

Morgan State University

External Research Advisory Panel

Report No. 3

May 2015

Submitted to:

*Dr. Victor R. McCrary, Vice President,
Research & Economic Development*

Compiled by:

Dr. Edet E. Isuk, Director, Research Compliance

Edited by:

Dr. J.V. Ortiz, Panel Chair



MORGAN
STATE UNIVERSITY™

Growing the Future ~ Leading the World

Morgan State University
External Research Advisory Panel
Report #3
May 2015

TABLE OF CONTENTS

Panel Members.....	0 2
MSU D-RED Senior Staff	3
ERAP Roles and Responsibilities.....	0. 4
MSU Vision and Mission.....	0... 5
Enterprising Responses to Current Challenges.....	0.6
Measures in Progress	0 8
Recommendation	0 8
APPENDIX	0... 11
Meeting Agenda.....	0... 12
Presentations.....	17

Morgan State University
External Research Advisory Panel

PANEL MEMBERS

Dr. J. V. Ortiz, Panel Chair

Ruth W. Molette Professor and Chairman
Department of Chemistry and Biochemistry
Auburn University

Mr. J. Walter Faulconer

Executive Vice President
American Astronautical Society
Strategic Space Solutions, LLC

Ms. Camylle C. Coley

Senior Consultant to the Director
DoD Office of Small Business Programs
Workforce Development & STEM Entrepreneurship

Dr. Godwin Odia

Captain, Commissioned Corps
U.S. Public Health Services
Centers for Medicare and Medicaid Services

Dr. Dianne L. Poster

Special Assistant to the Principal Deputy
Director's Office
National Institute of Standards and Technology

Dr. Filomena Califano

Associate Professor of Chemistry and Physics
St. Francis College, NY

Ms. Betsy Proch

IT Security Analyst
US Department of Homeland Security

General William (Kip) Ward

President and COO
SENTEL Corporation

Ms. Kelley L. Dempsey

Senior Information Security Specialist
National Institute of Standards and Technology
Information Technology Laboratory/Computer Security
Division

Mr. John Schuster

John Hopkins University
Applied Physics Laboratory

Mr. Vincent B. Knox

Senior Associate General Counsel
Johns Hopkins University Applied Physics Laboratory

Dr. Lisandra Geray-Vega

Project Manager
Office of Highway Safety, NTSB

Ms. Magdalena Navarro

Physical Scientist/Senior International Program Manager
National Institute of Standards and Technology
International and Academic Affairs/ Office of the Director

Dr. Joycelynn Nelson

Vice Chairman
Central State Hospital Local
Redevelopment Auxiliary Board

Ms. Joanne C. Murphy

Chief Architect, CISSP
Signature Client Group
AT&T Operations, Inc.

Dr. Roco Mennella

Professor
Mechanical Engineer
The Catholic University of America, DC

Dr. Anthony Dent

Adjunct Professor
Cheyney University

Submitted to:

*Dr. Victor R. McCrary, Vice President, Research & Economic
Development*

Compiled by:

Dr. Edet E. Isuk, Director, Research Compliance

Edited by:

Dr. J.V. Ortiz, Panel Chair

Ms. Tanaga Boozer

Program Advisor
Office of Education and Outreach
United States Patent and Trademark Office

MSU Division of Research & Economic Development (D-RED) Senior Staff



Dr. David Wilson
President
Morgan State University



Dr. Victor McCrary
Vice President
Division of Research & Economic Development



Dr. Mildred H. Ofosu
Assistant Vice President
Research Administration



Dr. Tim Akers
Assistant Vice President
Research Innovation & Advocacy



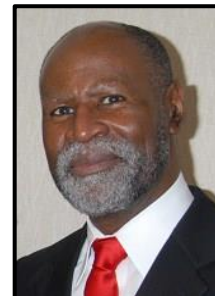
Dr. Edet Isuk
Director
Research
Compliance



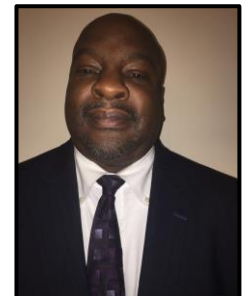
Gerald Whitaker
Director
Base Realignment/
DoD Liaison



Dr. Kelton Clark
Director
Morgan P.E.A.R.L.



Ellis Brown
Acting Director
Morgan Community
Mile



Jeffrey Copeland
Director
Restricted Funds
Accounting

Morgan State University External Research & Advisory Panel (ERAP) Roles and Responsibilities

General Statement

The principal objective of the External Research & Advisory Panel (ERAP) is to advise Morgan State University (MSU) on how to achieve its vision as it relates towards being a premier, *research*, urban institution that conducts high quality, forward-looking, innovative research activities across its various schools and colleges. In addition, the ERAP is expected to offer advice on areas supportive and aligned to Morgan's research enterprise including technology transfer, and economic development activities. The External Research & Advisory Panel will meet twice a year, and provide a written summary report of its observations and recommendations to the MSU Vice-President of Research & Economic Development. The VP of Research & Economic Development will share this report with the Morgan State University President, President's Cabinet, and the Morgan State University Internal Research Council.

Specific Roles and Responsibilities

- 1. Assess Morgan's Research Activities based on:**
 - a. Domain expertise and experience in specific research areas
 - b. Current research trends and prior work
 - c. Current funding levels and trends
 - d. Domestic and foreign technology advances
 - e. Balance of STEM & non-STEM research across the University

- 2. Assess Morgan's Research Administration by:**
 - a. Evaluating the overall University Research Strategy led by the VP for Research & Economic Development
 - b. Evaluating the University environment for its support of faculty research
 - c. Evaluating the adequacy of metrics to assess reporting of sponsored programs
 - d. Sharing of best-practices for oversight of sponsored programs
 - e. Sharing of best practices for technology transfer
 - f. Sharing of best practices for the University as a catalyst for economic development

- 3. Benchmark Morgan's Research Capabilities:**
 - a. Relative to alternative providers (e.g. other universities, National laboratories) and potential partners, based on quality, reputation and cost
 - b. Based on potential for technology transfer and potential work for industry (where appropriate)
 - c. Based on the adequacy of faculty to meet anticipated challenges
 - d. Based on the adequacy of technical facilities to meet anticipated challenges
 - e. Based on the University's reputation to attract both grants & contract and research faculty

- 4. Advocacy of Morgan's Research Enterprise by:**
 - a. Identification of potential partners and resources for Morgan State University
 - b. Identifying opportunities for faculty and staff members to increase participation on external boards, and working groups to increase their exposure to the greater research community

MORGAN STATE UNIVERSITY

Vision Statementⁱ

Morgan State University is the premier public urban research university in Maryland, known for its excellence in teaching, intensive research, effective public service and community engagement. Morgan prepares diverse and competitive graduates for success in a global, interdependent society.

Mission Statementⁱⁱ

Morgan State University serves the community, region, state, nation, and world as an intellectual and creative resource by supporting, empowering and preparing high-quality, diverse graduates to lead the world. The University offers innovative, inclusive, and distinctive educational experiences to a broad cross section of the population in a comprehensive range of disciplines at the baccalaureate, master's, doctoral, and professional degree levels. Through collaborative pursuits, scholarly research, creative endeavors, and dedicated public service, the University gives significant priority to addressing societal problems, particularly those prevalent in urban communities.

Core Values

The following institutional core values guide the promotion of student learning and success, faculty scholarship and research, and community engagement at Morgan:

Excellence. Excellence in teaching, research, scholarship, creative endeavors, student services, and in all aspects of the University's operations is continuously pursued at Morgan to ensure institutional effectiveness and efficiency.

Integrity. At Morgan, honest communications, ethical behavior, and accountability for words and deeds are expected from all members of the University community.

Respect. Each person at Morgan is to be treated with respect and dignity and is to be treated equitably in all situations.

Diversity. A broad diversity of people and ideas are welcomed and supported at Morgan as essential to quality education in a global interdependent society. Students will have reasonable and affordable access to a comprehensive range of high quality educational programs and services.

Innovation. Morgan encourages and supports its faculty, staff, and students in all forms of scholarship including the discovery and application of knowledge in teaching and learning and in developing innovative products and processes.

Leadership. Morgan seeks to provide rigorous academic curricula and challenging co-curricular opportunities to promote the development of leadership qualities in students and to facilitate leadership development among faculty, staff, and students.

ⁱ *Growing the Future, Leading the World:* The Strategic Plan for Morgan State University, 2011-2021

ⁱⁱ Ibi

**Final Report of the
External Research Advisory Panel Meeting**

**Morgan State
University**

**J. V
Ortiz**

May 19, 2015

Enterprising Responses to Current Challenges

Widespread reductions in support for its historical missions of teaching and research require a bold response from the faculty, administration and students of Morgan State University. Trends in state-government finances are evident. Support from the state of Maryland cannot be expected to increase in a period of financial strain. Thousands of businesses in Maryland have relocated to Virginia and other states. Decreased investment in university missions and reduced confidence in Maryland's business and employment prospects could become mutually reinforcing. Public institutions must act to prevent such a downward spiral.

Other states with stronger traditions of entrepreneurial activity stimulated by partnerships between business and academic organizations are more resistant to such decline and more likely to attract investments (such as venture capital) that lead to economic growth. Although the state of Maryland has several important advantages, such as excellent universities, federal laboratories and proximity to important government institutions, it could benefit from stronger efforts to promote local business and to train people for entrepreneurial activities. Institutional leadership from MSU could have a decisive influence in responding to this need.

The encouragement of entrepreneurial activity by the faculty is an atypical and innovative response to the problems that currently beset urban universities. Limited funding for research grants is an obvious and ubiquitous difficulty. Despite the difficulties and risks of encouraging faculty to branch out beyond grants to government contracts, substantial rewards await institutions that embrace this strategy. This response to current challenges requires the staff to become more entrepreneurial and requires substantial in-house support in the arcana of contract writing that differ substantially from grant applications.

Encouraging faculty to become more collaborative and innovative and students to acquire an entrepreneurial point of view could transform the image of MSU. As members of the faculty become more adept at becoming research entrepreneurs, they can better teach their students how to learn and apply entrepreneurial principles. The ASCEND program illustrates this principle. Here, NIH sponsorship has enabled students to develop skills in health research by

employing entrepreneurial principles. The focus on students is essential, for their talent, energy and commitment lie at the core of every premier research institution. The ASCEND project is an example of MSU's commitment to develop and empower students so that they can assist in the creation of new businesses and jobs in the state of Maryland. ASCEND will provide students with the environment, resources, and research experiences that are needed to foster creativity, innovation, and collaboration. Although the program currently focuses on biomedical fields, it will yield lessons that are applicable in other disciplines. Competition for internal mini-grants promises to be especially instructive for inexperienced researchers. Another example is the Innovation and Entrepreneurship Program at the School of Business and Management. This program includes a campus-wide, business-plan competition, special events, management courses, and mentoring.

