University of Virginia
Report on the Use of Commonwealth Research Initiative Funds
October 2009

Legislative provision

The University of Virginia shall report on the use of these funds and the progress made under this initiative to the Chairman of the House Appropriations and Senate Finance Committees by October 1. The report shall include, but not be limited to: 1) how the funds were used, 2) the amount of federal and private funds that were leveraged, 3) collaborative efforts in support of private industry, 4) the number of junior and senior faculty recruited in each field, 5) the amount of federal or other grant funds received as the result of those recruitments, 6) additional grants or contracts being pursued, 7) the level of instructional activity conducted by these faculty, 8) the impact of research activities on undergraduate instruction, 9) the use of graduate student aid funds, and 10) recommendations for future investment.

Overview

In FY 2009 the University of Virginia applied Commonwealth Research Initiative (CRI) funds to solidify existing areas of strength in basic sciences and engineering and expand selectively in promising new areas that distinguish UVa as a thought leader, produce societal benefit, and transform the higher education experience. These funds are critical in support of the University's strategic mission outlined by the President's Commission on the Future of the University. The Commission highlighted research, innovation, science, and engineering as key areas for selected investment over the next ten years and beyond.

In support of the University's strategic vision, we funded recruitment packages for several key junior faculty members who expect to grow into the future leaders of the institution. These new faculty members had an immediate and significant impact on research productivity and external research funding. In FY 2009, as a result of state investment of $2.22 million, the University has been awarded $13.74 million in external federal and private funding (excluding any pending funding), representing a return of over 400%. A portion of the state's FY 2009 contribution ($706,594) is committed to fund several of the critical strategic projects identified below for next fiscal year as well.

The CRI funds have substantially increased the institution's research capacity by providing for the recruitment of faculty and advances in research strategic priorities in bioscience and bioengineering. Indeed, in FY2009, with innovative, privately funded translational grant programs, we have strengthened the University's translational research infrastructure and accelerated the application of basic research to the solution of urgent public health and economic development problems for the Commonwealth. In FY 2010 we anticipate continued expansion of research productivity and expanded applications of research to the benefit of the entire University through a broad-based undergraduate research-learning program and greater private sector participation in research, through private gifts and industry partnerships.

(1) How the funds were used

A. Faculty Recruiting: We used CRI funds to help support recruitment packages for 8 junior faculty members. These faculty members made an immediate and very significant impact on research productivity. Together, these new faculty members secured over $6 million in research awards, including major awards with emphasis on enhancing patient care, stimulating economic productivity in the bioengineering sector of the Commonwealth (with research likely to spin-off new companies), creating licensing opportunities for existing businesses, and creating new biotechnology solutions to health care needs.

These new faculty members constitute an important first step in our recruitment of a new generation of leadership in science, medicine, and engineering at the University. Faculty members recruited with CRI funds set a high standard for research excellence, for research collaborations that increase institutional productivity, and for research-based teaching and translational research.

1) Linda Columbus, Chemistry

Dr. Columbus seeks to determine the structure and conformational changes of membrane proteins involved in bacterial infection using a combination of site-directed spin labeling (SDSL), nuclear magnetic resonance (NMR) spectroscopy, and X-ray crystallography, She also develops tools to accelerate membrane protein structure determination by these methods.

2) James Morris, Psychology

Dr. Morris characterizes normal and abnormal social function using a multimodal approach. Techniques include functional magnetic resonance imaging, scalp-recorded event-related potential recordings, and eye-tracking. He is building a Social Neuroscience Laboratory at UVa and is interested in employing neuroscientific techniques to learn more about the nature of human social behavior. Past research has focused on social perception and cognition.

3) Archie Holmes, Electrical and Computer Engineering

Dr. Holmes' research interests are focused on the crystal growth of semiconductors and the design and fabrication of electronic and optoelectronics devices. Recent work has focused on the design, growth, fabrication, and testing of avalanche photodiodes for applications such as single photon counting, fluorescence spectroscopy, cancer detection, and optical communications. Other projects are focused on developing mid-infrared optoelectronic devices (lasers and detectors) for applications such as high resolution molecular spectroscopy, trace gas monitoring, space based communications, air pollution analysis, non-invasive medical diagnostics, night vision, thermal imaging, and tracking.

