

# Success!

## Using a NSF ERC to Build University-Wide Collaborations



David R. Shaw,  
*Vice President for Research and  
Economic Development*



*In the Beginning:*

**The NSF Engineering Research  
Center for Computational Field  
Simulation**



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## Funding for a New Building:

# MSU MEMO

August 21, 1987, Volume 12, Issue 3

MISSISSIPPI STATE UNIVERSITY  
National Science Foundation  
ENGINEERING  
RESEARCH CENTER  
COMPUTATIONAL  
FIELD SIMULATION  
COMPLEX GEOMETRY / COMPLEX PHYSICS



## Center for Scientific Computing at MSU

Mississippi State will be the location of a new computer research center, funded by a first-year grant of \$11.9 million from the Department of Defense, according to Sen. John C. Stennis.

The contract is for the largest single amount ever received by MSU for a research project.

The Research Center for Advanced Scientific Computing will conduct unique research in microelectronics and computational fluid dynamics.

President Donald Zacharias said, "I think this gives our area a significant boost in the level of scientific research being conducted. It should demonstrate clearly that this area will continue to grow in its scien-

tific investigations and will contribute not only to the state but to the national effort."

Although the center is expected to be a

writers for the project are Joe Thompson and David Whitfield of aerospace engineering.

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# The Reflector

Friday  
February 2, 1990

## MSU named an Engineering Research Center by National Science Foundation

**By Wendy Newberry**  
The National Science Foundation has designated an Engineering Research Center by the National Science Foundation and could receive up to \$17.7 million over the next five years.  
Chosen as one of only 14 centers nationwide, the center will study and develop the university's research program in the use of supercomputers to solve problems involving fluid dynamics.  
For the first year of the center's operation, \$1.7 million will be granted by the NSF. Additional funding over the five years will result from endowments and the progress of the center.  
The MSU center is the only one in the Mid South.  
The Engineering Research Center's program is a highly competitive competition and one of the most difficult to win, Robert Allen, chairman of the college of engineering, said.  
"MSU has become a national player," Allen said.  
University and state administrators packed in Jackson Wednesday morning to report on the NSF's decision.  
Casting key votes with the panel, MSU President Ray M. Cannon said the center is a "frontier" in engineering.  
Cannon said the center will be able to develop 32-bit-level computer codes that the American aerospace industry can use, MSU said.  
Clyde Ritz, president of MPE, was at the Jackson ceremony Wednesday morning.  
"We think it (the research center) represents a step forward for Mississippi State," Ritz said.



John Thompson reveals details of MSU as an engineering research center.

**NSF Engineering Research Center for Geometrically-Complex Field Problems**

**MISSION**

- Computational simulation capability for large-scale geometrically-complex physical field problems for engineering design and applications in U.S. industry.
- Developing this capability to the high level needed.
- Continually making available state-of-the-art technology for current applications on real-world configurations.

**GOALS**

- Competitive edge for U.S. industry in engineering applications involving physical field problems.
- Education of U.S. engineers through a cross-disciplinary integrated program in computational and computer engineering.
- Leadership for U.S. in large-scale scientific computing.

**SUPPORTERS AT SITE VISIT**

**PRESENT**

- Pratt & Whitney
- Calspan
- General Electric
- Teledyne/Brown
- Thinking Machines
- Sun Microsystems
- Cypress Semiconductor
- Air Force Armament Lab - Eglin AFB
- NASA Marshall Space Flight Center
- Army Engineer Waterways Experiment Station

**STANDING BY PHONE**

- General Motors Research Lab
- Boeing Commercial Airplanes
- Allison Gas Turbine
- Ardent Computer
- Vickers
- Analytical Methods
- McDonnell Aircraft
- IBM
- Cray Research
- Rockwell International
- Silicon Graphics
- NASA Langley Research Center
- NASA Lewis Research Center
- Sandia National Labs

**EDUCATIONAL PROGRAM**

**EDUCATIONAL VISION**

- Provide undergraduates, graduates, and continuing professional cross-disciplinary training in computational and computer engineering
- Emphasis on application in engineering field problems
- Collaboration with other universities and centers of effort
- Close cooperation with industry and government laboratories
- Advance research potential of nearby minority institutions
- Work with area high schools and junior colleges to enhance the career opportunities and retention of minorities in engineering and scientific computing.

**RESEARCH TEAM DEPENDENCY CHART**



## **NSF Engineering Research Center for Computational Field Simulation (1990-2001)**

**MISSION:** *To reduce the time and cost of complex field simulations for engineering analysis and design.*

### **Cross-Disciplinary Research Team with a Common Focused Mission**

*Science & Engineering Faculty; ASE, CE, CS,  
ECE, MA, ME, PH*

### **Mission Related Educational Programs**

*Computational Engineering MS & PhD Program  
Related CME, ASE, CS, ECE, MA, ME courses  
Undergraduate Outreach Programs*

