REPORT OF

Five-Year Outcomes

from the First Round of Research Challenge Grants

2002 - 2007

Report of **Five-Year Outcomes**

Foreword

In late 2002, six research projects were funded under the auspices of West Virginia legislative authority (SB 653) vested in the Higher Education Policy Commission (HEPC). These grants, now known as Research Challenge Grants (RCG), were authorized to enhance research infrastructure, stimulate original research, develop competitiveness for external funding, and initiate potential impact on the state's economy.

Forty-seven proposals were received and analyzed as a result of the competition managed by the HEPC. Of the six research projects funded after this extensive external review, four were at West Virginia University and two were at Marshall University. Proposals were allowed to request up to seven years funding but were required to scale down state support over the life of the grant. A review of the awards shows requests up to $600,000 in the first year declining to as little as $50,000 in the final year of support. One project proposed a five-year budget, one a six-year budget, and the remaining four proposed full seven-year budgets.

The total initial budget for the grants (FY03) was $2.3 million followed by an additional $1.6 million in FY04. In 2004, the West Virginia Legislature enacted a bill that established the Research Challenge Fund at the HEPC to support research and development projects at institutions of higher education. The legislature charged the West Virginia Experimental Program to Stimulate Competitive Research (WVEPSCoR) Advisory Council with developing plans for implementing the objectives of the legislature, including administering what came to be called the Research Challenge Grant (RCG) program. The Research Challenge Fund accrues 0.5% of the state's profits from video lottery proceeds at the state's racetracks.

In FY05, FY06 and FY07, RCG awardees received $1,726,317, $1,480,064 and $1,295,433, respectively, for a total investment by the State of West Virginia of $8.4 million over the first five years of the program.

The following pages (pgs. 4-15) provide a snapshot of each of these first six RCG projects. All six principal investigators (PIs) submitted yearly reports to WVEPSCoR. These yearly reports provided the basis of this analysis. The awardees were asked to provide yearly updates on their progress, significant accomplishments, personnel involved, budget justifications, projected financial needs, and a reevaluation of the original anticipated outcomes. The latter two items became important since the legislature, in separate action (SB448), reduced the performance period of all awards from seven to five years. This report summarizes the status of the projects at the end of the funding cycle on July 1, 2007, and to show the benefits to the State of West Virginia from the Research Challenge Grant initiative.

WVEPSCoR representatives made periodic site visits to each campus to assess the status of the projects, including a needs analysis and an evaluation of the progress toward stated goals. Meetings that included laboratory tours, presentations and discussions with all of the grantees were a continuing activity of the WVEPSCoR office during the course of the proposal implementation.

Very often when developing proposals to a national funding agency such as the National Science Foundation (NSF), the proposer is expected to identify both the cultural changes that will take place and the long-range impacts or applications of potential research findings. In West Virginia, the RCG initiative has enabled university researchers to transform their research into tech-based economic development (TBED) more expeditiously than predicted. Much of the following text comes from the PIs themselves and uses their words to showcase the success of the RCG program.

Analysis of Tech-Based Economic Development (TBED) Enabled by the Research Challenge Grant Initiative of the State of West Virginia

State Investment	Return on Investment in Six Research Projects at WVU and MU					
	External funding (grants and venture capital)	Academic workforce from external funding	Startup companies	Current number of employees	5-year projected annual revenue	5-year projected number of employees
$8.4 M	**$20,525,000**	**93**	**5**	**24**	**$124 M**	**295**

Intellectual Property: This category includes patent applications, patents and licensures that have resulted from intellectual property (IP) created with the Research Challenge Grant. This IP is expected to seed further research. If commercialized, the IP will result in new tax revenue, more high-tech employment and a better quality of life for the citizens of West Virginia.

# Patent Applications	# Patents	# Licenses
10	5	1 and 1 pending

Workforce: This category includes the number of researchers, post-docs, technicians, graduate students, and undergraduates partially or totally supported by external research grants and by the RCG. In particular, these figures demonstrate the number of positions supported by external funding. Typically, research projects do not have substantial short-term economic development outcomes, so it can be concluded from these statistics that the RCG funds are having a much more positive and significant impact on the workforce than expected. The funding community has recognized the potential of the research activity and has decided to partner with West Virginia. This is a strong indication not only of the robustness of the research but also the sustainability of the investigations they have generated.