4) **Kimberly Kelly, Biomedical Engineering**

Dr. Kelly generates imaging agents capable of the early detection in vivo of colon, pancreatic, lung, and prostate cancers as well as specific targets in atherosclerosis and inflammation. Advancement in the design of imaging agents has many far-reaching implications for the future directions of molecular imaging and radiological sciences including the following: (1) The early detection of disease by the identification of early molecular signatures; (2) The evaluation of various treatments and therapeutics; and (3) The high-throughput screening of various compounds during pharmaceutical development.

5) Jeffrey Holmes, Biomedical Engineering

The Holmes research group focuses on the interactions between mechanics, function, and growth and remodeling in the heart. The mechanical properties of normal and diseased myocardium are important determinants of overall heart function. These mechanical properties change during growth, remodeling or disease, often in part as a response to changes in the mechanical environment. Dr. Holmes studies this interplay between mechanical environment, tissue response, and heart function, not only to better understand the basis for heart disease but also to identify new opportunities to intervene.

6) Jason Papin, Biomedical Engineering

Dr. Papin's research goals include the construction and analysis of large-scale biochemical networks and their application to human disease. Currently, he is working to develop methods for incorporating high-throughput data with integrated signaling, metabolic, and regulatory network reconstructions, and he uses these tools to study fundamental problems in infectious disease, cancer, and bioenergy. The development and application of computational methods to analyze large biological networks will revolutionize medical research and lead to the characterization of novel therapeutic targets that would be impossible otherwise.

7) Kevin Janes, Biomedical Engineering

Dr. Janes develops experimental and computational techniques for quantitatively monitoring signaling networks as they become activated by diverse stimuli and perturbations. These tools allow us to collect complex datasets, which can be analyzed by "data-driven" modeling to address network-level questions about signal transduction. He currently is interested in studying the tissue responses of colonic epithelia and the morphogenetic responses of 3D-cultured mammary epithelia in vitro. Understanding how signaling networks enable cells to respond to their environment is important for diseases such as cancer, where the molecular "signal processing" has gone awry and cellular responses are inappropriate.

8) Jeffrey Saucerman, Biomedical Engineering

Heart function and disease are controlled by complex molecular networks that are just beginning to be mapped out. The Saucerman lab develops mathematical models to understand how these molecular control systems work, and then they perform a variety of experiments to test this understanding. Experimental techniques include cell culture, live-cell fluorescence imaging, and biochemical assays. These integrated approaches are helping harness molecular networks to reverse the progression of heart disease.

Table 1: State Support for UVa Junior Faculty Recruitment

Faculty Recruited	Department	State Funding
Linda Columbus	Chemistry	$ 50,000
Jamie Morris	Psychology	$ 50,000
Archie Holmes	Electrical Eng.	$ 200,000
Kimberly Kelly	Biomedical Eng.	$ 50,000
Jeffrey Holmes	Biomedical Eng.	$ 50,000
Jason Papin	Biomedical Eng.	$ 50,000
Kevin Janes	Biomedical Eng.	$ 50,000
Jeff Saucerman	Biomedical Eng.	$ 50,000
TOTAL		**$ 550,000**

B. Research Projects: These funds were used in existing areas of strength that are moving in new directions. These are current focus areas because of several quantitative and/or qualitative attributes. They exhibit current strength in funding and citations, they have active faculty champions with national peer recognition, they have potential for short-term enhancement of UVa revenue via commercialization, they have long-term potential for creating economic development, they pursue fundamental paradigm changes in niche areas, they produce knowledge that is transferable between several fields, they improve peace or social justice processes, or they have high promise for breakthrough impact on human health and environmental sustainability. The purpose of cross-university projects is to stimulate high-risk, high-reward research exploration between members of the faculty in different schools of UVa.

1) **Environmental Sustainability:** Environmental sustainability is a major global need, due to increasing pressure for sufficient and safe food supplies, health care, housing and workplace structures, transportation infrastructures, raw materials and manufacturing practices, IT systems, media, and policies that effectively provide for freedoms and democracies to be maintained while enhancing social justice and economic stability at the same time. The embeddedness of environmental sustainability in many educational areas and practices that impact society is the reason that so many schools of the university are already highly involved in research in this area.