Innovation, collaboration, and entrepreneurship are admired by most universities and businesses, but are seldom understood, much less embraced. If MSU can come to embody these principles, it will not only make its students successful, but also will establish a formidable reputation for the quality of its programs.

As elucidated by Dr. Foster, the entrepreneurship movement not only brings positive characteristics to the MSU programs, it also builds on principles learned naturally by children in less wealthy neighborhoods. They have been taught that success is not automatic but requires hard work and the will to strive. Teaching entrepreneurship builds on these life lessons and takes them to a new level.

The process of entrepreneurship can and must involve all of the disciplines at a university, for it underpins all types of proposals and endeavors. To go forward with any enterprise requires fundamental knowledge of the disciplines that inform it, the ability to articulate its purposes in speech and writing, and formation of teams to collaborate in planning and development of strategy.

Above all entrepreneurship is not just a business endeavor but a set of approaches and principles that apply to any endeavor. Anything that we do to influence other people requires that we be entrepreneurial and our success is generally directly proportional to how influential we can be.

Faculty and students may benefit from information provided by the volunteer entrepreneurial mentoring group SCORE at www.score.org and by the Small Business Administration at www.sba.gov. SCORE will provide volunteer mentors.

There were indications that liberal arts colleges were perhaps having difficulties with their roles in entrepreneurial education. In fact, the liberal arts have a critical role that relates to

collaboration in teams and to verbal and written communication. Many organizations fail because of bad communication. The liberal arts should take the lead in making MSU known for the communication skills of its students.

Measures in Progress

Three initiatives discussed by Dr. McCrary will enable MSU to exercise institutional leadership:

1. Building awareness of entrepreneurial activity among students and encouraging faculty to become involved by adding such activity as a criterion of merit.
2. Operating at the speed of business by accelerating the contract and grant proposal process and other bureaucratic procedures.
3. Helping faculty with the management of relationships, networking, competing for state and federal funding, navigation of the patent process, and framing proposals that emphasize impacts on economic development in Maryland.

Dr. Mary Fisher of the School of Business and Management built on these themes by describing the Innovation and Entrepreneurship Program at MSU. This program has developed majors and minors in entrepreneurship, as well as a PhD program, and thus has generated interest at many levels of education. This program is based on entrepreneurial principles that help students learn how to commercialize ideas while focusing on the skills and characteristics that they need to succeed. Although the program is new, it already has had multiple accomplishments. The program highlights the skills and characteristics that promote success. Because many MSU students come from poverty, the program focuses on developing interpersonal team skills as well as innovation skills. Promoting courage in the face of adversity shows students how to persist and see adversity as an opportunity to change and grow, instead of seeing it as a failure. Through recruitment of a student advisory board, the program has noted what areas are of particular concern to students, and now offers skill-development workshops and motivational speakers. In addition, lessons learned through participation in competitions have helped to create a culture of entrepreneurship. The entrepreneurship program uses an evidence-based approach to determine possibilities and expectations, encourage a growth mindset, stimulate innovation and develop interpersonal and team skills.

Recommendations

Among MSU's strengths has been its ability to coordinate activities between departments. The entrepreneurship program's many accomplishments set the stage for further collaboration. Departments in engineering and public health and the nascent cybersecurity program are potential sources of prototypes, models, examples, and standards that can help shape entrepreneurial ideas.

Existing MSU programs such as the Morgan Community Mile (MCM) can be great resources to tap for entrepreneurial or innovative opportunities. MCM has expanded MSU's influence into

the wider community and as such can be a gateway into opportunities through business and neighborhood associations.

Another existing program that could be used as an incubator for the entrepreneurship program is the Patuxent Environmental and Aquatic Research Laboratory (PEARL), a research facility that focuses on the Chesapeake Bay and its estuaries. PEARL can build on its existing relationships to expand its research into environmental problems that affect Baltimore, including food depletion, health dangers, and rising tides.

Other possible venues for the entrepreneurial program to explore are noted in the ERAP analysis papers from January 2014 and October 2014, including:

1. Nutritional food availability, allocation, and safety –
 - a. Expand or partner with local groups on Corner Store initiatives.
 - b. Establish a four–point program for community gardens and development
 - i. Partner with Baltimore City and with real estate interests to secure and clean up potential gardening sites
 - ii. Community outreach to train urban gardeners (e.g. what to plant, when to plant, fertilization)
 - iii. Harvesting food for community farmers’ markets and supplying the Corner Store initiative
 - iv. Education in public schools about gardening and eating fresh vegetables
2. Aging population - consider developing a nursing program that reaches out to the community to make sure aging citizens are properly fed and cared for, both in their homes and in institutions.
3. Resiliency – develop disaster recovery package suitable for sale to the community, or for non-profit use to augment an existing disaster recovery program.

Active participation in professional organizations can help to expand and promote student involvement in research, leadership, and developmental activities. Although some departments seems to be actively involved in professional organizations (e.g. the National Association of Black Accountants), student participation in professional organizations in other disciplines is not evident. Active participation in such organizations provides access to professional networks, internships, workshops, scholarships, student competitions, and community service, promotes interactions with students from other chapters within the region and has the potential to develop and empower students so that they can contribute to the creation of new businesses and jobs.

The discussion about MSU and the Maryland Innovative Initiative highlighted several problems that have hindered MSU’s ability to secure funding. These problems include defects in the preparation of proposals, deficiencies that appear during review, lack of commitment from investigators to complete the process (e.g. follow-up on comments), and MSU intellectual

property practices. A high-level plan to remedy these deficiencies which was presented at the meeting calls for improvements to the internal review process, collaboration with other universities in the program, and strengthening intellectual-property infrastructure. MSU can benefit from a series of faculty training sessions or programs to improve faculty awareness of the benefits of entrepreneurship, as well as knowledge of the processes associated with patents and trademarks. The Division of Research and Economic Development held a training session in August 2014 with emphasis on pre-award, post-award and compliance procedures. MSU also can benefit from training and other services provided by the US Patent and Trademark Office (USPTO). The USPTO offers information about the patent process and information on registering trademarks on their website, via webinars, and in on-site sessions. Developing a strategy to strengthen the intellectual property infrastructure at MSU that includes the needs of the faculty as well as the needs of the institution should be a priority.

The international program is rich and diverse, with a list of exchange countries that is quite different from that of most other universities. As such, it has the potential to differentiate MSU from other American universities. Interactions with African nations, Brazil, China and Middle Eastern countries have excellent potential to offer yield unique educational experiences and research opportunities. The cultivation of linguists and other professionals with broad cultural competence in international affairs is an especially opportune goal for educators at MSU. Combining such expertise with entrepreneurial skills such as team building and marketing can have a transformative effect on the careers of MSU students and faculty. However, it appears that there is limited participation in this program both from MSU and from foreign institutions. Increasing participation should be a near-term goal.

MSU recognizes the importance of developing globally knowledgeable and competent graduates. In addition to the programs described during the meeting in April, MSU can explore the feasibility of participating in programs such as AIESEC, which provides students opportunities to volunteer and participate in internships in a broad range of companies around the world.

Cyber security is an area of clear interest for the protection of MSU databases and because of its potential for future research. The briefing by Dr. Kornegay on cyber security related to the internet of things was stimulating and innovative. It is an area of research on the cutting edge of cyber security. This is exactly the kind of work that can enable MSU students to garner key jobs in the future.

Appendix

1. Meeting Agenda

2. Meeting Presentations

- a. Division of Research & Economic Development- Dr. Victor McCrary*
- b. Innovation and Entrepreneurship Program-Dr. Mary Foster*
- c. ACEND- Dr. Payam Sheikhattari*
- d. Maryland Innovation Initiative- Dr. Christopher Hollinsed*
- e. Embedded Systems Security Research via Reverse Engineering and Countermeasure- Dr. Kevin T. Kornegay*
- f. Internalization of Morgan Campus- Dr. T. Joan Robinson*

Appendix 1:

Meeting

Agenda



**MORGAN STATE UNIVERSITY EXTERNAL RESEARCH ADVISORY BOARD
(ERAP)
THURSDAY, APRIL 9, 2015
Boardroom, 4th Floor, Richardson Library**

AGENDA

- | | |
|----------------------------|---|
| 8:30 am - 9:00 am | Arrive at Morgan State University- Continental Breakfast
Boardroom, 4th Floor Earl Richardson Library,
Morgan State University |
| 9:00 am - 9:30 am | Welcome to Morgan State University:
Dr. Victor McCrary,
Vice President, Research & Economic Development
Introduction of New ERAP Members |
| 9:30 am - 10:00 am | Division of Research & Economic Development:
Update from October 2014 Meeting |
| 10:00 am - 10:15 am | Break |
| 10:15 am - 11:00 am | Entrepreneurship: Dr. Mary Foster
School of Business & Management |
| 11:05 am - 11:55 am | The ASCEND Program
Dr. Payam Sheikhattari
School of Community Health & Policy |
| 12:00 pm - 1:00 pm | Interactive Lunch Meeting with the MSU Internal Research
Council |
| 1:00 pm - 1:30 pm | International Research Collaborations
Dr. Joan Robinson, Vice President for International Affairs |
| 1:30 pm - 2:00 pm | Title III: Its Role in Research & Technology
Dr. James Haynes, Director, Title III Program |



Division of Research & Economic Development

1700 East Cold Spring Lane • Baltimore, Maryland 21251
Tel: 443-885-4630 • Fax: 443-885-8030



2:00 pm - 3:00 pm	Cybersecurity: Infrastructure & Research Dr. Adebisi Oladipupo, Chief Information Officer Dr. Kevin Kornegay, School of Engineering
3:00 pm - 3:15 pm	Break
3:15 pm - 4:00 pm	Maryland Innovation Initiative: Dr. Chris Hollinsed
4:00 pm - 4:30 pm	Closed Session
4:30 pm	Depart Morgan State University

Victor McCrary's Cell # 301-580-1941



Division of Research & Economic Development

1700 East Cold Spring Lane • Baltimore, Maryland 21251
Tel: 443-885-4630 • Fax: 443-885-8030

Appendix 2:

Meeting

Presentations



Division of Research & Economic Development (D-RED)

09 April 2015
V. McCrary, Vice-President
Research & Economic Development
Morgan State University

The President's Vision



Growing the Future, Leading the World: The Strategic Plan for Morgan State University, 2011 – 2021

Morgan's motto, "Growing the Future, Leading the World," underlies the development of this strategic plan.

Approved by the MSU Board of Regents 8/2/11
David Wilson, President

"Morgan State University is the premier public urban research university in Maryland known for its excellence in teaching, intensive research, effective public service, and community engagement. Morgan prepares diverse and competitive graduates for success in a global, interdependent society."