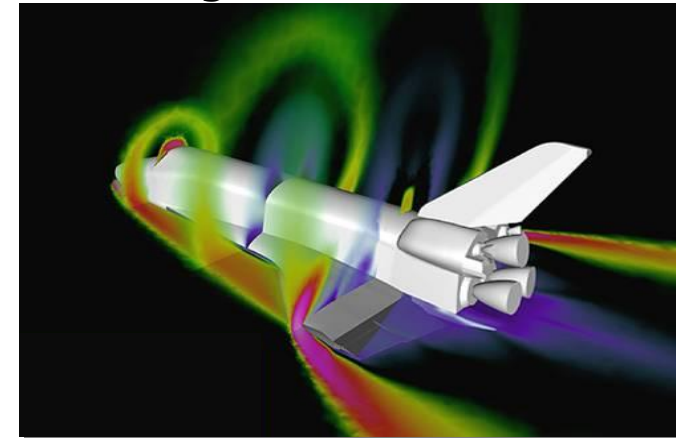
### **Test-bed Integrated Systems**

*Applied to relevant customer defined problems*

### **Technology Transfer Programs**

*Industrial, government, & academic  
collaborators*

*Software & technology widely used*



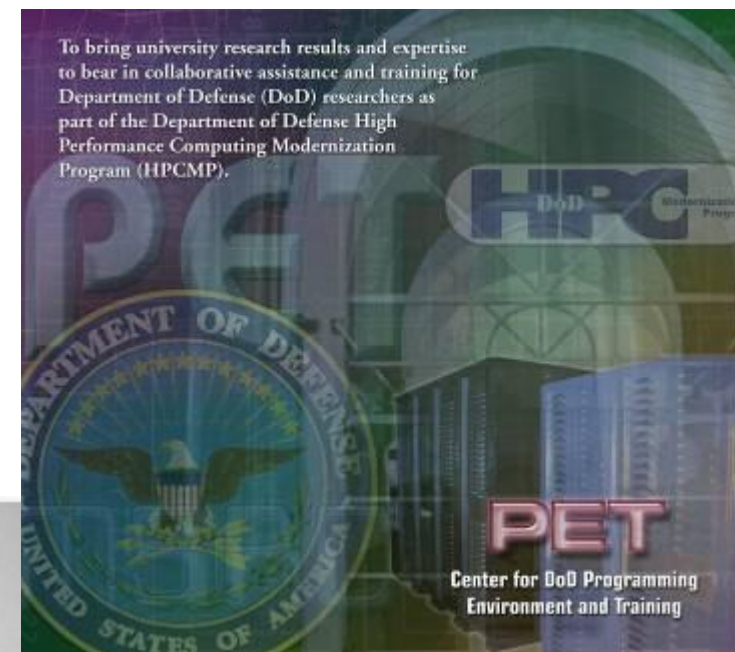
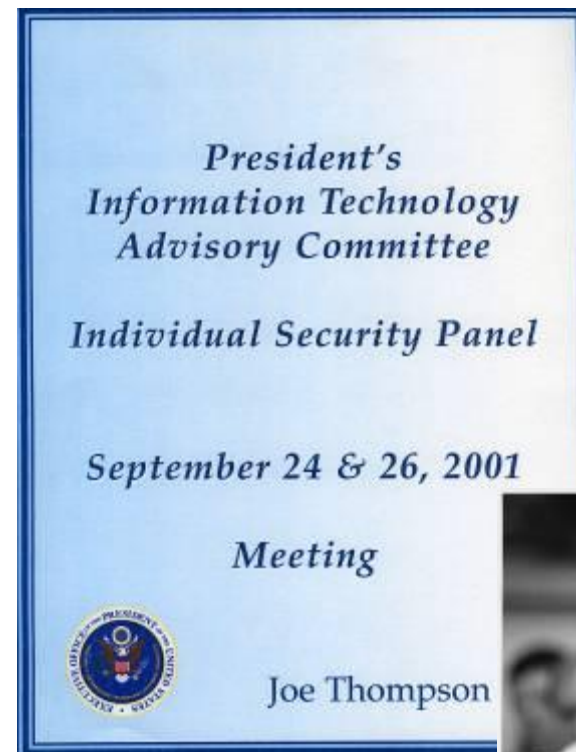
In the 1998 STS-95 (John Glenn) Mission the drag chute door fell off at launch.

A Shuttle simulation was completed by the ERC during the Mission. This demonstrated that the ERC had reduced the CAD to solution time from 2 months to 2 days.



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- Won the DoD PET contract in 1996.
- Thompson appointed by President Clinton to PITAC in 1997.




CAVE opened in 1999.



Stennis Space Center  
branch opened in  
1999.




In 1999 Rita Colwell, NSF Director, singled out the NSF ERC at MSU as an example of the NSF ERC program success.



**“HOW WOULD YOU CHARACTERIZE ENGINEERING'S ROLE WITHIN NSF?”**

“Absolutely critical. Engineering successes, especially in research centers, are a bridge to discovering new applications. For example, I am very pleased with the Mississippi Engineering Research Center, which effectively demonstrates that you can institute change in a very positive way, in an architecturally and aesthetically pleasing facility filled with and run by very bright people, with companies located close enough to facilitate partnership efforts. That is what engineering centers should be.”

— ASEE PRISM, January 1999



Rita Colwell, the first woman to hold the top post at the National Science Foundation, peers into the agency's future and forecasts a growing role for engineering education.



- With the presence of the NSF ERC, Mississippi landed Nissan in 2000, which led to CAVS.



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The ERC graduated successfully from the NSF ERC program in 2001.



## Legacy of the NSF ERC

- Fourteen new faculty positions
- PhD programs in Math and Computer Science
- Computer art program at MSU
- Ten-fold increase in HPC research funding
- Repeatedly on Top 500 HPC Sites list
- Nissan in Mississippi
- Membership on PITAC
- Leadership on \$108M DoD PET contract
- Culture of multidisciplinary research at MSU



*The Next Generation:*

# High Performance Computing Collaboratory



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- In 2003, SimCenter, PET, GRI, CAVS, CCS formed a confederation for computational science and HPC, carrying forward the ERC name.
- ERC became HPC<sup>2</sup> in 2005.