Workforce Personnel	Number supported by external funding	Number supported by the RCG
Faculty Researchers	12	12
Post-Docs	11	8
Technicians	7	7
Graduate Students	30	18
Undergraduates	33	32

Research Challenge Grant Projects

Title: University-Industry Center for Extrusion-Compounding of Additives for Superior Plastics Performance

Rakesh Gupta, Ph.D.
Department of Chemical Engineering, West Virginia University, P.O. Box 6102, Morgantown, WV 26506.
Tel: (304) 293-2111; e-mail: Rakesh.Gupta@mail.wvu.edu
Grant Number: RCG0301 – Gupta

Title: Using GIS and Virtual Reality to Deliver Real-time, Virtual Information Spatially Embedded in Mission-Critical Environments

Trevor Harris Ph.D.
Department of Geology and Geography
West Virginia University
Grant Number: RCG0302 – Harris

Title: Foundation of Basic and Translational Research for the Edwards Cancer Center

Richard M. Niles, Ph.D., Professor and Chair
Department of Biochemistry and Molecular Biology
Joan C. Edwards School of Medicine, Marshall University
Phone: 304-696-7323 Fax: 304-696-7253 Email: niles@marshall.edu
Grant Number: RCG0303 – Niles

Title: DNA Sensor Infrastructure Development

Michael L. Norton, Ph.D.
Department of Chemistry, Marshall University Email: norton@marshall.edu
Grant Number: RCG0304 – Norton

Title: The Biometric Knowledge Center (BKnC) at West Virginia University

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Grant Number: RCG0305 – Rood (now Williams)

Title: Proteomics and Cancer: A Partnership between WVU and the Biotechnology Industry

Aaron Timperman, Ph.D.
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Grant Number: RCG0306 – Timperman

University-Industry Center for Extrusion-Compounding of Additives for Superior Plastics Performance

Grant Number: RCG0301 – Gupta

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"RCG support is now beginning to pay off. Results will be seen for many years to come."

—Gupta 2007, Final RCG Report

The University-Industry Center for Extrusion-Compounding of Additives for Superior Plastics Performance was established at West Virginia University (WVU) in 2002. A major goal of this Center is to assist in the creation and retention of high-paying jobs in the state by expanding the research capabilities of polymer companies in support of their business lines. Specifically, support to the polymer industry includes providing state-of-the-art laboratories and research expertise. It is also intended to generate external funding and conduct research that leads to intellectual properties that create jobs and improve the ranking of WVU among research universities. At the end of the five-year term of the Research Challenge Grant, the University-Industry Center can justifiably claim to have built the infrastructure for conducting cutting-edge research in the area of plastic materials

The Center at WVU has focused on wood/plastic composites (WPCs) since the evidence is that WPCs are likely to have the maximum impact on economic development in West Virginia. Details of the research cannot be disclosed since these are the subject of an invention disclosure that should lead to product and process patents. The research has led, however, to 12 conference proceedings and 7 journal publications that help to showcase the Center activities and to make it better known, and that it is a center that will grow on the partnerships with industries.

The partnership with industries is to become the funding mechanism for the Center and the Center facilities have been utilized by many others; both from the academic and the industrial areas. These include Professor Lakshmi Sridhar of the University of Puerto Rico, Mayaguez; Professor Masud Khan of Central Queensland University in Rockhampton, Australia; Professor Adam Al-Mulla of Kuwait University; Professor J.S.N. Murthy of Osmania University in Hyderabad, India and Dr. Satish Gaggar, Principal Scientist of GE Plastics in Washington, WV. Researchers in other universities are now collaborating with the Center, primarily because of the modern and fee-available facilities. These are very well-known researchers and include Professor S.N. Bhattacharya of RMIT University in Melbourne, Australia and Professor C.A. Wilkie in the Chemistry Department at Marquette University in Milwaukee; these collaborations have led to joint publications in prestigious journals.