*Morgan State University
2011-2021 Strategic Plan



MSU STRATEGIC PLAN 2011-2021: Goals

- **Goal 1:** Enhancing Student Success
- **Goal 2:** Enhancing Morgan's Status as a Doctoral Research University
- **Goal 3:** Improving and Sustaining Morgan's Infrastructure and Operational Processes
- **Goal 4:** Growing Morgan's Resources
- **Goal 5:** Engaging with the Community

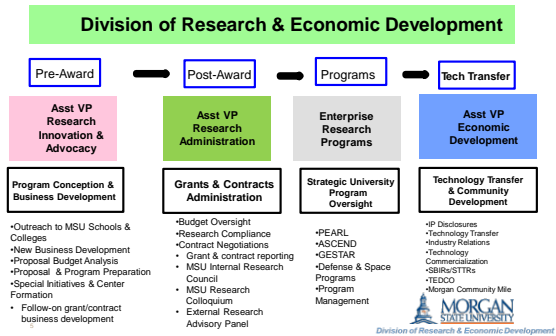


Division of Research & Economic Development

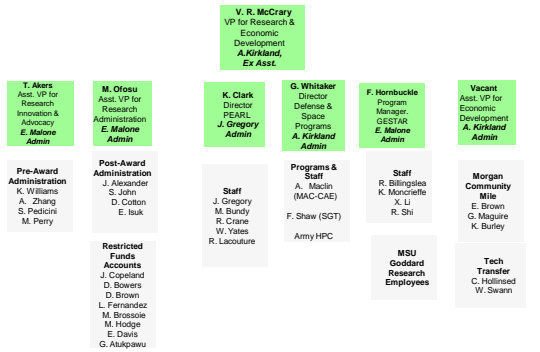


<p>MSU Vision</p> <p>Morgan State University (MSU) is the premier public urban research university in Maryland, known for its excellence in teaching, intensive research, effective public service and community engagement</p> <p>D-RED Goal</p> <p>Create a research ecosystem which promotes and incentivizes innovation and entrepreneurship among faculty, students, and our surrounding community</p>	<p>Strategic Focus (FY14 – FY17)</p> <ol style="list-style-type: none"> 1. Expand opportunities for student research experiences 2. Provide tools & processes to increase faculty success in obtaining grants & contracts 3. Be customer-focused to faculty and sponsor stakeholders through the use of improved work processes and technology platforms 4. Establish strategic relationships with Federal and Local, funding agencies and private industry 5. Increase faculty & student engagement within the Morgan Community Mile <p>Execution Priorities (FY15)</p> <ol style="list-style-type: none"> 1. Ensure success of GEAR Student Program resulting in 15-20 Morgan students at NASA Goddard in 2015 2. Increase web presence and external visibility of research faculty accomplishments 3. Establish written procedures for critical operations in DRED 4. Focus the Division's efforts to achieve \$32M in grants and contracts 5. Establish near-term and mid-term goals for each Priority Area of the Morgan Community Mile
---	--

D-RED: Organizational Structure



D-RED: Organizational Structure



Division of Research & Economic Development: Status Update – 04.09.2015

Selected Accomplishments	Programmatic Status										
<ul style="list-style-type: none"> • MID 2015: 18 Exhibits in Annapolis (K. Clark, J. Gregory) • Awarded \$1M NSF RISE grant – Reverse Engineering (K. Kornegay) • Awarded \$80K sub-contract from JHU-APL for IRAD funding of reverse engineering (W. Thompson) 	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td></td> <td style="color: #0070C0;">FY12</td> <td style="color: #0070C0;">FY13</td> <td style="color: #0070C0;">FY14</td> <td style="color: #0070C0;">FY15</td> </tr> <tr> <td style="text-align: left;">Funding \$M:</td> <td>30</td> <td>28</td> <td>30</td> <td>24</td> </tr> </table> <p>Proposal Submissions: 115 (\$36.6M)</p> <p style="margin-left: 20px;">23 awarded (\$4.9M) 8 declined (\$2.3M) 78 pending (\$29.4M)</p>		FY12	FY13	FY14	FY15	Funding \$M:	30	28	30	24
	FY12	FY13	FY14	FY15							
Funding \$M:	30	28	30	24							
Selected Opportunities (6 months)	Announcements, Issues										
<p>Sponsors</p> <ul style="list-style-type: none"> NASA – HBCU URC, W. Thompson (\$5M) DoD – HBCU Instrumentation, K. Kornegay (\$200K) NSF – HBCU-UP W. Johnson/C. Martin-Dunlop (\$300K-\$1M) JHU-APL – Internal Research & Development funds contract (\$100K-\$300K) 	<ul style="list-style-type: none"> April 20th – Navy Program Review – NSWC Indian Head April 25th – Morgan Community Mile Summit 10 am – 12 noon; Engineering Auditorium Dr. Wilson, Keynote Speaker June 12th MSU-PEARL Open House Sponsor Appreciation Day 11am – 2 pm 										

Outline

- Pre-Award Activities Update
- Post-Award Activities Update
- Enterprise Programs
- Economic Development



PRE-AWARD ACTIVITIES UPDATE (proposal & business development)

D-RED 3QFY15 Update: FY15 Proposal Submissions

July 1, 2014 – March 31, 2015

FY15 1st Quarter	FY15 2nd Quarter	FY15 3 rd Quarter
\$13.0M	\$22M	\$36.6M
41 submissions	76 submissions	115 submissions



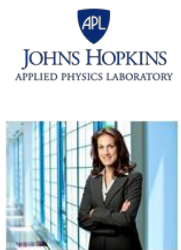
D-RED 3QFY15 Update: Contracts & Grants Snapshot

Operating Unit Proposal Submissions

Operating Unit	Proposals/Unit	Percentage of Total
Architecture & Planning	3	2.6
Business & Management	1	< 1
Community Health & Policy	9	7.8
Computer, Math, & Natural Science	31	27.0
Education & Urban Studies	2	1.7
Engineering	33	28.6
Graduate Studies	4	3.5
Global Journalism & Communications	0	0.0
Liberal Arts	5	4.3
Social Work	4	3.5
Other Divisions	23	20.0
Total	115	100

MSU Research Colloquium

- November 20, 2014; over 70 faculty & students in attendance
- Ms. Sezin Palmer, Mission Area Executive for Research and Exploratory Development, at the Johns Hopkins University Applied Physics Laboratory (JHU-APL)
- Takeaway – collaborative research opportunities with Morgan faculty



Delmock (DTI) Technologies

- \$15,000 given to Morgan
- Support of MSU Research Colloquium
- Collaborative effort with the Division of Institutional Advancement
- First DTI-MSU Research Symposium, April 8th



IARPA DIRECTOR VISITS MSU

- Met with over 40 MSU faculty members to describe basic research opportunities with IARPA
- Interested in MSU's expertise in sub-Saharan African languages; reverse chip engineering research



Division of Research & Economic Development

Morgan Innovation Day 2015



- March 19th in Annapolis – over 300 attendees
- 18 projects highlighting Morgan's innovations & research with focus on impact to the State of Maryland
- Lt. Governor Boyd Rutherford in attendance

POST-AWARD ACTIVITIES UPDATE (contracts & grants)



D-RED 3QFY15 Update: FY15 Contracts & Grants Snapshot

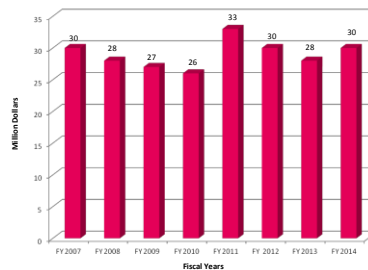
July 1, 2014 – March 31, 2015

FY15 1st Quarter	FY15 2nd Quarter	FY15 3rd Quarter
\$15.0M	\$19.4M	\$24.0 M
26 tasks	49 tasks	

- Increase over last year
- Proposal submissions from FY14 awarded in FY15

MSU Contracts & Grants FY2007-FY2014

Total Extramural Funding by Year



FY15: \$24M to date

\$300K NSF Grant to School of Education

- Dr. Whitney Johnson, Department of Advanced Studies
- Innovative re-design of innovative secondary teacher certification program for biology & mathematics
- Leverages the Morgan Community Mile and the MSU PEARL



\$100K Grant to School of Computer Mathematics, Natural Sciences

- Dr. Vojislav Stojkovic, Department of Mathematics



- Research Topic: Big Data

- Ten-year initiative with the US Army Research Laboratory (ARL), New Mexico State University, University of Texas-El Paso, and Stanford University (lead)



NSF-RISE: Embedded System Security via Reverse Engineering and Countermeasures PI: Dr. Kevin T. Kornegay, kevin.kornegay@morgan.edu



<p>Research Goals</p> <ol style="list-style-type: none"> 1. To assess the vulnerabilities of Internet of Things (IoT) devices. 2. To provide countermeasures to secure IoT devices against cyber attacks. 3. To provide secure data exchange between IoT devices. 4. To maintain operability. 	<p>Sponsor: National Science Foundation Award Amount: ~\$1M</p> <ul style="list-style-type: none"> - Support for 5 Doctoral Students - Infrastructure Support - Serves as a precursor to the Center for Reverse Engineering and Assured Microelectronics (CREAM) <p>Duration: 36 Months Research Team: 5 ECE Faculty Members</p>
--	---



ENTERPRISE RESEARCH PROGRAMS

MSU GESTAR PROGRAM



- A five year cooperative agreement to carry out experimental, analytical and theoretical research in support of NASA's Earth Sciences.
- University Space Research Association (USRA) bid and won this program in 2010; Morgan a sub-contractor on the proposal



MSU GESTAR PROGRAM

Scientists cooperatively carry out experimental, analytical and theoretical research on all aspects of the Earth system, the atmosphere, the biosphere, the oceans, and the solid earth – NASA Code 600

- Research areas:**
- Atmospheric Aerosols,
 - Carbon Cycle and Ecosystems
 - Climate Modeling and Analysis
 - Oceanography
 - Terrestrial Water Cycle
 - Weather and Short-Term Climate
 - Earth Rotational and Gravitational Dynamics
 - Planetary Analog Studies
 - Sun-Earth Connection Studies



MSU GESTAR PROGRAM

- Technical milestones and progress on track
- Administration – environment of continuous improvement & customer satisfaction!
- Five MSU student interns for Fall 2014; 14 Spring 2015
- Two MSU Goddard scientists tapped for NASA Awards



\$23M NIH BUILD AWARD -ASCEND



National Institutes of Health

- Program to develop a pipeline of students to become biomedical researchers
- 5+5 award – renewable if program goals are met
- 12 Awards given for \$33M



