University of Virginia

Report on the Use of Commonwealth Research Initiative Funds
Updated October 2008

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, 2008. 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 FY08 the University of Virginia applied Commonwealth Research Initiative Funds (CRI) to sustain and expand the important research projects initiated in FY07. We completed recruiting of key faculty members; as these faculty members arrived at the University, they in turn recruited team members for their laboratories and purchased research equipment. As our FY07 report indicated, the new faculty members we recruited with state funds had an immediate and very significant impact on research productivity and external research funding. In FY08, as a result of the state's two-year investment of $21.3 million that has been allocated ($13.45 million GF and $7.85 million ETF), the University has received $79.86 million in external federal and private funding awards (excluding any pending funding), representing a return of nearly 375% and an increase of $27.26 million from FY07.

Cumulatively, over FY07 and FY08, these funds have substantially increased the institution's research capacity by providing for the recruitment of distinguished faculty, the acquisition of research equipment, and advances in research strategic priorities, such as morphogenesis and regenerative medicine and cancer research. Indeed, in FY08, 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 FY09 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 much 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 recruit or complete the start-up packages of 40 faculty members (18 senior, 24 junior). These faculty members made an immediate and very significant impact on research productivity. Together, these new faculty members and other faculty members supported through ETF funds secured $79.86 million in sponsored awards, including major awards in public health and in breakthrough research on chemical reactions. Six of these new faculty members are part of the University's $126 million Board of Visitors Research Enhancement Recruiting Program that also included the construction of two new research buildings. State funds were used to complete recruitment packages for:

> Joe Campbell, Electrical and Computer Engineering (from University of Texas-Austin)
> Dr. Campbell is a member of the National Academy of Engineering and an expert in integrated optics. He previously worked in private industry for Texas Instruments and AT&T Bell, where he

conducted research on a variety of optoelectronic devices, including semiconductor lasers, optical modulators, waveguide switches, photonic integrated circuits, and photodetectors. He supervises large postdoctoral fellow and student groups. His research crosses several department and school boundaries and typically involves industry collaboration and support; he already has received new research awards from industrial and federal sponsors and has recruited an outstanding faculty collaborator.

Steve Rich, Center for Public Health Genomics (from Wake Forest University).
Dr. Rich is a highly distinguished investigator, with a long record of scientific productivity and demonstrated skills as both a program-builder and academic leader in the field of human genomics. He has authored or co-authored twenty book chapters and over 200 peer-reviewed scientific articles. His highest impact work has appeared in *The New England Journal of Medicine* (3 articles), *Nature*, and *Nature Genetics*. These articles alone have been cited over 1,300 times by colleagues. He ranks as one of the top NIH investigators in total dollars awarded and has an impressive track record of large multi-investigator projects.

Since his arrival Dr. Rich has created the Center for Public Health Genomics (CPHG). The major research thrust of the Center is to identify genetic factors contributing to common diseases that are important both in Western societies (e.g., heart disease, diabetes, and cancer) and in developing countries (malnutrition, infectious disease). CPHG is using state funds to recruit 6 faculty positions; 3 laboratory faculty, 2 genetic epidemiologists and 1 bioinformaticist.

John Yates, Chemistry (from University of Pittsburgh)
Dr. Yates is recognized as one of the top surface chemists in the world and is a member of National Academy of Sciences. He teaches a large undergraduate course, Chemistry for Engineers, from a textbook he created. He moved his surface science research activity to UVA and in addition is developing new research programs in astrochemistry. He already has received new sponsored research awards since moving to UVA and is partnering with Chemistry colleague Brooks Pate and Astronomy faculty to develop a large multi-year NSF proposal.

Mark Yeager (MD/PhD), Molecular Physiology (from the Scripps Research Institute)
Dr. Yeager is a leading physician/scientist, with an MD/PhD from Yale and cardiology residency, fellowship, and postdoc at Stanford. He is a cardiologist in the clinic one day a week and at the same time a cell biologist doing research on the structural biology of membrane proteins, a specialty of considerable strength at UVA. Dr. Yeager uses electron microscopy, which complements our other investigators, and publishes in top journals. He is internationally recognized for work on gap junction channels and virus structures. At Scripps he was the lead scientist-administrator in catalyzing translational research. Dr. Yeager plans to recruit 6 faculty to support his research efforts.