   In 2009 we created a multi-school initiative which developed the UVa Bay Game, an agent-based simulation of the impact of human behavior on the health of the Chesapeake Bay watershed. This initiative also developed a comprehensive plan for new solutions to Bay conservation, in collaboration with federal and state agencies, NGOs, the private sector, and other educational institutions. This effort culminated in an invitation from the White House EPA-Chesapeake Bay coordinator for proposals to assist with new EPA-state initiatives in Bay conservation. The Bay Game has attracted national and international attention, with potential collaborations with Arizona State and the University of Melbourne, Intel, IBM, and Philippe Cousteau's media group.

2) **Technology Transfer Enhancement:** One of the primary missions of a comprehensive university is "dissemination of knowledge." An important method of realizing this mission is through technology transfer – the process of transferring new ideas, inventions, processes, know-how, or services that are invented or created at the university to society, usually via commercialization in the private sector. This is the most common path for university inventions to produce the desired impact on society. Most of the University's technology is bioscience and bioengineering. We plan to better integrate our technology transfer operations, enhance deal flow and revenues, and build new relationships with outside partners that are conducive to maintaining a highly innovative and entrepreneurial environment in our UVa research operations.

   There are some early successes achieved in FY 2009 using the new approach. A $4 million master agreement was completed with a top-ten pharmaceutical company; closure of a $4.5 million Series A finance round by a start-up company that received UVa seed investment and assessment; UVa was named a "Top 10 Center for Biomedical Research" for the 2nd year in a row by the Hartwell Foundation; and UVa received high scores along with Stanford, Duke, and Michigan for a potential $10 million endowment by the Coulter Foundation for our translational research and commercialization efforts that provide substantial benefits to humanity. We also have pending a large clinical trial proposal of $5 million a year for 5 years. We expect future gains in technology transfer revenues in the upcoming years as we recruit new staff to lead and manage this process.

3) **Nursing Research**: We created a new Nursing Research Fellowship Award which provided summer support for School of Nursing faculty to write proposals that include interdisciplinary collaboration, that fit with School of Nursing research priorities in areas of existing research strength such as oncology, aging, complementary and alternative therapies, mental health treatment and delivery, rural health, nursing history, ethics, domestic violence and patient outcomes. These awards strengthen research collaborations with the Institute of Aging, the Cancer Center, the School of Medicine and other areas throughout the university. It also strengthens external relationships with community agencies such as hospitals, primary care clinics and community health centers as these are frequent sites of our research studies.

4) **Healthy Aging Research**: One of the primary goals of the University of Virginia Institute on Aging is to stimulate research related to issues of aging, and to encourage the formation of collaborative teams to pursue innovative approaches to topics relevant to later life. In support of this goal, funds were available for pilot projects that have a reasonable likelihood of generating data that will result in successful applications for external funding. The Institute also supported education events in the community.

5) **Nanotechnology Research**: The University's nanoSTAR Institute established a research fund to seed new interdisciplinary cross-school research projects in the three thrust areas of the institute: nanoelectronics, medicine, and energy and the environment. The primary goal of this fund is to promote collaboration and support new projects enabling the development of preliminary results for use in proposal submissions to external sources. These projects are still underway, but preliminary results have already led to funded proposals from federal and private sources. Much

of the year the group also focused on the development of "The Virginia Academy of the X-Gate," a proposal for the fifth national multi-million dollar industrially sponsored research center of the Nanoelectronics Research Initiative (NRI) of the Semiconductor Research Corporation. The UVa proposal was accepted and the funding award announcement is expected in 2010. Phase I funding could be expected at $10 million a year for 3-5 years. In support of the NRI initiative, UVa was awarded an NSF seed grant for $400,000.

6) **Junior Faculty Seed Funding**: Fund for Excellence in Science and Technology (FEST) Grants: This is an internal grant program for junior faculty research projects in the sciences, engineering, and medicine. The program provided four awards totaling $200,000 to support innovative research projects from multiple schools and departments. This research led to strong proposals for outside funding and early career recognition. This past year the four junior faculty have received $455,000 in external funding

7) **Astrochemistry/Radioastronomy Research Collaboration:** This effort forges robust connections between Chemistry, Astronomy, SEAS, NRAO, NIST, as well as industry, and Arizona and Harvard universities. This collaboration gives UVA an excellent opportunity to launch a world-leading Astrochemistry program centered in Charlottesville with the prospects to create a regional research project of great public appeal (origins of life) in which we enjoy some unique competitive advantages. In FY 2009 the University was awarded an NSF Center Grant of $1.5 million to explore new types of chemical reactions that occur under the extreme conditions of space. The center combines laboratory experiments, theoretical studies and radio-telescope observations to dramatically expand our understanding of the processes that build molecules that may "seed" young planets with the building blocks of life. If the NSF then fully approves the initiative, the foundation will provide funding of $4 million per year for up to ten years.

