

REPORT OF

## Five-Year Outcomes

From the **Second Round** of

# Research Challenge Grants

2007-2012



## Research Challenge Grants awarded in 2007 produce big results

In 2007, the State of West Virginia, through its Division of Science and Research, invested \$7.7 million in five-year Research Challenge Grants to four research teams at West Virginia University and one at Marshall University.

By 2012, as the original funding for the five-year grants came to an end, those research teams had turned the state's \$7.7 million investment into an additional \$44.6 million of research funded by external parties, supporting 193 research-related employment positions and resulting in the creation of seven patents, plus the development of six intellectual property licenses.

This extraordinary return on the state's research investment was made possible by the West Virginia Legislature's establishment of the Research Challenge Fund. The fund was initially established in 2002, and modified to its current form by statute in 2004.

This report provides an overview of the Research Challenge Fund, focusing on five-year outcomes of the second round of Research Challenge Grants initially funded in 2007. This document also includes brief information about the first round (funded in 2002) and the third round (funded in 2012) of Research Challenge Grants.

## Research Challenge Fund is critical part of State's economic development strategy

As "a critical component in the state's strategic plan for economic development," the Research Challenge Fund supports research and development projects at institutions of higher education. Per statute, the Research Challenge Fund receives dedicated revenue of 0.5% of the state's proceeds from racetrack video lottery terminal income.

Priorities of the Research Challenge Fund, as established by the Legislature, are to:

- focus on research that builds on the state's existing research strengths in emerging science, technology, engineering and mathematics (STEM) fields;
- develop students and faculty;
- promote collaboration between Grades K-12 and higher education;
- recruit eminent scholars to strengthen research capacity and competitiveness; and
- seek economic development projects that have significant potential to attract industrial, federal and foundation partners and funding.

The Fund is managed by the Higher Education Policy Commission's Division of Science and Research, which also manages academic research funding from other sources, primarily the National Science Foundation's Experimental Program to Stimulate Competitive Research (EPSCoR).

In implementing the program, the Division of Science and Research developed these objectives for the Research Challenge fund:

- 1) increase the research capacity and competitiveness of institutions of higher education;
- 2) stimulate research that is directly applicable to improving the competitiveness of state industries and to developing new businesses;
- 3) leverage state resources with private and federal funds;
- 4) increase the production of undergraduate and graduate students in fields of Science, Technology, Engineering and Mathematics (STEM); and
- 5) hold institutions more accountable for the success of research projects.

## 2007 Research Challenge Grant (2nd round) highlights

The five projects chosen for funding in the second round of Research Challenge Grants were selected competitively from 15 proposals submitted to the Higher Education Policy Commission's Division of Science and Research.

From the State's initial \$7.7 million investment allocated over a five-year period, the researchers garnered external funding totaling \$44.6 million. That combined funding supported total research employment of 193 positions, as detailed below:

Faculty supported	37
Visiting scholars	2
Post-doctoral researchers	22
Grad students	90
Undergraduates	42
Patents	7
Intellectual Property licenses	6

Detailed information about each of these projects is included later in this report.

**Research Challenge Grants** are the largest awards from the Research Challenge Fund. These grants support the creation of research centers and foster economic development and workforce advancement at the state's two research universities, Marshall and West Virginia.

Other programs supported by the Research Challenge Fund are:

- **Instrumentation Grants**, which fund scientific equipment for advanced undergraduate laboratories at primarily undergraduate institutions;
- **Innovation Grants**, which fund creative improvements in scientific equipment and facilities, curriculum, classroom instruction or delivery at primarily undergraduate institutions; and
- **Mini-Grants**, which provide summer stipends for faculty members to prepare research or research equipment proposals.

Since 2005, the Research Challenge Fund has awarded approximately \$28 million for research, supporting 19 institutions across West Virginia.

### **Review of 2002 Research Challenge Grants (1st round)**

A great return on the original investment also was a result of the first round of Research Challenge Fund grants awarded in 2002. During that funding cycle, the state awarded \$8.4 million. After the five-year period, six research projects leveraged external funding of more than \$20 million, resulting in five startup companies, 10 patent applications and five patents.