Confidentiality agreements have been signed with a large number of companies and Universities. Proprietary, collaborative research has been done with Excel Polymers of Burton, OH; GE Plastics, Washington, WV; and Mine Safety Appliances of Pittsburgh, PA. Future work is planned with the Empire State Paper Research Institute in Syracuse, NY with whom we have an executed non-disclosure agreement. Sponsored research is being done with Kraft Foods Global and with the National Energy Technology Laboratory. Also, the Bayer Foundation has gifted $381,600 and made a 5-year commitment to set-up and support the "Bayer Scholars for Extrusion Compounding" program to train Ph.D. students in polymer engineering. It is noteworthy that much of this collaboration has resulted from the efforts of industrial members of the Advisory Committee of the Center.

Invention disclosures include:

1. R.K. Gupta, S. Agarwal and S.K Yeh, Wood plastic composites from recycled acrylonitrile-butadiene-styrene and wood products, WVU Research Corporation docket number 350, June 16, 2006.
2. R.K. Gupta, S. Agarwal, E.B. Kennel and M.M.K. Khan, A method of making highly conductive thermal interface material (TIM) containing aligned fibers of varying domain, WVU Research Corporation docket number 377, December 11, 2006."

It is important to note that the WVU Research Corporation is nurturing the potential patents through the maze of government required effort that often discourages the academic from protecting the developed intellectual property.

The PI, Dr. Rakesh Gupta, has received external research grant awards amounting to $129,303 as a result of RCG funding. The funding agencies were the Excel Polymers, Burton, Ohio ($20,000) and National Energy Technology Laboratory of US DOE ($109,303).

Using GIS and Virtual Reality to Deliver Real-time, Virtual Information Spatially Embedded in Mission-Critical Environments

Grant Number: RCG0302 – Harris

Dr. Trevor Harris
Department of Geology and Geography
West Virginia University

"Our project then was to develop commercially focused research for new geospatial emerging markets; leverage academic and commercial funding opportunities; retain WV owned patent and company equity; and increase the overall competitive strength of WV in the national and international technology marketplace. In our opinion we have been extremely successful in all these areas …Underpinning this work was a desire to use our proposed advances in science and technology to support economic development in West Virginia through the realization of protected intellectual properties that could be exploited by domestic and international licensing and royalty programs."

—Harris 2007, Final RCG Report

Specific Outcomes of the complete five year grant

1. The RCG funding enabled the principal investigators to recruit and retain highly skilled personnel in the areas of GIScience, virtual reality, immersive technologies, relational database management systems, and software engineering. The GeoVirtual Laboratory houses a pool of talent capable of pursuing geo-spatial science and technology research and application development that makes the group part of a critical infrastructure able to compete for competitive long-term research.

2. The software developments that have taken place are truly innovative and have advanced understanding of 3D geovisualization and linked Internet capability. The resulting software components have provided a foundation upon which the team built a commercially viable product and further opportunities for grant applications and for commercial development.

3. The RCG funding was a component in the development of protected intellectual property that currently amounts to four US patents. WVU Research Corp has provided the expertise and capability to move these patent applications forward. The Geo team is also submitting additional patents via WVU Technology Transfer on technologies proposed for the recent round of RCG awards based on our concept of Reality Computing. Datacaster has expressed interest in protecting and capitalizing on the sale of products based on our Reality Computing platform.

4. Based on the patents noted above, a West Virginia based company, Datacaster, has licensed this technology through WVU Research Corporation and is actively marketing the product (Press release is at the end of this component of the report

5. Since RCG funding expired at the end of June, 2007, the GeoVirtual Laboratory has been funded on venture capital generated through Datacaster. Given a revenue stream arising from the marketing of the product it is anticipated that the GeoVirtual Laboratory to be hereafter self financing.

6. The identification and pursuit of new research directions that promise to open up further areas of commercially exploitable science that include immersive virtual GIS and real-world geospatial visualization now represent an active component of the groups activity.

7. The importance of the research undertaken by the GeoVirtual Lab was instrumental in attracting the USDA Natural Resource Conservation Service to establish the National Geospatial Development Center at WVU.