8) **Cancer Research:** Financial support from the Commonwealth has been essential to the continued success of the Cancer Center in its mission to bring the best cancer care and research to the citizens of Virginia. The funds have primarily supported two broad categories of activity, improving both our capacity to deliver cutting edge research and care, and making sure that the benefits reach the citizens of Virginia:

* Growth of our clinical trials and translational research programs and infrastructure.
* Enabling access to care for underserved populations, locally and in far Southwestern Virginia.

The Cancer Center's goal is to develop a robust portfolio of cutting edge clinical trials, and ensure their availability to all the citizens of Virginia. There is already a clear and significant return on the Commonwealth's investment in the Cancer Center. The funds have facilitated over $1.1 million in external funding in addition to the $2.7 million in new funding received last year. In addition, the state funds have been very important for several pending applications. The greatest benefit is for the citizens of Virginia to achieve longer better lives through better cancer research and care.

Table 2: State Support for UVa Research Projects

Research Projects		State Funding
Sustainability/Bay Game		$ 100,000
Technology Transfer		$ 148,000
Nursing Research		$ 30,000
Healthy Aging Research		$ 50,000
Nanotechnology		$ 100,000
Junior Faculty Seed Awards		$ 200,000
Astrochemistry		$ 60,000
Cancer Research		$ 970,000
Venture Summit		$ 20,000
TOTAL		**$ 1,678,000**

(2) Amount of federal and private funds that were leveraged – *recruitment and projects*

Table 3: State Support for UVa Faculty Recruitment and Funding Leveraged

Faculty Recruited	Department	Federal Funding	Private Funding	Total Funding	Pending Funding		State Funding
Linda Columbus	Chemistry	$ 987,416	$ 30,000	$ 1,017,416	$ 245,600		$ 50,000
Jamie Morris	Psychology	$ 319,468	-	$ 319,468	$ 70,500		$ 50,000
Archie Holmes	Electrical Eng.	$ 523,471	$ 30,000	$ 553,471	$ 554,393		$ 200,000
Kimberly Kelly	Biomedical Eng.	$1,036,967	$ 151,350	$ 1,188,317	$ 528,000		$ 50,000
Jeffrey Holmes	Biomedical Eng.	$1,197,538	$ 456,186	$ 1,653,724	$ 146,906		$ 50,000
Jason Papin	Biomedical Eng.	$ 400,000	$ 194,795	$ 594,795	$ 328,000		$ 50,000
Kevin Janes	Biomedical Eng.	-	$ 340,000	$ 340,000	$2,220,000		$ 50,000
Jeff Saucerman	Biomedical Eng.	$ 398,142	$ 308,000	$ 706,142	$ 23,000		$ 50,000
TOTAL		**$4,863,002**	**$1,510,331**	**$6,373,333**	**$4,116,399**		**$ 550,000**

Table 4: State Support for UVa Research Projects and Funding Leveraged

Research Projects	Federal Funding	Private Funding	Total Funding	Pending Funding		State Funding
Sustainability/Bay Game	-	-	-	-		$ 100,000
Technology Transfer	-	$ 4,500,000	$ 4,500,000	$ 35,000,000		$ 148,000
Nursing Research	-	-	-	-		$ 30,000
Healthy Aging Research	$ 106,000	-	$ 106,000	-		$ 50,000
Nanotechnology	$ 400,000	$ 410,000	$ 810,000	$ 53,428,758		$ 100,000
Junior Faculty Seed Awards		$ 455,000	$ 455,000	-		$ 200,000
Astrochemistry	$ 1,500,000	-	$ 1,500,000	$ 40,000,000		$ 60,000
Cancer Research	$ 1,100,000	-	$ 1,100,000	$ 100,000		$ 970,000
Venture Summit	-	-	-	-		$ 20,000
TOTAL	**$3,106,000**	**$5,365,000**	**$ 7,371,000**	**$128,528,758**		**$1,678,000**

Total funds awarded due to recruiting: **$6.37 million**
Total funds awarded due to projects: **$7.37 million**

(3) Selected collaborative efforts in support of private industry

1) **Cancer Center:** In FY09, $50,000 of support from state funds went to CareSpark as part of our match for Healthy Appalachia Works. These funds are being used to complete the architecture of an electronic medical record for a consortium of private and public medical care providers in SW Virginia. It should be noted that the overall goal of the Healthy Appalachia Works project is to help grow the economy of Southwestern Virginia. This is being done by improving the health of the work force and by expanding the range of cancer care services, thus making the region more desirable for existing and new employers. A significant portion of this project is evaluation of the economic benefits that accrue.

