remain competitive in a market-based economy, the Commonwealth cannot neglect its investment responsibilities in public education, higher education, transportation, communications and public safety networks.

Drawing on recommendations from university research officers and the plethora of Commonwealth studies in recent years, the VRTAC concludes that the most affordable, most realistic state-fostered research strategy is one led by renewed investments in human capital. VRTAC makes eight specific recommendations that can build human capital and meet a second strategy that encourages collaboration and partnerships.

1. **The Commonwealth of Virginia should assemble and dedicate resources necessary to attract and retain top researchers, research faculty and graduate research assistants at Virginia's colleges and universities. This strategy incorporates specific suggestions, such as a significantly more robust eminent scholars fund for science, technology and engineering and a new graduate research assistant stipend program.**

The human capital-led research strategy allows discrete responses by the Commonwealth and its institutions of higher learning to the "important opportunities for discovery and development" cited by the federal government. It mirrors important NSF priorities across fields of investigation. Because researchers increasingly define teams, facilities, equipment and opportunities, this strategy allows highly targeted complementary funding and investment initiatives.

Star researchers and teams also provide links to federal research priority funds, industry partners, commercial opportunities and capital flows. Moreover, a human capital strategy

provides direction for other public and higher educational investments given the rapid growth in jobs projected by the U.S. Department of Labor over the decade at every level for science and technology workers.

Renewed investments in human capital can only be built on an adequate base at institutions of higher education, which means the Commonwealth of Virginia should strengthen its general fund commitments to science, technology, mathematics and engineering programs, faculty, students and workers for the future and existing programs to nurture R&D and technology company activities in the state.

2. **The Commonwealth of Virginia should review and invigorate partnerships with local governments, economic development agencies and regional technology councils to improve the attractiveness of Virginia as a location for new private and non-profit research and development enterprises. This effort might include targeted investments in science, technology and engineering workforce development; in quality-of-life improvements; in tax and other business incentives specifically for R&D activity; in real time prospects/projects of opportunity information sharing; and in coordinated marketing initiatives.**

A third preferred strategy is to nurture new collaborative mechanisms and partnerships, such as the Institute for Defense and Homeland Security research consortium launched in 2003, to supplement and project what individual institutions are doing.

3. **The Commonwealth of Virginia should reestablish the strong foundation necessary to coordinate and integrate the teams, consortia and partnerships of the R&D future by funding its Center for Innovative Technology for at least $7.65 million annually, but preferably a baseline level consistent with annual appropriations made prior to the rounds of budget-driven cuts in the last two years. The Commonwealth also should monitor and analyze continuously the investments and initiatives of other states to remain competitive.**

CIT is focusing in three areas that are critical to expanding Virginia's R&D future.

- Establishing world-class research hubs to include the creation and operation of the Institute for Defense and Homeland; developing a unified Commonwealth nanotechnology strategy; developing new life sciences research initiatives and identifying additional leading edge research opportunities.
- Accelerating research products to commercialization by providing opportunities for new technology companies to acquire federal and private investment for commercialization initiatives.
- Supporting the development of emerging technology companies by providing access to market assessment, intellectual property management and growth management support services.

CIT's new focus on turning Virginia's technology assets into world-class research hubs and in making the state a global leader in entrepreneurial technology ventures provides strategic goals for the Commonwealth. Maintaining state support for CIT's collaborative role, regional operations and entrepreneurial support programs is critical to expanding Virginia's R&D future.

4. **The Commonwealth of Virginia should ensure there are dedicated state research and investment funds in the existing Commonwealth Technology Research Fund (CTRF) to meet leverage and/or match requirements for the federal and private sector investments it is pursuing. Annual budget allocations should be set based on the projected federal and private investment targeted. Additionally, the Commonwealth should renew its commitment to seed R&D ventures in Virginia directly by investing $10 million annually in CTRF.**

Federal R&D funds sought on a competitive basis require states or state university consortiums to match federal funds awarded. Funds in a new technology investment fund will have a high leveraging factor and would be drawn down only in the event of winning federal awards or attracting private sector investment dollars. Similarly, collaborative efforts through the CTRF require matching funds if the Commonwealth or its institutions of higher learning are primary partners.

5. **The Commonwealth of Virginia should continue to promote the Institute for Defense and Homeland Security, the consortium of university, industry and federal research and development partners launched in 2003, and to invest where possible to further the work of the Institute.**

Few initiatives of recent years in the Commonwealth have matched up more thoroughly with rapidly evolving science and technology R&D activities than the Institute for Defense and Homeland Security (IDHS). IDHS already is exhibiting extraordinary promise in identifying new opportunities in the federal marketplace and focusing attention on Virginia's R&D assets to be applied in areas such as security, diagnostics and sensors.