All the R&D steps mentioned above were paralleled with patents submitted by WVU attorneys through the Office of Technology Transfer. The first utility patent submitted was named “Method and apparatus for storage and distribution of real estate related data”, submitted on 11/04/2004. This patent comprised a client similar to the one using the ROAM algorithm, a Client Connectivity Manager and the backend databases. The Service Oriented Architecture and streamlined Geometry Clipmaps client along with Web Services and WMSs was submitted under a provisional patent named “Method and Apparatus for Storage and Distribution of Soil Related Data”, which was submitted on 5/20/2005. Subsequently, the CUTE s ubsystem was incorporated it into the application patent named “A Multi-Source Data Retrieval System”, submitted on 19/05/2006. In the Fall of 2005, we presented our system to Amazon A9, as well as Mapquest and Yahoo. In preparation for these meetings we developed a web-enabled data viewer that did not require plug-in installers and yet delivered 3D imagery, terrain and geoPoints to web users. The utility patent for this invention was submitted recently on 10/02/2007, and is labeled “Multi-Dimensional Web-Enabled Data Viewer”.

Foundation of Basic and Translational Research for the Edwards Cancer Center

Grant Number: RCG0303 – Niles

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"A new biotech start-up company, Progenesis Technologies, LLC also indirectly benefited from the RCG…"

—Niles 2007, Final RCG Report

Specific Outcomes of the complete five year grant

1. Preliminary Data and State support used to secure $9.2 million COBRE award entitled "Transcription Factors in Cancer"
2. Attracted several new cancer research faculty members
3. Elaine Hardman, Ph.D. from LSU – Role of fatty acids in breast and colon cancer (directed support by the RCG)
4. Pier Paolo Claudio, M.D., Ph.D. from Sbarro Cancer Center, Temple University – Use of microbubbles and ultrasound for site-directed cancer therapy
5. John Wilkinson, Ph.D. from Wake Forest Compreshensive Cancer Center – Role of iron and micronutrients in cancer.
6. Piyali DasGupta, Ph.D. from the Moffitt Comprehensive Cancer Center – Nicotine receptors and lung cancer; tumor angiogenesis
7. Contributed in part to development of the biotech start-up Progenesis Technologies, LLC

Dr. Niles' initial proposal was to develop translational research at the Edwards Cancer Center focusing on reproductive tumors. Due to uncertainty of funding in years one and two, the research nurse was not hired and the tissue bank of tumors was not established. Gene expression profiles of a series of breast tumors were not pursued as a consequence. On the other hand, the specific gene tbx2 was isolated, and important thyroid cancer investigations were established. The successful COBRE application was enhanced by the State commitment and support of MU through the RCG. The focus on tbx2 gene expression in thyroid cancers was potentially a significant development for MU and WV, given a high incidence of thyroid cancer in the Kanawha Valley.

The thyroid cancer project unfortunately was halted early in the investigation however. Further experiment research did not support the conclusion that Tbx2 expression is consistently altered in thyroid cancer vs. normal thyroid tissue and the project needed to be redirected.

In place of the thyroid cancer project, Dr. Niles used RCG funds to further develop the research on the non-hypoxic expression of hypoxia-inducible factor-1alpha (HIF-1alpha) and its role in progression of melanoma. The data from this project are very compelling and reproducible. It is clear that HIF-1alpha, which is normally only expressed under hypoxic conditions found inside of solid tumors, can also be expressed by melanoma cells under non-hypoxic conditions and appears to contribute to their malignant

phenotype. These data are currently being formulated into a manuscript which will be submitted to the Journal of Biological Chemistry. An abstract of this work has already been accepted for presentation at the 4th International Melanoma Congress to be held in New York City this November. An RO1 grant application on this topic will be submitted for the Feb. 5th, 2008 deadline.

The five years of RCG support has led to NIH grant support in excess of $10 million. It has directly or indirectly contributed to five new faculty hires in the area of cancer research. Each hire has generated 2-5 new graduate student or technical support positions. The RCG has contributed to purchase of state of the art equipment for genomics, proteomics and cell characterization/sorting. These pieces of equipment are important for attracting grant support and new faculty. A new biotech start-up company, Progenesis Technologies, LLC also indirectly benefited from the RCG through use of equipment referenced above. The significance of this RCG to Marshall's research program was enormous. Although there was some deviation from the original aims of the proposal, the goals of the RCG program, i.e. to increase federal grant support and to spur economic development have been met.