MSU ASCEND PROGRAM

- Richard Carmona, former Surgeon General of the United States
- Michael Klag, Dean, Johns Hopkins Bloomberg School of Public Health
- Kim Nickerson, Assistant Dean for Diversity, University of Maryland College Park
- Joyce Payne, Founder of the Thurgood Marshall College Fund
- Joel Schildbach, Professor and Vice Dean for Undergraduate Studies, Johns Hopkins University
- James Anthony, Professor of Epidemiology, Michigan State University
- Andrew Campbell, Associate Professor, Brown University
- Marilyn Belcher, Associate Professor, Johns Hopkins University
- Michael Willis, Vice President and Chief Business Information Officer, Kaiser Permanente Mid-Atlantic Region
- Casonya Johnson, Associate Professor, Georgia State University



National Institutes of Health



MSU MAC-CAE PROGRAM

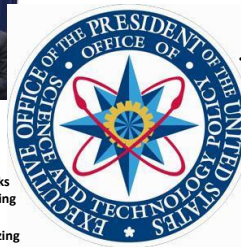
- Mid-Atlantic Consortium Center of Academic Excellence (MAC-CAE)
- Dr. Arlene Maclin, PI
- Training program to prepare students for intelligence analysis (sponsor is the Defense Intelligence Agency)
- Annual Colloquium held October 30, 2014 at Bowie State, attracted over 75 students



ECONOMIC DEVELOPMENT UPDATE



Morgan 'Makers' at White House



- September 24, 2014 HBCU Maker Workshop at OSTP
- Morgan, NC A&T, Spelman, & UMass at Boston had exhibits

- Maker Movement seeks to couple formal learning with hands-on skills
- Opportunities for utilizing Morgan's 3D-printing, wind tunnels and other 'shop facilities'



Maryland Innovation Initiative (MII) Award

- Awarded our 2nd MII Phase 1 grant for translational research
Dr. Viji Sittler, Dept. of Biology
- Bio-engineering a salt-tolerant gene into algae strains to produce biofuels
- Biofuel industry over the next 10 years projected to be a \$185 billion industry
- Proposal endorsed by the US Navy



Maryland Innovation Initiative

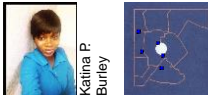
- 3 Provisional Applications filed with USPTO in February
- As a result of Phase 1 Award in January 2013, Morgan State University has spun off its first company – **iCrystal**; MSU NIH STTR
- Additional site miner: Wayne Swann



Morgan Community Mile



Live Near Your Work



Katrina P. Burrely



Community Engagement with the BCPS 21st Century Schools Building Plan



Gussie Maguir



Morgan StreamWalk Project, Sesquicentennial Park Design



Morgan Community Mile

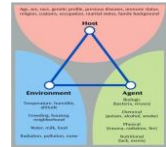
PROJECT PI: PAVAM SHEIKHATARI,

PROJECT PI: LORECE V. EDWARDS,

The CEASE intervention will be implemented at 18 new sites between 2013-16, including the **Morgan Community Mile (MCM)**
FY2014 funding – \$460K, NIH

- Project Goals**
- Prevent and reduce substance abuse and transmission of HIV/AIDS
 - Develop environmental strategies to reduce risk factors and increase protective factors

- Research Outcomes:**
- Feasibility, Fidelity, Penetration, Acceptability, Uptake, Cost
 - Retention, Effectiveness, Timeliness
 - Satisfaction (Clients, Peer-Motivators, Community Organizations)



THE GET SMART PROJECT (STUDENTS MOBILIZED AND RETOOLING TO TRANSFORM)



2014 Morgan STEM Expo, October 2014

Key partners:

- Office of Senator Ben Cardin
- Morgan Community Mile
- School of Education,
- School of Engineering,
- School of Computer, Natural Sciences, & Math
- Over 375 participants
- 40 exhibitors



DRED Looking Ahead to FY16: Opportunities

- **Department of Defense** - Expand sponsor funding base to the Department of Defense funding environment favorable for research intensive HBCUs – **contracts a key!!**
- **Cybersecurity** – Morgan's student demographics favors workforce development for this growing industry which is a major concern for the Nation – both government and private sectors
- **PEARL** – Opportunity for this MSU facility to be a nexus for educational awareness of conservation, environmental research and economic development for Maryland's fishing/oyster/crab industry – National Security



DRED Looking Ahead to FY16: *Challenges*

- Building a sense of entrepreneurship among MSU **research faculty & students**– *takes time and perseverance!*
- Research Administration at the “speed of business” – **need for best practices**
- Securing external funding in a very tight Federal and State funding environment – *relationship management is the key to success here!*

37



2015 Events

- **February 23:** *NCURA Workshop, Morgan State*
- **March 19:** *Morgan Innovation Day, Annapolis, MD*
- **June 2-5:** *NSPAA Technical Assistance Workshop, Arlington, VA*
- **June 12:** *MSU PEARL Open House – Sponsor Appreciation Day Event, Calvert County*
- **November 1-6:** *Maryland STEM Festival*



Thank You!



Morgan – “The HBCU of Choice”

38



Innovation & Entrepreneurship Program

April 2015



The Issue

Black Americans have a high interest in entrepreneurship

Yet, their participation rates and success rates are lower than other groups

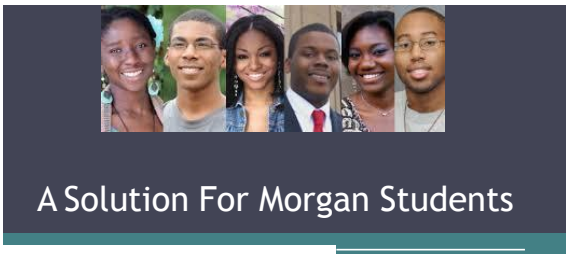
Why?

Robb, A. M., & Fairlie, R. W. (2006). Access to financial capital among U.S. businesses: The case of African-American firms. Washington, DC: Center for Economic Studies.
 Fairlie, R. W., & Robb, A. M. (2008). *Race and entrepreneurial success*. Cambridge, MA: MIT Press.

The Causes

- Lack of education
- Lack of experience
- Lack of access to capital

Fairlie, R. W., & Robb, A. M. (2008). *Race and entrepreneurial success*. Cambridge, MA: MIT Press.
 Kollinger, P., & Minniti, M. (2006). Not for lack of trying: American entrepreneurship in black and white. *Small Business Economics*, 27(1), 59-79. doi:
<http://link.springer.com/journal/volumesAndIssues/1187>
 Robb, A. M., & Fairlie, R. W. (2006). Access to financial capital among U.S. businesses: The case of African-American firms. Washington, DC: Center for Economic Studies.

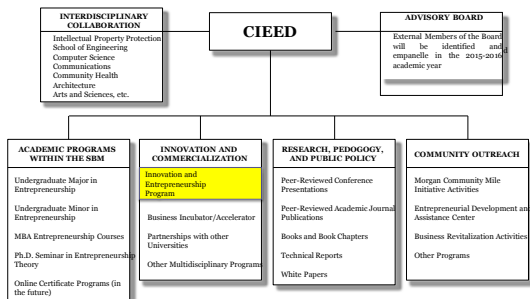


A Solution For Morgan Students

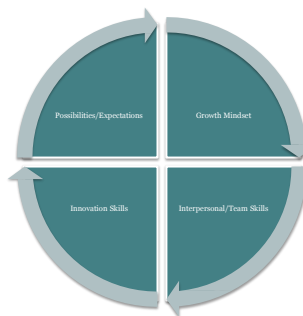
Education and Experiences

The Morgan State University
 Innovation & Entrepreneurship Program

The Context

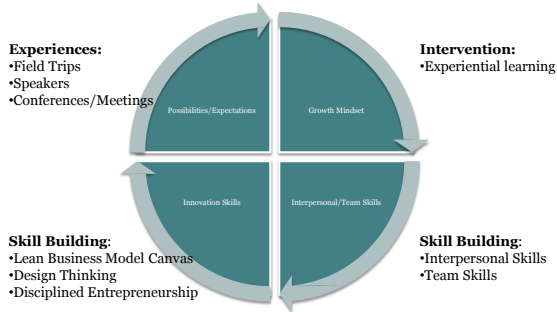


An Evidence-Based Approach



- Evaluation Criteria**
- Evidence-based
 - Low cost
 - Easy to implement
 - Effective
 - Scalable

An Evidence-Based Approach



Program Goals

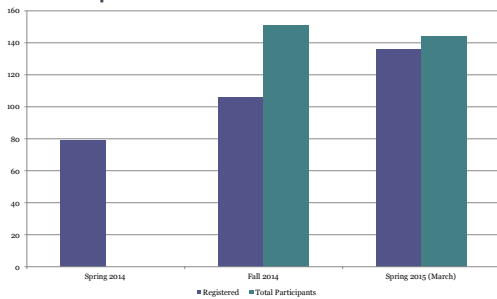
- Help students learn how to successfully commercialize ideas
- Increase the odds of success for African American innovators/entrepreneurs
- Eliminate disparities/barriers
- Provide a gateway to resources
- Contribute to economic growth



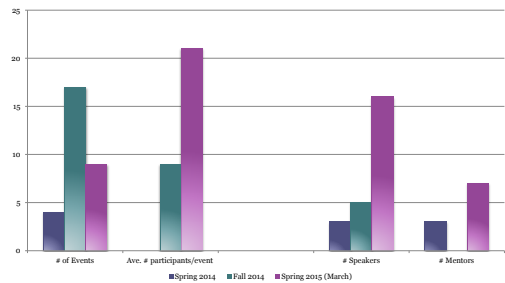
Key Program Components

- A campus-wide business plan competition
- Events
 - Campus-wide student events
 - Field trips/conferences/meetings
 - Speaker series
 - Skill development workshops
- Courses
 - Innovation Management (graduate and undergraduate)
- A practitioner advisory board
- A student advisory board
- Alumni mentors
- Faculty mentors

Participation



Activities

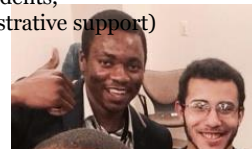


Courses

	Fall 2014	Spring 2015	Fall 2015
Undergraduate	16	-	~30
Graduate	-	19	~30

University Innovation Fellow Program

- Venture Well
- 6 week training
- MeetUp
- Pinning
- Leadership Council (5 students, interdisciplinary, Administrative support)



Resources Needed

-\$200,000 to develop, implement, and evaluate the program annually

\$28,000 to support 10 students per year in the University Innovation Fellow Program (October and May Leadership Circles)

Questions?