2) **Nanoelectronics Industrial Partnership**: Considerable effort was focused on responding to an opportunity to propose a multi-million dollar industrially sponsored nanoelectronics research center. The Nanoelectronics Research Initiative (NRI), a consortium of companies in the Semiconductor Research Corporation, seeks to accelerate research in nanoelectronics to develop a device that scales beyond the approaching limitations of traditional CMOS electronics. NRI research is conducted through university-based centers, with the involvement of NRI participants from the semiconductor industry. There are four primary NRI research centers: The Western Institute of Nanoelectronics (WIN) in California headquartered at UCLA; The Institute for Nanoelectronics Discovery and Exploration (INDEX) headquartered at University at Albany-State University of New York; The South West Academy of Nanoelectronics (SWAN) centered at The University of Texas at Austin; and The Midwest Institute for Nanoelectronics Discovery (MIND) based in Indiana at the University of Notre Dame. Beyond the direct funding of these centers, the stature and recognition associated with the awarding of such a center attracts other interactions and funding resulting in a much broader impact. Member companies of NRI include Advanced Micro Devices, Inc., IBM Corporation, Intel Corporation, Micron Technology, Inc., and Texas Instruments Incorporated.

   With the encouragement and guidance of Micron and Intel, a proposal for the Virginia Academy of the X-Gate (VAX) was developed, submitted and accepted with expected funding award to be made in 2010. Phase I funding is projected at $10 million a year for 3-5 years.

3) **Nanotechnology Partnership and Innovation Program**: Industrial interactions are integral to the research, education, and innovation mission of the University's Nanotechnology Institute. Industrial interactions ensure relevance of our research direction, provide an avenue to assist in the commercialization of our discoveries, present opportunities to broaden our students' experience, and enable a new revenue stream to support the institute's activities. Modeled in part after industry programs in federally funded research centers (i.e. the NSF Engineering Research Center programs) our nanoSTAR Partnership and Innovation Program (PIP) enables meaningful relationships with a wide range of entities, including small start ups, ongoing concerns, large corporations, national laboratories, government agencies, and non-profits. The PIP includes activities such as but not limited to, seminars, research projects, student internships, proposal teaming opportunities, and an annual workshop hosted by the nanoSTAR Institute. The primary objective of the nanoSTAR PIP is to support the nanoSTAR vision: to encourage, facilitate, and support collaborative research, development and commercialization in the key areas

of nanoelectronics, biology and medicine, and energy and the environment through partnerships with academia, industry and national laboratories. Our goal over the next year is to recruit at least 5 new members to the program.

4) **Venture Capital Summit** : UVa organized the first annual Venture Capital Summit. We hosted $10 billion in capital, exceeding our goal of $1 billion in venture capital funds with regular UVa review. The Summit featured UVa thought-leaders on forefront topics, venture capitalists and alumni from top investment firms across the nation, discussions with inventors and researchers, and relationship-building opportunities with the University and with participating leaders from the venture community. This event provided a forum for faculty to engage venture capitalists in thought-provoking conversations about cutting-edge scientific research and innovations that could provide the next generation of investment opportunities. The University sees the summit as a way to mesh the expertise of the University's faculty with the interests of venture capitalists who are looking for game-changing ideas in which to invest. The summit created partnerships between University researchers and investment professionals so that there is a flow of good information leading to solutions that are in alignment with strategic priorities that will benefit society. Topics explored included clean technology and energy innovation; personalized and regenerative medicine; grid computing; medical devices and imaging; nanotechnology in engineering and medicine; and complex systems, cyber-security and intelligent infrastructure. Biomedical faculty were key participants in this event.

