

# Space Strategy Forum



## Rice University Space Connection

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Physics & Astronomy

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## RELEVANT AREAS OF STRENGTH AT RICE:

Rice has a number of areas in which we are making an impact on the space industry. These include:

- Nano-technology – Smalley Institute; CONTACT program
- Space engineering – Oshman Engineering Design Kitchen
- Space and Earth Science – Rice Space Institute
- Space Life Sciences – BioScience Research Collaborative
- Business – Jones Graduate School of Business MBA program
- Policy – Baker Institute for Public Policy
- Students – Rice undergraduate and graduate students are among the most successful in the country
- Education and Public Outreach – Rice Space Institute





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## RICE SPACE INITIATIVE

POC: David Alexander

The Rice Space Initiative is designed to foster partnerships between our University, NASA, and local industry, to generate collaborative research projects of specific interest to the exploration of space, and to educate a new generation of leaders in the related disciplines.



- Space Frontiers Lecture Series : **Norm Augustine will speak in the Fall**
- Collaborative partnership across campus
- Formal relationship with NASA JSC
- Multi-disciplinary connections to Greater Houston Space industry
- Professional Science Masters in Space Studies (Fall 2012)





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## PROFESSIONAL SCIENCE MASTERS IN SPACE STUDIES

The goal is to educate graduates to bridge the gap between business and engineering/science allowing them to better contribute and manage the business demands within a science and technology based industry.

The curriculum is built on a framework of:

**Planned start: Fall 2012**

- Space Engineering and Science
- Space weather
- Business/management, policy and economics
- Professional development: (i.e. communication, research and/or practical experience)
- Approx. 39 – 42 credit hours required (approx. 13 - 14 courses), plus an **internship**

POC: Dagmar Beck



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## RICE SPACE INSTITUTE

POC: Pat Reiff

The mission of the Rice Space Institute is to "Make the Universe Smaller" by interdisciplinary research and education at all levels, charting the course for the next generation of peaceful uses of space.

### AREAS OF INTEREST

- Space Weather : Monitoring and Forecasting
- Solar Physics : Space Radiation, Energetic solar events
- Magnetospheric Physics : Radiation Belts, Response to solar activity
- Astronomy & Astrophysics : Extrasolar planets, Cosmic Rays, HEDLA
- Earth Sciences : LPI connections, Planetary climates
- Public Outreach: Sally Ride Festival, MMS, Texas Space Grant





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## SMALLEY INSTITUTE FOR NANO-SCALE SCIENCE AND TECHNOLOGY



POC: Wade Adams

LANCER (Lockheed Martin Advanced Nanotechnology Center of Excellence at Rice)

A unique partnership between Rice faculty and Lockheed Martin engineers funded by Lockheed Martin to:

- Pursue nanotechnology research, develop education program and technology transfer.
- Explore new technologies for materials, electronics, energy, security and defense.



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## NANO-SCIENCE SPACE APPLICATIONS



### SPACE VEHICLES

- Lightweight materials
- Thin films
- Multifunctional nano-composites
- Structural health monitoring
- EMI shielding

### ADVANCED PROPULSION & POWER

- Thermal management
- Solar cells
- Supercapacitors
- Solar Sails

### AVIONICS

- Collision avoidance
- Radiation mitigation

POC: Jack Agee

### TRAINING SYSTEMS

- Modeling for Autonomous Systems

### SPACE SYSTEM ANALYSIS

- Modeling for improved automation of functions

**Over 20 projects already identified**





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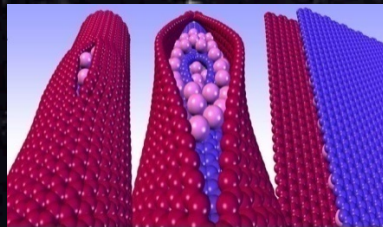
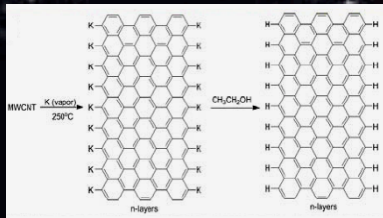
## NANO-SCIENCE SPACE APPLICATIONS

### EXAMPLE: Graphene-Nanotube Composites



POC: Jack Agee

Project Goal: Design and synthesize structural 3D composites systems with multifunctionality.



Active Rack Isolation System on ISS (NASA/JSC)

**Operational Pay Off:** Novel lightweight multifunctional materials critical for the development of next generation space technology systems. Payload, damping/vibration control, EMI shielding, thermal management, and health-monitoring for spacecraft.





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## NANO-SCIENCE SPACE APPLICATIONS



### EXAMPLE: Cognitive Modeling of Human Sensory-Motor Skill Acquisition

POC: Jack Agee

**Technical Objective:** Study and model human performance and acquisition of motor skills in virtual and real environments.

**Operational Pay Off:** Identify NASA-relevant manual performance domain, develop motion-based performance metrics, implement a computational cognitive model, and synthesize a training regimen based on the model. Aids integration of human element into autonomous and robotic systems.





