

Missouri Space Grant Consortium  
Missouri University of Science & Technology  
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## PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The **Missouri Space Grant Consortium** is a Program Grant Consortium funded at a level of **\$660,000** for fiscal year 2010.

## PROGRAM GOALS

### Consortium Objectives

The mission of the Consortium is being accomplished through the following objectives:

1. Maintain and expand a network of Missouri universities and corporate partners with interests and capabilities in aerospace and space related science, engineering, and technology.
2. Inspire, motivate, recruit, educate, and train students, especially women, underrepresented minorities, and persons with disabilities, for professional careers in all disciplines of interest to NASA.
3. Promote and enhance a strong science, technology, engineering, and mathematics (STEM) education base from elementary through university levels.
4. Support interdisciplinary education, research, and public service programs involving the STEM fields.
5. Encourage cooperative education and training programs in aerospace and space related science, engineering, and technology among universities, aerospace industry, and other federal, state, and local entities.

### Metrics for Measuring Goal Achievement

The proposed efforts of mentoring, teaching, advising, nurturing, and associated scholarly activities will be assessed by the following set of outcomes as can be quantitatively related to NASA's Strategic Education Outcomes 1, 2, and 3:

- Number of Master Theses and Doctoral Dissertations produced.
- Number of Undergraduate Degrees conferred.
- Number of Undergraduate and Honors Thesis produced.
- Number of Journal Articles and Conference Papers published.
- Number of Student Research Paper and Team Competition Awards.
- Number of NASA Field Center and Corporate Internships.
- Number of Teachers and Students participating in Pre-College Programs.
- Number of Persons served in Public Education and Outreach Programs.

### PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, OR 3)

#### Outcome 1: *Employ and Educate*

The Missouri Consortium's Fellowship, Scholarship, and Internship; and Higher Education programs strongly address the objectives of NASA's Education Outcome 1. In 2010-2011 there were 83 directly supported students participating in independent research and hands-on scientific and engineering group projects. 120 additional non-directly supported students participated in 14 Higher Education projects funded by the MOSGC. The Consortium exceeded the Fall 2008 NCES NASA-targeted underrepresented minority statistic for all Missouri Institutions higher learning of 16.7% with an average targeted minority participation of 20.5% for the directly supported students. The Consortium also very nearly met its female participation level target of 40% with 39.8% of the directly supported students being women.

Some particularly exciting Outcome 1 anecdotes are as follows:

*Two Missouri University of Science & Technology graduate students, Ryan Pahl and Chris Tutza, from the M-SAT satellite team took first place in the student paper competition at the 24th Annual AIAA/USU Conference on Small Satellites, Logan, Utah, August 9-12, 2010.*

*University of Missouri - St. Louis graduate student Kristen Erickson won 2nd prize in the graduate poster competition at the Great Midwestern Space Grant Regional Meeting at the University of Minnesota in September 2010.*

*The Missouri University of Science & Technology satellite team was fourth overall and won the Best Outreach Award in the NanoSat-6 competition. They are one of ten teams to be selected to compete in NanoSat-7.*

*The St. Louis University satellite team's CubeSat has been selected to fly on the 2012 NASA ELaNa IV (Educational Launch of Nanosatellites) CubeSat mission. They are also one of ten teams to be selected to compete in NanoSat-7.*

#### Outcome 2: Educate and Engage

Of the seven Pre-College Education programs supported by the MOSGC, there were a total of 157 teacher and 2540 student participants in 2010. Projects meant to bring excitement and education to the pre-college participants include High School Summer Internships, Classroom Visits, Planetarium Programs, Summer Space Academy, Middle School Educator Training Project, Introduction to Aerospace Engineering, and Space Explorers, Inc. Many of these programs are minority student focused with an average of ~60% of the participants being from NASA-targeted under-represented minorities.

#### Outcome 3: Engage and Inspire

Of the five Public Education and Outreach programs supported by the MOSGC, there were a total of approximately 7,000 participants in 2010. Projects meant to bring inspiration and informal education to the general public include telescope observation and night sky viewing programs, public lectures, and public information services.