### **2012 Research Challenge Grants (3rd round) have begun**

In July of 2012, the Division of Science and Research awarded three Research Challenge Grants totaling more than \$4 million. Over the five-year period beginning in 2012, each of the following projects will receive \$1,350,000 in declining investments. The projects will:

- create a **Center for Energy Efficient Electronics** at Marshall University and West Virginia University to investigate and develop devices that will lead to next generation electronics that are smaller, faster, and more energy efficient than currently available technology. The principal investigators are Drs. David Lederman, Alan Bristow, Mikel Holcomb, and Tudor Stanescu, Department of Physics at West Virginia University, and Dr. Thomas Wilson of the Department of Physics at Marshall University;
- establish a **Center for Electrochemical Energy Storage** at West Virginia University to conduct fundamental and applied research leading to the development of devices for storing electricity. Principal investigator is Dr. Xingbo Liu of the Department of Mechanical and Aerospace Engineering at West Virginia University; and
- further develop and expand the **West Virginia Cancer Genomics Network** to involve Marshall University, West Virginia University, and Charleston Area Medical Center. Principal investigators are Dr. Richard Niles and Dr. Donald Primerano of the Department of Biochemistry and Microbiology at Marshall University, Dr. William Petros of the Department of Basic Pharmaceutical Sciences at West Virginia University, and Dr. Todd Kuenstner, Department of Pathology at Charleston Area Medical Center.

## 2007 Grant (2nd round) Summary Reports

Following are final reports for each of the five Research Challenge Grants awarded in 2007, showing the amount of grant, names of principal investigators, research title, summary outcome data and the principal investigator's Summary Report.

### Energy Material Science and Engineering Program at West Virginia University

Grant # EPS08-01

#### Dr. Ever Barbero, Department of Mechanical and Aerospace Engineering

Establishment of an Energy Materials Science and Engineering Program to research energy materials, including materials for energy conversion (fuel cells, batteries, solar-cells, thermo-electrics, and solid-state lighting), energy storage (hydrogen materials), energy utilization (turbine materials, boiler and tubing materials, thermal barrier coating), energy saving (reflective or thermal insulation materials/coating), energy efficiency and environment protection (sensing materials, corrosion/wear resistant coatings).

<b>Research Challenge Grant amount:</b>	\$ 1,641,725
<b>External funding obtained:</b>	\$ 21,737,608
<b>Workforce Development Impact – employment supported by funding</b>	
Faculty supported	8
Post-docs	5
Graduates students	26
Undergraduates	13
Patents	7
Intellectual Property licenses	6

#### Executive summary:

The Energy Material Science and Engineering program (EMSE) objective was to create a reputable and sustainable research group at WVU in the specialty of Materials Science with emphasis on materials used for energy conservation, extraction, conversion, storage, and utilization.

In the years of the grant, EMSE secured \$21,737,608 either entirely within EMSE or collaborating with synergistic entities in the State such as WVNano. We have \$5,160,000 in proposals pending. In FY11 alone, EMSE core faculty formalized 6 new IP partnerships, secured 7 patents and published one book, 2 book chapters, 64 journal papers, and 29 technical presentations, including 3 student-only presentations.

EMSE faculty have created and contributed to 6 new courses to teach Energy Materials to graduate and undergraduate students. EMSE has trained 29 users, including one West Virginia industry, in the operation of EMSE's Scanning Electron and Transmission Electron Microscopes. Also, we have pioneered a new recruiting modality that is attracting top Materials Science students from elite schools worldwide.

During the grant period, EMSE faculty:

- Discovered a new plating method to develop coating for interconnect in solid oxide fuel cell systems that can be convert coal syngas to electricity with very high efficiency and low emission of greenhouse gases. This technology received the R&D 100 Award in 2011.
- Discovered a new class of ceramic/glass composite electrolyte for batteries that can be used to store renewable solar and wind energy to be used at night or when there is no wind.
- Discovered thin and thick film thermoelectric materials that can double the power harvesting density (per unit weight of device) of waste heat of any system that requires cooling, such as aircraft and satellite electronics cooling, with very low weight and high power harvesting efficiency.