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## RICE/JSC PARTNERSHIP: GREEN CARBON BUILDING

Green Carbon is fuel with a carbon-base, but with an increasingly greater renewable energy component to these fuels.



- ❑ a zero CO<sub>2</sub> emission building that uses natural gas as a source of primary fuel
- ❑ natural gas is the source of the primary fuel, then Texas-based companies will be the primary drivers of the clean energy economy using this carbon bridge
- ❑ NASA/Rice Space Act Agreement in process for a small Green Carbon building as a prototype for later commercial reality.

POC: Jim Tour/Eric Malroy





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## BIO SCIENCE RESEARCH COLLABORATIVE

NSBRI

NATIONAL SPACE BIOMEDICAL  
RESEARCH INSTITUTE

ABOUT NSBRI | DISCOVERIES FOR SPACE & EARTH | SCIENCE & TECHNOLOGY | EDUCATION & TRAINING | FUNDING OPPORTUNITIES | COLLABORATIONS | NEWS & EVENTS

NSBRI RESEARCH SEEKS SOLUTIONS  
TO HEALTH CONCERNS FACING  
ASTRONAUTS ON LONG MISSIONS.  
THESE ADVANCES WILL BENEFIT  
HEALTH CARE ON EARTH.



EXPLORE

INNOVATE

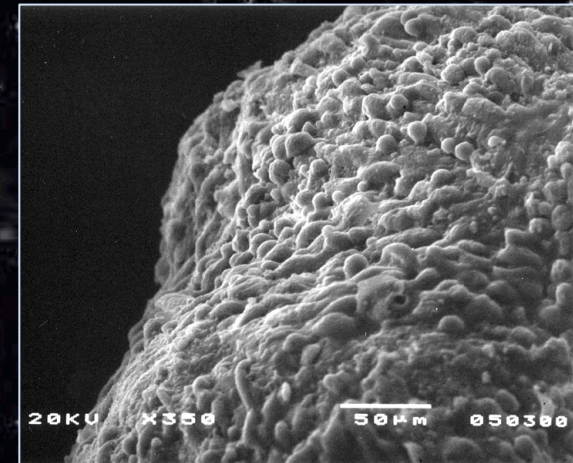
EDUCATE

CONNECT

NSBRI will take up tenancy in the BRC in September. Many of their objectives align well with ongoing research in the BRC and the campus.



Space Strategy Forum <http://spaceforum.rice.edu>



Prostate Modeling Experiment  
Success Becomes Part of Legacy of  
Shuttle Astronauts.

Rice is part of this program project  
team. We now do these studies in 3D  
core in BRC.

POC: Cindy Farach-Carson/  
Jeff Sutton

David Alexander

July 1 2011



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## ENGINEERING

POC: Tony Elam

- Grand Challenge in Engineering
  - Design/Develop - Star Trek Tricorder
  - Build on OUR (NASA & Rice) Strengths in Engineering
    - Complex Systems/Integration
    - Signal Processing
    - Communications
    - Rice New Initiative in Biomedical Devices (ECE)
  - Partner with the TMC
    - Baylor College of Medicine
    - UT Health Science Center
  - Partner with Industry
    - Texas Instruments
    - National Instruments





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## ENGINEERING

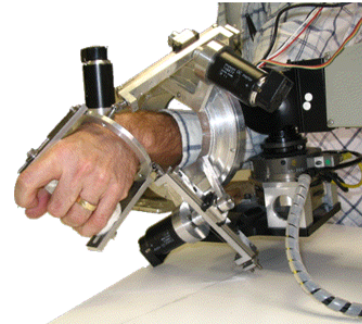
### MAHI Lab @ Rice Mission

Design, manufacture, and evaluate mechatronic or robotic systems to model, rehabilitate, enhance or augment the human sensorimotor control system



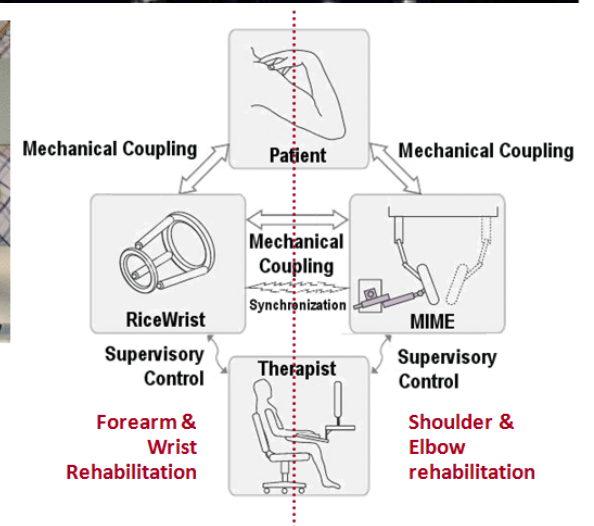
POC: Marcia O' Malley  
<http://mahilab.rice.edu>

Robotic devices facilitate rehabilitation  
MIME/RiceWrist Integrated System for Upper  
Extremity Rehabilitation



In collaboration with the  
Central Texas Veterans  
Health Care System  
Contract VA V674P-3804