Feedback

Dean Fikru Boghossian
 Dr. Augustus Abbey, augustus.abbey@morgan.edu
 Dr. Mary K. Foster, mary.foster@morgan.edu, 443-310-5116

**A STUDENT-CENTERED,
ENTREPRENEURSHIP DEVELOPMENT
(ASCEND) MODEL TO INCREASE
DIVERSITY IN BIOMEDICAL RESEARCH**



Dr. Payam Sheikhattari
Co-Principal Investigator

ASCEND PROJECT

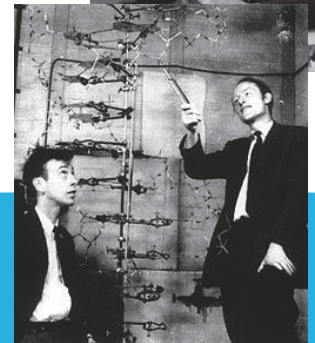
- NIH Award
- \$23.3 million over 5 years
- The largest NIH grant in the history of MSU
- < 10% of the applications received the award
- Potential for renewal for another 5 years, for a cumulative amount of \$50 million

BACKGROUND AND NIH OBJECTIVE

- Underrepresented minorities (URMs) do not receive NIH grants commensurate with their proportion in the population
- Many URMs exit the research path at undergraduate level
- NIH issued a funding opportunity entitled “Building Infrastructure Leading to Diversity” or BUILD
- The objective of the grant is to train URM undergraduate students for a successful career in biomedical research

BIOMEDICAL

- Includes all health-related research
 - Public health
 - Nursing
 - Nutrition
 - Biology
 - Psychology
 - Social work
 - Biochemistry/Chemistry
 - Biophysics/Physics
 - Environmental engineering



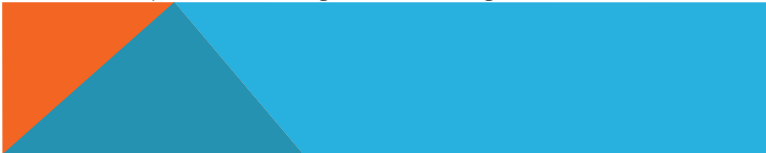
KEY FEATURES REQUIRED BY NIH

- Novelty
- Measurable outcomes
- Flexibility
- Sustainability

Problem	Proposed solutions
Inadequate autonomy	Using the ASCEND training model. Participation in SSRC and SRI. Please see Sections 1.4.1. and 1.4.2.
Lack of immediate gratification	Using the ASCEND model, to immediately engage the students by supporting student research proposals, and providing students with the opportunity to present in scientific meetings. See Section 1.4.1.
Lack of peer support	Creating opportunities to conduct research with fellow students, particularly minority students. See Sections 1.4.1. and 1.4.2.
Lack of role models	Providing access to mentors from minority backgrounds. Participation in SSRC. See Section 1.4.2.
Lack of appropriate mentoring	Close mentoring and monitoring. See Section 1.4.2.
Inadequate infrastructures	Enhancing MSU’s research infrastructure. See Sections 1.4.2., 1.4.4., and 1.4.5.
Less than optimal preparation	Selecting the most prepared and motivated students, using a variety of methods. See Section 1.4.3. Using novel methodologies to better prepare students. Please see Section 1.4.4.
Inadequate integration/racial biases	Training minority students for competition in majority institutions; Training faculty members at majority institutions about the cultural sensitivities of minority students. See Section 1.4.6.
Financial problems	Providing financial support. Students selected as ASCEND scholars will be supported using funds from the BUILD grant. See section 1.4.7.

APPRENTICESHIP VS. ENTREPRENEURSHIP

- **The traditional method (apprenticeship)**
 - Undergraduate students are apprentices
 - Asked to do repetitive functions, mostly in labs
 - Little room for autonomy or creativity
 - Inadequate peer support
- **The proposed approach (entrepreneurship)**
 - Let students be immersed in an environment with peer and near-peer support
 - Provide the best research training for the brightest
 - Allow students to choose their research topic of interest and apply for internal mini-grants (entrepreneurship)
 - Provide the best possible mentoring for them
 - Let the students execute the project, under mentoring, and experience the entire gamut of conducting a research



OBJECTIVES/NOVELTY

- To foster peer support by creating an environment dedicated to student research
- To provide room for creativity and autonomy for students to select their research topics of interest
- To actively engage the undergraduate students in a full range of research experience
- To increase interest by redesigning curricula and improving facilities



METHODS

- Establishing Students' Scientific Research Center
- Organizing Summer Research Institutes
- Selecting ASCEND Scholars and providing the best training to them
- Improving curricula



METHODS (ANNUAL PLAN)



PARTNERS

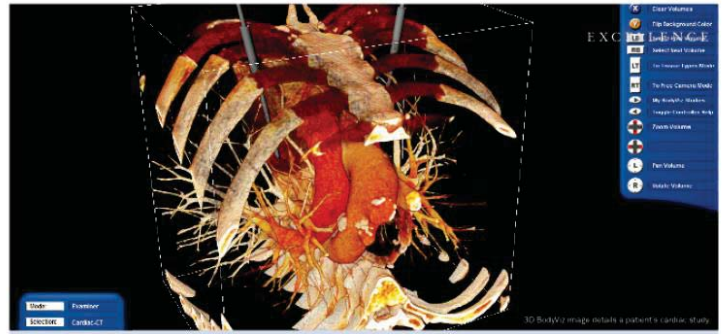
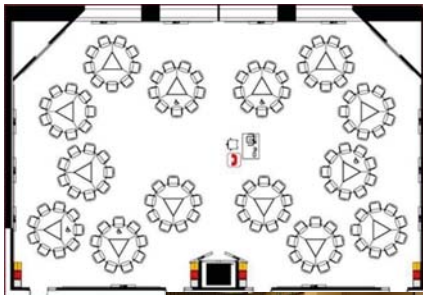
- Partnership with major research institutions
 - Johns Hopkins University
 - University of Maryland
 - The NIH Intramural Program
 - Tufts University
 - Northeastern University
 - Lehigh University
- Partnership with community colleges in the area
- Partnership with Baltimore City Schools System



WHAT ARE THE FUNDS INTENDED FOR?

- Creating state-of-the-art educational facilities within MSU
 - Active Learning Centers
 - Educational software
- Improving science curricula
- Strengthening the research infrastructure of the university
 - **Faculty development awards**
 - Enhancing the library (e.g., adding Scopus and ISI)
 - Animal lab facilities
 - Funds for community-based participatory research
 - **Mini grants for student research and new faculty members**
 - **Travel and sabbatical funds**





BodyViz technology creates 3D classroom experience



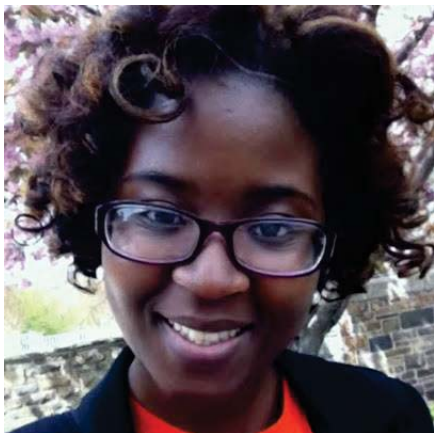
Virtual MRI Laboratory



Morgan State University

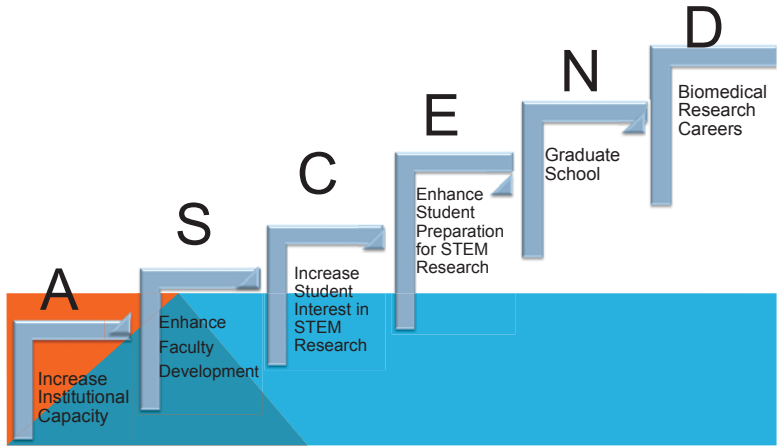
SUCCESS IN FIVE YEARS

- Higher enrollment, more high-caliber students, and increased retention
- Stronger research infrastructure
- Better-prepared research-oriented faculty
- Stronger connections with research-intensive institutions, locally, nationally, and internationally
- Stronger community connection, particularly with Morgan Community Mile
- Renewal of the grant



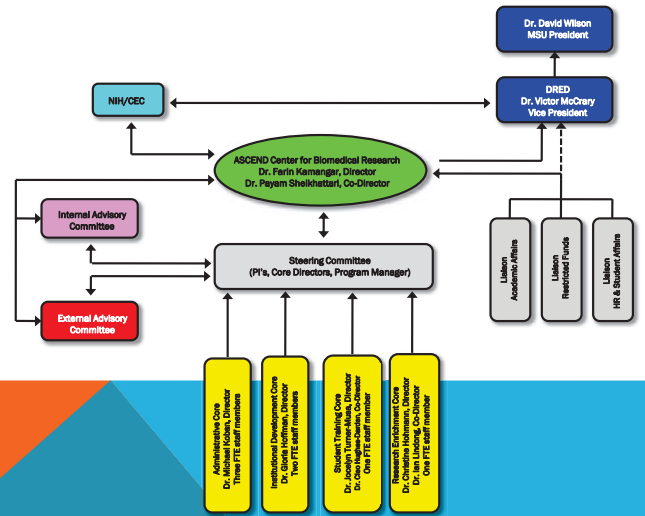


“IT TAKES A VILLAGE....”



STEPS TAKEN (APRIL 2015)

- Establishing the ASCEND Center for Biomedical Research
- Hiring staff for the ASCEND Center for Biomedical Research
- Identifying & renovating a physical space for the ASCEND Center
- Purchasing and installing equipment & software for the ASCEND Center
- Establishing the Student Research Center (SRC)
- Preparing curricula and faculty for the Summer Research Institute
- Advertising the program to current and prospective MSU students
- Informing faculty about how ASCEND can help their academic career
- Establishing effective relationships with research & pipeline partners
- Establishing an External Advisory Board, Internal Advisory Board, and Steering Committee and scheduling meetings



KEY PERSONNEL (CORE RESEARCH TEAM)



MORGAN STATE UNIVERSITY AND THE MARYLAND INNOVATION INITIATIVE

CONVERTING ACADEMIC SCIENCE
TO BUSINESS INNOVATION AT AN
HBCU

W. Christopher Hollinsed, Ph.D.
Site Miner, (New Business Development Liaison)
Morgan State University



THE 4TH MISSION FOR ACADEMIC INSTITUTIONS

- Teaching
- Research
- Service to the Community
- Economic Development
 - What is the “value” of the University?

STATE INSTITUTIONS

- What is the value of the University?
- What is the return on our investment to the residents and taxpayers in our state?

WHY SHOULD WE BELIEVE IN UNIVERSITY- BASED ECONOMIC DEVELOPMENT?