# Definition and Goal

The **High Performance Computing Collaboratory (HPC<sup>2</sup>)** is a coalition of member centers and groups that share;

a common core objective of advancing the state-of-the-art in **computational science and engineering** using **high performance computing**,

a common approach to research that embraces a **multi-disciplinary, team-oriented** concept,

and a commitment to a full partnership between **education, research, and service.**

Our **goal** is to become the nation's premier interdisciplinary high-performance computing research facility.



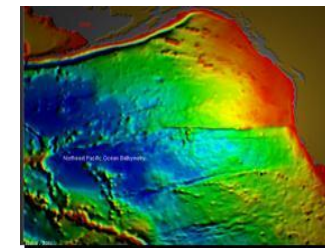
## The Original Centers of the HPC<sup>2</sup>



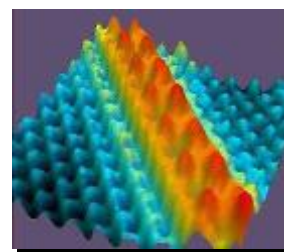
*Center for  
Advanced Vehicular  
Systems  
(CAVS)*



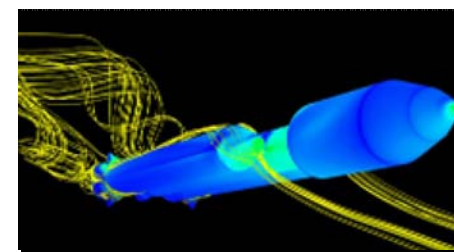
*Center for  
DoD User  
Productivity  
Enhancement  
& Technology  
Transfer  
(PET)*



*GeoResources  
Institute  
(GRI)*



*Center for  
Computational  
Sciences  
(CCS)*

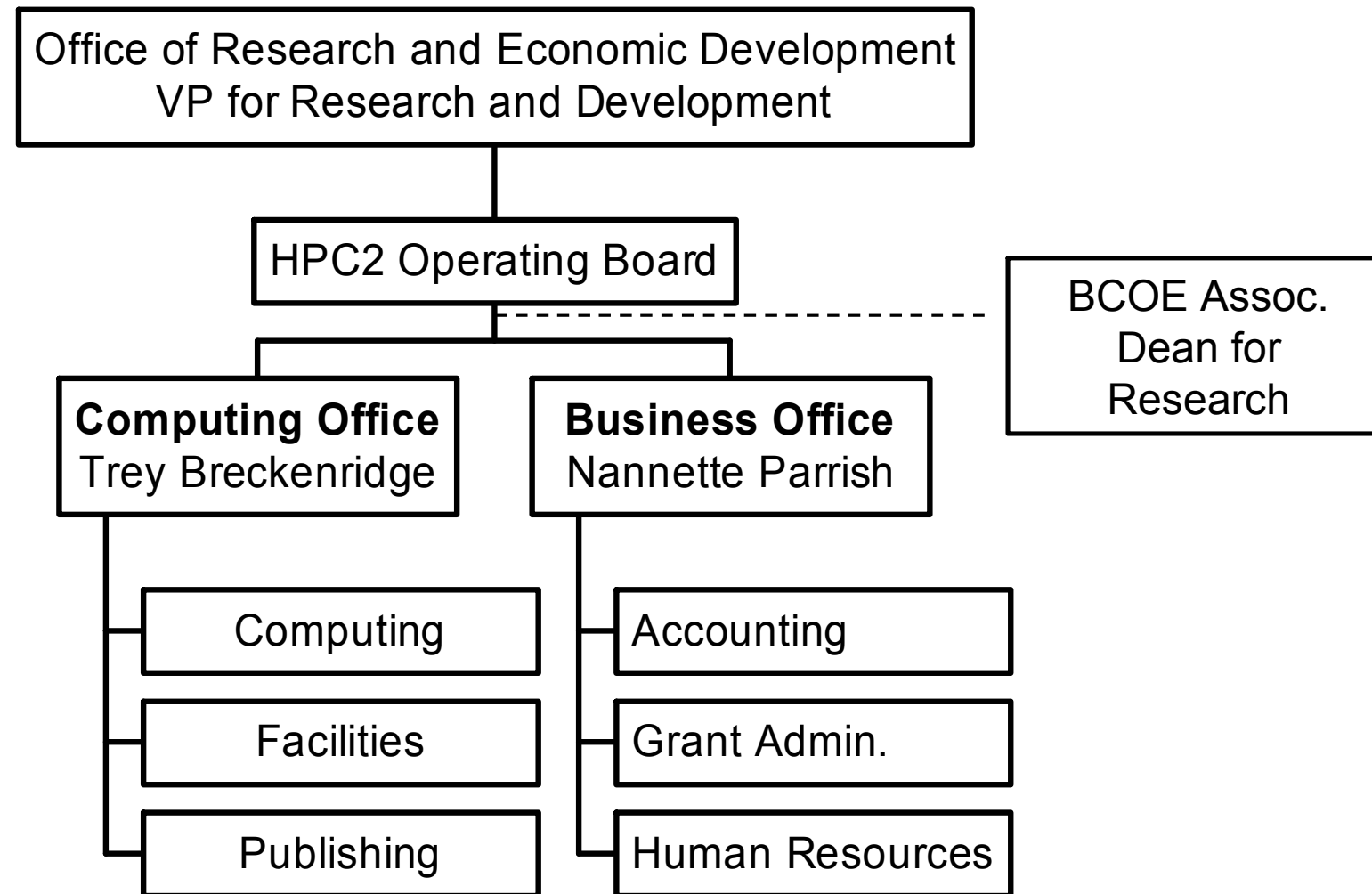


*Computational  
Simulation &  
Design Center  
(SimCenter)*



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# Organizational Structure





## Facilities: Buildings

- HPC Building - Starkville
  - 71,000 square feet
- CAVS Building - Starkville
  - 57,000 square feet
- NASA Stennis Space Center – MS Gulf Coast
  - Construction of ~40,000 square foot facility to begin in early 2010*