(Gupta et al., IEEE TMECH 2006)  
(Gupta et al, IJRR 2008)



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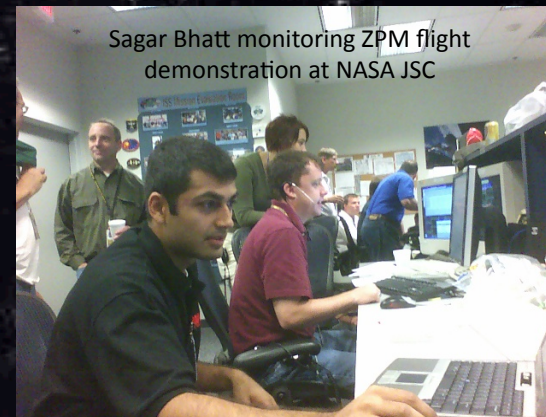


## COMPUTUTATIONAL AND APPLIED MATHEMATICS

POC: Mattias Heinkenschloss

### Zero Propellant Maneuver (ZPM) for the International Space Station (ISS);

- Use only Control Moment Gyroscopes (CMGs) to perform ISS large angle rotations
- Formulate as optimal control problem; solve using state-of-art mathematical optimization and differential eqn. solvers
- No propellant consumed (money saved); new capability to rotate spacecraft when thrusters fail



- CAAM research provides US aerospace industry with new capability to extend satellite lifetime
- **Trains new generation of aerospace talent**





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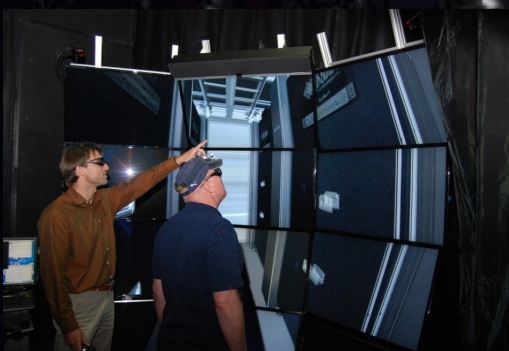


DAVINCI Visualization Lab for  
Science & Engineering:  
Fall 2011

POC: Jan Odegard

Funded by NSF under  
award OCI-0959097

- Processing
- Analysis
- Visualization
- Interpretation
- Analytics



**State-of-the-art imaging and visualization  
is a cross-cutting tool for NASA, TMC, Oil  
& Gas, Homeland Security, ...**





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## Human Factors: Living in Space

- RSI Enhancement – Multi-disciplinary research
- Partnerships with NASA and Industry
  - Opportunities and work experience for Undergraduate and graduate students
  - Professional Science Masters – internships, speakers
  - Research projects – innovative partnerships in science, engineering and technology
  - Workforce transition – **the prepared student**
- University Affiliated Research Center (JSC-Rice)





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## UNIVERSITY AFFILIATED RESEARCH CENTER (UARC)

- Research Center involving one or more universities and government agency – e.g. Rice University and JSC.
- Establish collaborations to best deliver research and technology for the future.
- Enrich in-house work with a strong link to university talent.
- Faster response time, stability and flexibility.
- Build scientific relationships between university and agency.

### JSC - Rice UARC OVERVIEW

- Rice University - world class faculty and expertise to provide technology solutions for NASA and their future technology needs.
- Multidisciplinary projects focused on materials, nanotechnology, life- and space-sciences.
- Emphasis on transfer to NASA and industry.
- Link to R&D groups at JSC and other Centers.



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*Continuum of hands-on workforce. Training & education facility for scientists, engineers, operators, technicians & trades.*

**Academia**

*Technology roadmap driven by world leaders in manufacturing.*

**UARC INDUSTRY ENGAGEMENT**

**Industry**

*R&D partnerships with small & large companies, academia & gov't labs.*

**JSC**

*R&D manufacturing systems with equipment and material supplies; uniform manufacturing*





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## JSC/RICE UARC

### MISSION

To identify and develop innovative technologies for human space exploration by generating knowledge, preparing students, transitioning technologies and partnering with leading industrial, academic, and government institutions.

### AREAS of RESEARCH

The center will focus on technologies for aerospace applications by using its research infrastructure and that of its associated members from industry, universities and JSC laboratories. The proposed center will be aligned to JSC technical competencies in the following example areas:

- Space vehicles (Materials and Structures)
- Advanced Propulsion and Power
- Avionics
- Radiation risk and mitigation
- Urgent Response (mix of any or all disciplines)



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## RELEVANT WEBSITES

Space Strategy Forum: <http://spaceforum.rice.edu>

Rice Space Institute: <http://rsi.rice.edu>

Wiess School of Natural Science: <http://natsci.rice.edu>

George R. Brown School of Engineering: <http://enr.rice.edu>

Richard E. Smalley Institute for Nano-scale Science and Technology: <http://smalley.rice.edu>

CONTACT program: <http://www.contact.rice.edu>

Green Carbon Center: <http://greencarbon.rice.edu>

MAHI Lab: <http://mahilab.rice.edu>





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# THANK YOU