Collaborators:

Daniel Flynn, Ph.D. – West Virginia University, Cancer Center
Bruce Chertow, MD - Marshall University School of Medicine, Endocrinology
Gary Meadows, Ph.D. – Washington State University, Pharmaceutical Sciences
Zalfa Abdel-Malik, Ph.D. – University of Cincinnati, Dermatology

DNA Sensor Infrastructure Development

Grant Number: RCG0304 – Norton

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"A new company, Vandalia Biotech, was founded in March of 2004. … At this point Vandalia is better positioned than any other known company to meet the requirements for massive quantities of very pure DNA that future vaccines could require."

—Norton 2007, RCG Final Report

Specific Outcomes of the complete five year grant

Economic Development: A new company, Vandalia Biotech, was founded in March of 2004. It was anticipated that this company would be one of the first to utilize the Biotech Incubator when it was established on the MU campus. The company was incubated and mentored in business practices by Marshall faculty owners of the local company, Microbiological Consultants. This extensive mentorship was gained from one of the few biotech entrepreneurs in Huntington, Frank Binder. An initial stock offering yielded support of approximately one million dollars, which has been sufficient to provide some stability for the company as it grew, re-configured a wing of a major historical hotel in Huntington and built a suite of excellent production laboratories. Students and technicians trained in the Marshall laboratories before joining Vandalia as employees. Vandalia has produced a set of educational kits named "Lyle and Louise" which are marketed by Fisher Scientific. Although the initial kit is based on DNA identification of people involved in crimes, the other kits simply expand the forensic emphasis of that first offering. Van dalia's proprietary technology affords the capability to produce DNA at rates unmatched on the market. Most recently a world record was set, with the production of 11 liters of PCR product for an international company. Vandalia is listed as an exporter company in the state of West Virginia. The first human DNA vaccine trials utilized a form of DNA called plasmids and have met with success. Vandalia's product, which is competitive with plasmid, is now in animal testing. At this point Vandalia is better positioned than any other known company to meet the requirements for massive quantities of very pure DNA that future vaccines could require.

Development of basic DNA sciences: With matching funds from the NSF EPSCoR grant, the Norton team obtained a microscope (Atomic Force Microscope) that allowed two undergraduates to investigate DNA at the molecular scale. The projects have, in general terms, been devoted to devising methods for precise placement of DNA molecules on surfaces, an essential component of using DNA as a structural "smart polymer". Methods for the production of very complex, cutting edge nanostructures have been implemented successfully. It can readily be said that there are only 3 or 4 laboratories in the world competitive with the level of research in DNA nanostructures being performed at MU. The development of a company which can produce DNA for nanoscale structure generation provides a significant advantage over other groups.

While some instrumentation has been very project specific and not of general use, an exception has been an instrument for the quantitative study of very small quantities of DNA and proteins. The Nanodrop

spectrometer allows researchers to use about 1/20th as much material as normal, and obtain results which are at least twice as accurate (error reduced by a factor of at least 2). Faculty from 3 other laboratories make routine use of this instrument for their research.

The grant and contract activity of the group at this time (post-RCG) which is on the order of $500,000 this year and the level of research interconnectedness of the group is well characterized by the listing of 16 current collaborators at the end of this document. A web of collaborators has been created with researchers on the Marshall campus, at WVU and around the country (including Sandia, a national laboratory).

Education: In collaboration with several other researchers, Dr. Norton had a successful program involving High School Teachers, High School Students, Undergraduate Students, Graduate Students, faculty and postdocs in year-round research. The high school component is most active during the summers, with major support provided to two high school teachers for most of the summers the grant was active. The numbers and quality of students increased each year until the last year, when a planned decline was executed, as originally programmed. Student research support is an investment that pays dividends both directly in research productivity and indirectly, by increasing visibility of biotechnology in local schools as well as on the MU campus. A major component of the fund use in the Challenge grant has been to support people in furtherance of the investigation of DNA.