5) **Development of Bone Targeting Imaging Agents**: Kim Kelly from the Biomedical Engineering department has partnered in her research with Pradama Inc. Pradama Inc. is a pharmaceutical company focused on the development of drugs for bone diseases and disorders. The goal of the research is to use bone-targeting agents to develop successful drugs.

6) **Princeton Lightwave (PLI)** Archie Holmes from the Electrical Engineering Departments collaborates with New Jersey firm Princeton Lightwave. The company has expertise in high power lasers and avalanche photodetectors with applications in the fields of aerospace and defense, optical networking, industrial processing, and bio-medical instrumentation.

(4) Number of senior and junior faculty members recruited in each field

Faculty Recruited	Department	Status
Linda Columbus	Chemistry	Junior
Jamie Morris	Psychology	Junior
Archie Holmes	Electrical Eng.	Junior
Kimberly Kelly	Biomedical Eng.	Junior
Jeffrey Holmes	Biomedical Eng.	Junior
Jason Papin	Biomedical Eng.	Junior
Kevin Janes	Biomedical Eng.	Junior
Jeff Saucerman	Biomedical Eng.	Junior

(5) Amount of federal or other grants received as the result of these recruitments

See Table 3 above.

(6) Additional contracts or grants being pursued

See Table 3 and 4 above for detailed amounts. We are pursuing very large federal center grants as well as collaborative corporate funding.

(7) Level of instructional activity conducted by these faculty members

See Appendix A for Spring 2009 – Fall 2009 courses taught

(8) Impact of research activities on undergraduate instruction

1) **UVa Bay Game**: In FY09 the Vice President for Research (VPR) coordinated development of the UVa Bay Game, an agent-based simulation of the Chesapeake Bay Watershed that enables students to play the roles of stakeholders such as farmers, watermen, developers, and policy makers and see the impact of their behavior on each other and on the Bay ecosystem over a 20-year period. A multi-disciplinary faculty team from 8 academic units with the counsel of an undergraduate student advisory committee designed and tested the game with 3 undergraduate classes (150 students). Through contacts with other universities, NGOs, and industry, we have learned that the UVa Bay Game is unique, and thus provides distinctive learning opportunities for UVa undergraduate students. Over the summer the VPR team further developed the Game so that any faculty members can manage the Game independently for any class at UVa; three undergraduate classes will use the Game in fall 09 (in the College, Commerce, and Architecture). In addition, the Game can support 1,000 players at one time; plans are under way for a major undergraduate student Game event, with 1,000 players.

2) **Beckman Scholars Program and Howard Hughes Medical Institute (HHMI)**: In FY09 our Beckman Scholars proposal reached the finalist round but was not funded. Preparation of this proposal sparked discussions throughout the research-intensive academic units about institutional strategies for expanding research-based learning opportunities for undergraduate students. Over the FY09 academic year VPR coordinated planning sessions, including the All University Retreat, focused on undergraduate research-based learning. Through the VPR strategic planning process (V-RISE) undergraduate research-based learning is emerging as a top institutional priority. As part of a new proposal to HHMI, led by new hire Linda Columbus, we have developed programs for linking undergraduate research opportunities to School of Medicine labs, through an innovative collaboration between the Department of Chemistry and biochemistry scientists in School of Medicine departments. We also are developing new "best practices" undergraduate mentoring courses for School of Medicine faculty members and new courses on writing about and publishing research, research ethics, and the commercialization of intellectual property for undergraduate students that will enhance their laboratory experience.

3) **Nano and Emerging Technologies Club (NExT):** Noting how nanotechnology has captured the interest of students across grounds, Matthew Smith, nanoSTAR student associate, formed a student organization this spring. The Nano and Emerging Technology (NExT) (the x stands for cross-disciplinary) group is focused on building awareness among the student body of the ongoing research in nanotechnology, and other emerging technologies, and its application to commercial products. Future activities will include organizing: guest speakers; networking events to link students to faculty researchers; contests and public outreach. After several meetings with students interested in leading the effort as officers and the drafting of a constitution, the club was established as an official university CIO. More than fifty interested students attended the launch event. NExT is interested in linking with other student groups including Engineers without Borders and the E*Society. These interactions will be more fully defined in the coming year. Although an independent student-run organization with dues to support their activities, it will likely remain closely tied with nanoSTAR. One area of particular interest is supporting undergraduate research.

