2010

Investing in Research & Innovation

The STARS Program, Report and Plan

WA Economic Development Commission

January, 2010

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The Washington Economic Development Commission is an independent, non-partisan commission charged by the Legislature with the mission of creating a comprehensive statewide strategy to guide investments in economic development, infrastructure, workforce training, small business assistance, technology transfer and export assistance. The WEDC membership is comprised of business, labor, academic, and association and government leaders. In carrying out this legislative mandate and related responsibilities the WEDC will:

- Provide leadership, guidance and direction to the Governor and Legislature on a long-term and systematic approach to economic development.
- Formulate a common set of outcomes and benchmarks for the economic development system as a whole and measure the state's economic vitality.
- Define public, private, and philanthropic sector roles and best practices ensuring Washington captures the next generation of technology investment and global market opportunities.
- Provide a forum for geographic and industry cluster "institutions for collaboration" to build stronger partnerships.

WASHINGTON HIGHER EDUCATION COORDINATING BOARD

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Prepared for the Washington Economic Development Commission by the Higher Education Coordinating Board, the University of Washington, and Washington State University

January 2010

We are pleased to transmit the final report-- **Innovation Research Teams (STARS Program): FY08-09 Program Report and FY10-11 Program Plan--** as required by RCW 43.330.280.

The Innovation Research Teams (IRT) program provides funding to support the recruitment of entrepreneurial researchers to Washington – individuals with the knowledge, skills, and ability to generate research products and innovations with direct commercial applications. The program is meant to foster both product innovation and longer-term statewide economic development. The STARS program, as it is known informally, is a bold departure from traditional attitudes that inhibit commercial efforts of university researchers. The program is playing a pivotal role in setting a new direction and benchmarks for university based research aimed at commercialization. It is changing the standard research model away from primarily a technology push driven model to more of a market pull driven effort.

The STARs program of today is making impressive progress and helping evolve a larger innovation ecosystem that is characterized by:

- Early interaction between research and business as a key commercial success factor
- Integration of technical advances (push) with emerging market demand (pull)
- Leveraging of federal and private sector R&D
- Collaboration as a core competency for business partnerships, networks and investors.
- Entrepreneurship as a vital ingredient
- New sources of growth and competitive advantage for Washington state

The program is a quantum advance in the WEDC strategy to capitalize on the intersection of university based entrepreneurial research and the competitive needs of industry. The program plan presented lays out the roadmap on how the IRT program will optimize its investment in the next eight entrepreneurial research teams and advance Washington's future innovation capacity and global competitiveness. We wish to acknowledge the outstanding work of John Lederer of the HECB, Egils Milbergs and Noreen Hoban of the WEDC, and all the members of the Innovation Advisory Committee in the preparation of this report.

Respectfully,

Jack Breese*, Co-chair*
Innovation Advisory Committee
WA Economic Development Commission

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Executive Summary

The Innovation Research Teams (IRT) program, authorized in 2007 by state statute, provides funding to support the recruitment of entrepreneurial researchers to Washington – individuals with the knowledge, skills, and ability to generate research products and innovations with direct commercial applications. The program is meant to foster both product innovation and longer-term statewide economic development.

The STARS program, as it is known informally, is a bold departure from traditional attitudes that inhibit commercial efforts of university researchers. The STARS program is playing a pivotal role in setting a new direction and benchmarks for university based research aimed at commercialization. It is changing the standard research model away from primarily a technology push-driven model to more of a market, pull-driven effort. The program is a quantum advance in the Washington Economic Development Commission (WEDC) strategy to capitalize on the intersection of university based entrepreneurial research and the competitive needs of the Washington innovation economy.

The STARS program is guided by the WEDC and an Innovation Advisory Committee and administered by the Higher Education Coordinating Board (HECB). In 2008, the state's first two STARS researchers were hired, one at the University of Washington (UW) and one at Washington State University – Tri Cities (WSU). These new faculty, who are now leading teams that include eight other researchers, already have brought millions of dollars in research funding into the state.

During the 2009 legislative session, WEDC was instructed to develop a new, forward-looking plan for the STARS program. This report addresses the planning requirements of the statute and provides information on program expenditures and outcomes for the first two years of planning, development and operations.

Initial program operations

In 2008, the University of Washington hired Michael Hochberg to lead its research team. A prolific inventor with a doctorate in Applied Physics from the California Institute of Technology, Hochberg specializes in the field of nanophotonics.

Subsequently, Washington State University Tri Cities hired Birgitte Ahring as Battelle Distinguished Professor and director of the Center for Bioproducts and Bioenergy (CBB). A microbiologist recruited from the Technical University of Denmark, she directs an interdisciplinary center focused on research and academic programming in the use and conversion of biomass into bioproducts and biofuels.

Both universities have used their own funds to jump-start new Entrepreneurs-In-Residence (EIR) programs designed to help move existing and future research commercialization in key industry sectors. Washington State University's Entrepreneur-In-Residence program has commercialized new technologies to revolutionize the food industry, including investment strategies to support the development of a new, lightweight material capable of shielding radiation.

The University of Washington's Entrepreneur-In-Residence program has supported the commercialization of biomedical devices, clean technology, software development, and biotechnology. Both UW and WSU are expected to develop additional EIRs in 2010 with STARS and institutional support. The rapid growth of these programs reflects the commitment both public research institutions have to

the vision of the STARS program, and the translation of research into expanded economic development in our state.

Current biennium program planning

In the current biennium, UW and WSU plan to recruit researchers to work in the smart grid energy distribution and management field. The University of Washington will focus primarily on the customer-grid interface, while Washington State University will focus on energy management and distribution systems. Both institutions have identified significant opportunities for research support and university-industry strategic partnerships.

State budget cuts forced by the recession will hamper these efforts. The program's annual budget was reduced by $220,000 in FY 2009 and by $291,000 (13.2 percent below FY09 appropriated levels) in the current biennium. It is possible that further cuts may be necessary.

Longer-term program planning: From idea to market

The legislation establishing the STARS program calls for the recruitment of ten researchers in ten years. The fundamental purpose is bolstering the state's innovation capacity in emerging technology fields with high commercial potential. Innovation is the process of transforming an idea into a commercial product, process or service of value to a customer. If the technology is commercially successful, the downstream economic benefits are significant: increases in revenues, exports, jobs, incomes and wealth creation. By building on the strengths of the state's research universities across a number of disciplines, Washington can shape the direction of emerging technologies and foster the critical relationships for commercialization. The STARS program today is already evolving into a larger innovation ecosystem that is characterized by:

- Early interaction between research and business as a key commercial success factor;
- Integration of technical advances (push) with emerging market demand (pull);
- Leveraging of federal and private sector R&D;
- Collaboration as a core competency for business partnerships, networks and investors;
- Entrepreneurship as a vital ingredient;
- New sources of growth and competitive advantage.

For the strategy to work going forward two questions need to be addressed. The first question is what additional areas of research have a high probability of making technical progress and innovation breakthroughs? UW and WSU have identified several research fields in which the recruitment of STARS researchers could produce significant technical results with longer-term economic development implications for Washington. For the University of Washington these include clean technology and advanced materials, global health, and human health and medicine (bio-medical devices/robotics). For Washington State University they include renewable energy, engineering of renewable composite materials, and spectral analysis of plant productivity.

The second question however is the one most relevant--what is the probability of commercial (market) success? Technical progress does not automatically translate into economic value. STARS recruitment is necessarily made at time when commercial prospects are still uncertain and cannot be precisely predicted. Value is generated when technical progress, affordable pricing and end user demand are aligned around a desirable product, process or service. This question puts a premium on expert

intelligence about the market and competitive forces likely to shape emerging technologies and their commercial potential.

Accordingly, the WEDC Innovation Advisory Committee will collaborate with UW, WSU and business groups to integrate industry and market perspectives into the candidate portfolio of STARS researchers. Each research area needs to be considered as to its relevance to end-user market segments, strategic industry clusters, innovation partnership zones, investor expectations, manufacturing capability, competitive alternatives, profitability, regulatory environment and other related factors. The weighing of these criteria may vary with research area and market domains. It will be important to capture lessons learned from the current STARS researchers as a way of enhancing the commercial potential of future STARS investments. A number of assessment methodologies may also be helpful in this process: technology foresight, market segmentation, technology road-mapping, venture capital trends, Delphi studies, R&D industrial surveys, focus groups, industry cluster analysis, new product development, research portfolio analysis, risk management and futures studies. Through this framework, **STAR research areas** will be related to **commercial potential** through a **stakeholder validation process**. This framework will help optimize the recruitment of future STARS researchers and ensure a high return from merging technological opportunities.

The best way to take full advantage of these opportunities is through continued high levels of state support for the STARS program. If current funding levels are maintained, the program may just be able to meet this statutory goal of ten STAR researchers in ten years. The quality of the program will suffer in all likelihood from a reduced level of resources. Having less recruitment money will impact the quality of the candidates who can be attracted, and over time will result in lower levels of research commercialization.

Introduction

The Innovation Research Team program (commonly referred to as the STARS program) was created by the Washington Legislature in the 2007 session. Program planning and development occurred through January 2008 when the WEDC authorized the use of program funds to hire the first two STARS researchers. In the 2009 legislative session, the Legislature directed the WEDC to develop a new forward-looking plan for the STARS program. RCW 43.330.280 states:

- the WEDC must develop a plan to build on existing, and develop new, intellectual assets and innovation research teams in the state in research areas where there is a high potential to commercialize technologies;
- the WEDC must present the plan to the governor and legislature; and
- the HECB shall be responsible for implementing the plan in conjunction with the publicly funded research institutions in the state.

The legislation requires the plan to address the following elements and other such elements as the commission deems important:

(A) Specific mechanisms to support, enhance, or develop innovation research teams and strengthen their research and commercialization capacity in areas identified as useful to strategic clusters and innovative firms in the state.

(B) Identification of the funding necessary for laboratory infrastructure needed to house innovation research teams.