Energy Material Science and Engineering Program, continued

EMSE recruited and provided support for two new tenure-track faculty for four years, one female and recruited a minority female faculty that was funded by a synergistic initiative; then recruited an additional tenured faculty that was not part of the initial proposing team. The core membership of EMSE has doubled from 4 to 8 faculty. In addition, EMSE currently nucleates 13 undergraduate students, 11 Master's students, 15 Ph.D. students, and 5 post-doctoral fellows.

EMSE spent nearly \$1 million in new equipment that was leveraged with matching funds from other parties to culminate in the acquisition and installation of major research instrumentation including a state-of-the art High Resolution Transmission Electron Microscope, refurbishing a Scanning Electron Microscope donated by GE Plastics-WV, and several other state-of-the-art instrumentation and characterization equipment.

## Center for Transportation Security and Infrastructure Innovations – TranS-I2 at West Virginia University

Grant # EPS08-02

**Dr. Julio Davalos, Department of Civil and Environmental Engineering.**

Establishment of a Center for Transportation Security and Infrastructure Innovation. The project is in conjunction with the Nick J. Rahall Appalachian Transportation Institute at Marshall University.

<b>Research Challenge Grant amount:</b>	\$ 1,412,416
<b>External funding obtained:</b>	\$ 10,399,822
<b>Workforce Development Impact – employment supported by funding</b>	
Faculty supported	9
Visiting Scholars	2
Post-docs	2
Graduate students	15
Technician/Administration	2

**Description:** The aim of this initiative is to establish the proposed **Center for Transportation Security and Infrastructure Innovations (TranS-I<sup>2</sup>)** as a nationally recognized leading entity contributing novel solutions to two major worldwide pressing needs for transportation infrastructure:

- (1) security against potential terrorist attacks; and
- (2) rehabilitation, maintenance, and new construction to improve performance and achieve better and longer service-life of highway materials; while at the same time contributing significantly to graduate education, technology transfer, workforce training, and economic development.

### Grants Received:

- *District 3-0 Investigation of Fiber Wrap Technology for Bridge Repair and Rehabilitation.* PennDOT - **Davalos J.F.**, Barth K., and Ray I.  

<b>Phase I:</b>	(2004 - 2006) <b>\$137,725</b>
<b>Phase II:</b>	(2006 – 2008) <b>\$142,900</b>
<b>Phase III:</b>	(2007 – 2009) <b>\$204,216</b>
<b>Total</b>	<b>\$ 484,841</b>
- *Aquaculture Product and Marketing Development.* USDA/CSREES. Task 54. (2005-2008).  
**Davalos J.F.** **\$ 93,900**
- *Advanced Materials Program: High-Performance Concrete, Deck Overlays, and Steel*  
WDOH: **Davalos J.F.**, Barth K., and Ray I.  

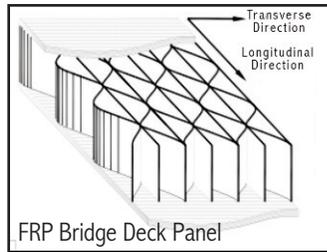
<b>Phase I:</b>	(2004-2007) <b>\$775,000</b>
<b>Phase II:</b>	(2007-2009) <b>\$1,257,887</b>
<b>Phase III:</b>	(2010-2012 - expected) <b>\$850,000</b>
<b>Total</b>	<b>\$2,882,887</b>
- *Field Evaluation of the Culloden IBRCP 100KSI Bridge*  
WDOH: Barth K., and **Davalos J.F.** (2007 – 2009) **\$263,194**

Center for Transportation Security, continued

- Resilient Tunnel System – Flood Containment Plug:* (2007-212)  
 Batelle Memorial Institute, Pacific Northwest National Laboratory  
 Funded by: U.S. Department of Homeland Security, Science & Technology Directorate  
**Davalos J.F.**, Barbero, Banta, Chen An, Huebsch, Means, and Martinelli Diana  
**Phase I:** (2007-2009) **\$880,000**  
**Phase II:** (2008-2009) **\$375,000**  
**Phase III:** (2010-2011) **\$2,300,000**  
**Total expected over 5 years:** **\$6,475,000**
- Inflatable Plug for Underwater Tunnel Protection*  
 U.S. Department of Homeland Security, International Programs Division  
**Davalos J.F.**, Barbero E., and Barth K. (2007-2010) **\$ 200,000**