6. **The Commonwealth of Virginia should form and fund aggressively new research consortiums devoted to life sciences and nanotechnology.**

In two of the most promising, fastest-growing fields, Virginia needs to combine, strengthen and market virtual research entities to exhibit potential and to compete for federal and privately funded projects and initiatives. The rapid progress being made by IDHS provides one model. Collaborative efforts started by universities, such as the Virginia Life Initiative, the Institute for Nanotechnology in Virginia and the Lambda Light Rail project provide other models. Renewed investment and energy devoted to life sciences and nanotechnology match two high federal priorities with areas of great potential strength for Virginia.

7. **The Commonwealth of Virginia should encourage and reward those institutions of higher education making the most progress in expanding their R&D efforts in priority fields of inquiry in a collaborative manner by authorizing institutions to recover the 30 percent of indirect costs associated with R&D that is now credited to the general fund.**

Facilitating the investment of more R&D funds directly in R&D activities can accelerate positive developments already underway at Virginia's colleges and universities. Criteria for recovery should be drawn to match research strategy priorities, such as research conducted in recommended areas and with collaborative teams. Additional incentives to keep more university R&D funds in R&D program activity are consistent with incentives now given to (and new ones to be considered for) private sector R&D enterprises.

8. **The governor and General Assembly should develop plans to convert into specific investments the results of the 2003 governor's initiative to identify the most promising R&D areas and programs in Virginia.**

The governor enlisted the National Research Council to recommend members of a review panel to examine R&D programs at Virginia universities. The review panel in turn has identified R&D programs which are or realistically can become nationally competitive within the decade, which already are considered among the top programs and could benefit significantly from targeted investment and which offer opportunities for synergistic relationships with other programs in the state. The study team submitted its findings to the Steering Committee on Research Capabilities and Centers of Excellence (Steger Committee), which will report to the Secretary of Education.

Appendix A HB 2760

CHAPTER 653

An Act to direct the Virginia Research and Technology Advisory Commission, in conjunction with the Secretaries of Technology, Commerce and Trade, and Education, to develop strategies for research and development in the Commonwealth.

[H 2760]
Approved March 18, 2003

Whereas, the Virginia Research and Technology Advisory Commission was established to advise the Governor on appropriate research and technology strategies for the Commonwealth with emphasis on policy recommendations that will enhance the global competitive advantage of both research institutions and technology-based commercial endeavors within the Commonwealth; and

Whereas, maximizing the amount of basic and applied federal research and development (R&D) and subsequent commercialization of related intellectual property would benefit the research institutions and technology-based commercial endeavors within the Commonwealth and industry-supported R&D at these institutions would provide unique educational opportunities and spur economic development; and

Whereas, a rigorous strategic planning process should lead to current and accurate information resources that support strategic decision-making and establish criteria to measure success; now, therefore,

Be it enacted by the General Assembly of Virginia:

1. *§ 1. The Virginia Research and Technology Advisory Commission (VRTAC), in conjunction with the Secretaries of Technology, Commerce and Trade, and Education, shall develop strategies for research and development in the Commonwealth. The strategies should consider the areas the federal government will emphasize within the next five years, the Commonwealth's R&D assets and capabilities, the current and future growth industries in the Commonwealth, and the means to strengthen the Commonwealth's position in global research and development competition. The Commission shall provide the strategies to the Governor and the General Assembly by November 30, 2003.*

§ 2. The Innovative Technology Authority, Virginia Economic Development Partnership, and State Council of Higher Education shall provide staff support to the Commission.

Appendix B Report on the Status of the Commonwealth's Technology Assets to the Joint Commission on Technology and Science of the Virginia General Assembly (January 1999)

Applied Research Center, Newport News
Biotech Informatics Center (IB3), George Mason University, Fairfax
Engineering Research Center in Power Electronics, Virginia Tech, Blacksburg
Free Electron Laser, Newport News
Langley Full-Scale Wind Tunnel, Hampton
Smart Road Project, Virginia Tech, Blacksburg
The University of Virginia's Institute for Microelectronics, Charlottesville
Virginia Biotechnology Research Park, Richmond
Virginia Modeling, Analysis and Simulation Center, Suffolk
Virtual Reality Competence Center, Virginia Tech, Blacksburg
Virginia Space Flight Center, Wallops Island

Internet Technology Innovation Center (UVA, VT, CNU, GMU)
Center for Plasma and Photon Processing (WM, ODU, NSU, CNU)
21st Century Manufacturing Center, James Madison University, Harrisonburg (Partners include PVCC, DSLCC, BRCC and Virginia Philpott Manufacturing Extension Partnership)
Hampton Roads Technology Incubator, NASA Langley Research Center

Appendix C Growth Statistics

Table 1. Fastest growing occupations and occupations projected to have the largest numerical increases in employment between 2000 and 2010, by level of education or training