Bernard and Christine Thisse, Cell Biology (from the Institute of Genetic, Molecular, and Cell Biology, France)
The Thisses are outstanding developmental biologists and geneticists from the Institute of Genetics and Molecular and Cellular Biology (IGBMC) in Strasburg, France who pioneered analysis of the genome of the zebrafish, an important animal model for understanding cell and organ development. The Thisses bring a very special range of talents and expertise that does not exist at UVA. The zebrafish has become one of the leading organisms for modern biological research, especially in morphogenesis, organogenesis, and vertebrate genetics. As one of the leading zebrafish groups in the world, they bring instant recognition to UVA in zebrafish genomics and informatics. The Thisses have already received external funding since their arrival.

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. Over the next ten years, as part of the University's strategic planning effort (Commission for the Future of the University, 2008) we plan to hire 150 new faculty members in science, medicine, and engineering. 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.

Four other senior faculty recruits, Edmond Brodie III in biology and Manuel Lerdau in environmental science, constitute a new generation of leadership for the University's field research stations at Mountain Lake and Blandy Farm that provide significant research and education programs for Virginia higher education and K-12 programming. An additional two senior recruits in Psychology and Environmental Sciences, Steve Boker and Stephan De Wekker, complete a strong College of Arts & Sciences recruitment effort using state funds.

B. Equipment

School of Medicine
The University set aside ETF to support equipment purchases for the new Carter-Harrison biomedical research building scheduled to open spring 2009. The new 200,000 GSF, facility will house cancer, immunology, and infectious disease researchers who are expected to generate millions of dollars in research. Also, in partnership with the College, the School of Medicine was awarded $2 million for Nuclear Magnetic Resonance (NMR) equipment from NIH. This equipment dramatically enhances analysis of large protein systems and low protein concentrations. State ETF supported this proposal.

College of Arts & Sciences
Chemistry used equipment funds to leverage $1.5 million for an NSF Center for Chemical Innovation grant. Phase one of the award starts October 1. The University has an outstanding chance to obtain phase two funds of $40 million over a 10-year period. The bulk of the CRI ETF allocation for *Astronomy* was dedicated to purchasing an infrared detector array and a set of array drive electronics. The array and electronics helped leverage NSF support of $740,000. The *Physics* ETF allocation is earmarked for equipment to coordinate and promote research and training in the Center for Atomic, Molecular, and Optical Sciences (CAMOS) research group. In addition, a small portion of ETF funding was earmarked for cost sharing on a DARPA grant.

Engineering
The School of Engineering used CRI ETF funds to complete start-up packages for faculty members in Biomedical Engineering, Chemical Engineering, Civil & Environmental Engineering, Computer Science, Electrical and Computer Engineering, Mechanical & Aerospace Engineering and Systems & Information Engineering. Over $10 million in pending proposals.

C. Research Programs

We also used state funds to seed four top priority research programs.

* *Morphogenesis and Regenerative Medicine Institute*: Mechano-Adhesion Transduction
This research project is the first ever to identify and measure the role of physical forces in morphogenesis, with an emphasis on the role of physical forces in the chemistry of cell signaling during embryo development. In FY08, the multi-disciplinary team made substantial progress on developing new methodologies that will be used in this project, as well as completing a collaborative paper on mechanotransduction in embryogenesis. In FY09, we will integrate these

cutting-edge approaches to address the specific question of how adhesion dependent mechanotransduction regulates differentiation and morphogenesis.

* *Department of Orthopedics, School of Medicine*: Orthopedics used state research funds for salary support and research seed money for three assistant professors, with research concentrations on musculoskeletal regeneration and tissue engineering. These new faculty members bring a wide, complementary range of expertise in novel biomaterial synthesis, scaffold synthesis and fabrication, cartilage tissue regeneration, bone tissue regeneration, drug delivery, and development of new treatments for fracture repair.