**Discoveries and their Potential Use:**

- Fiber-reinforced Polymer (FRP) Sandwich Panels with Honeycomb Cores for Bridge Decks, Aquaculture, Blast/Ballistic Protection, and Energy Efficient Wall Panels



- Rehabilitation of Concrete bridges with Externally Bonded Carbon FRP Fabrics

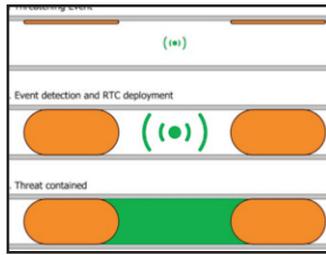


- Advanced Concrete Materials for Highway Bridge Decks and Riding Overlays



Microscopic-scale Analysis; Lab-scale Samples; and Plant-scale Application

- Composite Fabrics for Inflatable Tunnel Protection Plugs for Flood-Mitigation



Resilient Tunnel Concept (RTC) deployment sequence for a threat event



First RTC prototype for low inflation pressure

- Structural Wood Composites from Waste Products and Synthetic Resins



Wood clippings



Making panels



Structural Joists

### Economic Development:

- Concrete plants, contractors, and building suppliers in West Virginia will switch production from conventional concrete to High-Performance Concrete, leading to nationally competitive new markets for their products.
- The wood industry in West Virginia will begin production and marketing of new reconstituted value-added wood structural products.

### Faculty, Scholars, and Students Supported by the RCG Project:

**Faculty:** Six tenure-track faculty, including Engineering, Wood Sciences, and faculty at Marshall University.

**Visiting Scholars:** Dr. Silvia Uchoa (Brazil) – High-Performance Concrete; Dr. Denes Levente (Hungary) – Wood Composites

**Research Faculty:** Dr. Indrajit Ray (CEE) – Concrete research; Dr. An Chen (CEE) – FRP Composites; Dr. Eduardo Sosa (CEE) – Composite Fabrics

**Post-Doctoral Fellows:** Dr. Chunfu Lin – Blast / ballistic protection; Dr. Javier Martinez – Inflatable plug for tunnel protection

**Students:** Graduated three doctoral and six Master's students; six additional students are continuing their studies.

**Technical/Administrative Support:** One technician and one administrative assistant. Industry and Professional Associations: Numerous industries and associations have been participating in the Center's enterprise.

**Outside Universities:** We have established collaborations with several universities in the United States and abroad, including Virginia Tech, Washington State, University of Akron, University of Missouri Columbia/Rolla, Mayaguez Puerto Rico, Lecce Italy, Alagoza Brazil, Hungary, China, and Guanajuato, Mexico.

## Center for Astrophysics at West Virginia University

Grant #EPS08-03

**Dr. Maura McLaughlin and Dr. Duncan Lorimer, Department of Physics.**

Creation of a world-class Center for Astrophysics at West Virginia University in partnership with the National Radio Astronomy Observatory in Green Bank. Researchers study pulsars, which have a wide range of applications: from testing Einstein's theory of general relativity to probing the interstellar medium of the galaxy to understanding the physics of super dense matter.

<b>Research Challenge Grant amount:</b>	\$ 1,553,316
<b>External funding obtained:</b>	\$ 9,144,000
<b>Workforce Development Impact – employment supported by funding</b>	
Faculty supported	3
Post-docs	6
Graduate students	10
Undergraduates	10

The Department of Physics at West Virginia University used the Research Challenge Grant funding to establish a center for excellence in Astrophysics. The Center studies compact stars, galaxies and star formation with students and postdoctoral researchers and offer undergraduate and graduate courses to prepare students for graduate school and research.

Since 2007, the Research Challenge Grant has supported three faculty members, six post-doctoral scholars, 10 graduate students and 10 undergraduates. McLaughlin and Lorimer study pulsars – rapidly spinning neutron stars formed in supernova explosions. They use pulsars as tools to investigate fundamental physics questions ranging from the properties of material at nuclear density to the nature of gravity.

Faculty member D. J. Pisano was hired in 2009 using Research Challenge Grant funding and has established a research program through which he studies the properties of external galaxies. Since his hiring, Dr. Pisano has earned a prestigious National Science Foundation CAREER award. Based on the success of the Center, the University recently hired new faculty member Loren Anderson whose research specialty is in star formation and Galactic astronomy. Currently, a fifth astrophysics faculty member is being sought with an emphasis on Gravitational Wave Astrophysics.