- Since 1980 American universities have spun off more than 4,000 companies
- In 2012 alone, \$36.8 billion of net product sales were generated
- Startup companies started at 70 academic institutions employed 15,741 full time employees.
- Over the past 30 years 153 new FDA approved vaccines, drugs and/or new indications for existing drugs were discovered through research at public sector research institutions

SOME WELL-KNOWN UNIVERSITY INVENTIONS

- Google (Stanford),
- Gatorade (Florida),
- Warfarin/Coumadin (Wisconsin)

PROBLEMS ENCOUNTERED IN DEVELOPING UNIVERSITY START-UPS

- Common to all academic institutions:
 - Faculty are not interested in learning about business development.
 - Faculty believe that they know all they need to know about business development.
 - Faculty do not believe it is their job to do business development.
 - Faculty members do not have an entrepreneurial mindset.

PROBLEMS ENCOUNTERED (CONTINUED)

- Faculty do not understand or recognize their obligation to the University to disclose inventions.
- Faculty believe that they have a great idea and the University is trying to steal it.
- Faculty have no idea how to evaluate a commercial or market opportunity.
- Faculty believe that writing a proposal for business funding is the same as writing a proposal to a federal agency for research funding.

PROBLEMS ENCOUNTERED AT HBCUs

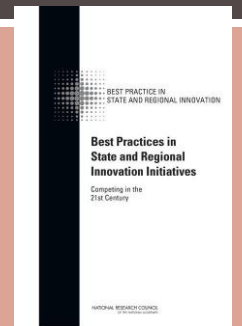
- Problems specific to Historically Black Colleges and Universities
 - There is no legacy (and therefore no culture) for securing intellectual property
 - There is no infrastructure (funding or budget) to support the procurement of intellectual property
 - Intellectual property procurement may be governed by a legal structure which developed before the economic development mission was incorporated
 - The intellectual property policy is significantly outdated (good news /bad news)

PROBLEMS ENCOUNTERED AT HBCUs

- No one knows anyone at the institution who has started a company based on their University research (there may not be anyone) who can point the way through the pitfalls and successes
- Research equipment, hardware, and/or discretionary funding to seed research may be limited or non-existent.
- Many HBCUs evolved out of the Teachers College model and do not have a strong research bias nor a bias toward research aimed at business development.

STATE INITIATIVES IN SUPPORT OF UNIVERSITY START-UPS

- National Academy of Sciences report: "Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century"
- Board on Science, Technology and Economic Policy (STEP), National Academies Press, 2013



THE ISSUE FOR THE STATE OF MARYLAND

"Maryland is already #1 in research. It is unacceptable that we rank 37th in transferring that research and technology into job creation. For all of our assets – and all of the resources we've invested together – we should be #1 in technology transfer and the commercialization of new ideas into jobs."

Governor Martin O'Malley at State of the State 2012

THE MARYLAND INNOVATION INITIATIVE

- An historic partnership between the State and its world-renowned research universities that unites researchers with entrepreneurs across disciplines and institutions to strengthen Maryland's economy, start new businesses and create jobs.

THE MARYLAND INNOVATION INITIATIVE



- Awards grants in 3 phases:
 - Phase I (\$100,000, 9 months) Technology Validation
 - Phase II (\$15,000, 3 months) Market Assessment
 - Phase III (\$100,000, 9 months) Commercial Launch
- May partner with another University for a larger (\$150,000) grant. (at least 25% to partner University)
- Proposals accepted every two months.
- Each University assigned a New Business Development Liaison or Site Miner

QUALIFYING UNIVERSITIES

- Qualifying research institutions include
 - University of Maryland-College Park (27/70)
 - University of Maryland-Baltimore (27/88)
 - University of Maryland-Baltimore County (12/29)
 - Morgan State University (3/26)
 - Johns Hopkins University (55/104)

MORGAN EXPERIENCE

- Submitted: 26 (includes some re-submissions)
- 3 funded (2 Phase I, 1 Phase II) (\$215,000)
- 4 more in the queue (3 Phase I, 1 Phase III) (\$450,000) (1 Joint w JHU)
- Compare to total program:
 - \$12.0 million to 124 projects (as of 3/31/2015).

ISSUES

- Deficiencies in proposals
 - Weak commercialization section (everyone will buy!)
 - Weak intellectual property section (no one else is doing this!)
 - Short (last minute) preparation time
 - Failure to confer with the Site Miner (Me!)
- Deficiencies in the review process
 - Reviewers do not understand technology
 - Reviewers do not believe that technology will be successful in our hands (Ambitious!)
 - Site Miner (Me!) fails to make a persuasive case

OTHER ISSUES

- Proposals not submitted (after planned and promised)
- Proposals not submitted (after rejection)
- Lack of entrepreneurial drive (Investigator does not even write 1st draft proposal) or follow-up on comments
- Morgan IP Practice ~~is still limited~~ (influences reviewers)

PLAN

- Work with Business School partners to evaluate business credibility of proposal ideas
- Map proposal sections solidly against all proposal criteria regardless of investigators inclinations
- Submit many more high quality proposals than before
- Collaborate with other universities in the program
- Strengthen the intellectual property infrastructure at Morgan
- Add an experienced site miner
- Program approved for \$5.7 million for FY2015. This translates to ~57 grants. Morgan will get 10-12 of these.

Embedded Systems Security Research via Reverse Engineering and Countermeasures

Dr. Kevin T. Kornegay

kevin.kornegay@morgan.edu



Outline

- **The Frontline: Internet of Things (IoT)**
- Cybersecurity Research Vision
 - Center for Reverse Engineering and Assured Microelectronics (CREAM)
- Embedded systems security
 - From USB stick to iPhone6
 - Current Attacks
 - Cryptographic devices
- What is reverse engineering (RE)?
 - Side channel analysis (SCA)
 - Capture and playback
- SCA Attacks and countermeasures
 - Breaking a key
 - Seizing control of a drone
 - Countermeasure Theory
- Conclusions

2 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

The Frontline: Internet of Things (IoT)



- Everything will have an IP address and the ability to transfer data over a network
- Evolved from convergence of wireless technologies, sensors, and the Internet
- Most IoT devices are some form of an embedded system
- The IoT is the new cyber battle field

3 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Outline

- The Frontline: Internet of Things (IoT)
- **Cybersecurity Research Vision**
 - Center for Reverse Engineering and Assured Microelectronics (CREAM)
- Embedded systems security
 - From USB stick to iPhone6
 - Current Attacks
 - Cryptographic devices
- What is reverse engineering (RE)?
 - Side channel analysis (SCA)
 - Capture and playback
- SCA Attacks and countermeasures
 - Breaking a key
 - Seizing control of a drone
 - Countermeasure Theory
- Conclusions

4 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Research Vision: Center for Reverse Engineering and Assured Microelectronics (CREAM)

- Launched with over \$1.2M in grants from NSF and DOD
- Research Goals
 - Focus: Physical layer cybersecurity
 - IoT device vulnerability assessment
 - Develop countermeasure to secure IoT device against cyber attacks
 - Secure IoT device data exchange
 - Maintain operability during an attack
 - Grow Morgan's IP portfolio
- Education Goals
 - Provide research experiences and training for students
 - Reverse engineering course and laboratory development
 - Embedded Systems Security Certificate Program
 - Resource for Cyber community
 - Outreach – cyber camps for high school students

5 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Outline

- The Frontline: Internet of Things (IoT)
- Cybersecurity Research Vision
 - Center for Reverse Engineering and Assured Microelectronics (CREAM)
- **Embedded systems security**
 - From USB stick to iPhone6
 - Current Attacks
 - Cryptographic devices
- What is reverse engineering (RE)?
 - Side channel analysis (SCA)
 - Capture and playback
- SCA Attacks and countermeasures
 - Breaking a key
 - Seizing control of a drone
 - Countermeasure Theory
- Conclusions

6 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

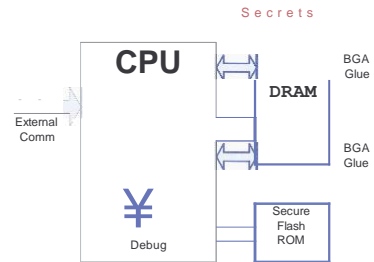
Embedded Systems Examples



7 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Classic Embedded System Attack



8 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Cryptographic Devices

- Smart cards represent the ultimate cryptographic device
 - Perform cryptographic operations on data
 - Harnesses both the cryptographic operation and the key
 - Tamper resistant
- Embedded system processors are incorporating more smart credit style security
- Why not use a smart card?
 - Requires a reader for access
 - Example: PayTV

9 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Outline

- The Frontline: Internet of Things (IoT)
- Cybersecurity Research Vision
 - Center for Reverse Engineering and Assured Microelectronics (CREAM)
- Embedded systems security
 - From USB stick to iPhone6
 - Current Attacks
 - Cryptographic devices
- What is reverse engineering (RE)?
 - Side channel analysis (SCA)
 - Capture and playback
- SCA Attacks and countermeasures
 - Breaking a key
 - Seizing control of a drone
 - Countermeasure Theory
- Conclusions

10 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

What is Revere Engineering (RE)?



- Reverse engineering is the process of extracting knowledge or design information from anything man-made and reproducing it from the extracted information
- Classical RE is expensive, invasive, and destructive
- **Our approach is low cost, non-invasive, and non-destructive**

11 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

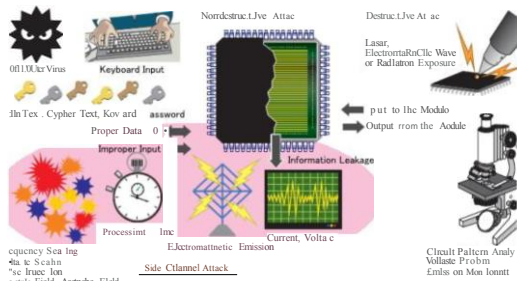
Side Channel Analysis (SCA)

- What?
 - Reading of hidden signals through unintended physical channels originating from the embedded system
 - Side channels include time, sound, electromagnetic radiation, light emission, and power consumption
- Why?
 - Retrieve secrets such as encryption keys (e.g. AES, DES) or intellectual property
- How?
 - Attack channels using SCA
 - Methods
 - Tools

12 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

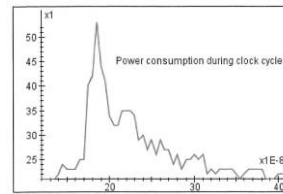
Side Channel Attack



13 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Principle Behind Power Analysis



- Current flows in a transistor during switching and power is consumed during a 1 → 0 or 0 → 1 transition
- The shape of the power consumption profile reveals activity
- Comparison of profiles reveals data

14 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

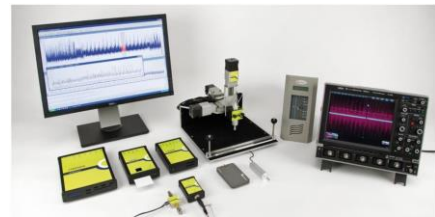
Side Channel Analysis System Requirements