Potential economic development in further years: Vandalia Biotech offers the prospect of job growth in the region. Applications in DNA identification studies have been enabled by acquisition of a robotic DNA chip printing system and requisite DNA purification systems. The system can print as many as 20,000 tests on one glass slide (called DNA chips), there are several markets which may require as few as 20 tests per slide. Many of these chips may be used locally. The system is located in a shared facility, so that students from multiple departments (Biology, IST and Chemistry) can benefit from this new capability. Several present and future markets are of interest, and products are being developed to meet current market needs

Patents, licenses: Vandalia Research and Marshall University have applied for one patent, and a licensing agreement with Marshall has been developed and signed. Marshall has not yet filed further supporting patents, even though their policy requires disclosure.

A patent for nanocircle sensors is still pending. “Our DNA nanostructure studies proposal was selected as one of the first projects to be funded by the newest National Nanotechnology Laboratory called CINT or the Center for Integrated Nanotechnologies, in Albuquerque, NM, a joint venture between Sandia and Los Alamos National Laboratories.” (Final Report from Dr. Norton)

6 publications and 2 poster presentations

Collaborating Organizations:
WVU, MU, Parabon Computations Inc., University of New Mexico, Texas A&M, University of Virginia, North Carolina State University, University of South Carolina, Los Alamos National Laboratory.

The Biometric Knowledge Center (BKnC) at West Virginia University

Grant Number: RCG0305 – Rood (now Williams)

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The Biometric Knowledge Center is the Economic Development and Program Development arm for Identification Technologies at West Virginia University. Working in tandem with CITeR (Center for Identification Technology Research) the groups have forged a strong, unified, interdependent synergy that has moved Identification Technologies at West Virginia University even more to the forefront of the science and has magnified its national reputation and presence.

The Biometric Knowledge Center (BKnC) has brought five (5) new "trusted partners" to the CITeR organization in the past two (2) years; Computer Sciences Corporation, Lockheed Martin of College Park, Northrop Grumman, Booz Allen Hamilton, and the Department Of Defense Research and Engineering. These members include the four largest integrators in the Biometric industry at the present

In the President's budget, the BKnC is tasked to aid the Rapid Reaction Technology Office in the development of a Defense Biometrics Research Agenda to address DOD Science and Technology issues

The BKnC has been working with the FBI on a Cooperative Agreement naming West Virginia University as the academic research arm for the FBI and as a research portal to the academic world by implementing and operating an academic research cooperative within the FBI's planned FBI Biometrics Center of Excellence.

In a report to the State, WVU BKnC described the goal of establishing a lab that would be a hotbed for innovation with government researchers, faculty, and students in identification technologies and serve as a magnet for further funded activity investment. This goal was named as the BKnC 2007 target for accomplishment. The BKnC has met the target and in doing so has evolved into a new role of Research Enterprise Economic Development, Program Development and Management.

In 2006, the WVU BKnC had over $500,000 portfolio value. CITeR researchers (represents 16 Faculty) as of July 2006 have authored one book (Dr Arun Ross), 4 book chapters, 3 magazine articles, 30 Journal papers, 11 workshop papers, and 11 extended abstracts. The BKnC through RCG funding has been able to enhance the growth and visibility of CITeR by Program Development efforts, infrastructure staffing, outreach activities, and Program Management efforts. The CITeR Research Portfolio value presently stands at $2.2 Million. CITeR is now extending its growth by expanding to another site at University of Arizona which speaks to its prominence as a national center that is highly successful.

The BKnC again served as the Program Management for the highly successful Biometrics Symposium, which is the Research Session of the Biometrics Consortium Conference held in Baltimore, MD on September 19-21, 2006. This Symposium serves as a national focal point for research, development, testing, evaluation, and application of biometric-based personal identification/verification technology. The Consortium has more than 1,000 attendees and is the premier Biometric conference. WVU's management of this highly visible, federal government partnered conference clearly marks it as a national leader in the field of Biometrics. The BKnC is already acting as the Program Management for the Biometrics Symposium to be held in Baltimore, Maryland at the Baltimore Convention Center September 11-13, 2007.