Group members have published more than 70 papers in refereed astrophysical journals. Major discoveries from this research to date include:

- (1) a rapidly spinning neutron star in an X-ray binary system;
- (2) a highly dispersed radio burst of unknown origin;
- (3) a highly eccentric radio pulsar binary system;
- (4) relativistic spin precession in a double pulsar binary system;
- (5) three dozen new millisecond pulsars found through their gamma-ray emission;
- (6) a survey of HI in the Milky Way with unprecedented angular and velocity resolution;
- (7) detection of high-velocity clouds around a spiral galaxy;
- (8) the first measurement of radio recombination lines in an external galaxy;
- (9) the involvement of over 400 high-school students in nine states in the Pulsar Search Collaboratory project.

### Long-term prospects for further funding

Pulsar research at WVU over the next five years is currently funded in part by a \$6.5 million National Science Foundation Partnerships for International Research and Education (PIRE) award which aims to use pulsar timing measurements to detect low-frequency gravitational waves. Predicted by Einstein's theory of general relativity, gravitational waves have been inferred but so far never directly observed.

The PIRE award will help the North American Nano-Hertz Gravitational Wave Observatory (NANOGrav, currently chaired by McLaughlin) establish the necessary international connections to allow sensitive measurements of gravitational waves thought to be produced via early universe expansion and mergers of distant super massive black holes. This award supports a computer systems administrator, one administrative assistant and two graduate students at WVU.

A postdoctoral scholar is expected to be supported by this award over the period 2012-2015. Other pulsar research activities are currently supported by Lorimer and McLaughlin's Cottrell scholar awards, as well as National Radio Astronomy Observatory, NASA and National Science Foundation single investigator awards listed below. Further funding is expected in the form of NSF CAREER awards, NSF Astronomy and Astrophysics grants as well as from solicitations to private foundations.

## Economic Development

The astrophysics research at WVU was a large driver in getting stimulus funds to support a high-speed link from Green Bank to Morgantown. In addition, our grants have resulted in the hiring of support personnel including an administrative assistant and computer support person. Furthermore, we are fostering the development of a technological workforce by motivating high-school students in our Pulsar Search Collaboratory program to pursue majors in science, technology, and engineering. Our undergraduate and graduate students are also receiving training in technical skills that are transferrable to the private sector.