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# High Performance Computing



# Academic Collaboration

## Academic Affiliations

- **College of Agricultural and Life Sciences**  
Ag Econ, BioChem and Molecular Biology, Entomology and Plant Pathology, Plant & Soil Sciences
- **College of Arts & Sciences**  
Biological Sciences, Chemistry, Geosciences, Math and Statistics, Physics and Astronomy, Sociology Anthropology and Social Work, Psychology
- **College of Veterinary Medicine**
- **College of Engineering**  
Aerospace, Ag & Bio, Civil, Chemical, Computer Science, Electrical & Computer, Industrial, Mechanical
- **College of Arch., Art and Design**  
Art
- **College of Business**  
Finance and Economics
- **College of Forest Resources**  
Forestry, Wildlife and Fisheries

## Education Program

- **Computational Engineering MS, PhD**
  - Computational Mathematics (e.g., numerical analysis, numerical solutions to PDEs, numerical linear algebra)
  - High-Performance Computing (e.g., parallel algorithms, software engineering, computer architecture)
  - Application area from engineering or physical science (e.g., computational fluid dynamics, electromagnetics, structural analysis, hydrodynamics, geospatial modeling)

>75 MS graduates  
>25 PhD graduates



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# Research Funding & Personnel

## 486 Total HPC<sup>2</sup> Personnel

70	Academic Faculty	27	Staff
38	Research Faculty	134	Graduate Students
16	Postdoctoral	110	Undergraduate Students
91	Research Associates		

## Major External Funding Agencies

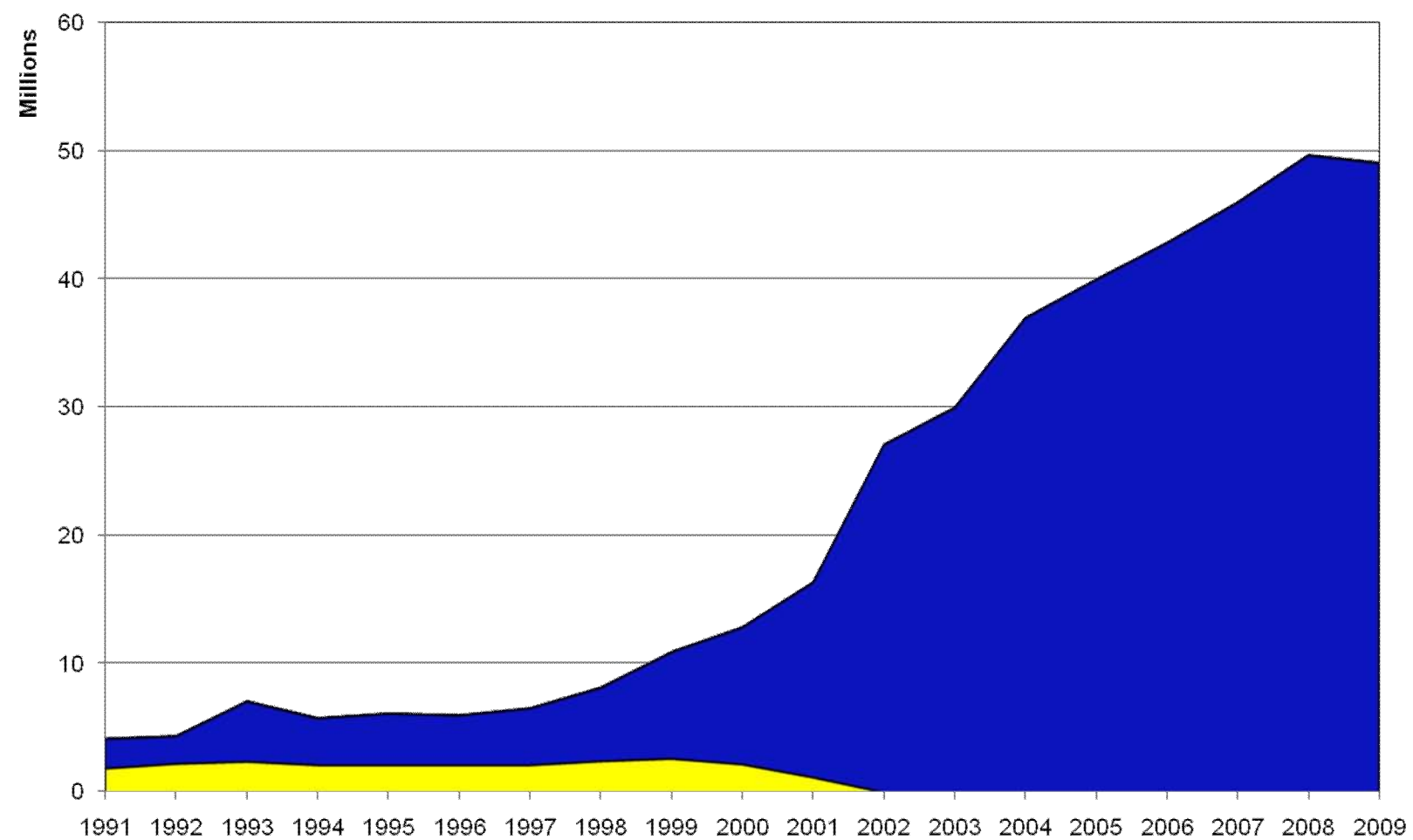
DoD, NASA, NOAA, USDA, NSF, DIA, DoE, USGS, USDOT, NIEHS, NIST, HUD, DoL, EPA, SBA, MS-DEQ, MS Space Commerce Initiative, MDA Bell Helicopter, Boeing, Northrop Grumman, Sentel Corp., Miltec Corp., General Motors, ESI Group