* *Department of Biomedical Engineering (BME), Schools of Medicine and Engineering & Applied Sciences:* BME used state research funds as partial support for five recently recruited junior and senior faculty with an 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 also will educate UVA students in their laboratories to contribute to the further development of a robust biotechnology infrastructure of the Commonwealth. The computational and experimental research of these new faculty members also includes: drug discovery using phage display, the mechanics of cardiac scarring after heart attack; low-cost medical imaging systems; systems bioengineering of a cure for malignant glioblastoma (the most deadly form of brain cancer); tools for relieving middle ear inflammation in children (the most common childhood ailment requiring surgery); and tissue engineering the growth of new blood vessels in skull fractures. $15 million in pending NIH proposals.

* *Cancer Center Support*: 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 clinical and translational research to the citizens of Virginia. The funds support:
    - Development of the cancer bioinformatics program
    - Growth of our clinical trials programs
    - Outreach to Southwestern Virginia to provide care for underserved populations
    - Recruitment of new faculty and development of our research infrastructure.

  There is already a clear and significant return on the Commonwealth's investment in the Cancer Center. The funds have facilitated $2.7 million in new funding and the state funds have been very important for several pending applications as well. $6.4 million in pending proposals.

(2) Amount of federal and private funds that were leveraged

A. Senior faculty recruiting (faculty member, awarded funds, and pending funding where known)

1 Joe Campbell Group, Electrical and Computer Engineering: Awarded $3,979,897; Pending $488,000
2 Stephen Rich Group, Public Health Genomics: $43,072,789; Pending $4.4M
3 John Yates Group, Chemistry: Awarded $1,025,842; Pending $2.06M+$40M
4 Mark Yeager, Molecular Physiology: Awarded $1,200,000
5 Bernard and Christine Thisse, Cell Biology: Awarded $310,463
6 Edmund Brodie, III, Biology: Awarded $912,358; Pending $764K
7 Manuel Lerdau, Environmental Sciences: Awarded $52,029; Pending $2.9M
8 Stephan De Wekker, Environmental Sciences: Awarded $15,060; Pending $824K
9 Steve Boker, Psychology: Awarded $1,418,370; Pending: $2.2M

TABLE 1: State Support for UVA Senior Faculty Recruitment and Funding Leveraged

Faculty Member Group	Discipline	Awarded & Pending Funding			Leveraged Funds		
		Federal Funding	Private Funding	Total	State ETF	State Investment	Total
Joe Campbell	Electrical and Computer	$1,749,504	2,230,393	$3,979,897	$1,732,600		$1,732,600
		+ pending grants of $488K					
Stephen Rich	Public Health	$38,879,989	$4,192,800	$43,072,789	$2,000,000	$3,350,000	$5,350,000
		+ $4.4M in pending grants					
John Yates	Chemistry	$804,648	$221,194	$1,025,842	$ -	$60,000	$60,000
		+ pending $2.06M DOE & DTRA grants + $40M NSF Phase 2 Center					
Mark Yeager	Molecular Physiology	$1,200,000	$ -	$1,200,000	$ -	$1,186,817	$1,186,817
		+ NIH grants transferring from Scripps					
Bernard & Christine Thisse	Cell Biology	$ -	€218,498 $310,463*	€218,498 $310,463*	$ -	$4,480,683	$4,480,683
		+ pending NIH grants					
Edmund Brodie	Biology	$912,358	$ -	$912,358	$158,000	$ -	$158,000
		+ $764K pending NSF grants					
Manuel Lerdau	Environmental Sciences	$52,029	$-	$52,029	$60,000	$ -	$60,000
		+ $2.9M pending NSF grant					
Stephan De Wekker	Environmental Sciences	$15,060	$ -	$15,060	$80,000	$ -	$80,000
		+ $824K pending NSF grants					
Steve Boker	Psychology	$1,418,370	$ -	$1,418,370	$80,000	$ -	$80,000
		+ pending $2.2M NIH grant					
Total		$45,031,958	$6,954,850	$51,986,808	$4,110,600	$9,077,500	$13,188,100

* Euro to US Dollar at 17-SEP-2008 Exchange rate of €1 = $1.42

FY2007/2008: Total funds awarded due to senior faculty recruitment: $51.99 million
FY2007: Total funds awarded due to senior faculty recruitment: $40.83 million