## Grants received

• A 350-MHz Drift Scan Search for Pulsars with the Green Bank Telescope, McLaughlin, National Radio Astronomy Observatory,	10/07	<b>\$6,500</b>
• PSR J1832+0029: A Unique Probe of Pulsar Emission Physics, Lorimer, Smithsonian,	10/07	<b>\$13,800</b>
• The Pulsar Search Collaboratory, McLaughlin, NSF,	01/08	<b>\$344,000</b>
• Searching for X-Ray Variability in Rotating Radio Transients, McLaughlin, Smithsonian,	06/08	<b>\$15,300</b>
• Where are the RRATs in the Neutron Star Zoo? McLaughlin, NASA,	07/08	<b>\$49,500</b>
• The High-B Radio Pulsar PSR J1718-3718, McLaughlin, Smithsonian,	02/09	<b>\$49,400</b>
• Timing of New and Old Rotating Radio Transient Sources McLaughlin, NRAO,	06/09	<b>\$22,400</b>
• NRAO Visitors Program: Summer Research at NRAO-Green Bank, Pisano, NRAO,	06/09	<b>\$17,000</b>
• A Search for Gamma-Ray Pulsations, McLaughlin, Eureka Scientific, Inc.,	08/09	<b>\$21,400</b>
• Bursts, Flickers and Cosmic Flashers, Lorimer, Cottrell Scholar Award,	08/09	<b>\$100,000</b>
• Einstein's Cosmic Ripples: Pursuing the Elusive Waves of Gravity,	08/09	<b>\$100,000</b>
• A New Census of Globular Cluster Pulsars, Lorimer, NSF,	09/09	<b>\$267,000</b>
• Constraining Pulsar Emission Physics, McLaughlin, NASA,	12/09	<b>\$46,000</b>
• Radio Recombination Lines in Nearby Star Forming Galaxies, Pisano, NRAO,	02/10	<b>\$27,700</b>
• Tracing the Accretion History of a Missing Link, Lorimer, Smithsonian,	03/10	<b>\$46,100</b>
• International Pulsar Timing Array for Gravitational Wave Detection, McLaughlin, NSF,	06/10	<b>\$6,500,000</b>
• Timing and General Relativity with the Double Pulsar System, McLaughlin, NRAO,	06/10	<b>\$23,400</b>
• NRAO Visitors Program: Summer Research at NRAO-Green Bank, Pisano, NRAO,	06/10	<b>\$12,600</b>
• Constraining the Spectrum of a Nearby Unusual Binary Pulsar, Lorimer, Smithsonian,	09/10	<b>\$26,600</b>
• Crab Giant Pulses: A Correlation Study at Radio and X-rays, McLaughlin, Smithsonian,	11/10	<b>\$29,100</b>
• Continued Timing of Three Rotating Radio Transients, McLaughlin, NRAO,	02/11	<b>\$12,200</b>
• X-Ray Observations of a Nearby, Old Rotating Radio Transient, McLaughlin,	02/11	<b>\$27,500</b>
• Pulsar Research at the Arecibo Observatory, Lorimer, NSF,	03/11	<b>\$28,600</b>
• PSR J1832+0032: A Unique Target for Pulsar Emission Physics, Lorimer, Smithsonian,	03/11	<b>\$11,600</b>
• X-Ray Observations of Four New Fermi Pulsars, McLaughlin, Smithsonian,	05/11	<b>\$31,600</b>
• Unusual Extended Emission Around RRAT J1819-1458, McLaughlin, Smithsonian,	05/11	<b>\$24,200</b>
• National Radio Astronomy Observatory-Green Bank: Summer Research, Pisano, NRAO,	06/11	<b>\$8,300</b>
• HI Mapping of the M31-M33 Stream, Pisano, NRAO,	07/11	<b>\$29,200</b>
• Tracing the flow of gas from the Cosmic web onto Galaxies, Pisano, NSF CAREER,	05/12	<b>\$800,000</b>
• An all-sky radio survey for millisecond pulsars, exotic binary systems and transients, McLaughlin, NSF,	05/12	<b>\$453,000</b>

## Information Fusion Networks for Intelligence and Security at West Virginia University

Grant #EPS08-04

**Dr. Arun Ross, Department of Computer Science and Electrical Engineering**

Development of an Information Networks Research Group to develop identity management technology to process data for use by businesses and the intelligence community.

<b>Research Challenge Grant amount:</b>	\$ 1,637,304
<b>External funding obtained:</b>	\$ 660,000
<b>Workforce Development Impact – employment supported by funding</b>	
Faculty supported	8
Post-docs	4
Graduate students	16

### Description:

The digital era has resulted in the generation of significant amounts of data pertaining to the social, financial, cultural and behavioral aspects of individuals in a variety of scenarios. This data include video surveillance, internet-browsing activity, credit card transactions, online chats, blogs, and Twitter and Facebook conversations. The goal of the InfoNets Research Group is to develop automated techniques to process this data in order to predict events, detect fraud, discover social network works, identify security threats, and gauge mass sentiments to world events. This research has direct applications in national security, intelligence analysis and computational medicine.

### Grants Received:

- [1] Members of the InfoNets group successfully contributed to a National Security Administration proposal that was spearheaded by DCCA (the VoxGlo Project). The proposal was selected by NSA thereby allowing all team members (including WVU) to continually respond to Task Orders posted by the government. This has opened up the possibility of the group being funded over a longer period of time.
- [2] Proposal submitted to National Geospatial-Intelligence Agency (joint proposal with CMU) has been selected for award. However, funding not received as of yet (4 years, \$660,000).
- [3] Additionally, the group has submitted proposals to Office of the Director of National Intelligence, National Science Foundation, National Institutes of Health, National Security Administration, Army Research Office, and National Institute of Justice are currently under evaluation.