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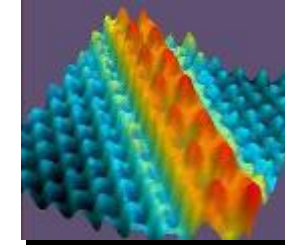
# Research Expenditures



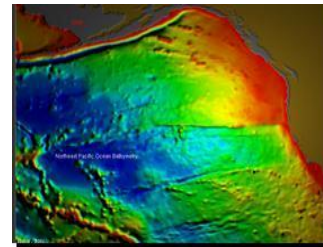
## Current HPC<sup>2</sup> Centers/Institutes



*Center for  
Advanced Vehicular  
Systems  
(CAVS)*



*Center for  
Computational  
Sciences  
(CCS)*



*Geosystems  
Research  
Institute  
(GRI)*



*Northern Gulf  
Institute  
(NGI)*



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***The Children:***

**Geosystems Research Institute**



# **Geosystems Research Institute**



***A University-Level  
Research Center  
focused on Geospatial  
Technology  
Applications  
Development***



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# Who is GRI?

## Areas of Expertise

- GIS
- remote sensing
- data/image visualization
- data fusion
- scientific modeling
- high performance computing

## University Level Research Institute

- Interdisciplinary Project Teams
- More than 50 Faculty from 6 colleges and 22 departments
- More than 100 students actively involved in research projects
  - PhD - 34
  - MS - 32
  - BS - 45