- Digital storage oscilloscope
- High bandwidth amplifier
- Probes
 - Power Analysis: Intercept the device's power circuitry using a small resistor
 - EM Analysis: Requires a coil with a low noise amplifier
- Computer with statistical analysis tools and control software

15 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Commercial Power/EM Analysis System



16 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Wireless Device Capture and Playback

- Capture Signal
 - Embedded system device with wireless interface (e.g. Drone)
 - Over the air
- Analyze Waveform in Multiple Domains
 - Frequency/Phase/Amplitude over time
 - Spectrum Analysis
 - Modulation Analysis
- Save the Waveform in a usable format
 - Analysis
 - Playback through RF/Arbitrary Waveform Generator
- Playback the waveform using an waveform generator

17 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Outline

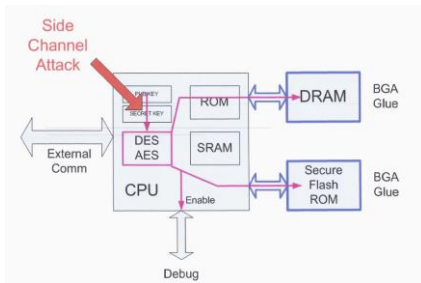
- The Frontline: Internet of Things (IoT)
- Cybersecurity Research Vision
 - Center for Reverse Engineering and Assured Microelectronics (CREAM)
- Embedded systems security
 - From USB stick to iPhone6
 - Current Attacks
 - Cryptographic devices
- What is reverse engineering (RE)?
 - Side channel analysis (SCA)
 - Capture and playback
- SCA Attacks and countermeasures
 - Breaking a key
 - Seizing control of a drone
 - Countermeasure Theory
- Conclusions

18 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Attacks and Countermeasures

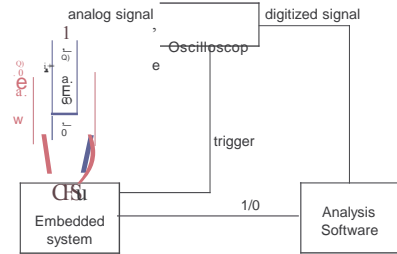
- Embedded system encryption key extraction via SCA



19 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Power/EM Side Channel Analysis Attack System Setup

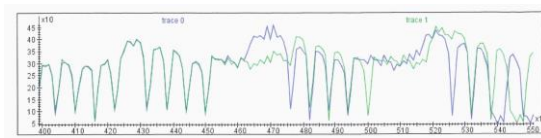


20 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Power/EM Side Channel Analysis

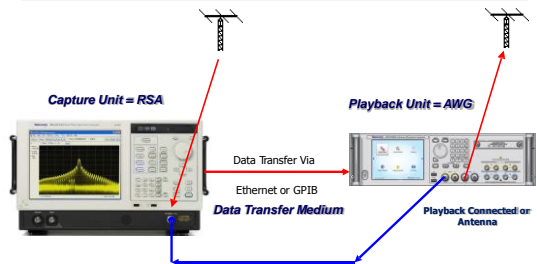
- Recovers information by inspection of single or averaged traces during system start up
- Can also be used to RE algorithms and implementations



21 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Drone Capture/Playback Demo Setup

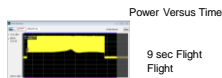
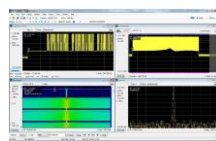


22 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Drone Signal Capture

- RSA Setup
 - Center Frequency 49.83Mhz
 - Span of 2MHz was used to capture
 - Drone Maneuvers:
 - Initialize
 - Hover
 - Rotate Right
 - Rotate Left



- Extract 300ms snippets of each maneuver
- Save four .TIQ Files for import to RFXpress

23 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Drone Playback Configuration

- Create Play Sequence
 - Wait for TrigA then Play Initialize
 - Wait for TrigB then Play all Waveforms
 - Hover 8x
 - Rotate Right 8x
 - Hover 8x
 - Rotate Left 8x
 - Hover - Go back to Index 2 - Wait for TrigB

Name	Setup	Waveform	Sequence	Duration	Total Time
Wait	Controls		Steps: wait 0	Remaining: 16377	5%
TrigA	Initialize	PL TrigA	Ctrl: Init	Next: 20.858 M...	
TrigB	Hover	R	Ctrl: Hover	Next: 89.858 M...	
Ctrl	Rotate Right	R	Ctrl: Rotate Right	Next: 89.858 M...	
Ctrl	Hover	R	Ctrl: Hover	Next: 89.858 M...	
Ctrl	Rotate Left	R	Ctrl: Rotate Left	Next: 89.858 M...	
Ctrl	Hover	R	Ctrl: Hover	Next: 89.858 M...	



24 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Drone Capture/Playback Attack Demo Video



- The same attack can be performed on wireless key entry systems, garage doors, home security systems, etc.
- You can now purchase a handheld RSA for \$3K that covers the spectrum of all IoT devices

25 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Countermeasure Theory

- Reduce device leakage
 - Balance processing of values
 - Limit number of operations per key
- Introduce noise
 - Introduce timing variations during processing
 - Hardware generated noise sources

26 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Outline

- The Frontline: Internet of Things (IoT)
- Cybersecurity Research Vision
 - Center for Reverse Engineering and Assured Microelectronics (CREAM)
- Embedded systems security
 - From USB stick to iPhone6
 - Current Attacks
 - Cryptographic devices
- What is reverse engineering (RE)?
 - Side channel analysis (SCA)
 - Capture and playback
- SCA Attacks and countermeasures
 - Breaking a key
 - Seizing control of a drone
 - Countermeasure Theory
- **Conclusions**

27 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

Conclusions

- With the continued evolution of the IoT, securing embedded device security is **paramount!**
- Side channel attacks pose a significant threat to our nation's cyber infrastructure
- Most embedded system devices do not contain hardware countermeasures for side channel attacks, particularly in the commercial sector

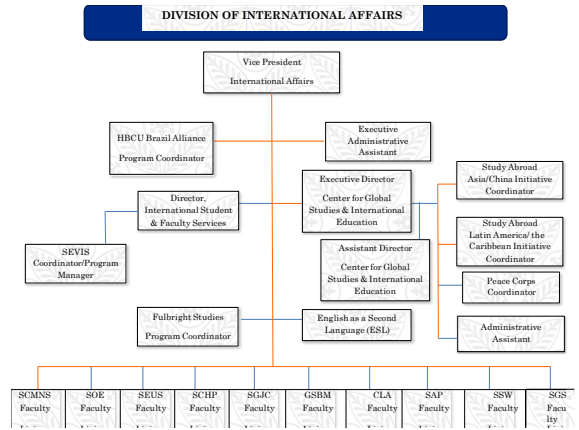
28 | April 10, 2015

MORGAN STATE UNIVERSITY
CLARENCE M. MITCHELL, JR. SCHOOL OF ENGINEERING

DIVISION OF INTERNATIONAL AFFAIRS
Montebello D206 – D210

T. Joan Robinson, Vice President

Internationalization of Morgan Campus
Thursday, April 08, 2015

Internationalization of Morgan Campus – Background

- New Incoming International Students bring with them their values, religious beliefs, customs, and assumptions, all of which are products of their societal upbringing;
- In this country, international students encounter differences in social norms, academic practices, and communication styles;
- International students contribute \$15 billion to the U.S. economy in the form of tuition, fees and living expenses;
- International students often experience initial culture shock upon arriving in the United States;
- Their cultural adjustment process is complicated by their having to learn to navigate the institution's culture and expectations, including enrolling in classes, learning about campus policies and procedures, and overcoming any language barriers that might exist;

Internationalization of Morgan Campus

- There is a great advantage to having international students on the campus:
 - Diversity;
 - For students who are unable to study abroad, having the opportunity to interact with international students on their campuses is invaluable in terms of learning about different cultures and perspectives;
- Morgan State in Baltimore, MD, has increased the number of international students on its campus by 64 percent since 2007, in part as a result of the White House's HBCU-Brazil Alliance, which gives Brazilian students the chance to study at some of America's Historically Black Colleges and Universities – *The Chronicle of Higher Education*:

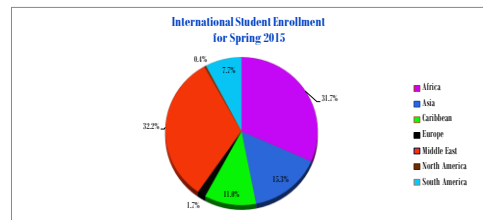
<http://chronicle.com/article/Foreign-Students-Bring-Global/229019>

DIA's Internationalization Goals

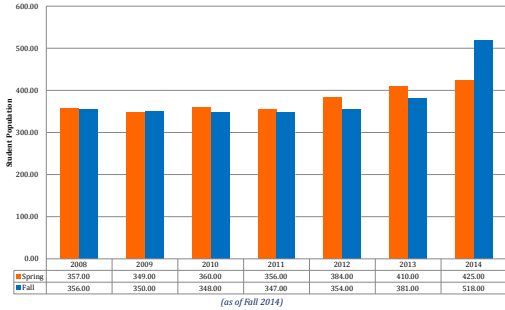
- The DIA works collaboratively with various constituencies and units at the University to:
 - integrate a global perspective throughout Morgan's academic departments and co-curricular programs;
 - enhance student and faculty development through workshops, study abroad, internships, exchanges and other relevant international education programs, and,
 - provide the schools, college and the supporting units of the university with assistance in developing an international focus to their programs and enabling them to produce globally knowledgeable and competent graduates.

International Student Enrollment

- International Enrollment at Morgan State University has dramatically increased to 636 students from 60 countries. Of these 99 are engaged in Optional Practical Training (OPT) and 20 are Non-Degree Seeking Scholars from Brazil. The countries reporting the highest number of students by their region are Saudi Arabia , Nigeria, Nepal, and Jamaica.



International Student Enrollment (For the Past 7 years)



Distribution of International Students by Regions as of Spring 2015

Regions	# of Students	Regions	# of Students
Middle East Saudi Arabia (226), Iran (5), Kuwait (9), Jordan (2), Qatar (2), Turkey (1), UAE (1) & Egypt (1)	247	Africa Nigeria (109), Kenya (16), Ghana (14), Senegal (3), Gambia (2), and other countries	156
Asia Nepal (22), India (8), China (2), Philippines (2) and other countries	37	Caribbean Jamaica (17) T&T (12), Bahamas (6), Dominica (4), St. Lucia (3) and other countries	48
South America Brazil (20)	20	Europe Russia (2), Greece (1) Netherlands (1) Serbia (1) UK (1)	6
North America Canada (2)	2		

as of Spring 2015



What have you noticed about international students?

