WHY IS MIZZOU GOOD FOR ECONOMIC DEVELOPMENT AND WHAT DOES RESEARCH HAVE TO DO WITH IT?

Jim Coleman
Vice Provost for Research
MU
April 7, 2006
“The future of business is about innovation…” Nick Donofrio, Senior VP for International Technology and Manufacturing, IBM
WHAT DO THOMAS JEFFERSON, A DRILL AND MIZZOU HAVE IN COMMON?

- Some thoughts on today’s world and how to remain economically competitive in the market place of the information age
- An analogy: Designing the optimal drill
THE “TAKE-HOME MESSAGE”

<table>
<thead>
<tr>
<th>WHAT DO YOU HAVE AND WANT?</th>
<th>WHAT DO YOU NEED?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Round Hole</td>
<td>Sustainable Economic Development</td>
</tr>
</tbody>
</table>

- Sustainable Economic Development
MU as a Source of Innovation and Creativity

MU is a Large, Successful Economic Enterprise

MU Helps Propel Other Economic Enterprises

MU Helps Propel Economic Development

MU as the Sun in an Economic Development Solar System
So, how strong of a source for innovation is MU?
MU is #2 in growth in federal research of all AAU publics over the last decade (1993-2002)
TOTAL RESEARCH AND DEVELOPMENT EXPENDITURES
*(based on 2003 data collected by the National Science Foundation*)

<table>
<thead>
<tr>
<th>Institution</th>
<th>Total R &amp; D Expenditures</th>
<th>% of Total R&amp;D Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington University (rank = 19 of 618)</td>
<td>$474,328,000</td>
<td>59%</td>
</tr>
<tr>
<td>MIZZOU (68 of 618)</td>
<td>$205,212,000</td>
<td>25%</td>
</tr>
<tr>
<td>Saint Louis University (164 of 671)</td>
<td>$41,189,000</td>
<td>5%</td>
</tr>
<tr>
<td>University of Missouri – Rolla (174 of 671)</td>
<td>$35,999,000</td>
<td>4.5%</td>
</tr>
<tr>
<td>University of Missouri – KC (183 of 671)</td>
<td>$31,104,000</td>
<td>4%</td>
</tr>
<tr>
<td>University of Missouri – STL (248 of 671)</td>
<td>$12,819,000</td>
<td>1.6%</td>
</tr>
<tr>
<td>Lincoln University (365 of 671)</td>
<td>$ 2,601,000</td>
<td>0.3%</td>
</tr>
<tr>
<td>Missouri State University (430 of 671)</td>
<td>$1,423,000</td>
<td>0.2%</td>
</tr>
<tr>
<td>Univ. of the Health Sciences (466 of 671)</td>
<td>$1,020,000</td>
<td>0.2%</td>
</tr>
<tr>
<td>Kirksville Osteopathic (499 of 671)</td>
<td>$691,000</td>
<td>0.1%</td>
</tr>
<tr>
<td>Truman State University (525 of 671)</td>
<td>$521,000</td>
<td>0.1%</td>
</tr>
<tr>
<td>SE Missouri State Univ. (not listed)</td>
<td>Not reported</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>$806,907,000</td>
<td></td>
</tr>
</tbody>
</table>

*Most recent comparative data available from NSF*
**TOTAL RESEARCH & DEVELOPMENT EXPENDITURES VS. SOME OTHER AAU UNIVERSITIES**