### PROGRAM ACCOMPLISHMENTS

#### Directly Supported Student Programs

The Missouri Space Grant Consortium has been conducting highly successful Fellowship and Scholarship, Higher Education Internship, and Research Infrastructure Assistantship programs. The competitive selection of participants is primarily based upon academic achievement and research project merit. This year, 35% the annual program participants were graduate students and 65% were undergraduate students. These students are supported to perform independent mentored research throughout the academic year and summer, including summer internships and academy student placement at NASA Field Research Centers. Students are requested to report the results of their work and present their research at an annual statewide conference. The goal is to provide graduate and undergraduate research training and contribute to the national workforce in the aerospace industry and in space science related fields as needed to achieve NASA's strategic goals to educate and employ. In FY2010 there were a total of 83 directly supported students of which 20.5% were from underrepresented minorities and 39.8% were women. The minority participation level exceeded the latest NCES statistic of 16.7% for Missouri and the female participation very nearly met the Consortium's target of 40% through improved recruitment and retention of minorities and women at the affiliate institutions.

Fellowships & Scholarships: The Missouri Space Grant Consortium Fellowships are competitively awarded to doctoral and master's degree candidates in

aerospace and space related science and engineering. Programs of study must relate to one or more of the NASA Mission Directorates. These awards are normally provided for an entire academic year (Fall and Winter semesters) and are reported annually as part of each Affiliate's Fellowship and Scholarship Program.

Research Infrastructure Assistantships: Both undergraduate and graduate students are competitively selected to assist in the support of Research Infrastructure projects at the Affiliate Institutions. Students work with faculty to develop, maintain, and enhance the capability to perform cutting-edge research at the Consortium's affiliate institutions.

Undergraduate Internships: Summer and academic year Higher Education undergraduate internships are competitively awarded undergraduates in faculty-mentored programs of study that relate to one or more of the NASA Mission Directorates at the Affiliate Institutions.

Puerto Rico Summer Undergraduate in Residence at UMC Nuclear Engineering: This project expands and formalizes the MOSGC's involvement in an on-going partnership between the Nuclear Science & Engineering Institute (NSEI) faculty at UMC and their counterparts at the Polytechnic University of Puerto Rico (PUPR).

NASA Field Research Center and Corporate Summer Programs: Both undergraduate and graduate students are competitively selected by NASA Centers and corporate partners to participate in these programs. These students travel to NASA Centers and corporate facilities to perform independent research under the guidance and mentorship of professional engineers and scientists. The Consortium supported five NASA Center interns in FY2010.

The students who have been selected by the Consortium, NASA Centers, and Corporate partners have generally been outstanding in their academic capabilities and impressive in their accomplishments. They have authored and co-authored many published papers and have presented their work at a multitude of professional meetings. In FY2010, Missouri Space Grant's directly supported students produced a total of 36 journal and conference publications in addition to 78 MOSGC technical reports that will be presented at the Consortium's annual statewide meeting in April. Furthermore, five students will be awarded MS degrees and three will earn PhD degrees this year.

Higher Education Engineering Design Teams and Scientific Research Groups: The Affiliates of the Missouri Space Grant Consortium are involved in a wide range of activities that are designed to promote a strong science, mathematics, and technology base at the university level. To greatly enhance the MOSGC's

contribution to Outcome 1, support is provided for several design team projects and scientific research groups on the Affiliate campuses; thereby opening opportunities for groups of post-secondary students to engage in authentic NASA-related mission-based R&D activities. These projects also have a significant potential to attract and retain students in STEM disciplines through a progression of educational and hands-on research and development opportunities for students, teachers, and faculty as desired in Outcome 2. The Consortium also invested in the curriculum development of NASA-related course resources for integration into STEM disciplines at the university level as indicated by Outcome 1. This section briefly describes the Consortium's higher education team and group activities in 2010-2011:

- *Society of Automotive Engineers (SAE) AeroDesign East Competition* - The Missouri S&T Advanced Aero Vehicle Group has been designing and building a heavy lift aircraft for the SAE Aero East competition in Marietta, GA on April 30-May1. The governing design concepts focus around the aircraft's ability to carry a large payload fraction while limited to a total weight of 55 pounds. This year's plane utilizes twin .30 in<sup>3</sup> engines, a wing span of 16 feet, and a leading edge slat design. The team has also been working on a gearbox design to employ two truck engines and drive a single large propeller.
- *University Student Launch Initiative (ULSI) Competition* - The Missouri S&T Advanced Aero Vehicle Group participates in the University Student Launch Initiative run by NASA every year. The competition calls for teams of students to design and build a reusable, high power rocket targeting one mile altitude while carrying a scientific payload. This year the team opted for a payload specified by the Science Mission Directorate consisting of an array of electronics from pressure and humidity sensors to solar irradiance and ultraviolet light detection. Launch day in Huntsville, AL is on April 16, 2011.
- *NanoSat-6/NanoSat-7 Competition Teams* - The Missouri Consortium supported two NanoSat-6 competition teams in FY 2009-10, one from MS&T and one from SLU. The Nanosat-6 Program (NS6) is a joint Air Force Research Laboratory and AIAA activity and eleven schools made the final selection to participate in this 24-month satellite design competition. The winning schools were decided in January 2011 and the MS&T took the "Best Outreach" award. Both of these teams have been selected to participate in the NanoSat-7 competition.
- *The "Pathfinder" Collegiate Undergraduate Program* - The Pathfinder Program at Washington University in St. Louis involves the use of remote sensing data sets and analysis techniques applied for both environmental sustainability and for the study of terrestrial terrains as analogs for other planetary surfaces. This program is a four-year experience involving a small group of highly motivated students of exceptional academic caliber, a senior faculty member, and a research team that is actively involved with environmental studies. The program utilizes case studies and field-oriented approaches to introduce students to issues surrounding environmental sustainability and the duty to

- preserve the environment for future generations
- *Strengthening the Multidisciplinary Astrobiology Research Community* - The goal of this project was to bring together faculty and undergraduate students from four diverse disciplines to create a new astrobiology-themed research community at Truman State University. Research teams worked independently on astrobiologically relevant projects, and came together at weekly community-building events to share knowledge across disciplines and to foster a sense of shared purpose. Students and faculty supported by this project had the opportunity to increase their exposure to astrobiology through field trips to a research observatory, NASA Field Centers, and a major astrobiology conference.

#### Pre-college Education Programs

The primary goal of the Consortium's Pre-college Education Program is to expose aerospace and space related science, technology, and engineering topics to young students in such a way as to be an enjoyable learning experience; leaving students, parents, and teachers with a better appreciation for and understanding of these disciplines. The Consortium's approach to many of these activities is to assist pre-college educators with developing and presenting programs and activities. The assistance may include use of technical/scientific staff and facilities, logistical support, and modest amounts of funding for program materials. The list of projects supported in FY 2010 is as follows:

- *High School Summer Internships*
- *Classroom Visits*
- *Planetarium Programs*
- *Aerospace Extravaganza*
- *Summer Space Academy*
- *Middle School and Informal Educator Training*
- *Introduction to Aerospace Engineering*
- *Space Explorers, Inc.*

#### Informal Education Programs

Of five supported programs, there were of approximately 7,000 participants in FY 2010. With the matching funds provided by the Consortium's Affiliates, industry, and local communities, it was possible to provide excellent service to the general public. Of particular value is the extensive outreach to underrepresented minorities through these outstanding programs. The successfulness of these programs is measured primarily by the high number of participants for a relatively low investment cost. The following Space Grant supported activities are currently being conducted: *NASA Nights at MSU's Baker Observatory*, *Telescope Observing Sessions* at UMSL and Washington University in St. Louis, *Monthly Aerospace Lectures*, and a *Space Science Information Service* (the latter two of which are also implemented by WashU).

## PROGRAM CONTRIBUTIONS TO PART MEASURES

Longitudinal Tracking: The Missouri Consortium's present approach is to track students from FY06 onward and has been highly successful in following the current and 'next-step' status of the students that meet the threshold for tracking. Using the presently known data for the students supported from FY2006 through FY2010, the breakdown of these students present status is as follows:

21% are still enrolled from FY06-FY09

35% are still enrolled from FY09

21% have graduated and are pursuing an advanced STEM degree

9% have graduated and are seeking STEM employment

8% are employed STEM fields by aerospace contractors

3% are employed in non-aerospace STEM field positions

0.5% is employed by NASA (JSC)

0.5% is employed in a K-12 STEM field academic position

1.3% are employed in post-secondary STEM field academic positions

0.7 are pursuing a non-STEM employment or advanced education

While not mandated by NASA, the Consortium has the desire to monitor the progress of its High School Interns beyond the influence of Space Grant to assess the effectiveness of this program. All seventeen of the High School Interns supported the MOSGC since FY05 have gone on to enroll in post-secondary STEM-field education programs.