(C) Specification of the most promising research areas meriting enhanced resources and recruitment of significant entrepreneurial researchers to join or lead innovation research teams.

(D) The most productive approaches to take in the recruitment, in the identified promising research areas, of a minimum of ten significant entrepreneurial researchers over the next ten years to join or lead innovation research teams.

(E) Steps to take in solicitation of private sector support for the recruitment of entrepreneurial researchers and the commercialization activity of innovation research teams.

(F) Mechanisms for ensuring the location of innovation research teams in innovation partnership zones.

This report will address each of the planning requirements in the statute. It also includes information on program expenditures and outcomes for the program's first two years of planning, development and operations.

Background on the STARS program

This document was developed by the WEDC to:

- provide a program and fiscal report of the activities and performance outcomes of the STARS Program for its first 17 months of operation;
- provide a plan for the expenditure of funds and program activities for the coming biennium; and
- identify opportunities for recruitment of additional STAR researchers over the next two years and beyond.

Under RCW 43.330.280, the HECB is responsible for implementing the STARS program, in collaboration with the publicly funded research institutions and with policy direction from the WEDC. The program received an initial start-up appropriation of $2.37 million in the 2007-2009 biennium.

To prepare for program startup, the WEDC was required to develop an *Innovation Opportunity Analysis and a Program Plan* and to conduct an assessment of industry clusters in the state in collaboration with the Workforce Training and Education Coordinating Board (WTECB).
The HECB, the UW and WSU developed the *Innovation Opportunity Analysis and a Program Plan* in December 2007. The industry cluster analysis was completed in fall 2008. Both reports were submitted to the WEDC after they were completed.

Washington's areas of research preeminence

The *Innovation Opportunity Analysis* identified the areas of research preeminence at our two public research institutions that support commercialization opportunities in Washington State, as shown in Table 1 below.

Table 1

Areas of research preeminence at Washington research universities that intersect commercialization opportunities

University of Washington	Washington State University
Biotechnology, Genomics, and Biomedical Applications	Molecular Plant Science and Genetics
Advanced Materials and Nanotechnology	Chromosome Biology and the Science of Reproduction
Clean Technologies	Advanced Materials
Global Health	Clean Energy Technologies
Information Technology (E-Science)	Global Infectious Diseases at the Human-Animal Interface
Sensor and Sensor Networks	The Brain, Behavior, and Performance

These areas overlap considerably and can be combined into five broad categories of research activity that are congruent with the cluster-based Innovation Partnership Zones recently designated by the Washington Department of Commerce, as indicated in Table 2 below.

Table 2

Congruence between UW and WSU areas of preeminence and Innovation Partnership Zones

Area of Preeminence	Related Innovation Partnership Zones (IPZs)	WSU Critical Basic Research Strengths	UW Critical Basic Research Strengths	Primary Location(s) of IRT[1] Research
Clean Technology & Advanced Materials Nanophotonics Energy Environmental Monitoring/Sensors	Tri-Cities IPZ Pullman IPZ Grays Harbor IPZ Aerospace (Snohomish County) Life Sciences (Seattle) Discovery Corridor (SW Washington) Central Washington Regional Energy Consortium Grays Harbor Sustainable Industries IPZ	Atmospheric Sciences Chemical Eng. Electrical Eng. Mechanical Eng. Chemistry Physics Materials Science Biosystems Eng. Materials Sci. & Eng. Architecture, Wood Materials, plant sciences, extension	Chemistry, Chemical Eng. Physics Electrical Eng. Materials Sci. & Eng. Mechanical Eng. Microbiology Oceanography, Forest Resources Fisheries Conservation Biology Architecture and Urban Planning	Pullman, Seattle, Spokane, Tri-Cities, Vancouver
Global Health and Infectious Diseases at the Human-Animal Interface (Global Animal Health)	Seattle Global Health Spokane (future)	Global Animal Health Veterinary Microbiology and Pathology Molecular Biosciences International Programs Economics	Global health, Environmental Health, Public Health, Infectious Diseases, Law, Economics	Pullman, Seattle, Spokane
Human Health and Medicine Molecular Medicine Biomedical Devices Chromosome & the Science of Reproduction Brain, Behavior and Performance	Seattle Global Health Bothell Biomedical Manufacturing Corridor University District Spokane (future)	Molecular Biosciences Basic Medical Sciences Bioengineering Chemical Eng. Chemistry Nursing Pharmacy VCAP Psychology Physics	Chemical Eng. Chemistry Electrical Eng. Materials Sci. & Eng. Bioengineering Medicine Radiology	Pullman, Seattle, Spokane, Vancouver
Molecular Plant Science and Genetics (WSU)	Walla Walla Valley IPZ, Tri-Cities IPZ	Institute for Biological Chemistry Crop Sciences Horticulture Molecular Biosciences, Biological Sciences, Extension	N/A	Pullman, statewide research and extension centers
E-science (UW)	Discovery Corridor (SW Washington) Global Health (Seattle) Aerospace (Snohomish County) Pullman IPZ Information Technology Seattle/Bellevue/Redmond (future)	N/A	Computer Sci. & Eng., Medicine Biochemistry Astronomy Aerospace & Aeronautical Engineering Chemical Eng. Oceanography Physics	Seattle

[1] IRT – Innovation Research Team

Since the *Innovation Opportunity Analysis* plan was developed in 2007, several key factors have changed the opportunity landscape. First, Congress passed the ARRA, which is pumping billions of dollars of new federal investment into research and development on new energy resources, energy distribution systems, health informatics, and the telecommunications and built infrastructures. This provides new short-term opportunities for a research team to "hit the ground running," and the potential to access substantial amounts of applied research funding. Our research institutions have been aggressive pursuing and securing ARRA research funding.

Second, there are major federal policy changes on the horizon, especially in health care and carbon emissions control, that offer the potential for new areas of research and product development as industry and consumers adjust to the new policy regimes. These factors may affect which research areas Washington should select now for STARS recruitment, and which might be more appropriate several years from now.

The first two STAR researchers

Based on the plan submitted by the HECB, the WEDC authorized the universities to move forward with the first two STAR researcher recruitments in January 2008. The UW hired Michael Hochberg as an assistant professor in electrical engineering effective June 16, 2008. Hochberg is a prolific inventor with a doctorate in Applied Physics from the California Institute of Technology who specializes in Nanophotonics.

Subsequently, Birgitte Ahring was hired by Washington State University – Tri Cities as Battelle Distinguished Professor and the Director of the Center for Bioproducts and Bioenergy (CBB). A microbiologist recruited from the Technical University of Denmark, she began work part time March 1, 2008 and shifted to full time on August 15, 2008.

These recruitments illustrate how the STARS program can produce optimal outcomes when needs for key industry sectors in the state intersect with existing strengths at the research universities. The ideal recruitment is one that builds on university strengths, leveraging the existing academic community, while filling a gap that fits industry needs, translating basic research into industrial potential.

The next two recruitments planned for the 2009-2011 biennium will be prioritized by the WEDC to address one or more of the broad areas identified in Table 2. Due to severe budget cuts, the research institutions have few faculty positions available, and those are generally in areas in which student demand dictates new investments. Therefore, this plan addresses options in areas that seem most likely to have a faculty line available.

Setting context: the STARS program compared to other state programs

Compared to many other similar state-funded programs across the country, the STARS program is under-funded in terms of the level and duration of direct state support for faculty recruitment, retention, and research team operations. STARS provides about $1.7 million annually for recruitment and retention of research teams. Georgia provides $12.5 million; Utah, $15 million, and New York $30 million. Ohio made $187 million available to its research institutions in 2008 for recruitment and retention of entrepreneurial researchers, but is unlikely to sustain that level of commitment.
In addition, the STARS program provides about two years of financial support to a researcher while Georgia creates perpetual endowments and New York provides five years of support. Ohio and Utah vary since each project/recruitment is different. In Utah, the funds are appropriated directly to the two

public research institutions allowing them maximum flexibility for structuring each recruitment package or using funds for retention. In Ohio, the program is jointly funded by the state economic development agency and the Chancellor's Office.

Some of the major provisions of the state programs with respect to funding of faculty recruitment and retention are outlined below in Table 3, and more detailed information about other state programs is found in the Appendix.

Table 3

Funding Provisions of Selected State Programs for Recruitment and Retention of Entrepreneurial Researchers

Comparison of state funding to recruit and retain researchers

From funding provided by the State Science and Technology Institute

State	Total Program Recruitments (to date)	Total Annual Funding (Most Recent Year)	Program Funding Per Researcher Per Year	Maximum Duration of Researcher Funding
Georgia Research Alliance	61	$13m	$750,000	Open Endowment
Florida 21st Century World-Class Scholars	N/A	$20m	$1 million	One Year
Kentucky Research Challenge Trust Fund	199 Endowed Chairs	$25m	Institution Determined	Institution Determined
NYSTAR Faculty Development Program	41	$4m	N/A	Five Years
Ohio Eminent Scholars Program	50	$147m	$2.5 to $50 million	One Year
S. Carolina Centers of Excellence	21 Endowed Chairs	$25m	$2 to $5 million	Open Endowment
UtahSTAR Program	22	$17m	Institution Determined	Institution Determined
Washington STARS Program	2	$2m	$250,000 to $1 million	Two Years

Note: Funding shown is primarily for recruitment and retention of research teams including laboratory build-out. Most of these state programs provide funding for additional technology commercialization activities that are not shown.

STARS Program Performance and Fiscal Report for FY 08-09

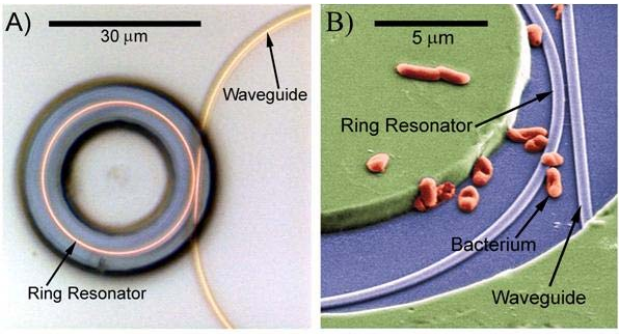
This section looks at the activities funded by the STARS program in FY08-09 and shows how the STARS program funds were expended. It also assesses the impact of the program's investments to date, keeping in mind that the researchers recruited in 2008 have been in the state for less than a year. Most of the performance outcomes of these investments will occur in future years.