*(based on 2003 data from NSF)*

<table>
<thead>
<tr>
<th>Institution</th>
<th>Total R&amp;D Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Chicago</td>
<td>$247,322,000</td>
</tr>
<tr>
<td>University of California - Irvine</td>
<td>$234,656,000</td>
</tr>
<tr>
<td>University of Virginia</td>
<td>$206,199,000</td>
</tr>
<tr>
<td><strong>MIZZOU</strong></td>
<td><strong>$205,212,000</strong></td>
</tr>
<tr>
<td>SUNY – Stony Brook</td>
<td>$200,330,000</td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
<td>$186,351,000</td>
</tr>
<tr>
<td>Princeton University</td>
<td>$179,951,000</td>
</tr>
<tr>
<td>University of Kansas</td>
<td>$173,024,000</td>
</tr>
<tr>
<td>University of California – Santa Barbara</td>
<td>$149,130,000</td>
</tr>
<tr>
<td>Brown University</td>
<td>$125,090,000</td>
</tr>
</tbody>
</table>
### National Science Foundation Funding
#### 2000-2005

<table>
<thead>
<tr>
<th>Institution</th>
<th>Funding</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIZZOU</strong></td>
<td>$91,624,000</td>
<td>36%</td>
</tr>
<tr>
<td>Washington University and Med</td>
<td>$86,265,000</td>
<td>33%</td>
</tr>
<tr>
<td>University of Missouri - Rolla</td>
<td>$24,345,000</td>
<td>9%</td>
</tr>
<tr>
<td>University of Missouri - STL</td>
<td>$14,511,000</td>
<td>6%</td>
</tr>
<tr>
<td>University of Missouri - KC</td>
<td>$11,504,000</td>
<td>4%</td>
</tr>
<tr>
<td>Danforth Plant Science Center</td>
<td>$11,076,000</td>
<td>4%</td>
</tr>
<tr>
<td>Saint Louis University</td>
<td>$ 4,829,000</td>
<td>2%</td>
</tr>
<tr>
<td>Missouri State University</td>
<td>$ 4,451,000</td>
<td>2%</td>
</tr>
<tr>
<td>Truman State</td>
<td>$ 3,686,000</td>
<td>1%</td>
</tr>
<tr>
<td>Missouri Botanical Garden</td>
<td>$ 3,497,000</td>
<td>1%</td>
</tr>
<tr>
<td>Northwest Missouri State</td>
<td>$ 987,000</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Central Missouri State</td>
<td>$ 480,000</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Southeast Missouri State</td>
<td>$ 299,000</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Missouri Western State College</td>
<td>$ 294,000</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Stowers Medical Institute</td>
<td>$ 200,000</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

In 2005, MU had 44%, and Wash U. had 41% of MO’s NSF Funding
What are some examples of innovation through research at MU?
MU’s Innovation in the Life Sciences

- Health Sci.
  - Medicine
  - Nursing
  - Health Prof.
- Veterinary Medicine
- Biological, Animal, Plant and Food Sci.
- Social Sci., Law and Journalism
- Chemistry, Physics, Psych., Math
- Engineering and Computer Sci.

- Health Sci.
  - Medicine
  - Nursing
  - Health Prof.
- Veterinary Medicine
- Biological, Animal, Plant and Food Sci.
- Social Sci., Law and Journalism
- Chemistry, Physics, Psych., Math
- Engineering and Computer Sci.
Gabor Forgacs just learned that he had the top rated ($5,000,000) proposal in NSF’s Frontiers in Integrated Biological Research competition. Gabor and his team are examining tissue printing - a new technology to create functional tissues and organs by building biological structures using layer-by-layer deposition of self assembling multicellular systems.
Bruce Bartholow’s research linking violence to video games was highlighted in *Science* (1/06) and the general press. It was specifically quoted by Prime Minister Tony Blair as the basis for British policy. The BBC reported on January 25th 2006 “Mr. Blair said We will be looking very carefully studying the impact of that research (by the University of Missouri) and then we will have a debate obviously as to how we take it forward”.
Mike Roberts and his team’s research on controlling the differentiation of stem cells in culture by regulating the oxygen concentration in the environment was listed in the **2005 Scientific American top 50 scientific accomplishments in the world**.
Mike Roberts and his team also received national attention in February, 2006 for their publication in *Science* in which they reported a new discovery about the formation of an embryo and a placenta before implantation that could explain why cloning often fails in farm and laboratory animals.