B. Programs and Equipment used to leverage federal and private funds

TABLE 2: State Support for UVA Research Programs/Departments and Funding Leveraged

Project Seed Funding Projects/Departments	Awarded Federal Funding	Awarded Private Funding	Awarded Total	Leveraged Funds State ETF	Leveraged Funds State Investment	Leveraged Funds Total
Department of Biomedical Engineering, School of Medicine-School of Engineering and Applied Sciences (Tom Skalak)	$ 4,600,000	$ 800,000	$ 5,400,000	$ -	$ 1,000,000	$ 1,000,000
Department of Orthopedics, School of Medicine (Cato Laurencin)	$ 2,250,000	$ -	$ 2,250,000	$ -	$ 300,000	$ 300,000
Morphogenesis and Regenerative Medicine Institute (DeSimone/Schwartz)	TBD	$ -	$ -	$ -	$ 500,000	$ 500,000
Total	$ 6,850,000	$ 800,000	$ 7,650,000	$ -	$ 1,800,000	$ 1,800,000
Astronomy	$ 740,000	$ 2,600,000	$ 3,340,000	$ 315,000	$ -	$ 315,000
Cancer Center	$ 2,958,655	$ 30,000	$ 2,988,655		$ 2,000,000	$ 2,000,000
Chemistry	$ 2,776,000	$ 103,000	$ 2,879,000	$ 285,000	$ -	$ 285,000
Physics	$ 3,750,000	$ 1,220,000	$ 4,970,000	$ 340,000	$ -	$ 340,000
Environmental Science	$ 38,350	$ -	$ 38,350	$ 200,000	$ -	$ 200,000
SEAS Add'l Recruits	$ 3,288,647	$ 722,375	$ 4,011,022	$ 1,614,482	$ -	$ 1,614,482
SOM/College NMR	$ 2,000,000	$ -	$ 2,000,000	$ 200,000	$ -	$ 200,000
New Carter-Harrison Research	TBD	$ -	$ -	$ 785,000	$ -	$ 785,000
Total	$ 15,551,652	$ 4,675,375	$ 20,227,027	$ 3,739,482	$ 2,000,000	$ 5,739,482

FY2007/2008: Total funds awarded due to projects and department funding: $27.88M
FY2007: Total funds awarded due to projects and department funding: $11.79M
*572,500 of state general funds remained unallocated for budget reductions

(3) Selected collaborative efforts in support of private industry

1 **Cancer Center: State funds supported participation in** CareSpark, a part of the Healthy Appalachia Works project, to assist a consortium of private and public medical care providers in developing a strong electronic medical record system. The overall goal of the Healthy Appalachia Works project is to help grow the economy of Southwestern Virginia. This will be done by improving the health of the work force and by expanding the range of cancer care services to make the region more desirable for existing and new employers. A significant portion of this project is evaluation of the economic benefits.

2 **Biomedical Engineering:** Will use state funds to sponsor a Venture Showcase event in 2009 to promote successes in translational research (including the innovative Coulter, Johnson & Johnson, and Ivy Foundation translational research grant programs); venture capital (VC) fund managers with more than $2B in active VC funds will visit UVA and hear from new ventures and thought leaders. We anticipate that this showcase will result in investments in UVA research and research commercialization and the development of a continuing network for privately funded research.

3 **Engineering:** Richard Kent (Mechanical and Aerospace) has several research collaborations with Autoliv Research AB (Sweden) on restraint system design for improved crash protection, primarily for older people. He also has extensive collaborations with Nissan (Japan), most

recently on improved restraint performance. Benton Calhoun (ECE) has funding from Freescale Semiconductor through the Semiconductor Research Corporation (SRC) for research on low power SRAM. Calhoun also has funding from the Center for Circuit and System Solutions, which is a consortium of universities, chartered by the US semiconductor industry and US government to address circuit design challenges. Kim Hazelwood (Computer Science) had funding from Semiconductor Research Corporation and is also a faculty consultant and collaborator with Intel in Hudson, MA on the Pin Project.