In FY09, the Higher Education Coordinating Board expended $15,000 for its administrative and planning role in the program. These funds are used for program planning, funding allocation and monitoring, performance and fiscal reporting, and overall program coordination. No program funds were expended for these purposes in FY08.

Program activities and expenditures at the University of Washington

Michael Hochberg was hired as an assistant professor in electrical engineering effective June 16, 2008. Hochberg holds a doctorate in applied physics from the California Institute of Technology. He was awarded the *Demetriades-Tsafka* Prize by Cal Tech for his dissertation, which was judged the best thesis in nanotechnology. Before coming to the UW, Hochberg co-founded two companies: Simulant and Luxtera.

Hochberg would not have come to the UW absent the very strong support for acquiring electron beam lithography capability, since it he would not have been able to carry out his research without this cutting-edge instrumentation. STARS program funding made the development of this capability possible. A group of venture capitalists and companies in the Puget Sound area that are focused on developing an industry cluster around nanophotonics also were instrumental in Hochberg's recruitment. All agreed this high-technology area has tremendous potential for commercialization in the state, and concurred the STARS recruitment of Hochberg was projected to be both transformational and catalytic in this effort.



In his first year at UW, Hochberg has demonstrated success in building his research team, in collaborations, in raising money, in publication, and in advancing toward commercialization of his work. Innovation Research Team (IRT) recruitment funds in FY08 ($250,000) were used to purchase items of equipment in his group and to pay salaries of students he recruited. In FY09, the IRT recruitment funds are being used to set up the e-beam facility (see below for more details). The use of the FY09 IRT commercialization funds is described in the commercialization section below.

The Nanophotonics Lab

In this first year, Hochberg made a key hire for his lab: Tom Baehr-Jones, who holds a doctorate in Applied Physics from Cal Tech. In addition to his extensive publication record, Baehr-Jones was a co-founder of Simulant and Luxtera. While at Simulant, at the age of 20, he wrote an engineering modeling software that generated significant commercial sales. Baehr-Jones's position as UW staff scientist positions him well to help recruit and train students, but also to take a very large technical and business role in startups. Baehr-Jones will lead the effort to start companies based on the lab's work.

In the last year, Hochberg also succeeded in recruiting extraordinary new students. Hochberg's new group is effectively competing with universities such as Stanford for top students in the field of nanotechnology.

The e-beam lithography facility in Fluke Hall will place the UW's facilities for nanotechnology research among the top 10 universities in the nation. The e-beam lithography facility is moving rapidly through the design phase. The system (a JEOL 6300 FS) has been ordered and was installed in November 2009. After a testing and calibration phase, the facility will be running and available for both research and prototyping by January 2010.

Collaborations

Hochberg has established international collaborations with multiple groups, including companies with interests in nanophotonics. Intel is interested in licensing technology and doing sponsored research. Hochberg has an extensive collaboration with BAE Systems, a major defense contractor. He is a subcontractor on two NSF grants and will soon be a subcontractor on a Small Business Innovation Research (SBIR) grant as well.

Hochberg has been invited to speak at national conferences and is a member of the program committee for EIPBN, which is the premier nanofabrication conference in the world. He is currently collaborating with groups at Yale, Rochester, Arizona, and Rome, in leading institutions in the nanophotonics area.

Hochberg has also begun to collaborate with the Fred Hutchinson Cancer Research Center and the UW Bioengineering Department on new kinds of sensors for medical devices.
In addition to his relationships with industry and the research community, Hochberg has developed a close relationship with the nanotechnology program at North Seattle Community College. He serves on their advisory board and hired two NSCC students last summer as interns. He is helping with an effort to establish a curriculum in integrated photonics design for both graduates and undergraduates, which will provide skilled workers to local companies.

Raising money

The e-beam lithography facility is an excellent example of how STARS program funds can be leveraged. To date, the $1,230,000 in program funds dedicated to this facility through IRT funding have brought in matching funds of $1,300,000 from the Washington Research Foundation and $350,000 from the Washington Technology Center. In addition, the College of Engineering, the Washington Technology Center Nanotechnology User Facility, and the Department of Electrical Engineering have committed to building and operating the facility, which will add significantly more resources to the STARS funds. An estimated total of $2 million in leveraged funds will be available for the facility.

Hochberg has already brought $1,280,000 in external research support to the UW. He won an extremely prestigious Air Force Office of Scientific Research young investigator award (one of about 20 in the country) for $300,000 over three years, and a Murdock Foundation award for $700,000 for an optoelectronics center. He has received equipment donations from Tektronix valued at $250,000 and from Intel at $30,000.

Hochberg is optimistic he will receive additional external funding for his group's research over the next 12 months of between $500,000 and $1,500,000 from a variety of sources, including the Department of Defense and private foundations.

Raising stature

In his first year at the UW, Hochberg was published in the highly prestigious journal *Nature*. This accomplishment raises national visibility for the laboratory, the department, the university, and the state. Articles on his work were published in *Scientific American, Small Times, Physorg,* and the *New Scientist*, publications that reach broad, more general audiences and reflect his standing in the field. Hochberg was also featured on the National Science Foundation website, and one of his articles was featured on the cover of the *Journal of Physical Chemistry C*.

President Barack Obama talks with the Presidential Early Career Award for Scientists and Engineers winners in the East Room of the White House, Jan. 13, 2010. Washington STAR Michael Hochberg received his award in Engineering.

Toward commercialization

Hochberg has recently demonstrated a Mach-Zehnder modulator with slot waveguides and electrooptic polymers that requires only 0.25 V drive voltage, more than 10 times less than contemporary commercial modulators. This modulator has the potential to greatly improve data communications for both military and civilian applications, from computing to radar systems. Hochberg expects to form his group's first startup company in the next 24 months.

Commercialization activities

The commercialization funds ($85,000) were awarded in FY09 and are being used for two sets of efforts. About $60,000 is being used to enhance commercialization in the Hochberg group by supporting two personnel focused on moving laboratory breakthroughs to the point of commercialization. Tom Baehr-Jones and Alex Spott also have been working on various projects with significant commercial potential in the silicon nanophotonics space, including novel sensors, nonlinear optics, and new kinds of waveguides and modulators.

Tom's work has resulted in numerous patent applications, and Alex has been instrumental in getting ready to test a variety of new optical devices. The remaining $25,000 is being used to contribute to broader efforts at UW to bring together the emerging regional industrial nanophotonics community.

Funds have been used as part of the UW CLEAN Initiative (Center for Low-cost Energy through Advanced Nanomaterials) to help support workshops and conferences attended by a variety of industry groups as well as others, and to develop promotional and education materials, including a website (http://depts.washington.edu/ clean/index.html). The CLEAN Initiative mission is to marshal regional expertise in advanced organic and hybrid nanomaterials to develop cost-effective solutions for generating, storing, distributing, and using solar energy.

Team Performance Metrics, To Date

Below are the first 10 months of innovation research team's (IRTs) and Entrepreneurs-In-Residence (EIRs) start-up operations.

Table 4

Performance Metrics for the UW Nanophotonics Innovation Research Team (IRTs) and Entrepreneurs-In-Residence (EIRs), December 2009

Metric	FY09 value	Notes
Recruiting		
# of IRT researchers recruited	1	
# of IRT researchers hired	1	
Size of IRT teams	8	IRT Researcher; 3 Research Faculty, 2 graduate students, 2 undergraduate students.
Activity		
# of scholarly publications	7	
# of inter-institutional collaborations	12	Intel, Tektronix, BAE Systems, U. of Arizona, Genalyte, Semion, Boeing, Adlantis, FHCRC, Combimatrix, LETI (Europe), IMEC (Europe)
# of EIRs	6	Currently 6 EIRs, plus 3 emeritus EIRs
Impact		
Research funding awarded to IRTs from federal sources and foundations	$4,960,000	Plus $1,775,000 in follow-on awards anticipated; and over $15M in pending grants and white papers under consideration.
Research funding awarded from industry	$338,000	Primarily donated equipment
Tech startups based on IRT technology	1	Portage Bay Photonics
First-round investment in tech startups	n/a	
Total investment in tech startups (est.*)	$50,000	STTR award, phase I (awarded), phase II is expected to be between $300K and $1M.
Licenses of IRT technology to third parties	0	Early deals are now pending
Review		
Satisfaction survey	n/a	
Jobs created	10	Direct jobs

UW Expenditure Report

Expenditures for the current biennium are presented in Table 5 below.

Table 5

UW STARS Program Expenditures in FY2008 and FY2009

Budget Category	FY08	FY09
Salaries	$32,366	$64,976
Services	$8,873	$3,000
Equipment	$199,472	$975,000
Benefits	$9,289	$17,024
Total	**$250,000**	**$1,060,000**

Program activities and expenditures at Washington State University

Birgitte Ahring, an internationally recognized microbiologist, joined Washington State University as the director of the Center for Bioproducts and Bioenergy and as the Battelle Distinguished Professor, based at WSU Tri-Cities. She is leading WSU's interdisciplinary center, which will focus research and academic programming in the use and conversion of biomass into bioproducts and biofuels.

Ahring will lead research conducted throughout the WSU system, but much of it will happen inside the Bioproducts, Sciences, and Engineering Laboratory (BSEL), a 57,000-square-foot, $24.8 million facility at WSU Tri-Cities. BSEL is administered in partnership with Pacific Northwest National Laboratory (PNNL). Ten jointly appointed scientists will conduct cutting-edge research and development in bioenergy.