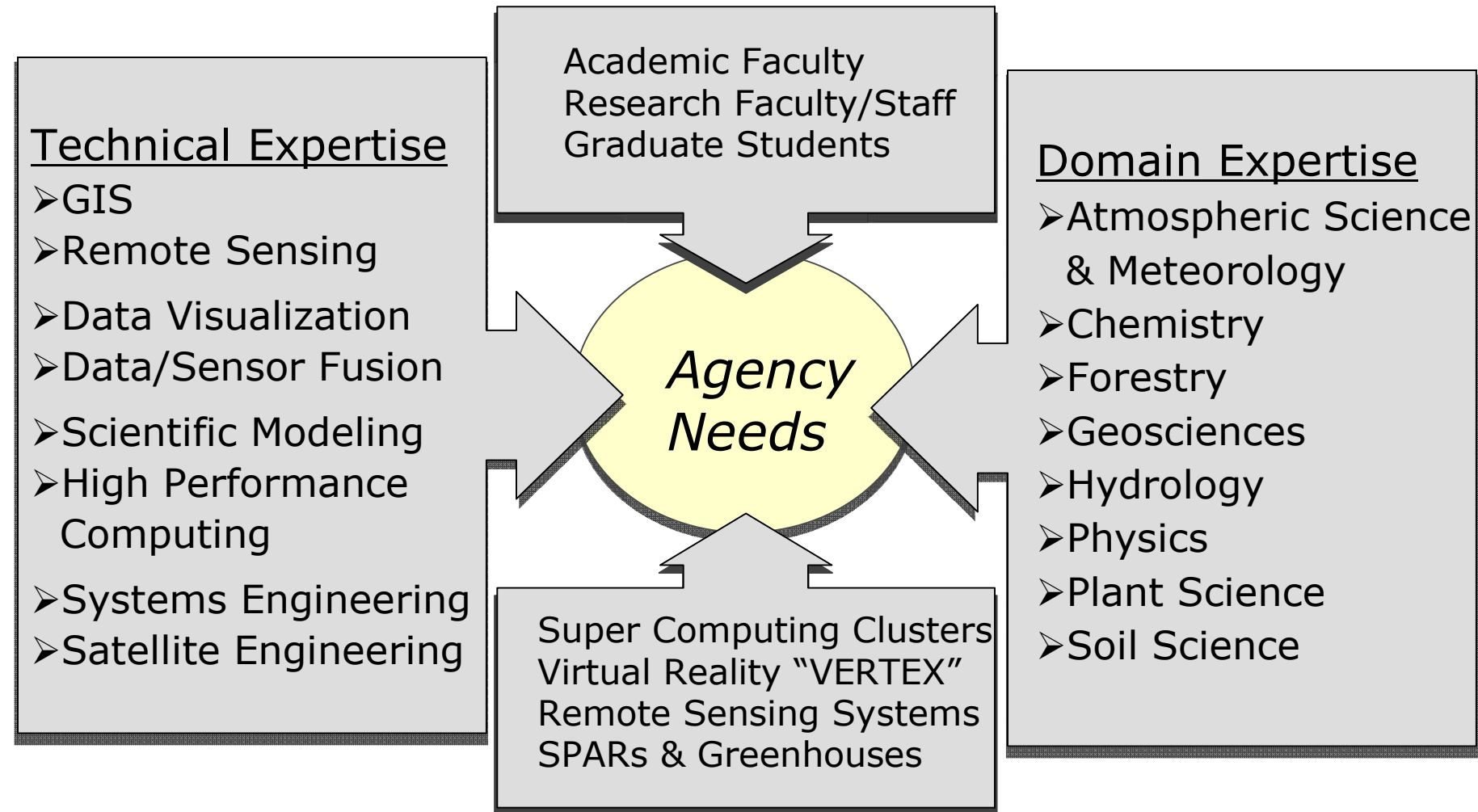
Total expenditures in FY 08 - \$20M

74 active projects funded from DHS, NOAA, NASA, USGS, DoD, USDA, EPA, SBA/Census, USDOE, USFS, USDOT...



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# GRI's Philosophy

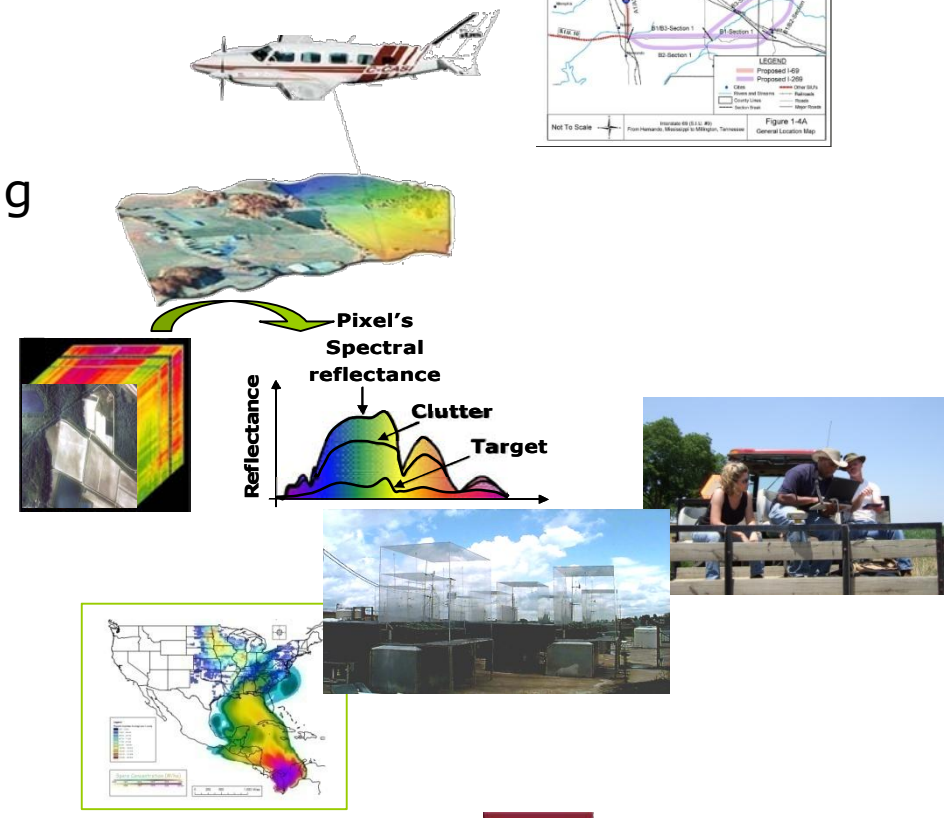
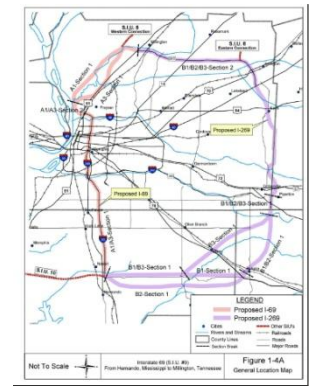


# Example Research Projects

## Technical Expertise

- GIS
- Remote Sensing
- Data/Image Visualization
- Data/Sensor Fusion
- Scientific Modeling
- High Performance Computing
- Systems Engineering
- Satellite Engineering

USDOT - Validate use of GIS and RS technologies for major corridor planning



DHS – Automated target detection algorithms for hyperspectral imagery – detecting bio-chemical induced vegetative stress

# Example Research Projects

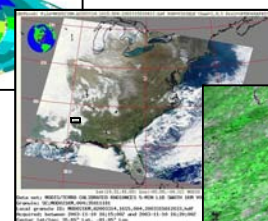
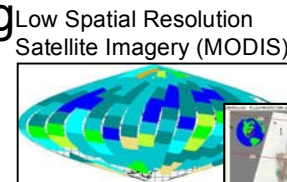
## Technical Expertise

- GIS
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NOAA – Improved Visualization,  
Spatial depiction of threats,  
Avoiding sensory overload



USGS, NASA –  
Subpixel target detection  
algorithms for invasive  
vegetation mapping



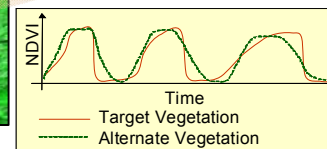
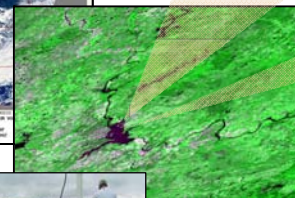
Target: Waterhyacinth  
(*Eichhornia crassipes*)