![Image of a mouse oocyte taken at the MU microscopy core showing Cdx2 mRNA expression](image-url)
Kattesh Katti and his colleagues are developing truly cutting edge technology to use gold and silver nanoparticles in the diagnosis and treatment of breast and prostate cancer. This new technology was the basis of a $3,000,000 award from NIH. The work is receiving international recognition……..
On March 16, 2006, the President of India devoted three paragraphs of his address to the International Conference on Nano Science and Technology in New Delhi to Dr. Katti’s work…

“Scientists at MU are carrying out important nanoparticle research which can improve the methods of detection and treatment for patients with prostate cancer……”

“One of the important aspects of this research is MU uses interdisciplinary team of scientists – all on one campus …..”
MU just recruited Fred Hawthorne from UCLA (he starts March 1). Fred is one of the world’s leading chemists and has been nominated to receive the Nobel Prize. He decided to join MU because he feels that the combination of MU’s interdisciplinary environment and the Research Reactor will ensure that he meets his research goal of a new treatment for cancer.
Like animals, most plants avoid mating with close relatives. But, how plants decide who is a relative has been a mystery to science. Bruce McClure made national headlines for his February, 2006 publication in *Nature* where his team provided insight into how this decision process is governed and the important role of S-RNase. Bruce was also recognized for excellence in teaching in NSF’s press release!
Bill Folk worked with a team of researchers from MU, Missouri Botanical Garden and the University of Western Cape in South Africa that will rigorously test indigenous phytotherapies used to fight HIV/AIDS and secondary infection and to modulate the immune response. We began this $4M Center this Fall.
LIFE SCIENCE RESEARCH AT MU:
INNOVATION LEADERS IN
COMPARATIVE MEDICINE

- Diagnosing, treating, and possibly curing human and animal diseases via the use of unique animal models
Growing Limits in Human Organ Supply

Source: United Network for Organ Sharing, Scientific Registry, 86,716 March 17, ’05

Note: Donor can contribute more than one organ

http://www.unos.org/
A major problem has been hyperacute organ rejection caused by the presence of α-1,3-galactosyltransferase on the surface of pig cells.

To solve this problem (MU) researchers constructed a genetically-modified pig in which the α-1,3-galactosyltransferase gene was removed.

1st cloned pig lacking α-1,3-galactosyltransferase gene, born January 2003
Randy Prather and his collaborators from MU, Harvard and the University of Pittsburgh received international attention last week (March 27, 2006) including venues such as NPR, NY Times, NBC’s Today Show, etc. for being the first to use biotechnology to produce pigs capable of making omega-3 fatty acids – heart healthy fats generally associated with fish.
Mmmm ... Healthy Bacon
By Rhitu Chatterjee (Graduate Student at MU)
ScienceNOW Daily News
27 March 2006
Move over bacon, now there's something healthier. A team of researchers has created a transgenic pig that produces higher-than-normal levels of beneficial omega-3 fatty acids. .................
LIFE SCIENCE RESEARCH AT MU: Leaders in Biomedical Ethics

- Randy Prather will receive the 2006 American Physiology Society Award for Biomedical Ethics. The award is given to the researcher who promotes integrity in science and fosters the highest ethical standards in research, publication, teaching and training of young physiologists.
LIFE SCIENCE RESEARCH AT MU: MAJOR ADVANCES IN ORTHOPEDIC SURGERY VIA COMPARATIVE MEDICINE

- Jimi Cook received $500,000 from IAMS & another large private gift to continue his groundbreaking work in orthopedics.
- Jimi developed a new implant from swine gut tissue that has successfully treated severely arthritic dogs and has recently been approved by FDA for trials in humans.
MU as a Source of Innovation and Creativity