4) **The E*Society**: The Virginia Entrepreneurial Society is a student organization devoted to developing and supporting an entrepreneurial ecosystem at the University. They organize social networking events, informal get-togethers, competitions & team formation, and speakers and education to link interested students, faculty, and staff. NanoSTAR became a supporting organization and co-hosted one networking event this past year. We look forward to continued interactions to help with the translational end of our activities. For example, we envision partnering interested researchers with Darden students, perhaps to enter the existing competitions or as a sponsored internship, to develop business plans, market analysis, etc.

(9) Use of graduate student aid funds

As part of the Commonwealth's research initiative, an annual allocation of $1.6 million was dedicated to graduate student aid. Graduate students engaged in scholarly research support the research mission of the University by helping to drive the process of discovery, gathering preliminary data for research proposals, producing new knowledge that is published in archival journals, and mentoring undergraduates who participate in research projects, thereby imparting the skills and encouragement necessary for future graduate study. Each year, these funds support more than 300 graduate students in four of the University's graduate schools.

The graduate aid funds allocated by the Commonwealth were used to create competitive recruitment and retention programs. The primary goal of these programs is to enhance the University's ability to attract the highest-quality graduate students and to recognize research excellence among currently enrolled graduate students. At the same time, the programs aim to address projected workforce needs for highly skilled labor. Table 1 represents a summary of the programs developed with these funds.

Table 5: Programs supported by Commonwealth allocation of $1.6 million

School and/or Unit	Annual Allocation	Purpose(s)
Graduate School of Arts & Sciences	$640,000	(1) To raise stipends associated with the President's Fellowship to $18,000 per year; (2) to extend the term of the President's Fellowship to four years.
School of Engineering & Applied Science	$450,000	To create first-year fellowships for recruiting outstanding Ph.D. applicants in engineering.
School of Medicine (biomedical sciences)	$180,000	(1) To create first-year fellowships for recruiting outstanding Ph.D. applicants in the biomedical sciences; (2) to provide merit fellowship supplements to outstanding students in the biomedical sciences.
School of Architecture	$130,000	(1) To create full-tuition fellowships for recruiting outstanding graduate applicants in architecture; (2) to create graduate assistantships, inclusive of tuition and fees, tuition differential, stipend, and healthcare subsidy.
Office of the Vice President for Research	$200,000	To encourage and reward students who successfully compete for prestigious external fellowships by leveraging such awards with state funds to make them more attractive to high-quality graduate students.
Total	**$1,600,000**	

The programs implemented by the School of Medicine and the Office of the Vice President for Research (VPR) focused heavily on attracting students supported by, or with future potential to be supported by, prestigious federal and private fellowships. Many such fellowships provide stipends and some level of tuition assistance. However, they often do not cover the entirety of tuition, fees, and/or health insurance subsidy. Such fellowships are portable, allowing students to attend the institution of their choice. In such cases, additional funding is needed to attract, and provide full support to, such promising students. In addition to attracting the most highly-qualified graduate students, such funds also encourage currently enrolled graduate students to compete for the most prestigious national awards.

The program, implemented by the Office of the Vice President for Research (VPR), leveraged state funds by providing supplemental aid to students supported by, among others, the following fellowship programs:

> The American Heart Association Predoctoral Fellowship; Department of Defense – Congressionally Directed Medical Research Programs; Fulbright; Gates Millennium Foundation; National Defense Science and Engineering Graduate Fellowship; National Institutes of Health – National Research Service Award; National Aeronautics and Space Administration – Graduate Student Researchers Program; National Science Foundation – Graduate Research Fellowship Program; the Pharmaceutical Research and Manufacturers of America; and NIH training grants focusing on cell and molecular biology, medical sciences, neuroscience, oncology, and pharmacology.

Two additional programs created or expanded upon competitive fellowship programs aimed at attracting the highest quality graduate students. The School of Engineering and Applied Science (SEAS) created the Commonwealth Fellowship, a first-year fellowship providing full tuition, health insurance, and competitive stipend support. The Graduate School of Arts and Sciences

(GSAS) enhanced the President's Fellowship, the most prestigious University fellowship, by increasing the annual stipend to $18,000 and the duration of the fellowship to four years.