NonTarget:  
American Lotus  
(*Nelumbo lutea*)



Ground Truth  
Field Data



Wavelet Analysis of Temporal Signatures



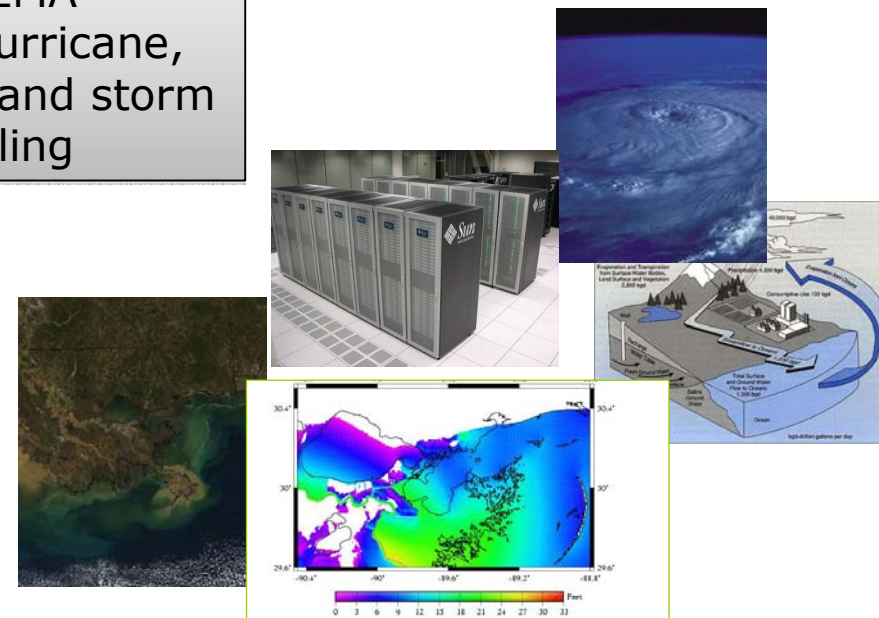
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# Example Research Projects

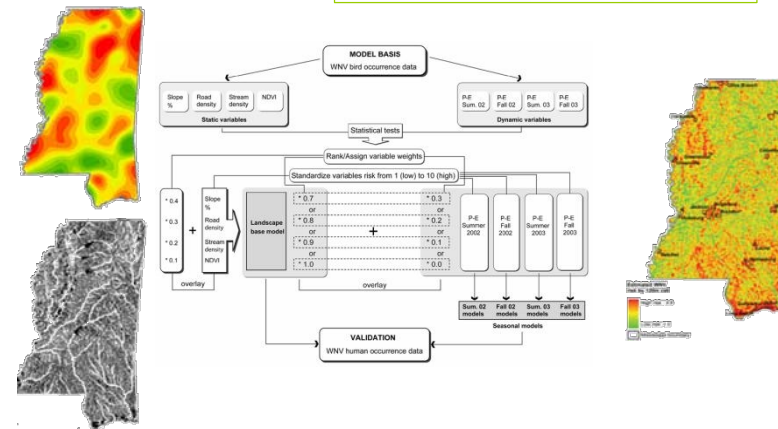
## Technical Expertise

- GIS
- Remote Sensing
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- Data/Sensor Fusion
- Scientific Modeling
- High Performance Computing
- Systems Engineering
- Satellite Engineering

NOAA, NWS, FEMA –  
Improved hurricane,  
watershed, and storm  
surge modeling



NASA – Model development  
and V&V for GIS and RS  
based “risk mapping” for  
West Nile Virus

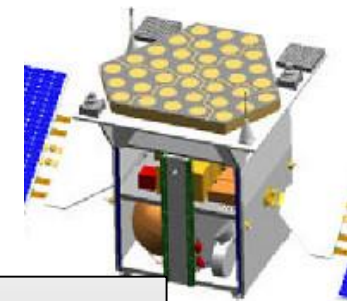
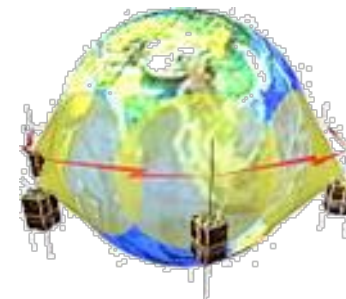




# Example Research Projects

## Technical Expertise

- GIS
- Remote Sensing
- Data/Image Visualization
- Data/Sensor Fusion
- Scientific Modeling
- High Performance Computing
- Systems Engineering
- Satellite Engineering



NASA – Small Satellite  
Engineering –  
Educational Program  
Development,  
Collaborative Research



[photo courtesy of SSTL]



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# Example Service Activities

## Hurricane Katrina Emergency Response

- Worked with federal agencies to plan imagery acquisition and distribution
- Deployed teams of students and faculty to provide GIS operations for emergency management
- Utilized the University's "Geospatial Education Mobile" bus, equipped with 14 computer workstations conduct GIS tasks



*And the Grandchildren:*

**Northern Gulf Institute**



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# Concept

## Northern Gulf Institute

- Critical needs in northern Gulf; currently underserved by NOAA
- Opportunity for pilot effort to closely link divisions across NOAA
- Integrated research, outreach, education programs
- Strong affiliation with other federal agencies