PNNL, in turn, is operated by Battelle for the U.S. Department of Energy. The WSU-PNNL partnership brings together WSU expertise in agriculture research and PNNL proficiency in conversion technologies to create a world-class center to tackle the type of multidisciplinary research, challenges critical to the development of cost-effective bioproducts and biofuels.

Ahring received her doctorate in microbiology in 1986 from the University of Copenhagen. As a professor at The Technical University of Denmark, she gained an international reputation as an authority in using anaerobic bacteria—bacteria that exists in an oxygen-free environment—to biodegrade waste. She also is founder and Chief Executive Officer of BioGasol, an engineering and technology company that designs and develops technologies for second-generation bioethanol production. Her company is a partner in the Pacific Northwest's first ethanol plant, which is funded with $24 million by the U.S. Department of Energy. This plant is being built in Boardman, Oregon, about 70 miles southwest of WSU Tri-Cities.

In her first year, Ahring began building her research program and team, developed her collaborations, pursued areas to raise funding, increased the visibility of the program, and has made progress towards commercialization.

Research program and team development

Ahring has made key personnel decisions in hiring Keith Thomsen as Laboratory Manager and Aftab Ahamed as research associate. Ahamed is working on research in advanced biofuels from fungal organisms; and has already connected with visiting scholars who are performing fundamental research on fermentative microbes, pathways and processes as well as research on enzyme extraction, expression and optimization related to conversion of biomass into fermentable sugars.

In addition, through its world-renowned plant science programs, WSU, via BESL, works to develop and create renewable and environmentally friendly energy systems. With BESL expertise in biofuels and bioproducts, researchers are working on the next generation of fuel/product groups. Work includes understanding the use of anaerobic bacteria, which uses substances other than oxygen to metabolize hard-to-handle industrial and hazardous wastes. The anaerobic process has the added advantage of producing methane and ethanol, which can generate electricity, and thermofilic digested sewage sludge, an agricultural fertilizer.

In collaboration with PNNL, researchers plan to develop technology to convert biomass, including value agricultural residues, into value-added fuels and chemicals like plastics, solvents, and fibers. As well, the BESL facility will provide much needed classrooms and laboratories for science education and additional research. Through its affiliation with Ahring, the Lab brings scientific talent and an established track record for transformational research that has led to demonstration projects in Oregon and Denmark.

Ahring has made important equipment purchases by obtaining two (2) Applikon 7-liter Microbial Bioreactor Bio-Bundles, an Agilent Gas chromatography-mass spectrometry (GC/MS), model 5975C, bundled with a CTC Analytics' CombiPAL and GC PAL automated sample injectors, a MiniOpticon real-time PCR detection system with a compact two-color real-time detector built on a MJ Mini cycler, and miscellaneous other equipment such as an LF Horizontal Flow Clean Bench, Forced convection incubator from Germany, a Sanyo top loading portable autoclave and a UV/VIS Spectrophotometer from the United Kingdom.

Collaborations

BSEL researchers are currently collaborating with PNNL on fundamental research into microbial pathways used to produce biofuels by various microorganisms. Ahring is also collaborating with

- the City of Cusick, WA regarding using invasive weeds as a biofuel;
- with the Prosser Research Station regarding the viability of various agricultural and native plant biomass as biofuels feedstocks; and
- Oregon State University on a Sun Grant related to biofuels research.

She has also submitted collaborative grant applications with OSU and the University of Idaho. BSEL is also collaborating with Weyerhaeuser Company, Energy Northwest, and the City of Richland on a US DOE integrated biofuels pilot plant grant application. Finally, WSU-Tri Cities (BSEL) has signed a collaboration agreement with the University of Aalborg in Denmark to conduct joint research and training in the areas of biofuels and biotechnology.

Raising money

Along with the several of the equipment purchases and loans completed for the BSEL, Ahring continues to propose research projects to federal and state entities. Currently she is awaiting responses on pending sources of research funding: $360,000 for the *Production of Infrastructure Ready Biofuels* with the National Science Foundation and $25,000 for *Exploring Field Crop Biomass Sources* in collaboration with OSU and the Washington Department of Transportation.

Additionally, she is preparing to submit three different proposals totaling $44,000,000, including $6,000,000 from Department of Energy Recovery Act Funds for a *Demonstration of Integrated Biorefinery Operations Project*; $13,000,000 from National Science Foundation for *Engineering Research Centers Funding*; and $6,000,000 from National Science Foundation for a *Major Research Instrumentation Program*. She continues to establish collaboration and license agreements with smaller companies and organizations for equipment and in kind support.

Raising stature

Ahring and BSEL researchers will publish a minimum of four articles in prestigious international peer reviewed publications. They will present at a minimum of one major national/international conferences and will make at least two presentations at regional/state level symposia or conferences. In addition,

Ahring will make at least two trips to Washington, D.C. to make presentations to congressional committees or federal agencies.

Commercialization activities progress

Ahring's pioneering work in bioethanol research and development has led to the construction of one Denmark's first cellulosic bioethanol pilot plants, and the company BioGasol, of which she was a co-founder of in 2006, was recently selected by the Danish government to develop an integrated biorefinery for the island of Bornholm. The plant will convert agricultural and other organic wastes into bioethanol.

In addition to international commercialization work, Ahring is involved in the design and development of the Pacific Ethanol's West Coast Biorefinery facility in Boardman, Oregon, which is being funded in part by the U.S. Department of Energy. She has established a solid partnership with PNNL at BSEL by establishing avenues for joint research and the development of innovative clean technologies through the shared employee appointments at WSU and PNNL. This collaborative effort will allow greater capabilities for the commercialization of any new technologies developed.

Ahring's international experience has allowed her to continue relationships she established prior to coming to WSU. Her company, BioGasol, is a partner in the ethanol plant being built in Boardman, Oregon. Upon her arrival at WSU, the university signed an agreement with Denmark's Aalborg University to establish as international bridge in the quest to develop bio-fuels and bio-products that reduce the world's dependence on oil. Her many relationships internationally, nationally, and locally have allowed avenues to open for the development of future technologies.

BSEL facility impact

The BSEL is a multipurpose research and development facility with operating space for all activities required to advance the science and engineering of processes for bio-based product manufacture. The building is located on the WSU Tri-Cities campus, about a mile south of the main campus of PNNL.

A key feature of the facility is the Biorefinery, a 2,500-square-foot high-bay facility for integration and scale-up of the various processing steps in bioproducts manufacture. In addition to the Biorefinery, the

BSEL includes:

- high-pressure catalytic reactor rooms (for hydrogenation and other chemical processing);
- bioprocessing labs for development and engineering of fungal fermentations;
- supporting wet chemical labs for synthesis and preparation of catalysts and feedstocks;
- the Combinatorial Catalysis research laboratory;
- analytical chemistry including chromatography and spectroscopy; and,
- process engineering research and development.

As a part of the WSU Tri-Cities campus, the BSEL has a key role in education. It contains both classrooms and teaching laboratories and it houses faculty, their research labs and space for graduate student research.

Team performance metrics to date

Below, Table 6 shows the performance metrics for the first 10 months of innovation research team's (IRTs) and Entrepreneurs-In-Residence (EIRs) start-up operations.

Table 6

Performance Metrics to date for the WSU Biofuels Innovation Research Team (IRTs) and Entrepreneurs-In-Residence (EIRs), December 2009

Metric	As of Dec, 2009	Notes
Recruiting		
# of IRT researchers recruited	1	Mounted international search for both post-doctoral researchers and joint WSU/PNNL faculty positions.
# of IRT researchers hired	1	Director of the Center for Bioproducts and Bioenergy
Size of IRT teams	13	One director, Four professors/scientists, five post-doctoral research assistants, three Ph.D. students and one manager make up the Center for Bioproducts and Bioenergy staff.
Activity		
# of scholarly publications	3	
# of inter-institutional collaborations	25	Research collaborators include Pacific Northwest, Argonne, Los Alamos, and National Renewable Energy Laboratories; UOP/Honeywell, Pall Corp., Amyris Biotechnologies, Valero, Albemarle Corp., Tesoro, Weyerhaeuser, Virent Energy Systems, Pacific Ethanol, Biogasol, EverGreen Renewables, Energy Northwest, Iowa State U., Colorado School of Mines, U. of California, Davis, City of Richland, Northeastern U., Georgia Tech U., South Dakota State U., U. of Minnesota, Wash. Dept. of Ecology
# of EIRs	1	Plan is to expand program in FY 2011.
Impact		
Research funding awarded to IRTs from federal sources and foundations	$739,000	The Center for Bioproducts and Bioenergy currently has $9.7 million in research proposals submitted and pending with various federal agencies.
Research funding awarded from industry	$0	
Equipment	$12,000,000	Access to PNNL Equipment
Tech startups based on IRT technology	0	
First-round investment in tech startups	0	
Total investment in tech startups (est.*)	0	
Third party licenses of IRT technology	0	
Review		
Satisfaction survey	n/a	
Jobs created	14	Direct employment of Center researchers and staff.

WSU expenditure report

Expenditures for the current biennium are presented in Table 7 below.

Table 7

WSU STARS Combined Program Expenditures for FY2008 and FY2009 (Estimated)

Budget Category	FY08/FY09 Expenditures
Salaries	$91,737
Services	$37,477
Equipment	$468,985
Benefits	$21,766
Total	**$619,965**

Budget planning for the 2009-2011 biennium

Overall budget activity for the program

The 2009 Legislature appropriated $4.2 million for the program for the 2009-2011 biennium. This represented a $200,000 reduction in funding from the program's biennial maintenance-level budget of $4.4 million. The funding reduction was made necessary by the recession, which has reduced state government revenues and precipitated funding cuts across most state programs and services.

In July and August of 2009, two additional funding reductions totaling $382,200 were made to the 2009-2011 budget. These cuts and the previous cut, totaling nearly $600,000, reduced the program's maintenance-level budget by 13.2 percent.

Additional cuts are also possible in the current biennium given the continued uncertainty regarding state revenues. Funds have been set aside for this contingency ($105,000) and will be programmed later if additional cuts are not forthcoming.