MU is a Large, Successful Economic Enterprise

MU Helps Propel Other Economic Enterprises

MU Helps Propel Economic Development

MU as the Sun in an Economic Development Solar System
MU as an Economic Engine

- Approximately $1,300,000,000 dollar business (about 20% from the state) with a total economic impact of about $3,000,000,000 supporting about 40,000 jobs
- 12,000 full-time employees and 28,000 students
- $220 million in annual research expenditures ($440M economic impact supporting 9,000 jobs)
- $170 million annual private giving ($1,000,000,000 campaign)
- Annual athletic attendance over 1,119,000 generating over $18,000,000 in revenue
MU as an Economic Engine

- MU has given over $263,700,000 of financial aid to Missouri students
- Nearly $2,000,000 in tax revenue returned to Cole County in 2005 by nearly 300 MU and UM Health Care employees
- UM Health Care gave nearly $1,300,000 of uncompensated care to Cole County residents in 2005
- 3,812 visits by Cole County residents to MU Extension in 2005
- 3,253 MU alumni live in Cole County (about 5% of the population)
- 186 K-12 teachers (27% of all teachers) are MU Alumni
MU as an Economic Engine – Innovation and Commercialization

- Over 150 patents filed, 60 or so granted and nearly $18M in licensing revenue generated this decade.

- Over twenty new start-up companies based on the potential commercialization of MU technology or faculty expertise.

- Technology Business Incubator and Research Park on the horizon.
Tom Quinn, Sue Deutscher and Ed Sauter discovered two markers found in nipple aspirate fluid when breast cancer is present, but are absent when there is no breast cancer. They have identified a non-invasive early detection system for breast cancer. We believe the test will identify breast cancer earlier than mammography will identify it. They just received $750,000 of early stage venture capital.
Shubhra Gangopadhyay and her collaborators have developed an international reputation in nanoenergetics and biological applications of nanoscience. For example, venture capitalists are very interested in her recent work with “PCR on a chip.”
Peter Sutovsky received USDA’s first ever Discovery Award and is listed as BIO 2006 top 20 scientists in the Midwest. His research led to a new start-up company, Andrologika, which developed new technologies for fertility testing and a potential non-hormonal contraceptive.
Jeffrey Phillips, MU Department of Surgery, recently developed a new, more effective treatment for stress-ulcer related gastrointestinal bleeding in critically ill patients.

Basis of a new start-up company that went public (IPO) in June, 2004
MU as the Sun in an Economic Development Solar System

MU as a Source of Innovation and Creativity

MU is a Large, Successful Economic Enterprise

MU Helps Propel Other Economic Enterprises

MU Helps Propel Economic Development
MU as a Supporter of Existing Economic Enterprises

• Supporting existing businesses (e.g., biotechnology, film, agriculture, tourism)

• Developing human resources (e.g., workforce, extension, and entrepreneurship)
MU as a Supporter of Existing Economic Enterprises

- Last year, MIZZOU Business Development Extension helped 3,290 clients. This resulted in increased sales valued at more than $535 million; creation of 1,115 new jobs; business start-ups valued at more than $19 million; and acquisition of local, state or federal government contracts totaling more than $125 million.
MU as a Supporter of Existing Economic Enterprises

- MU’s Missouri Federal and State Technology Assistance Center (MoFAST) helped small innovative companies raise over $80,000,000.
The Center for Electromechanics and Energy Conversion uses the latest nano- and micro-technology to develop new materials, miniaturize electronic devices, and develop high-speed electric launchers.

Miniature 1000 V transformers
Miniature 1000 V battery
400 mph electric gun for U.S. Navy

Dr. T. Greg Engel, Director
Center of Electromechanics and Energy Conversion
MU as a Supporter of Existing Economic Enterprises - Agriculture

MU’s development of soybean varieties resistant to soybean cyst nematode has meant millions of dollars to MO farmers. We are also genetically engineering soybean plants for drought tolerance.

