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 **$590,000** for fiscal year 2009.

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 2009-2010 there were 90 directly supported students participating in independent research and hands-on scientific and engineering group projects. 149 additional non-directly supported students participated in 10 Higher Education projects funded by the MOSGC. The Consortium exceeded the most recent NCES NASA-targeted underrepresented minority statistic for all Missouri Institutions higher learning of 16.4% with an average targeted minority participation of 18.9% for the directly supported students. The Consortium also exceeded its female participation level target of 40% with 45.6% of the directly supported students being women.

Some particularly exciting Outcome 1 anecdotes are as follows:
Benjamin Bettis, a Ph.D. aerospace engineering student at the Missouri University of Science & Technology has was awarded a 2010-2011 "NASA Aeronautics Graduate Fellowship". With this award, Ben will continue his research on uncertainty quantification in high-fidelity computational fluid dynamics for high-temperature hypersonic flows applied to the aerospace vehicle analysis and design.

Justin Gilker, an undergraduate astronomy student at Missouri State University was awarded 7 nights of 2.1m telescope time at Kitt Peak National Observatory. Justin co-authored a paper titled "An EC 14026 Pulsator in a Reflection Binary", which was published in Astrophysics and Space Science in 2010, and presented his poster, "Baker Observatory Subminute Survey", at the 215th meeting of the American Astronomical Society in Washington, D.C.

Outcome 2: *Educate and Engage*

The *High School Educator Training Project* sponsored by the Department of Earth and Planetary Sciences at Washington University in St. Louis provides research opportunities and curriculum development collaboration for a high school educator in the areas of planetary geosciences, atmospheres, and global climate. For this program, a high school educator is selected to spend several weeks during the summer on campus working with

planetary sciences faculty and research groups

Outcome 3: *Engage and Inspire*
Of the five Public Education and Outreach programs supported by the MOSGC, there were a total of approximately 7,500 participants in 2010. Projects meant to bring excitement 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, 37% the annual program participants were graduate students and 63% 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 FY2009 a total of 90 directly supported students of which 18.9% were from underrepresented minorities, one was a student with disabilities, and 45.6% were women. The minority participation level exceeded the latest NCES statistic of 16.4% for Missouri and the female participation level exceeded the Consortium's target of 40% through improved recruitment and retention of minorities and women at the affiliate institutions.

Graduate Fellowships: 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 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 four NASA Center interns and one corporate intern at MEMC Electronic Materials in St. Peters, MO.

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 2009, Missouri Space Grant's directly supported students produced a total of 11 journal and conference publications in addition to 78 MOSGC technical reports that were presented at the Consortium's annual statewide meeting. Furthermore, three students have been awarded MS degrees and one has earned a PhD degree 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 2009-2010:

- S*ociety of Automotive Engineers (SAE) AeroDesign East Competition* - This year's Aero Design competition of the season took place April 29-May 2nd at the Fort Worth Thunderbird field in Fort Worth, Texas. The Advance Aero Vehicle Group at from MS&T placed entries in the Advanced and Micro R/C Aircraft Classes. The Advanced Class group placed fifth and the Micro Class group placed third.
- *University Student Launch Initiative (ULSI) Competition* - The 2010 MS&T AAVG USLI team's rocket featured spin stabilization of a two-stage rocket. The team successfully built their rocket, but a catastrophic failure during their final test flight ended their opportunity to compete this year.
- *Society of Flight Test Engineers (SFTE)* - The Society of Flight Test Engineers at MS&T continued the development of two experiments to be implemented in the aerospace engineering department's junior and senior class experimental methods courses during the upcoming academic year. The two topics chosen for this project

consist of longitudinal aircraft stability and rocket propulsion. As part of the curriculum development the students were assigned the task of designing their own laboratories This project has presented many great opportunities for the students of the SFTE group to improve themselves in the areas of teamwork, communication, leadership, and engineering knowledge and application. It is the hope of the SFTE that this pilot project will open a permanent avenue for student involvement in the continual development of the aerospace curriculum.