The original plan in 2007 for the STARS program was to ramp up funding in the initial years, not reduce it. Obviously, the recession has necessitated revision of that plan. Most of the cuts to the program have led to reductions in the planned size of the recruitment packages for the recruitment of new researchers. This will reduce the competitiveness of the recruitment packages the institutions are able to offer. Continued cuts to the program may make it impossible to achieve the program's statutory goals, including the goal of recruiting 10 high-value entrepreneurial researchers to the state by 2017.

The FY 2010-2011 program plan that follows was proposed by the HECB, UW, and WSU at the beginning of the current fiscal year, and has been modified several times to accommodate program funding cuts. **This plan was reviewed and approved for implementation by the WEDC's Investment Committee in October, 2009.**

Below is the overall program activity budget for FY2010-2011 with the funding cuts included, so that the totals equal the original amount appropriated by the Legislature for the STARS program.

Table 8

STARS Program Activity Budget, FY2010-FY2011

Budget Item	FY10	FY11	Total
WSU Grant	$681,760	$681,760	**$1,363,520**
UW Grant	1,022,640	1,022,640	**2,045,280**
HECB Admin/Planning/Reporting	21,000	21,000	**42,000**
Subtotal WEDC-HECB Transfer	*1,725,400*	*1,725,400*	***3,450,800***
Consulting Contract for: *IRT/IPZ Advisory Comm Support Performance Measurement STARS program planning Entre. Assistance for IRTs*	60,000	60,000	**120,000**
Emerging Cluster Research and Cluster Study Update	50,000	50,000	**100,000**
WEDC Administration, Reporting	21,000	21,000	**42,000**
2.5% Reserve for Additional Cuts	52,500	52,500	**105,000**
Subtotal WEDC State Level Activities	*183,500*	*183,500*	***367,000***
Budget Reduction Cuts	191,100	191,100	**382,200**
Total Appropriated STARS Funding	**$2,100,000**	**$2,100,000**	**$4,200,000**

Private support for STARS research teams

Both current STARS researchers, Michael Hochberg and Birgitte Ahring, began receiving support from private industry after their arrival in Washington. This support will continue to grow as they demonstrate success in their research and commercialization activities.

Additional private support for STARS research teams is expected to come directly to other researchers who are recruited for the program. Private companies will provide support primarily based on the potential impact of the research on their strategic plans. Developing a thorough business case that spells out the costs and benefits of the researcher's activity will be essential. This business case will require the specific field of inquiry and demonstrated excellence by the specific researcher within this field.

Private research support may play an increasing role in attracting and retaining research talent, but in the near term it still will be necessary for the state and its research universities to continue the up-front investment needed to recruit outstanding research faculty under the STARS program. When economic recovery is in full swing, private money may become available to support STARS researcher recruitment.

This would help Washington because it would significantly increase the pool of money available at the outset – money needed to recruit successful senior researchers from other institutions. In turn, these senior researchers would already have existing private sponsors, a history of accomplishment, and a mature research strategy that Washington would be able to leverage in seeking additional commitments for private support.

As the STARS program matures and demonstrates results, private companies and donors might begin to see the value of supporting the program itself rather than individual researchers as a way of encouraging more entrepreneurial activity. The STARS program would have to have more history, momentum and stability, and the general economy will have to recover, before we can begin to expect this kind of support.

The University of Washington

Fiscal Year 2010

Commercialization. The UW proposes to build out a robust Entrepreneur-in-Residence (EIR) program and to apply additional resources specifically to the commercialization of Hochberg's work in nanophotonics. The EIR program ($150,000 for 4-5 EIRs) brings experienced business leaders from industry into regular contact with our research teams and licensing officers. Each EIR receives a modest stipend to cover his/her out-of-pocket expenses; their primary motivations for participating are goodwill for the university and excitement about the market sector.

For Hochberg, UW proposes to provide additional resources directed at commercialization. These include funds for tapeouts[2], for commercial foundries ($32,640), to support commercialization prototyping, and a small amount of funds for market research expenses ($5,000), which will be used for some combination of industry reports, MBA assistance, local hosting or travel, specific to commercialization of Hochberg's work.

STARS support. Most of the funding ($825,000) will be used to enhance the e-beam system purchased in FY09 and sited within the Washington Technology Foundation's Fluke Hall. The original plan provided for a bare-bones facility; this funding will permit an expanded facility with increased capabilities and better usability for both the Hochberg group and potential industry users.

In addition, UW proposes to recruit a new STAR researcher in FY2010, hired in FY2011, in an area chosen by the WEDC linked to our state's economic development objectives, as well as leveraging strengths at the UW (see below for potential areas). Ten thousand dollars in STARS funding is set aside for recruitment expenses in FY2010.

Fiscal Year 2011

Commercialization. For FY2011, UW proposes to expand the EIR program ($225,000 for 6 EIRs) and to apply additional resources specifically to the commercialization of Hochberg's work. The latter will include more funding for tapeouts ($141,640), funding of release time for a staff scientist ($60,000) to investigate and pursue commercial opportunities, in conjunction with an EIR, funding for a post-doc ($68,000) for software development or hardware commercialization, and a small amount of funding for more market research ($8,000).

[2] In electronics design, tape-out or tapeout is the final stage of the design cycle of integrated circuits or printed circuit boards.

STARS recruitment

STARS support. $520,000 is set aside as part of a recruitment package for the new STARS researcher. A department at the UW will provide the faculty line for this recruitment and the UW will provide the remainder of the recruitment package.

Characteristics of STARS researchers

As with our first STARS researchers, it is important to recruit a faculty member with the following characteristics:

- academic excellence;
- strong track record of working with industry, including start-up company experience;
- high level of enthusiasm for a position that combines traditional academic efforts with close ties to industry;
- research area that supports economic development in the State, meshing with strategic business interests of the State of Washington; and
- a research area that leverages existing strengths at the University of Washington.

Potential areas for recruitment

The UW has identified six potential areas (noted below in order of priority) that fit the STARS criteria above, and also have the potential for an available faculty position for recruitment in FY10, hiring in FY11. These areas each involve one or more of the main areas of emphasis/industry clusters noted in Table 2, each build on existing strengths, and each are in a position such that a key hire could be transformational in bridging the gap between basic research strengths and translation to industry.

The top priority for the UW is in energy-related areas (bold-faced below), since this is a high priority for both the UW and the state, opportunities for federal funding are very high, and the growth potential in this sector is also very high. Two areas are listed, in order of priority for the UW:

Top priority: energy/clean technologies

- **Energy efficiency through nanosystems**
- **Smart grid**

Other potential areas, in order of priority:

- Healthcare/biotech and IT/eScience
  - Neural engineering
  - Point-of-care diagnosis
- IT/Communications
  - Cloud computing
  - Networked environmental monitoring

In the short descriptions below, each area includes a list of potential companies and foundations for which this area would be of interest. They have not yet been contacted, as we are awaiting strategic direction from the WEDC. It is expected that letters of support would be provided by these entities.

Energy efficiency through nanosystems

The computing industry has had a dramatic impact on the effectiveness of our local and national economy. However, the next generation of computing, driven by massive-scale "cloud computing" data centers, such as those operated by Amazon, Microsoft, and Google, is consuming an ever-increasing percentage of the world's electricity budget. A single such data center consumes as much electricity as a small city.

This will have a particular impact on the Northwest, since many of these data centers are being located here to gain access to low-cost hydroelectric power. Advances in photonic switches and transistors, in coordination with a more prominent role for high-performance communications, could lead to a dramatic reduction in energy consumption while at the same time increasing computing speed. The UW Clean, Low-cost Energy through Advanced Nanomaterials (CLEAN) Initiative includes energy-efficient devices as one of three key thrusts.

Researchers at UW have made important advances in materials, nanosystems and ultra-low-power electronics. Bringing in a researcher who bridges the gap between devices, computer architecture, and computer systems would lead to major advances in efficient power utilization. Strengths at UW: photonics, nanotechnology, Center for Materials and Devices for Information Technology Research, UW Experimental Computer Engineering Lab (EXCEL), and strong technology transfer record. Interface with industry: Google, Amazon.com, Intel, Microsoft Research, GigOptix.

Smart grid

Existing power grids provide the links between the producers of electric energy and the consumers assuming predominantly carbon-based energy producers located remotely from the load centers. However, the energy landscape is changing with the increasing penetration of renewable energy systems and the emergence of several microgrids. Future developments in renewable energy can only succeed if the customers are allowed to interact with the grid by becoming suppliers as well as users of electric energy. With self-diagnosis and regulation, the Smart Grid will also reduce blackouts and improve security. To build a smart grid, the innovations needed include advanced sensing, communication, routing, protection, and control technologies. UW strengths: sensors, control, networking, renewable energy research. Interface with industry and others: AREVA, Puget Sound Energy, BPA, Tacoma, Snohomish PUD, Seattle City Light, Batelle/PNNL and others. In this area, UW would work closely with WSU in a collaborative mode, as the strengths of the two institutions are complementary.

Neural engineering

Neural Engineering involves the intersection of robotics, computer science, neurobiology, and healthcare for patients with neural disorders. In neural engineering, a computer technology will interface with the human nervous system, making possible new ways for the nervous system to function. For example, electronics embedded in the brains of stroke victims could train and connect underutilized neurons to replace permanently damaged ones in order to move paralyzed limbs. Alternatively, robotic devices could non-invasively reprogram neural signals to improve motor skills, perception, and cognition in patients with damaged neural function as a result of disease, accidents, and birth defects. Strengths at UW: robotics, neural-computer interfaces, neurobiology, clinical research. Interface with industry and others: Microsoft, hospitals, Bill and Melinda Gates Foundation, Paul G. Allen Family Foundation, *Neurovista and Norstar (two startup companies).*

Point-of-care diagnosis

Our society has created remarkably sophisticated technologies for diagnosing illness, which contribute greatly to preserving life and enhancing quality of life. However, access to these capabilities is not distributed evenly among the world's populations, in part because they require infrastructure that does not exist outside urban hospitals and other centralized laboratories. New technologies in chemical measurement and medical imaging, combined with capabilities of cell phones and the internet, can move many sophisticated medical diagnostic capabilities to low resource settings within rural areas in the US and in the developing world. Strengths at UW: biomedical engineering, biochemistry, global health, medical school, computer science and engineering. Interface with industry and others: PATH, the Bill and Melinda Gates Foundation, Microsoft Research, Micronics, Inc., Nanogen, Inc., and The Washington Research Foundation.