4 **College:** *Physics:* Two projects for Professor Joe Poon involved collaboration with industry, namely General Electric and Boeing. The Boeing-UVA collaborative project is funded by DARPA/AFOSR on light structural amorphous metals for space applications. The GE-UVA collaborative project is funded by ONR on nanostructured soft magnetic for power systems. *Chemistry*: The $1.5M NSF-CCI award highlighted above involves collaboration with two commercial entities, a local firm, Virginia Diodes, and a national firm, Tektronix.

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

Biology (1): 1 senior
Biomedical Engineering (5): 1 senior and 4 junior
Cancer Center (1): 1 junior
Cell Biology (2): 2 senior
Chemical Engineering (2): 2 junior
Chemistry (1): 1 senior
Civil Engineering (2): 2 junior
Computer Science (7): 1 senior and 6 junior
Electrical and Computer Engineering (4): 3 senior and 1 junior
Environmental Sciences: (2) 2 senior
Materials Science (1): 1 senior
Mechanical and Aerospace (3): 2 senior and 1 junior
Molecular Physiology and Biological Physics (1): 1 senior with 6 more recruits TBD
Orthopedics (3): 3 junior
Psychology (1): 1 senior
Public Health Genomics (3): 2 senior and 1 junior with 4 more junior recruits TBD
Systems and Information Engineering (3): 3 junior

Total: 18 senior; 24 junior

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

See Table 1 above.

(6) Additional contracts or grants being pursued

Over $45.5 million in pending funding plus another $40 million possible through the NSF CCI program phase 2 and a multimillion dollar Clinical and Translational Science Awards (CTSA) application to NIH.

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

See appendix A for Spring 2008 – Fall 2008 courses taught

(8) Impact of research activities on undergraduate instruction

In FY08, newly recruited faculty members in the College and particularly those from the Department of Biomedical Engineering (BME), expanded opportunities for undergraduate research-based learning through senior capstone projects (in which senior year student teams work collaboratively on research projects funded by corporate or other external clients) and freshman and sophomore research projects. Many of these BME projects involve faculty mentors from the School of Medicine or biology or chemistry departments in the College. From these FY08 experimental laboratories--and from over a decade of capstone and other occasional faculty-mentored student projects--we have made undergraduate research-based learning a top priority in our current University strategic plan (Commission on the Future of the University, 2008).

We have developed for FY09 a broad-based pilot project in undergraduate research-based learning that will involve faculty teams from science and engineering departments and from multidisciplinary research programs. Through this pilot project we will systematically compare best practices for undergraduate research-based learning across the sciences and engineering disciplines and, simultaneously, secure private funds for expanding research opportunities to all interested students. Our goal is to make the University of Virginia the world leader in undergraduate research-based learning. Thus, the state funds have had a dramatic and pervasive impact on undergraduate learning throughout the institution

Research activities in the College of Arts and Sciences and School of Engineering and Applied Science have had a very significant impact on undergraduate instruction.

As reported previously in FY07 we used state funds to recruit new leadership for the two College field stations, Mountain Lake (Biology) and Blandy Farm (Environmental Sciences); both stations are experiencing a renaissance in student research programs through new grants and courses. These field stations support student field projects and outreach for UVA and the Commonwealth.

A. The Mountain Lake Biological Station is a field research and teaching facility located in the deciduous hardwood forest of the Appalachian Mountains of southwestern Virginia. It provides a wide array of natural environments for research as well as two modern laboratories. Scientists from UVA and other universities study plant and animal population biology, behavioral ecology, life history evolution, community ecology, ecological genetics, biosystematics, epidemiology, conservation biology, and the physiology of behavior.

Mountain Lake Biological Station's Research Experiences for Undergraduates (REU) program is sponsored by the National Science Foundation and brings undergraduate students together for a program of guided, but independent, original research in field biology. Student researchers work closely with researcher mentors in compatible fields of interest. Students take leadership roles in all aspects of the study; they design the study and prepare the proposal, collect data and perform analysis, and finally they interpret the results and prepare a written and oral presentation. Many projects are submitted for publication in leading biological journals. Students also participate in a weekly seminar about the conduct of biological research. REU participants have access to state-of-the-art facilities and are granted full use of all Station scientific and computer equipment.