- ☞ Focused
- ☞ Goal oriented/know what they want
- ☞ Astute
- ☞ Shy to ask for help
- ☞ Formal
- ☞ Insular

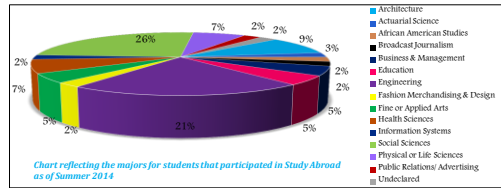
Integration & Social Challenges



International students want to know you are there to help them make the most of their experience.

Study Abroad

- ☞ Fifty-six (56) students participated in experiential learning activities abroad (through third party providers) with support from the Morgan State University Foundation during Spring 2014 to Spring 2015 (thus far).
- ☞ Six (6) students recently returned from a study abroad program in Brazil at the beginning of the semester.



Study Abroad

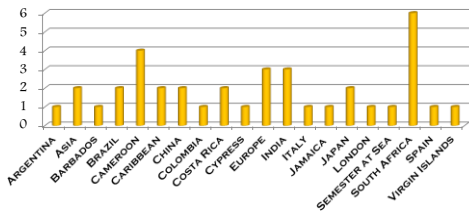


Chart reflecting the destinations for students that participated in Study Abroad as of Summer 2014

Recent Trends in Agreements- 2012- 2014

MOUs since 2012

- ☞ Mexico
- ☞ Australia (International College of Management, Sydney)
- ☞ Kenya
- ☞ Jamaica
- ☞ Brazil
- ☞ Saudi Arabia
- ☞ UAE
- ☞ South Africa
- ☞ Tanzania
- ☞ China
- ☞ Ghana



Initiatives: Latin America & the Caribbean

Established Agreements with Latin America & the Caribbean:

- UNESP, Sao Paulo, Brazil
- Faculdade Zumbi Dos Palmares, San Paulo.
- Pontificia Universidade Catolica Do Rio De Janeiro
- Benito Juarez Autonomous University of Oaxaca, Mexico
- Catholic University - PUC Sao Paulo, Brazil
- Catholic University - PUC Rio de Janeiro Brazil
- Universidade De Ribeirao Preto - UNAERP
- Universidade Paulista, Sao Paulo, Brazil
- Universidade Federal De Minas Geras (Pending)
- Universidade Paulista - UNIP
- Universidade Federal De Uberlândia
- University of Technology, Kingston, Jamaica
- University of the West Indies

Regional Initiatives: HBCU-Brazil Alliance

- Work with the White House Initiative on HBCUs to enhance the HBCU-Brazil Alliance
- Work with Scientific Mobility Program on the Brazilian students being distributed to the HBCUs
- Work with Academic Outreach and Engagement on the English as a Second Language Program (ESL) for Brazilian students and the Brazilians teacher program at MSU
- Collaborate with Academic Affairs and Academic Outreach and Engagement in identifying global programs, such as the [Dual Bachelor's Master's Degree Program and the Intensive English Language Program.](#)

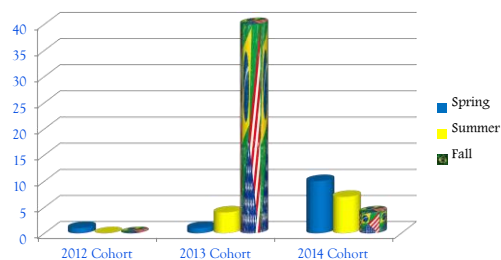
Science Without Borders Brazilian Science Mobility Program (BSMP)

- Since the inception of the Brazil Scientific Mobility Program (BSMP) in 2012, Morgan State has received **67** students from higher education institutions in Brazil;
- For the Spring 2015 semester, Morgan State had a total of **19** students enrolled in ESL and academic classes;



Science Without Borders Brazil Science Mobility Program (BSMP)

Student Distribution



Recent Trends 2013-2014

HBCU-Brazil Alliance Brazil Science Mobility Program

- ESL Required 1st Semester
- Managed by Morgan
- Live on campus
- Use all campus facilities all year
- Morgan is the Alliance Chair – for 45 HBCUs

Saudi Arabian Cultural Mission (SACM) / Princess Nora University (PNU)

- ESL not applicable at this time
- Scholarships managed by SACM
- Live off campus
- Use few campus services
- Morgan was the 1st HBCU to exhibit at the IECE in Riyadh, KSA in April

Initiatives: China

- Dr. Wilson signed an agreement on behalf of HBCUs with the Chinese Government for the implementation of the 1000-scholarship award for HBCU students to study in China from 3 months to 2 years to extend from 2014 to 2017.
- A proposal for an American Center for Minority Cultural Exchange



Initiatives: China

- Hosted Hubei University of Technology, Business College
- Recently a delegation of Presidents and senior administrators from 8 American HBCUs led by Dr. David Wilson, President of MSU went to Beijing, China to participate in a People to People Exchange from July 9-11, 2014
- This program is designed to enhance and strengthen ties between the citizens of the United States and the People's Republic of China.
- The Dean of the School of Business and a Faculty member in the Hospitality Management Program will be engaged in a 2 week program at Guizhou Forerunner College (GFC) in Guizhou, China, this summer.

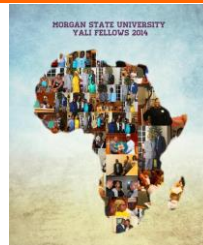
Regional Initiatives: China

- Established agreements with the following institutions in China:
 - Guilin University of Electronics and Technology
 - Hubei University
 - Guangxi Normal University
 - Fudan University
 - Nanjing Normal University
 - Xi'an Jiaotong University (Pending)
 - Sichuan University
 - Hainan University
 - Hebei University of Economics and Business
 - Guizhou Forerunner College (GFC)

Regional Initiatives: Africa

- Established agreements with the following institutions in Africa
 - Addis Ababa Institute of Technology
 - Centre Muraz, Bobo-Dioulasso, Burkina Faso
 - Federal University of Technology in Owerri, Nigeria
 - University of Botswana
 - Botswana International University of Science and Technology
 - University of Cape Town, South Africa
 - University of the Western Cape, South Africa
 - Universite Gaston Berger in Saint-Louis, Senegal
 - University of the Witwatersrand, Johannesburg, South Africa
 - University of Kwazulu-Natal, South Africa

YOUNG AFRICAN LEADERS INITIATIVE



- 25 Professional Fellows
- 18 African Nations
- 25-35 in Age
- MSU Program Included:
 - 6-week Academic and Leadership Institute focus on skills development in Public Management,
 - Site visits,
 - Community service,
 - A Presidential Summit with President Obama in Washington, DC in late July 2014

"You went to extraordinary lengths to ensure we were given the best possible experience in Morgan State University..."

Dr. Hilarius P.A.K. Abiwu
 2014 Mandela Washington Fellow (MSU)
 AG Medical Superintendent, Krachi West District Hospital
 Ghana, West Africa

YOUNG AFRICAN LEADERS INITIATIVE



"I can't even begin to say thank you to you for what you did for us..."
 Ila Mboob, Esq.
 2014 Mandela Fellow (MSU)
 Deputy Director of Legal Licensing and Enforcement
 Public Utilities Regulatory Authority
 Republic of Gambia, West Africa

Regional Initiatives: Middle East

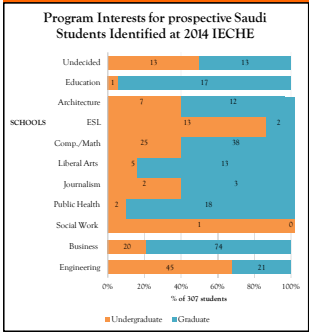
- Morgan currently has agreements with the following institutions in the Middle East
 - American University in the Emirates, Dubai, UAE
 - Princess Nora University

Our goals for this initiative are to:

- Enhance the recruitment of international scholarship students from the Middle East
- Promote Global Citizenship & Campus Diversity
- Develop more study abroad opportunities for Morgan students in the region
- Increase International Alumni contribution and involvement



Regional Initiatives: Middle East



- Outcomes**
- ∞ 44 active hours @ the International Exhibition & Conference for Higher Education (IECHE) – Riyadh, Saudi Arabia
 - 90% engaging prospective students
 - 8% developing relationships with potential university partners
 - 3% touring local university facilities and potential study abroad programs
 - ∞ 307 students perspective fall 2014, spring 2014, fall 2015 semesters.
 - 194 Graduate
 - 113 Undergraduate

Fulbright Scholarship Program

- ∞ (Dr. Carleen Leggett, Director)
 - Congress gave birth to the Fulbright Program in 1946, under the inspiration and guidance of Senator J. William Fulbright. The primary goal of the program is to increase mutual understanding between Americans and other peoples of the world.
 - Morgan State University now has **135** students who have received Fulbright or Fulbright-related grants.
 - An article in the publication DIVERSE ISSUES IN HIGHER EDUCATION (26 June 2008) pointed out that Morgan State leads all other historically Black colleges and universities in the number of its students who have received Fulbright grants.



Fulbright Scholarship Program

44 countries to which Morgan students have won 132 Fulbright-related grants:

Argentina	Ghana	Luxembourg	Romania
Belgium	Guatemala	Malaysia	Russia
Brazil	Honduras	Mexico	Senegal
Cameroon	India	Morocco	Sierra Leone
Ceylon (Sri Lanka)	Indonesia	Namibia	Spain
China	Italy	New Zealand	Switzerland
Colombia	Ivory Coast	Nicaragua	Tanzania
Czech Republic	Jamaica	Nigeria	Trinidad & Tobago
Ecuador	Kenya	Norway	Uruguay
France	Korea	Peru	Venezuela
Germany	Liberia	Philippines	Vietnam

Fulbright Scholarship Program

34 countries to which 39 Morgan professors and administrators have won 57 Fulbright-related awards:

Bangladesh	Ghana	Malaysia	Senegal
Benin	India	Mali	Sierra Leone
Brunei	Israel	Morocco	Singapore
Cameroon	Japan	Nigeria	Tanzania
Egypt	Jordan	Pakistan	Togo
France	Kenya	Peru	Tunisia
Gambia	Korea	Philippines	Turkey
Germany	Liberia	Poland	United Arab Emirates
			United States of America

Current Activities

- ∞ Hosted workshops for International Week - Topics included:
 - Global Health Epidemics
 - Non-State actors and international armed conflicts
 - The Value of Cross Cultural Awareness
- ∞ Hosted Nigeria delegation from Lagos State Scholarship Board
- ∞ Meeting with the Embassy of the Republic of Georgia
- ∞ Engagement in Webinar on “Opportunities to collaborate with Foreign Agricultural Service Trade and Scientific Exchange division on Short-term exchange programs.
- ∞ Invite to do a presentation Morgan State University and its international process at the NAFSA – International Educators meeting in Boston, May 27, 2015



∞ Thank You!!