Cloud computing

Cloud computing is a computing paradigm in which computing tasks are assigned to a combination of connections, software and services accessed over a network. This network of servers and connections is collectively known as "the cloud." This type of "on-demand computing" can sort through enormous amounts of data, and gives users supercomputer-level power as it is needed. This vast processing power is made possible though distributed, large-scale cluster computing, often in concert with server virtualization software and parallel processing. Cloud computing requires innovations from the application layer down to the broadband infrastructure. As all types of businesses grapple with an exponentially increasing data stream of relevance to their efforts as well as rapidly increasing online needs, new methods for cloud computing appear as a potentially highly leveraged and viable solution. In addition, as research needs also increase exponentially, some types of analyses are potentially viable in a cloud environment, which again, has the potential to solve problems of enormous and complex datasets. UW strengths: Computer Science and Engineering, eScience. Interface with industry: Microsoft, Intel, Google, Amazon.

Networked environmental monitoring

Increasing concerns about environmental pollution and climate impacts on the environment, coupled with the focus on accountability in the Obama administration make it clear that environmental monitoring will be a major emerging industry. Both climate predictions and life cycle analysis of new energy technology requires tracking the complex interactions between environmental subsystems (e.g. ocean, land, atmosphere) at multiple scales while maintaining the dependence of measurements across subsystems. Critical to the success of such an effort is a reconfigurable/portable and scalable networked infrastructure with embedded intelligence, combined with computational analysis tools for processing large data sets. Strengths at UW: sensor development, sensor networks, environmental observatories, climate impacts group, data mining and visualization, eScience initiative. Interface with industry and others: NOAA, Microsoft, Google, Amazon, and Boeing.

Proposed FY2010 and FY2011 budgets

For FY10, the installation of the e-Beam Lithography Laboratory is our primary priority. Because we are still completing the bidding process, construction costs still include a certain amount of risk, and thus these numbers are estimates. Biennium budget is outlined in Table 8, below.

Table 9

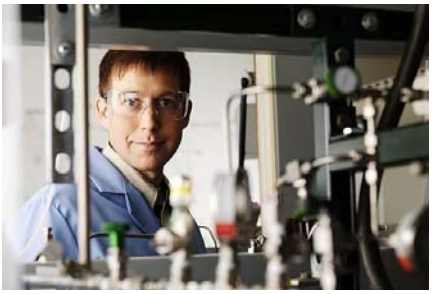
The Proposed Budget for UW in FY10 and FY11

Program Activity	FY10	FY11
E-Beam Lithography Laboratory		
Finish installation/construction/facility prep	$825,000	
Commercialization		
Tapeouts for commercial foundries	32,640	$141,640
EIR program	150,000	225,000
Release time for staff scientist – commercialization projects		60,000
Post-doc for software development or hardware commercialization		68,000
Market-research expenses	5,000	8,000
New Innovation Research Team		
Recruiting	10,000	
Recruitment package		520,000
Total	**$1,022,640**	**$1,022,640**

Washington State University

Fiscal Years 2010 and 2011

Commercialization



For FY11, WSU will increase the EIR program by $75,000. Tentative plans are to coordinate an eastern Washington regional effort among the cities of Pullman, Spokane, and the Tri-Cities. Sectors to focus on include food, agriculture, clean technology, global animal health, advanced materials, other opportunities directly related to WSU research.

WSU-BSEL, in cooperation with PNNL, will apply for funding to construct an integrated bioethanol pilot plant to be constructed adjacent to the BSEL facility in Richland, WA. This plant will conduct pilot scale research using an integrated series of discrete unit operations.

STARS recruitment

WSU has budgeted $520,000 for recruitment of a new STARS researcher, and will also include recruitment of:

- Four new joint WSU/PNNL faculty and research positions;
- Two new doctoral students; and,
- One to four new post-doctoral students (funded by specific research grants)

STARS recruitment characteristics

As with our first STARS researchers, it is important to recruit a faculty member with the following characteristics:

- academic excellence;
- strong track record of working with both industry and government sectors;
- integrate into a research area that advances economic development in the State;
- research area that will attract a significant portfolio of external competitive funding at the federal level; and,
- research area that augments existing strengths at Washington State University.

The WSU top priority is in energy-related areas (bold-faced below), since this is a high priority for both the WSU and the state. WSU is already seeking federal opportunities and collaborations based on funding opportunities provided by the U.S. Department of Energy. The areas listed are in order of priority for WSU.

Top priority: Modernization of the power grid

Other potential areas, in order of priority:

- Linking agriculture and plant biochemistry to alternative biofuels
- Global animal health and infectious diseases

In the short descriptions below, each area includes a list of potential companies and foundations for which this area would be of interest. They have not yet been contacted, as we are awaiting strategic direction from the WEDC. It is expected that letters of support would be provided by these entities.

Modernization of the power grid

This area of research is our first priority for this STARS hire. WSU scientists are already ranked among the strongest in the nation in developing and implementing the software necessary to manage the dynamic demands of the next power grid. However, it is critical to develop capacity in this area to allow the maximum contribution to the private sector. While the UW hire in this area will focus on the grid / consumer interface, the WSU focus will be the development of the information technology to enable the management of a highly dispersed power grid. As multiple sources for electrical generation (wind, solar, wave, etc.) come on line, a more dispersed set of input sources must be managed through the grid.

Likewise, the system needs to become “smarter” to better handle the efficiency of consumer use and more rapidly adjust power output in this more dynamic environment. WSU will interface with this sector of the industry and already has solid relationships with key sectors in this market (BPA, Areva, etc.). We will hire someone who will build this public/private connection and use this opportunity to directly impact economic development in our region. Furthermore, this research area is a high priority at the federal level with ARRA (stimulus) funding that will allow additional leveraging of state investments.

Linking agriculture and plant biochemistry to alternative biofuels

The second priority will be to link WSU's strength in agriculture and basic plant biochemistry to the energy sector, especially alternative biofuels. WSU's first hire (Birgitte Ahring) focuses on lignocellulosic conversion technologies and bioprocessing. However, WSU is ranked in the top 5 in the world in plant biochemisty. Many of our outstanding scientists are already funded to find novel plant compounds that can serve as sustainable high quality "drop in" fuel sources to replace petrochemicals and we likely lead the IP in this sector nationally. WSU can, however, broaden and deepen our impact in this young industry by taking further advantage of our expertise in plant- based biofuels by hiring someone who will specifically work on the translational science that will take these "frontier" molecules into full scale production.

Global animal health and infectious diseases

WSU's third priority will be to add to our global animal health mission in infectious disease research. Roughly 70% of human infectious diseases are zoonotic in origin – i.e. they enter the human population from animals. Generating new animal vaccines for diseases that are likely to jump to humans represents a powerful and innovative approach to decreasing global challenges associated with human disease. The state of Washington is well positioned to see this approach to fruition with the nexus of WSU's expertise in animal infectious disease, SBRI, and others in vaccine development, the UW School of Medicine and its expertise in global health and the global nature of our state's economy. This hire would focus on the market development that is needed to bring novel vaccine technologies into wide scale production.

Proposed budget for FY2010 and FY2011

For FY10, completing the anticipated equipment purchases, as shown below, will be our primary priority. Biennium budget estimates are outlined in Table 9, below the budget justification.

- Biomass pretreatment system. The pretreatment system being procured is an essential, custom-designed 10 liter reactor/pretreatment tank and 100-liter flash tank. These individual components are the feedstocks for subsequent research into enzymatic hydrolysis, fermentation and distillation of bioethanol fuel and bioproducts, and are also used as feedstocks by Pacific Northwest National Laboratories (PNNL) for their thermochemical research. **Estimated cost $250,000.**
- Procurement of a 100 liter Allegheny Bradford bioreactor that includes controller and user computers, a control panel and manuals. This 100 liter bioreactor will be an essential tool to study small pilot-scale fermentation experiments and reactor systems as well as to gain invaluable insights into scale-up challenges. **Estimated cost $50,000.**
- Purifier Logic Class II Biosafety Cabinet. This equipment provides BSEL researchers with protection from accidental exposure to potentially hazardous particulates, chemicals or organisms that require Biosafety Level II or III containment. **Estimated cost $8,000.**
- Leica M205 A automated stereomicroscope. This equipment will allow both BSEL and PNNL researchers to study filamentous microorganisms and the wide variety of morphology typical of these organisms. In addition, this will allow BSEL and PNNL researchers to study the potential of using fungal microorganisms to produce biofuels and/or bioproducts. **Estimated cost $50,000.**

Table 10

The Proposed Budget for WSU in FY2010 and FY2011

Program Activities		FY10	FY11
Biofuels Research Team Support			
Pretreatment system, bioreactor, safety cabinet, and microscope, post-doctoral researchers		$610,106	
Commercialization			
EIR program		65,000	$181,760
New Innovation Research Team			
Recruiting		6,654	
Recruitment package			500,000
	Total	**$681,760**	**$681,760**

HECB and WEDC administration

As in the previous biennium, The STARS program will continue to be implemented by the HECB in conjunction with the publicly funded research institutions. The HECB will take a lead role in planning coordination and the distribution of program funds. It will be necessary to develop a Memorandum of Agreement between the HECB and the WEDC that details the role and responsibilities of the HECB in fiscal and program oversight, and authorizes the transfer of funds to the HECB for distribution to the research institutions.