### Discoveries:

- [1] Algorithms to automatically assess mass political sentiments based on internet blogs.
- [2] A software tool to perform text mining based on keyword analysis.
- [3] Algorithm for clustering extremist web pages.
- [4] Modeling foreign policy interaction analysis.
- [5] Algorithms for social network analysis.
- [6] Discovering crime patterns based on data in the National Incident-Based Reporting System (NIBRS).

### Potential Applications:

- [1] Homeland Security.
- [2] Automatic Intelligence Gathering and Analysis.
- [3] Detecting Financial Fraud.
- [4] Discovering Rogue Social Networks.
- [5] Understanding Mass Sentiment on Critical Events.

### Economic Development:

- [1] Commercialization of software and generation of patents.
- [2] Training a unique interdisciplinary work-force (Math, Political Science, Economics, Computer Science).
- [3] New funding opportunities for WVU.

## Cell Differentiation and Development Center at Marshall University

Grant #EPS08-05

**Dr. Eric Blough and Dr. Philippe Georgel, Department of Biological Sciences.**

Development of a Cell Differentiation and Development Center focused on the epigenetic mechanisms underlying cell differentiation and development and the diseases that result from failure of these mechanisms, especially cancer and cardiovascular disease.

<b>Research Challenge Grant amount:</b>	\$ 1,480,701
<b>External funding obtained:</b>	\$ 2,728,708
<b>Workforce Development Impact – employment supported by funding</b>	
Faculty supported	9
Post-doctoral researchers	5
Graduate students	23
Undergraduates students	19

### Description of the project:

The objects of this project were threefold:

1. Establish the Marshall University Cell Differentiation and Development Center (CDDC)
2. Increase epigenetic research capacity at Marshall University by targeted hires and judicious investment in research infrastructure, and
3. Forge linkages between the research active faculty at Marshall University.

### Description of any discoveries and their potential uses:

Projects supported and developed by CDDC support include

- i.) the investigation of links between diet and cancer,
- ii.) molecular mechanisms of cellular differentiation, and
- iii.) the use of adult stem cells to treat cardiovascular disease. In addition, internal CDDC grants were awarded to support the development of a variety of projects including research on the effect of diet on breast cancer prevention (Dr. W. E. Hardman), dietary regulatory events related to lung cancer (Dr. P. Dasgupta), cellular patterning (Dr. P.S. Collier), epigenetics and fertility (Dr. G-Z. Zhu).

### Grants Received:

To date, the CDDC Internal Grant Program has invested \$240,000 on selected pilot projects. These CDDC-supported grants have led to the submission of 58 grant applications, of which 20 received funding from Federal agencies such as the National Institutes of Health, National Science Foundation, and Department of Defense (Table 1). Over the first four years, CDDC-supported projects have also led to 43 peer-reviewed publications and 65 abstracts (poster and oral presentations) at national and international venues.

Cell Differentiation and Development Center, continued

**Table 1: Summary of CDDC investment and return**

Year	Number of CDDC awards (\$ amount)	Proposal submitted	Proposal awarded
Year 1	5 (\$100,000)	15	2
Year 2	4 (\$80,000)	5	2
Years 3-4	3 (\$60,000)	38	16

From the initial \$240,000 invested by the CDDC, the awarded grants have generated a total of \$2,728,708, equating to a return ratio of 11.36 for Years 1-4.

**Economic development potential:**

The acquisition of an epigenetic expertise linked to bioinformatics is currently under development through training of CDDC members. Working in collaboration with the Marshall University School of Medicine genomics core, the College of Information, Technology and Engineering, and other universities and institutions (WVU, University of Victoria, NIH) scientists from different Marshall University schools and colleges are being trained in the design of epigenetic experiments and downstream data analysis. Once the training is completed, the CDDC plans to use the newly acquired expertise to offer a novel fee for service aimed at optimizing the design of research investigating epigenetic regulation of complex cell differentiation events and/or diseases.

**Number of faculty, students and post-docs supported by your RCG to date:**

**Table 2: Summary of faculty, students, post-docs support**

Year	Undergraduate	MS	Ph.D.	Post-docs	Faculty
Years 1-2	3	9	2	4	8
Years 3-4	16	8	3	1	5

In addition to the support listed on the table above, one new faculty has been hired (Dr. W. Zheng, MUSOM/CDDC).



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