B. Blandy Experimental Farm is a 700-acre research facility situated in the northern Shenandoah Valley, about 10 miles east of Winchester and 60 miles west of Washington, D.C. Blandy Experimental Farm is also the home of the State Arboretum of Virginia, with more than 8,000 trees and woody shrubs. The mission of Blandy Experimental Farm is to increase understanding of the natural environment through research and education on plants, plant biology, ecology, evolution, the environmental sciences, and the manner in which all of these are used and affected by humans.

Undergraduate education is one of the highest priorities in the Blandy Farm mission. Since 1992 Blandy has provided Undergraduate Research Fellowships to students in ecology and environmental science with funding from the National Science Foundation Research Experience for Undergraduates (REU) program. The primary goal is to teach students to formulate testable hypotheses about important ecological and evolutionary questions. The format of the program encourages students to develop skills in experimental design, data collection, analysis, and critical reading of primary scientific literature. Students also learn to prepare and communicate scientific information to other scientists and the general public.

(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, 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 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. The programs also address projected workforce needs for highly skilled labor. Table 1 represents a summary of the programs developed with the funds.

Table 1 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; Department of Defense – Congressionally Directed Medical Research Programs; Department of Homeland Security Fellows Program; Federal Highway Administration Eisenhower Transportation Fellowship; Gates Millennium Foundation; Jacob K. Javits Fellowship (Department of Education); 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 biotechnology, cell and molecular biology, cardiovascular medicine, informatics, medical scientist training, neuroscience, 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 VC investment.

As indicated previously, over the next ten years the University plans to hire approximately 150 new faculty members in science, medicine, and engineering as part of our strategic planning process. To sustain and enhance our research excellence and to attract external research funding, a significant fraction of these new faculty members must be comparable to the outstanding new faculty members that we have recruited with our state funds. To continue to recruit faculty members such as these, we will need special resources, as well as the strong expression of state support for research excellence.

Over the past two 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 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, such as the morphogenesis and regenerative medicine group featured in our current Commonwealth Research Initiative. 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 2008 – Fall 2008 Teaching Courses

School of Engineering and Applied Science

Joe Campbell
- Spring 2008
  - Optoelectronic Devices (ECE 642)
- Fall 2008
  - Optics and Lasers (ECE 541)

Archie Holmes
- Spring 2008
  - Science of Information (ECE 200)
- Fall 2008
  - Introductory Circuit Analysis (ECE 203)

Thomas Skalak
- Spring 2008
  - Biomedical Engineering Sem (BIOM 704)
- Fall 2008
  - Special Topics: Biomedical Engineering (BIOM 703)

David L. Green
- Spring 2008
  - Seminar (CHE 796)
- Fall 2008
  - Applied Surface Chemistry (CHE 442)
  - Applied Surface Chemistry (CHE 642)
  - Graduate Seminar (CHE 796)

Steven McIntosh
- Spring 2008
  - Chemical Reaction Engineering (CHE 618)
- Fall 2008
  - Intro to Engineering Workshop (ENGR 162)

Sudhanva Gurumurthi
- Spring 2008
  - Advanced Computer Architecture (CS 433)
- Fall 2008
  - Computer Organization (CS 654)

Kim Hazelwood
- Spring 2008
  - Compilers (CS 671)

Mary Lou Soffa
- Fall 2008
  - Computer Science Perspectives (CS 696)

Richard W. Kent
- Spring 2008
  - Orthopedic Biomechanics (BIOM 496)
  - Orthopedic Biomechanics (BIOM 695)
  - Orthopedic Biomechanics (MAE 492)
  - Orthopedic Biomechanics (MAE 692)

Mool Gupta
- Spring 2008
  - Nanocarbon Materials (ECE 695)
- Fall 2008
  - Capstone Project: Photocoltaics (ECE 407)
  - Photonics I (ECE 686)

Benton Calhoun
- Spring 2008
  - Digital Integrated Circuits (ECE 363)
  - Body Area Networks (ECE 687)
- Fall 2008
  - Introduction to Vlsi Design (ECE 432)
  - Vlsi Design (ECE 632)