An annual planning process will be implemented each spring by the HECB with the goal of transmitting to the institutions new policy goals, industry needs, and economic development opportunities and incorporating that information into an annual program and expenditure plan. This annual plan will also describe how the previous year's funds were expended, program results achieved, program activities to be implemented in the coming fiscal year, institution-level budgets, and performance targets. It will produce a report similar to this one at the end of each fiscal year.

In addition, the WEDC will hire a consultant to staff the STARS program advisory committee and, along with the Commission's Investment and Innovation Committee, set policy direction for the program and establish an accountability and evaluation regime. These groups will also coordinate a public outreach and information strategy for the program.

To make it possible for the HECB and WEDC to fulfill these administrative, planning, performance accountability and reporting functions as described above, the HECB and WEDC will reserve 2.0 percent of program funds for these purposes, or $21,000 per fiscal year. These funds will be split between the two agencies.

A total of $183,500 will be reserved at the state level by the WEDC for program planning and development (including staffing of a program advisory committee), emerging cluster research for identifying future areas of STARS researcher recruitment, contingency funds and administrative support (see Table 8). Of that amount, $21,000 per fiscal year will be reserved by the WEDC for it program administration expenses.

STARS program planning beyond the current biennium

The HECB, the UW, and WSU see the 2007 opportunity analysis as still accurate. The areas with the greatest potential for commercialization and promotion of innovation that overlap with areas of strength and future growth at the two institutions remain:

- Clean Technology (including renewable energy) and Advanced Materials
- Global Health
- Human Health and Medicine
- Molecular Plant Sciences and Genetics
- eScience/Information Technology

All five areas have strong overlap with growth areas in the State of Washington for the next three biennial recruitments. However, the institutions propose to integrate eScience/Information Technology into the other four areas.

Table 11 below sketches out the budget for the STARS program based on current and projected allocation of funds to the major activities supported by the programs. In implementing the program this year we have discovered that commercialization activities following on the second year of research team funding are often appropriate and required. This explains why the second year in each biennium shows a bump in the level of commercialization expenditures.

This scenario assumes program funding going forward at current funding levels, which the Commission is **not** recommending. Under a level funding scenario, there is only about $1.2 million available each year to support two innovation research teams, or an average of $600,000 per team per year. This level of funding is far below what most other states provide for this activity.

Table 11

Long Term Budget Allocation Scenario

Fiscal Year	Support Previous Teams	Commercial-ization	Recruit New Teams	Planning/ Administration	IRT Program Annual Total	Teams Started
2008	0	0	430,000	0	$430,000	1
2009	0	370,000	1,685,000	145,000	$2,200,000	1
2010	1,435,106	252,640	16,654	152,000	$1,856,400	0
2011	0	684,400	1,020,000	152,000	$1,856,400	2
2012	1,450,000	425,000	50,000	175,000	$2,100,000	0
2013	0	725,000	1,200,000	175,000	$2,100,000	2
2014	1,450,000	425,000	50,000	175,000	$2,100,000	0
2015	0	725,000	1,200,000	175,000	$2,100,000	2
2016	1,450,000	425,000	50,000	175,000	$2,100,000	0
2017	0	725,000	1,200,000	175,000	$2,100,000	2
	5,785,106	4,757,040	6,901,654	1,499,000	$18,942,800	10

Note: FY2010 and 2011 annual totals do not include funding reductions and contingency reserves.

Possible areas for recruitment in future biennia

The STARS program has a statutory goal to recruit ten entrepreneurial researchers in ten years (RCW 43.330.280). As is shown from the funding scenario presented above in Table 11, it may be possible to just meet that goal by maintaining the current level of funding. Obviously, **with more money available for recruitment and team support, the research institutions can recruit a higher-level researcher capable of producing more commercially viable technologies of greater economic impact than is otherwise possible under the level-funding scenario presented above.**

The UW and WSU have analyzed where they think the opportunities for recruitment are likely to be given current funding trends, policy directions, and institutional capabilities and our state's economic development priorities. Their analysis also takes into account where faculty lines may become available, since the program does not pay for the STARS researcher's salary (or their research teams' salaries) on an ongoing basis.

What follows are the institutions' best assessments under current conditions, with the understanding that those conditions are likely to change and the program needs to be open to taking advantage of opportunities for recruitment as they arise.

University of Washington

The University of Washington proposes that their next three STARS recruitments be in the following areas, with the understanding that changing economic and funding conditions and unanticipated opportunities will necessitate modifications to this plan:

1. Clean technology and advanced materials: energy generation and efficiency

In order to meet the ambitious goals for energy independence in the U.S., it will be necessary to develop new and emerging technologies for both energy generation and energy efficiency. The State has excellent resources necessary to meet this challenge, an excellent entrepreneurial environment, a public passion for the environment, and a superb IT infrastructure, which will all be crucial for advances in energy generation and efficiency.

The State has the potential to become a national leader in this area and the economic development potential is huge. The UW has existing strengths in the basic nanomaterials science and chemistry that is already beginning to generate research breakthroughs in these areas. An investment in a STARS researcher at the UW who would catalyze the translation of research breakthroughs into new devices would have dramatic impacts on our ability to generate clean energy, cheaply and in an environmentally friendly manner, and launch the State as a national leader in this area.

2. Global health: public health interfaces with health care efficiencies

The importance of the health of the world's population has gained broad recognition after recent global social, political and environmental crises. Furthermore, the HIV/AIDS and SARS epidemics also have emphasized the world-wide impact of disease. Public and private funding, through visionary foundations (e.g., the Gates Foundation, the Wellcome Trust, etc.) have made unprecedented contributions to these important efforts, but the challenge is still growing. At the UW, a broad group of global health researchers are working to generate new approaches to improving the world's health. This program builds on existing UW strength and brings together educational and service programs for creating or improving public health systems in various developing countries, programs that are advancing our knowledge of global pathogens and nutritional disorders, and a variety of social science, economics, law, and business programs focused on global health problems. With the strengths of the UW and other research institutions and the presence of the Gates Foundation, Seattle is poised to become the global

health center of the world, with many spinouts that will positively impact economic development in the state. Recruitment of a new STARS researcher who would help bridge the breakthroughs in basic biomedical science to societal implementation would fill a key gap and foster both economic development around implementation as well serve the State in creating regional health care efficiencies.

3. Human health and medicine: biomedical devices and robotics

The broad field of biomedical devices coupled to robotics has the potential to transform health care, especially for the elderly and disabled. Imbedded monitoring devices in the home and car, prosthetics that function like natural limbs, robotic surgery for highly delicate operations, inexpensive and painless diagnostic tests in the clinic—all are emerging possibilities with strong commercial potential in the life sciences area. The UW has strength in these areas already across a number of departments, and adding to this team with a new STARS recruit would not only strengthen the existing effort, it would further enhance the commercialization success of this group. As with the other two areas, STARS researchers are translators who bridge between scientific advances and commercialization.

Resources and STARS Researcher Recruitment

All three of these areas will require significant resources to recruit the very best researchers. The UW will provide the faculty positions and a basic recruitment package. However for these types of researchers, a basic recruitment package will not be sufficient. The IRT program funds will be used to increase the package. In addition, it is expected that once a candidate is identified, support from foundations and/or industry can be obtained.

If the STARS funding continues at the existing level, it will support recruitment of more junior faculty members, either at the assistant or associate professor level. If the funding is increased, it would be possible to recruit at the full Professor level. In general, more junior faculty will require longer to ramp up their research program and to have an impact in commercialization.
For the program's comprehensive entrepreneurial assistance component, the UW proposes to continue the successful EIR program.

Washington State University

Washington State University has identified three areas where there are opportunities for recruitment of entrepreneurial researchers into the state in the 2012-2018 period that build on the institution's existing areas of research pre-eminence and have significant potential for high value technology commercialization that catalyzes economic growth and innovation.

1: Renewable energy

Bioprocessing can produce many valuable products and is essential in the continued advancement towards renewable and sustainable fuels from biological sources. Bioprocessing may use yeast, fungi, bacteria, or genetically engineered organisms for specific substrates and end products. The researcher hired in this area will work with partners on fermentations and cell growth, cell mass harvesting, and product purification strategies especially focused on developing new approaches to obtain renewable energy from agricultural biomass. This work will augment our agricultural-based bioproduct utilization and biomass production across the state by developing new technologies and markets for these specialty crops.

2: Engineering of renewable composite materials

WSU is a world leader in the development and implementation of wood-plastic composites in the building industry. As our society and world advance towards greener buildings with low-carbon footprints, we will need to develop advanced composites from recycled precursors. Building on our

strength in this area, we will add a commercial perspective to develop core technologies around both advanced recycling methods and using these recycled materials to generate innovative building materials to replace existing wood and wood/plastic composites.

3: Spectral analysis of plant productivity.

Our planet faces a confluence of unprecedented challenges and opportunities that directly involve the plant sciences. The United Nations estimates that food production will have to increase by at least 70 percent over the next 30 to 50 years to achieve global food security. Unfortunately, while the need for food is increasing, the actual increases in plant productivity seen in the early years of the "green revolution" have flattened with no breakthrough technologies yet coalesced to meet this challenge. In addition, we also have to face the reality of global climate change (likely producing more drought conditions globally) and the need to attain national energy independence by increasing the use of plants as biofuels.

Anticipated changes in our global climate, and its impact on regional climate, confound our technological ability to simultaneously enhance food production and alleviate our need for fossil fuels. To address these challenges, we need to develop simultaneously the crop plants and crop management systems for highly productive and sustainable agriculture within a rapidly changing environment. These challenges are of such magnitude, and are occurring with such rapidity, that traditional methods of breeding, agricultural field research, and even laboratory scientific research will clearly not meet the challenge. Instead, a highly integrated approach that combines existing tools and creates new ones will be needed to probe and manipulate many kinds of plants, at multiple levels and under many conditions simultaneously. The U.S. must develop appropriate responses that drive synergy between multiple disciplines and technologies.