The graduate aid funds have also brought high-quality instruction to undergraduates. As part of their award, many students participating in the programs implemented by GSAS and SEAS engage in teaching responsibilities. Graduate teaching assistants (GTAs) enhance the undergraduate experience by leading introductory language and service courses, providing small discussion sections to complement large lecture courses, and allowing for hands-on laboratory courses. They assist faculty in creating intimate learning communities, characterized by high-quality instruction, which remains the hallmark of a positive undergraduate experience. Without such instructional assistance, faculty would be hard-pressed to provide the individualized attention expected by today's undergraduates.

The graduate aid funds allocated by the Commonwealth have assisted the University in its efforts to begin addressing the lack of competitiveness in its graduate aid packages. However, additional investment is needed to become fully competitive with top research institutions. As part of its capital campaign, the University has made graduate fellowships a priority. However, continued and additional assistance from the Commonwealth would augment the University's ability to compete with both public and private research institutions across the United States.

(10) Recommendations for future investment

The University of Virginia strongly recommends that the Commonwealth establish and support strategic priorities for research excellence at Virginia universities. With increased competition for federal funding, it is important that Virginia universities remain competitive--and become more competitive--for federal funding and for private sector funding, including national Venture Capital (VC) investment. To sustain and enhance our research excellence and to attract external research funding strong expression of state support for research excellence is required.

Over the past few years the University appointed a new generation of academic leadership, with a new Provost, new Vice President for Research, and new deans of the schools of medicine, nursing, law, education and the college of arts and sciences. Together these new leaders are committed to the continued expansion of the role of research within the institution and beyond it to the Commonwealth and the national and international community. Within the institution we will facilitate the combination of top researchers and scholars for collaborative research on important issues of public health and economic development. We also will integrate the practice of research into the undergraduate curriculum, so that research-based learning--or service-based learning--becomes a hallmark of a University education. In addition, we will expand dramatically our outreach to the private sector, by raising significant philanthropic funds for research and research-based learning and by attracting major VC investment. For these new funding relationships to succeed, we must count on sustained state support. With sustained state support for research, we anticipate greatly expanded leveraging.

APPENDIX A

Commonwealth Research Initiative Funds –
Faculty Spring 2009 – Fall 2009 Courses

Linda Columbus, Chemistry

Spring 2009
- Chemistry Lab

Fall 2009
- Biological Chemistry Lab
- Membrane Biophysical Chemistry

Jamie Morris, Psychology

Spring 2009
- Social Neuroscience

Fall 2009
- Cognitive Science Research

Jeffrey Holmes, BME

Spring 2009
- Biomedical Engineering Ideas II
- Physiology and Pathophysiology

Fall 2009
- Master's Research
- Dissertation

Archie Holmes, Electrical and Computer Engineering

Spring 2009
- Science of Information

Fall 2009
- Introductory Circuit Analysis
- Electrical Engineering Projects
- Graduate Teaching Instruction
- Dissertation
- Introduction to Engineering

Jason Papin, BME

Spring 2009
- Computational Biomedical Engineering

Fall 2009
- Special Topics in Biomedical Engineering
- Biomedical Engineering Advanced Projects
- Master's Research
- Dissertation

Jeffrey Saucerman, BME

Fall 2009
- Biomedical Systems Analysis and Design
- Special Topics in Biomedical Engineering
- Instrumentation and Measurement in Medicine I
- Master's Research
- Dissertation

Kimberly Kelly, BME

Spring 2009
- Supervised Project research

Fall 2009
- Nanomedicine
- Master's Research
- Dissertation

Kevin Janes, BME

Fall 2009
- Biomedical Engineering Integrated Design and Experimental Analysis Lab
- Special Topics in Biomedical Engineering
- Biomedical Engineering Advanced Projects
- Master's Research
- Dissertation

Phil Arras, Astronomy

Spring 2009
- Introduction to Astrophysics
- Concepts of Astrophysics

Fall 2009
- Introduction to Astrophysics
- Astrophysical Processed
- Supervised Research
- Non-topical Research
- Research Ethics
- Bioethics Seminar

Noelle Dwyer, Cell Biology

Fall 2009
Introduction to research
- Current Topics In Neuroscience
- Directed Readings in Neuroscience
- Non-topical Research

Avik Ghosh, Electrical and Computer Engineering

Spring 2009
- Fundamentals of Nanoelectronics
- Special Topics in Electrical and Computer Engineering

Fall 2009
- Solid State Devices
- Supervised Project research

Jing Yu, Cell Biology

Fall 2009
- Quantitative Methods I