Fastest growing occupations	Education/ Training Category	Occupations having the largest category numerical increases in employment
First-professional degree		
Veterinarians		Lawyers
Pharmacists		Physicians and surgeons
Chiropractors		Pharmacists
Optometrists		Clergy
Lawyers		Veterinarians
Doctoral degree		
Computer and information scientists, research		Postsecondary teachers
Medical scientists		Biological scientists
Postsecondary teachers		Computer and information scientists, research
Biological scientists		Medical scientists
Astronomers and physicists		Astronomers and physicists
Master's degree		
Audiologists		Educational, vocational, and school counselors
Speech-language pathologists		Physical therapists
Mental health and substance abuse social workers		Speech-language pathologists
Substance abuse and behavioral disorder counselors		Psychologists
Physical therapists		Mental health and substance abuse social workers
Work experience plus bachelor's or higher degree		
Computer and information systems managers		General and operations managers
Public relations managers		Computer and information systems managers
Advertising and promotions managers		Management analysts
Sales managers		Financial managers
Medical and health services managers		Sales managers
Bachelor's degree		
Computer software engineers, applications		Computer software engineers, applications
Computer software engineers, systems software		Computer software engineers, systems software

Network and computer systems administrators		Computer systems analysts
Network systems and data communications analysts		Elementary schoolteachers, except special education
Database administrators		Network and computer systems administrators
Associate degree		
Computer support specialists		Registered nurses
Medical records and health information technicians		Computer support specialists
Physical therapist assistants		Medical records and health information technicians
Occupational therapist assistants		Paralegals and legal assistants
Veterinary technologists and technicians		Dental hygienists
Postsecondary vocational award		
Desktop publishers		Automotive service technicians and mechanics
Fitness trainers and aerobics instructors		Licensed practical and licensed vocational nurses
Surgical technologists		Welders, cutters, solderers, and brazers
Respiratory therapy technicians		Hairdressers, hairstylists, and cosmetologists
Gaming dealers		Fitness trainers and aerobics instructors
Work experience in a related occupation		
First-line supervisors/managers of correctional officers		First-line supervisors/managers of retail sales workers
Aircraft cargo handling supervisors		First-line supervisors/managers of construction trades and extraction workers
First-line supervisors/managers of protective service workers,		First-line supervisors/managers of office and administrative support workers
Except police, fire, and corrections		First-line supervisors/managers of food preparation and serving workers
Private detectives and investigators		First-line supervisors/managers of mechanics, installers, and repairers
Transportation, storage, and distribution managers		
Long-term on-the-job training (more than 12 months)		
Telecommunications line installers and repairers		Cooks, restaurant
Actors		Police and sheriff's patrol officers
Recreational vehicle service technicians		Electricians
Interpreters and translators		Carpenters
Police and sheriff's patrol officers		Maintenance and repair workers, general
Moderate-term on-the-job training (1 to 12 months)		
Medical assistants		Customer service representatives
Social and human service assistants		Truck drivers, heavy and tractor-trailer
Dental assistants		Medical assistants

Pharmacy technicians		Executive secretaries and administrative assistants
Ambulance drivers and attendants, except emergency		Social and human service assistants
Medical technicians		
Short-term on-the-job training (0 to 1 months)		
Personal and home care aides		Combined food preparation and serving workers, including fast food
Home health aides		Retail salespersons
Physical therapist aides		Cashiers, except gaming
Occupational therapist aides		Office clerks, general
Veterinary assistants and laboratory animal caretakers		

Top 25 Manufacturing Industries In Virginia Ranked by Value Added	
SIC Code	**Industry**
2110	Cigarettes
3731	Ship Building and Repairing
3080	Miscellaneous Plastics Products
2710	Newspapers
2750	Commercial Printing
3711	Motor Vehicles
2824	Organic Fibers, Noncellulosic
2511	Wood Household Furniture
3714	Motor Vehicle Parts and Accessories
2210-2230, 2261-2	Broad woven Fabric Mills and Finishing
3674	Semiconductors and Related Devices
2830	Drugs
2630	Paperboard Mills
2082	Malt Beverages
3443	Fabricated Plate Work (Boiler Shops)
2015	Poultry Processing
2620	Paper Mills, Except Building Paper
2650	Paperboard Containers and Boxes
3663	Radio and T.V. Communication Equipment
3353-3355	Aluminum Rolling and Drawing
3010	Tires and Inner Tubes
2421	Sawmills and Planing Mills, General
3812	Search & Navigation Equipment
2731	Book Publishing
2720	Periodicals
Source: Minnesota IMPAN Group, Inc. 2003 - 2000 database. Value added consists of payments made by industry to workers, interest, profits and business taxes	