WSU has established a leadership position in rapid analysis of molecular markers and even the array of transcriptional products and metabolites in plants. Entire genomes and transcriptomes are now appearing at regular intervals, resulting in a huge and growing pool of such data that serves as the basis of much of current plant research and drives the future of agriculture. Ironically, obtaining detailed genomic data is currently far easier than knowing how the plant functions in its environment, because the technology and infrastructure for rapid throughput assessment of phenotypes has (simply) not yet been built. We need to consider augmenting our research capability with a STARS researcher focused on developing the spectroscopic technology platform to drive this new era of plant science. The result will be our ability to deploy novel germplasms into specific agro-ecosystems across the globe to develop new markets for food and fuel.

APPENDIX

State Programs to Recruit and Retain Researchers

(Compiled by the State Science and Technology Institute, May 2009)

Georgia

http://www.gra.org/

As of December 2008, the Georgia Research Alliance (GRA) had recruited 61 research faculty to Georgia through its Eminent Scholars Program. Each position goes to one of six universities in the state: Clark Atlanta University, Emory, Georgia Tech, Georgia State, the Medical College of Georgia, and the University of Georgia. To create a position, $1.5 million is needed for an endowment, with $750K coming from the state and $750K coming from the university. The GRA's funding from the state came to $41.1 million in 2008, with $12.5 million of that going to the eminent scholars and their labs. The operating budget for the GRA comes exclusively from individual companies, foundations, and donations.

Identified fields of interest for the GRA eminent scholars are advanced communications, drug discovery and vaccine development, advanced medical and technical devices, nanotechnology, bioinformatics, applied genomics, and energy.

The GRA does not take an equity position in any spin-off companies coming from GRA researchers. Additionally, the GRA coordinates an annual meeting where all of the eminent scholars in the program come together.

Florida

http://www.flbog.edu/about/cod/asa/pred.php

Florida's 21st Century World Class Scholars Program provides matching funds to state universities to attract nationally recognized faculty in the areas of the sciences, technology, engineering and mathematics. The program, which allocates state matching funds to attract 21st Century World Class Scholars to state universities, is administered by the Florida Board of Governors.

Applications from universities are reviewed by the Florida Technology, Research, and Scholarship Board. A state university must raise a minimum of $1 million to be eligible for state matching funds to recruit a 21st Century World Class Scholar. Funds raised by the university shall be eligible for a one-to-one match from the state. Revenues received from state appropriations, student tuition and fees, and state-funded contracts or grants are not eligible for state match. Matching funds are provided immediately subsequent to approval of awards.

Any state university may apply, but they must provide evidence that the institution places an emphasis on one or more emerging technologies or academic disciplines that could favorably impact the state's economic future. The university must also demonstrate pre-existing research competitiveness in the area of the application.

The program was established in FY06 when $20 million was allocated for this program. Sixteen Scholars were recommended for funding that year.

Kentucky

http://cpe.ky.gov/policies/budget/Trustfunddetail.htm#TF1

Created in 1997 and administered by Kentucky's Council on Postsecondary Education, the Research Challenge Trust Fund is a repository for legislative appropriations designed to encourage research activities at the University of Kentucky and the University of Louisville. It includes the research university portion of the state's Endowment Match program. Commonly known as "Bucks for Brains," the program uses state funds to match private donations and support research in strategically-defined areas. A smaller program provides funding for endowment matches at non-research state universities.

In 1998 Kentucky legislators invested $110 million in general fund appropriations to support Bucks for Brains at the state's research and regional universities. That investment was followed by an additional $120 million in 2000 and another $120 million in 2005. Lawmakers approved $50 million in bonds under the FY08-10 biennial budget agreement to expand the state's research endowment matching program. Two-thirds are allocated to the University of Kentucky and the remaining third to the University of Louisville. The funds, however, stay in the trust until a match is obtained.

The Council on Postsecondary Education establishes the areas of concentration within which program funds are used, develops guidelines for the distribution of program funds, and reviews reports from the institutions on the use of funds and the results achieved. Investment earnings from the endowments can be used to support various activities including chairs, professorships, research scholars, research staff, graduate fellowships, undergraduate scholarships, research infrastructure and mission support. Universities may determine the proper use of the funds, including awards size and duration, within a few parameters.

At the research universities only, at least 70 percent of program funds that an institution's board has designated for use under the traditional Bucks for Brains program must be endowed for the purpose of supporting chairs, professorships, research scholars, staffs, infrastructure, or fellowships directly linked to the research activities of an endowed chair or professor. No more than 30 percent of program funds may be endowed for the purpose of supporting mission support activities or fellowships that are not directly linked to the research activities of an endowed chair or professor. In addition, the number of research scholars funded through the match program may not exceed ten at the University of Kentucky and five at the University of Louisville.

At least 70 percent of program funds that an institution's board has designated for use under the traditional Bucks for Brains program must be endowed for the purpose of supporting Research Challenge programs or academic disciplines contained within five new economy clusters: human health and development, biosciences, materials science and advanced manufacturing, information technologies and communications and environmental and energy technologies.

As of 2007, the program had contributed to 199 endowed chairs and 256 professorships.

New York

http://www.nystar.state.ny.us/fdp.htm

NYSTAR in New York administers a Faculty Development Program (FDP), open to all institutions of higher education in the state. From 2001 to 2007, 41 research faculty were recruited to New York. In 2008, $3.98 million was allocated for the FDP.

To house a position, matching funds must be provided which can come from the federal government, venture capital, industry, or other non-state sources. The matching fund rate varies over the course of the state investment, which can be a five-year process. For example, in year one there must be a 1:1

match, increasing to a 1.25:1 match in the second year, 1.5:1 the third year, 1.75:1 the fourth year, and 2:1 in the final and fifth year.

Ohio

http://regents.ohio.gov/rgp/rsch/ and
http://www.ohiochannel.org/your_state/third_frontier_project/program.cfm?program_id=92897
Ohio efforts in research faculty recruitment have been undertaken in recent years by two programs. Started in 1983, the Ohio Eminent Scholars Program (OESP) has awarded over 50 positions to both public and private universities in the state, with the most recent awards coming in 2007. Most of these awards were made in technology-related areas, but not all of them. One OESP award funded one professor at one university. Two OESP awards were made in 2007, with $1.37 million coming from the state.

In 2008, the Ohio Research Scholars Program (ORSP), a component of the Third Frontier Initiative through the Ohio Dept of Development, announced $146.5 million in its first round of awards. OSRP awards were clustered around specific technologies, and could include one or several recruited researchers at one or several of the state's public or private universities. OSRP awards can vary from $2.5 to $50 million. The fields of investment align with those identified by the Third Frontier: advanced material, bioscience, instruments / controls / electronics, information technology, and power & propulsion which includes advanced energy.

A 1:1 match from non-state sources in required for Ohio's research faculty recruitment programs.

South Carolina

http://www.endowedchairs.org/ and http://www.sccoee.org/
South Carolina's Centers of Excellence program attracts and builds research teams at three of the state's universities: Clemson University, the Medical School of South Carolina, and the University of South Carolina – Columbia. At the core of these Centers of Excellence are endowed chairs that are recruited to the state.

Administered by the South Carolina Commission on Higher Education, approved Centers receive $2 to $5 million to become established. The Centers do not concentrate in specific areas of research, but they should be technology and science-related. Other state universities can join as partners, but one of the three main universities must be the key contact for each proposal as the university acts as the fiscal agent.

Funding to create the Centers comes from South Carolina Education Lottery proceeds, and $24.7 million was allocated to the program in 2008-09. A 1:1 match of non-state funds is required before setting up the Center. The program has been in existence since 2002 and a program evaluation over the years 2003 to 2008 is available at:
http://www.endowedchairs.org/CoEE_Program_Comprehensive_Evaluation.pdf

Utah

http://www.innovationutah.com/
The Utah Science Technology and Research initiative (USTAR) is a long-term, state-funded investment to strengthen Utah's "knowledge economy." Created in 2006, USTAR funds research teams at the University of Utah and Utah State University in strategic innovation development areas. USTAR

recruitment funding is allocated directly to the universities, which determine the level and duration of team support and approved use of the funds.

Senate Bill 75, passed in the March 2006 legislative session, allocated funds for strategic investments at University of Utah and Utah State University. It approved $15 million ongoing to be spent on the hiring of "all-star" research innovation teams. Senate Bill 240, passed in March 2009, directs $33 million in American Recovery and Reinvestment Act funds over a two-year period toward USTAR. The majority of funding will target new research efforts at the University of Utah and Utah State University.

The state has identified several focus areas in which Utah has a competitive advantage in innovation, which will service as the target of USTAR investment. The focus areas represent existing research strengths and have high potential for economic impact and commercialization opportunities. Focus areas include: biomedical innovation, brain medicine, nanotechnology, energy, digital media and imaging technology. In addition, both the University of Utah and Utah State have selected focus areas that complement their strengths.

As of December 2008, 22 faculty researchers had been hired through the program. USTAR anticipates hiring on average four new professors for each focus area to compliment and add to the talent pool of the focus area, attract additional grant funding, increase the number of patent disclosures, licenses, and number of spin-off companies from the university.

West Virginia

http://www.wvresearch.org/index.php?option=com_content&task=view&id=61&Itemid=5

West Virginia created the Research Trust Fund in 2008 to match state dollars with private donations to encourage university research and leverage private giving. The program, which is administered by the Higher Education Policy Commission, provides funds to West Virginia University and Marshall University to double private gifts that support expansions to research faculty and infrastructure in key areas linked to economic development, health care and job growth. An initial $50 million was provided to seed the program.

The fund supports research in energy, biotechnology, biomedical, identification technology, material science and engineering, and environmental science. Seventy percent of the fund is reserved for West Virginia University and 30 percent for Marshall University. Each university will create a plan for the use of Bucks for Brains funds and submit that plan to the Higher Education Policy Commission. Funds are disbursed only after private donations or pledges are received by the universities and the commission has approved the projects to which the funds are directed. Private gifts are matched dollar-for-dollar.

No data on the use of these funds has been released yet.