Collaborators and their organizations:
Federal Bureau of Investigation; Department of Homeland Security, US-Visit and Transportation Security Administration; National Biometrics Security Project; National Security Agency (two organizations); USSOCOM/SOALT; Department of Defense, Biometric Fusion Center; Computer Science Corporation; Lockheed Martin; FAA information Systems Security; Northrop Grumman; DDR&E; and Booz Allen Hamilton.

In the workforce: The BKnC has placed students in 11 industries; 10 university graduate programs; and 1 in DoD. Sixty students are working in projects at 7 universities.

[1]US-VISIT is a continuum of security measures that begins overseas and continues through arrival and departure from the United States to ensure the person crossing our border is the same person who received the visa. Robert A. Mocny served as the director of the United States Visitor and Immigrant Status Indicator Technology (US-VISIT) program.

Report of **Five-Year Outcomes**

Title: Proteomics and Cancer: A Partnership between WVU and the Biotechnology Industry

Grant Number: RCG0306 – Timperman

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"Research aim was to provide better tools for the analysis of proteins from humans and model biological organisms (broadly applicable to most diseases, including cancer)."

—Timperman 2007, Final RCG Report

Specific Outcomes of the complete five year grant

1. Six patent applications that have been supported financially by Protea Biosciences. Timperman was a co-founder of Protea Biosciences, which had been established before the funding of this project was initiated. Our laboratory work has formed the foundation for a number of products that are currently offered by Protea Biosciences. Because Timperman's laboratory worked in partnership with Protea, in many instances, scientists from both Timperman's laboratory and Protea Biosciences contributed to projects jointly.

2. The products and tools that are being developed focus on improving protein separations and sample handling prior to identification of the proteins in a mass spectrometer (MS). …these proteomic tools are broadly applicable to most diseases, including cancer.

3. Protea has made great strides during this grant period and has developed its first catalog for its product line, with too many entries to describe fully here (online catalog at www.proteabio.com).

4. Products worth noting are the GELutor device for removal of whole proteins from gel separations. T This product will enable researchers skilled in gel separations to move directly into the field of "Top-Down Proteomics" in which whole proteins are analyzed. This approach is best suited for identification of important post-translation modifications and differential protein splicing. Future versions of the GELutor are currently being developed and will provide enhanced functionality. For many analyses the proteins must be broken up into shorter segments called peptides for determination of the amino acid sequence and identification in the MS.

5. For automated proteolytic sample digestion, an enzyme cartridge was developed and is now being marketed.

6. To aid researchers in validating proper operation of their protein and peptide separation and MS systems, protein and peptide standards have been developed.

7. Coated capillary columns for capillary electrophoresis are available from Protea that were initially developed in the Timperman lab

8. Protea Biosciences offers fee for service analysis and in-depth research collaborations with customers in need of proteomic services. These services provide separation and MS analysis of complex protein samples. The lead scientists in charge of these services, Drs.Trust Razunguzwa and Matthew Powell, were both trained in the Timperman laboratory.

Six patents pending:

1. Microfluidic System for Proteome Analysis - 10/18/02
2. An Integrated Microfluidic System for Proteome Analysis Using a Concentrating Membrane - 2/23/04
3. Use of Laser Micromachining to Produce Hydrodynamic Flow Restrictors in Microfluidic Devices - 5/25/04
4. Novel Interfaces for Coupling Microfluidic Systems with Electrospray Ionization Mass Spectometry – 5/25/04
5. A Novel Saw-Tooth Shaped Gradient for Chromatographic Separations – 6/15/04
6. Traveling Wave Electophoresis – 7/15/07

Student demographics:

Total count of students involved 8; 2 undergraduates/6 graduate students; M: 3/F: 3; African (1), White (5), West Virginian (2).

Research scientists (5): Asian (1), White (5), Male (3) Female (2).

Collaborators and their organizations:

Boyd Edwards (WVU Physics)
Lloyd Carroll (WVU Chemistry)

Report of **Five-Year Outcomes**

Science and Research
West Virginia Higher Education POLICY COMMISSION

from the **First Round of Research Challenge Grants**