### Course Development:

*Enhancement of the Aerospace Laboratory Curriculum* - One of the main goals of the laboratory courses at Missouri S&T is hands-on demonstration of key fundamental aerospace concepts. This project enhanced the aerospace laboratory curriculum by developing two new lab modules in these deficient areas. Specifically, dynamics and feedback control of systems and spacecraft power sources and management modules were developed.

*Workshop on the Integration of Design and Hands-On Learning into the Early Stages of Engineering Curriculum* – This workshop was sponsored by the Great Midwestern Space Grant Region and was held at Missouri S&T in Rolla Missouri on June 17-10, 2010. The workshop content was designed to provide participants with knowledge of introductory engineering design and hands-on experiences that can be integrated into freshman and/or sophomore engineering programs of four-year university bachelor's degree programs or in associate degree engineering programs in community colleges or two-year institutions. 12 participants from 7 states attended the workshop.

Matching Funds: The cost share match ratio for the Consortium is estimated to be 1.2:1 in FY2010.

Minority-Serving Institutions: The Missouri Consortium continues to pursue a culturally diverse body of supported students with the goal of meeting or exceeding the targeted demographic statistics for the state as well as encourage students and faculty with disabilities to participate in Consortium activities. The Consortium has successfully established a partnership with a Missouri HBCU minority serving institution, Lincoln University in Jefferson City, MO. The MOSGC supported six students to perform independent research under the direction of three faculty members in the 2010-2011 academic year.

### IMPROVEMENTS MADE IN THE PAST YEAR

- Additional resources were allocated this year to initiate new projects that focused on involving more students in research, design, and hands-on experiences through the expansion of the Consortium to include two new Consortium Associate members and one new Affiliate Associate member.
- As noted above, the Consortium has established a partnership with Missouri's only HBCU with NASA relevant technical programs, Lincoln University of Missouri. Lincoln U will be provided with the opportunity to submit a proposal to continue its relationship with the MOSGC in FY2011 with the potential of becoming a full affiliate in the future.

### PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The Missouri Space Grant Consortium is composed of the Lead Institution, six Affiliates, and three Affiliate Candidates with an even balance of science and engineering disciplines that have specialization in research areas of interest to NASA. Each member institution pursues projects that best suit their unique capability and contribute the overall success of the Consortium, as summarized in the Outcomes section above. The Affiliates have been highly effective in promoting and executing NASA related opportunities on their campuses and in their local communities, which is considered one of the Consortium's greatest strengths. Some of the Affiliates collaborate in Space Grant activities with Associate Members of the Consortium. Furthermore, the Affiliates are being encouraged to seek out and join with organizations of common interest to increase the number of Associates and thereby extend the scope and reach of the Consortium. The list of current MOSGC Affiliate, Associate, and Affiliate Candidate Members and, along with their core departments is as follows:

#### **Affiliate Members:**

- Missouri University of Science & Technology (MS&T - Lead Institution)  
Department of Mechanical and Aerospace Engineering

- Missouri State University (MSU)  
Department of Physics, Astronomy, and Materials Science
- University of Missouri – Columbia (UMC)  
Department of Mechanical and Aerospace Engineering  
Nuclear Science and Engineering Institute
- University of Missouri – Kansas City (UMKC)  
Department of Civil & Mechanical Engineering
- University of Missouri - St. Louis (UMSL)  
Department of Physics and Astronomy
- Washington University in St. Louis (WashU)  
Department of Earth and Planetary Sciences  
Department of Energy, Environmental, and Chemical Engineering  
Department of Mechanical Engineering and Materials Science
- St. Louis Science Center (SLSC)  
James S. McDonnell Planetarium

**Consortium Associate Members:**

- Lincoln University of Missouri
- St. Louis Challenger Learning Center
- St. Louis University
- Truman State University
- William Jewel College

**Affiliate Associate Members:**

- St. Louis Astronomical Society (WashU-EPSci)
- St. Louis Gifted Resource Council (WashU-EPSci)
- Spaceweek-St. Louis (WashU-EPSci)
- Space Museum of Missouri (WashU-EPSci)
- Columbia Aeronautics and Space Association (UMC)