The Show-Me Heifer replacement program worked with 500 farms, 50,000 new female breeders, returning $13.9M to producers ($3.5M annually). MU faculty like Jerry Taylor are leaders in bovine genomics.
• **QuadraMet™**: Relieves the pain associated with metastatic bone cancer. Marketed worldwide (in US by Cytogen Corp.)
• **Ceretec™**: One of the first radiopharmaceutical for imaging brain blood flow. Marketed worldwide by GE Healthcare
• **TheraSphere™**: Y-90 microspheres designed for radiotherapy of primary liver cancer. Marketed in selected countries by Nordion and recently approved in the U.S.
MU as a Supporter of Existing Economic Enterprises – Workforce

• MU attracts more high school valedictorians, Curators Scholars and twice as many of the state's Bright Flight Scholars than any other college or university in MO.

• In 2003-4 MU ranked 4th in the nation in the number of Academic All-Americans and 1st in NCAA postgraduate fellowships.

• MU trained: more lab animal veterinarians than any other university; more Missouri physicians than any other university; 66% of MO’s veterinarians; and 20% of MO’s attorneys. MIZZOU students have incredibly high pass rates on professional exams (e.g., nursing, CPA, PT).
Stephanie worked with Dr. Silvia Jurisson of the department of chemistry on the role of radiopharmaceuticals in both the diagnosis and treatment of cancer. "Being involved with research has affirmed that this is the career for me," she says. "I am driven to be the one to find 'the answer' for cancer."
Katie, a Journalism major, is testing the hypothesis that memory is not necessarily affected by the content of the advertisements (i.e. attack or non-attack), but rather by the production values. “Being accustomed to learning in absolutes, my research has taught me that there is not always a simple answer to even seemingly simple questions. As my mentor says, “There is no perfect experiment.” I am beginning to learn there is no perfect answer.”
Teeranut Harnisattisai received the Research Dissertation Award at the International Honor Society of Nursing in 2005 for her research on how changes in behavior can speed recoveries from knee-replacement surgery. The award recognizes a nurse whose doctoral dissertation is exceptionally meritorious and exemplifies high standards of scholarship and knowledge development.
About 1,400 aspiring poets enter the National Poetry Series competition each year. This year, husband and wife doctoral candidates Steve Gehrke and Nadine Meyer were two of the five chosen poets. Nadine won the award for her first book *The Anatomy Theatre*. The panel chose Steve’s third book *Michelangelo's Seizure*. 
MU as a Supporter of Existing Economic Enterprises – Providing Leadership for Companies and Government

Mizzou alumni:
• lead 260 corporations in the Kansas City and St. Louis areas
• are 2 of the nation’s 50 governors
• are 34 members of MO’s legislature
### CHIEF EXECUTIVE OFFICERS OF THE 500 LARGEST COMPANIES IN THE US: WHERE ARE THEIR UNDERGRADUATE DEGREES FROM?*

<table>
<thead>
<tr>
<th>Institution and Ranking</th>
<th># CEOs with Undergraduate Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. University of Wisconsin (public)</td>
<td>13</td>
</tr>
<tr>
<td>1. Harvard (private)</td>
<td>13</td>
</tr>
<tr>
<td>3. Stanford (private)</td>
<td>10</td>
</tr>
<tr>
<td>4. Princeton (private)</td>
<td>9</td>
</tr>
<tr>
<td>4. University of Texas (public)</td>
<td>9</td>
</tr>
<tr>
<td>6. Yale (private)</td>
<td>8</td>
</tr>
<tr>
<td>7. University of Washington (public)</td>
<td>6</td>
</tr>
<tr>
<td>8. MIZZOU (public)</td>
<td>5 (soon to be 6)</td>
</tr>
<tr>
<td>8. Cornell (private)</td>
<td>5</td>
</tr>
<tr>
<td>8. Duke (private)</td>
<td>5</td>
</tr>
<tr>
<td>8. Northwestern (private)</td>
<td>5</td>
</tr>
<tr>
<td>8. Ohio State (public)</td>
<td>5</td>
</tr>
<tr>
<td>8. US Naval Academy</td>
<td>5</td>
</tr>
</tbody>
</table>