# Complementary Academic Strengths

## Member Institutions





# Ecosystem Level Focus

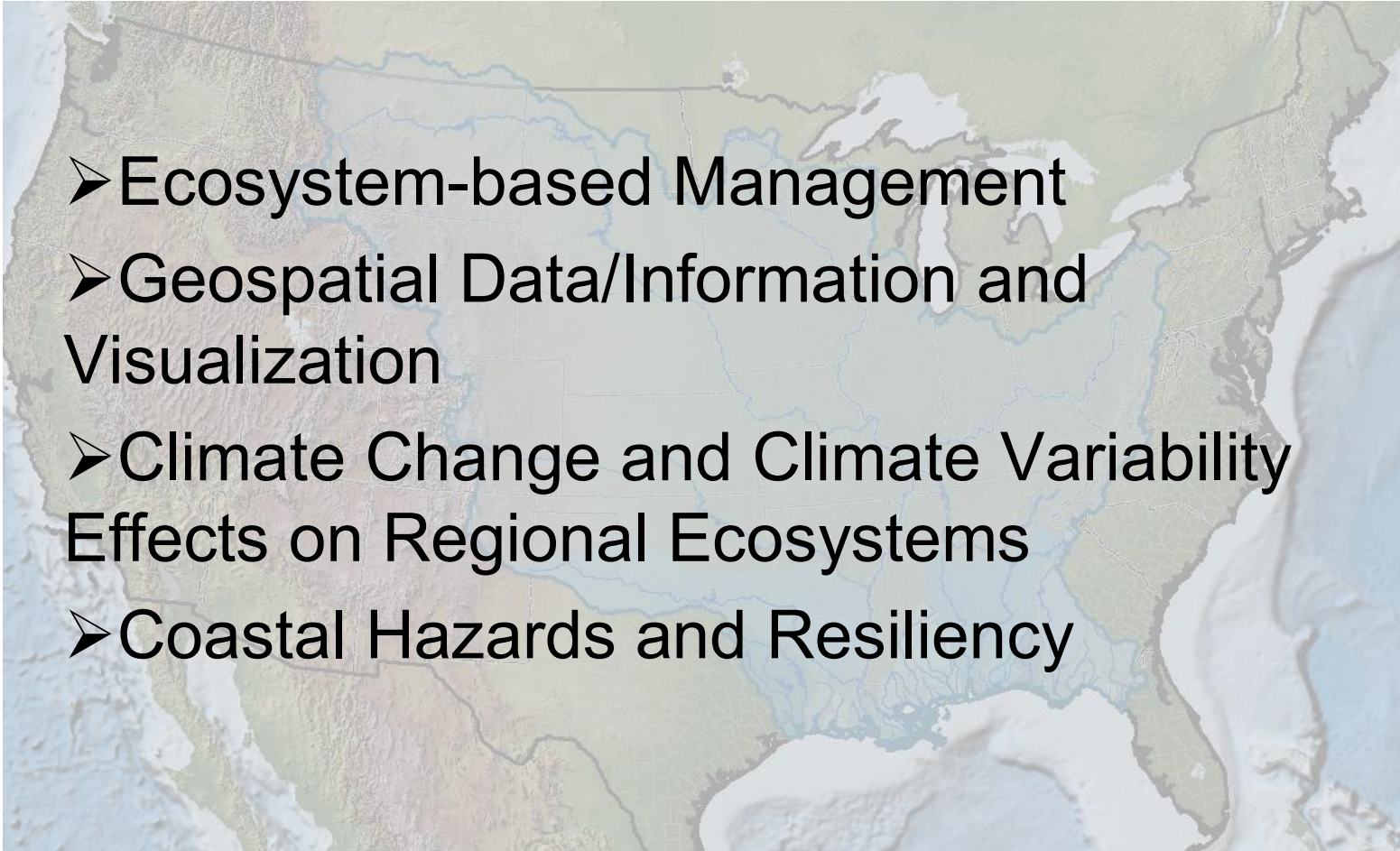


31 State Watershed of the Northern Gulf

White water to brown water to blue water



# Northern Gulf Institute Themes

- 
- A map of the Northern Gulf region, showing the Gulf of Mexico and the surrounding landmasses. The map is overlaid with a semi-transparent text box containing the list of themes.
- Ecosystem-based Management
  - Geospatial Data/Information and Visualization
  - Climate Change and Climate Variability Effects on Regional Ecosystems
  - Coastal Hazards and Resiliency





## Supporting Institutional Goals

- Sponsoring graduate students
- Increased competitive funding
- Economic development
- Strong agency, congressional support
- Additional funding opportunities great
- Strongly interdisciplinary within, outside of MSU
- Sustainable funding pathway



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# Northern Gulf Institute

## *Broadening the Impact*

- Facilitated discussions between NOAA and USDA, resulting in joint press conference on hypoxia; Farm Bill language now under consideration.
- Hosted Gulf stakeholder workshop for Unmanned Aerial Systems; coordinating development of priorities list; assisting in replicating efforts in other regions.



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## ERC – Foundation for Growth

- Infrastructure in place for growth – existing and new centers
- Strong focus on multi-disciplinary collaboration
- Strong focus on application of technologies
- Flexibility to develop, sunset new initiatives, centers





# Questions?

## Success!

**Using a NSF ERC to Build University-Wide  
Collaborations**



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*Vice President for Research and Economic  
Development*  
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