Hillary Bart-Smith
- Spring 2008
  - Strength of Materials (MAE 231)
  - Mechanical Engineering Special Project (MAE 496)
- Fall 2008
  - Aerospace Structures (MAE 331)

Donald E. Brown
- Spring 2008
  - Systems Design II (SYS 454)
- Fall 2008
  - Systems Design I (SYS 453)

Andres Clarens
- Fall 2008
  - Green Engineering and Sustainability (CE 647)

Jason D. Lawrence
- Spring 2008
  - Advanced Graphics (CS 451)
- Fall 2008
  - Intro to Computer Graphics (CS 445)

Westley Weimer
- Spring 2008
  - Programming Languages (CS 415)
- Fall 2008
  - Programming Languages (CS 615)

Randy Cogill
- Spring 2008
  - Data and Information Engineering (SYS 202)
- Fall 2008
  - Systems Design I (SYS 453)

Ginger Davis
- Spring 2008
  - Systems Design II (SYS 454)
  - Time Series Analysis and Forecasting (SYS 730)
- Fall 2008
  - Linear Statistical Models (SYS 421)
  - Systems Design I (SYS 453)
  - Linear Statistical Models (SYS 621)

Andrew Grimshaw
- Spring 2008
  - Wide-area Distributed Systems and Grids (CS 851)
- Fall 2008
  - High Perfmc Parallel Computing (CS 444)
  - High Perfmc Parallel Computing (CS 644)

Jeffrey W. Holmes
- Spring 2008
  - BME Ideas Lab II (BIOM 390)

Kamin Whitehouse
- Spring 2008
  - Computer Networks (CS 457)
  - Computer Networks (ECE 457)

Jerry Floro
- Spring 2008
  - Intro Sci and Engr of Materials (MSE 209)
- Fall 2008
  - Spec Topics in Sensor Networks (CS 851)

Marcel Utz
- Spring 2008
  - Measurement Theory and Adv Instrm (MAE 685)
- Fall 2008
  - Quantum Engineering (MAE 692)

Silvia Blemker
- Fall 2008
  - Motion Biomechanics (BIOM 428)
  - Motion Biomechanics (BIOM 628)
  - Motion Biomechanics (MAE 428)
  - Spec Topics in Mechanical Engr (MAE 491)

Matthew Begley
- Spring 2008
  - Finite Element Methods (CE 671)
  - Finite Element Analysis (MAE 671)
- Fall 2008
  - Continuum Mechanics w/applctns (MAE 602)

College and Graduate School of Arts and Sciences

Edmund Brodie (Biology)
- Spring 2008
  - Research: Evolution (BIOL 916)
- Fall 2008
  - Behavioral Ecology (BIOL 418)
  - Behavioral Ecology (BIOL 718)
  - Research: Evolution (BIOL 915)

Stephan De Wekker (EnviSci)
- Spring 2008
  - Atmosphere and Weather (EVSC 350)
  - Atmosphere and Weather Lab (EVSC 350L)
- Fall 2008
  - Mountain Meteorology (EVAT 753)
  - Atmospheric Mesoscale Modeling (EVAT 795)
  - Mountain Meteorology Seminar (EVSC 493)

John Yates (Chem)
- Spring 2008
  - Nanoscience on Surfaces (CHEM 984)
- Fall 2008
  - Molecular Physical Chemistry (CHEM 351)
  - Nanoscience on Surfaces (CHEM 983)

Steven Boker (Psych)
- Spring 2008
  - Design and Data Analysis (PSYC 797)
  - Research in Dynamical Systems (PSYC 906)
- Fall 2008
  - Intro to Structural Equat Mod (PSYC 881)
  - Research in Dynamical Systems (PSYC 905)

School of Medicine

Douglas Desimone
- Spring 2008
  - Developmental Biology (BIMS 508)
  - Jrnl Survey in Cell and Dev Biology (CELL 595)
  - Research in Cell Biology (CELL 904)
- Fall 2008
  - Cell and Tissue Structure (CELL 503)
  - Research in Cell Biology (CELL 903)