*Source: New York Times 11/27/05*
Sheryl Tucker, Associate Professor of Chemistry, will receive the very prestigious 2005 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring for her “Magic of Chemistry” program and her efforts to bring Chemistry to a diverse array of potential students. This award is only given to ten individuals annually, and Sheryl will be MU’s second recipient in three years!
In the first year of the St. Louis New Leaders Project, 23 aspiring principals are currently participating in an intensive 15-month professional development program designed by MU’s College of Education to enable them to become effective instructional leaders in urban settings. This is a partnership with Boeing, who is providing executive mentors for the aspiring principals.
MU as a Source of Innovation and Creativity

MU as the Sun in an Economic Development Solar System

MU is a Large, Successful Economic Enterprise

MU Helps Propel Other Economic Enterprises

MU Helps Propel Economic Development
MU supports economic development in a number of ways, including:

- Attracting new businesses and retaining existing ones
- Enhancing the quality of life
- Research to optimize economic development policies
MU Supports Economic Development: Recruiting and Retaining Companies

Expertise developed or housed at MU has been important in starting and retaining companies like ABC Labs and attracting companies like Ventria Bioscience to Missouri.
UM Supports Economic Development: Enhancing Quality of Life – Health Care

• In 2004 - UM Health Care saw 161,034 patients and had over 600,000 patient visits. Telehealth facilitates visits across Missouri.

• In 2002 - Missourians received $42 million of uncompensated care from UM Health Care

• MU is becoming a major center for several areas such as laparoscopic surgery

MU enhances the quality of life in many other ways including athletics, culture, entertainment, etc.
MU SUPPORTS ECONOMIC DEVELOPMENT BY ENHANCING QUALITY OF LIFE IN MANY WAYS

MU’s Veterinary and Animal Scientists partner with the Saint Louis Zoo in areas such as animal nutrition, health monitoring and disease treatment and diagnosis. The Director of the Zoo is also an MU graduate. The Zoo has 3,000,000 visitors a year and was the top rated zoo in the country last year.
MU Extension Supports Quality of Life for a Large and Diverse Population in Kansas City

MU Extension had contact with a diverse group of nearly 300,000 Jackson County Residents in FY 2004 (48% African American; 44% Caucasian; 5% Hispanic).

Fire and Rescue Training Institute (914 Fire Departments)
Business Development Program (471 KC clients)
4-H After-school Academic Program (1,800 KC youth)
Master Gardeners of Greater Kansas City (11,000 KC people)
Food Power (3,768 KC school children)
MU: SUPPORTING ECONOMIC DEVELOPMENT BY CONNECTING MISSOURI TO THE GLOBAL COMMUNITY

MIZZOU fosters many connections to the global community including 785 students in study abroad programs in 60 countries, faculty research in 22 countries and approximately 1,300 international students and visitors from 130 countries.
MU Supports Economic Development: Research and Policy Analysis

- **MU’s Rural Policy Research Institute (RuPRI)** – National experts conducting policy-relevant research to facilitate public dialogue and assist policymakers with public policies and programs. RuPRI houses the Kauffman initiated Center for Rural Entrepreneurship (as well as other programs).

- **MU’s Office of Social and Economic Data Analysis (OSEDA)** is the major Missouri source for demographic and economic data analysis used in development and evaluation of economic policy.

- MU’s Chancellor, **Dr. Brady Deaton**, is an internationally known scholar in economic development research.
MU as the Sun in an Economic Development Solar System

MU as a Source of Innovation and Creativity

MU is a Large, Successful Economic Enterprise

MU Helps Propel Other Economic Enterprises

MU Helps Propel Economic Development