- *Nanosat-6 Competition Teams* - The Missouri Consortium supported two Nanosa-6 competition teams in FY 2009, 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 school will be decided in January 2011 and they will deliver a flight-ready spacecraft in June 2011 for a future launch through the Department of Defense Space Test Program (STP).
- *CubeSat DesignTeam* - The goal set out for SLU's 2009-2010 CubeSat Team was to complete a flight-ready CubeSat by the end of second semester. From this goal, Team CubeSat created the following mission statement for the satellite: To test a student built experimental power board, photograph the Earth, and measure internal magnetic field strength at determined altitudes. In order to fully accomplish this goal and mission, five mission objectives were created, in which the team must finalize the past four years of CubeSat design analysis, select the flight design, test all necessary CubeSat components and subsystems, integrate CubeSat subsystems upon successful subsystem testing, test and verify the constructed CubeSat system against the calculated performance, and certify the CubeSat system for flight readiness adhering to the CubeSat programs requirements
- *Collegiate Autonomous Underwater Vehicle (AUV) Competition Team* - An autonomous underwater vehicle was designed by students at SLU's Parks College to compete in the collegiate AUV competition held by AUVSI and ONR at the TRANSDEC facility in San Diego, California in July of 2010. The design team consisted of two sub-groups: The ECE group was responsible for designing the intelligence of the AUV, whereas the ME group was tasked with designing vehicle propulsion, structure, buoyancy, and stability.
- *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
- *Establishing a 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 2009 is as follows:

- *High School Summer Internships*
- *Classroom Visits*
- *Unisphere Planetarium Program*
- *Summer Space Academy*
- *High School Educator Training Project*
- *Engineered Fun and Inventure University*
- *Introduction to Aerospace Engineering*
- *Space Explorers, Inc.*

Informal Education Programs

Of five supported programs, there were of approximately 7,500 participants in FY 2009. 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 requested data for the 206 students supported from FY2006 through FY2009, the breakdown of these students present status is as follows:

46 are still enrolled from FY06-FY08 (22%)
71 are still enrolled from FY09 (34%)
41 have graduated and are pursuing an advanced STEM degree (20%)
13 have graduated and are seeking STEM employment (6%)

18 are employed STEM fields by aerospace contractors (9%)
9 are employed in non-aerospace STEM field positions (4%)
1 is employed by NASA (JSC) (0.5%)
1 is employed in a K-12 STEM field academic position (0.5%)
4 are employed in post-secondary STEM field academic positions (2%)
2 are pursuing a non-STEM advanced education (1%)

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 fifteen of the High School Interns supported the MOSGC since FY05 have gone on to enroll in post-secondary STEM-field education programs.

Course Development: Curriculum development for courses, primarily undergraduate level, in the areas of meteorology, global climate, and remote sensing, were continued at Washington University in St. Louis in FY2009. The Earth and Planetary Sciences (EPSci) undergraduate curriculum already includes introductory courses such as Earth's Atmosphere and Oceanography. Another introductory course, on global climate change, was developed for initial offering in Spring 2009. Also, the High School Educator Training Project sponsored by the Department of Earth and Planetary Sciences at Washington University in St. Louis provides research opportunities and curriculum development collaboration for a high school educator in the areas of planetary geosciences, atmospheres, and global climate.

Matching Funds: The present cost share match ratio for the Consortium is estimated to be 1.17:1. The MOSGC leveraged over $47,000 in other federal funds in FY2009, primarily with NASA's expenses related to their contributions to the reduced gravity student flight opportunities.

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 2009-2010 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 though the expansion of the Consortium to include three new Affiliate Candidate members. In addition to a greater number of Higher Education Internships and Research Infrastructure Assistantships, three new design teams and one new scientific research group was established.

- The Consortium also improved recruitment and retention strategies, which led to a increased number of female participants, surpassing the Consortium's goal of 40% by 5.6%.
- 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 FY2010 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 (MAE)
- Missouri State University (MSU)
  Department of Physics, Astronomy, and Materials Science
- University of Missouri – Columbia (UMC)
  Department of Mechanical and Aerospace Engineering (MAE)
  Nuclear Science and Engineering Institute (NSEI)
- 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 (EPSci)
  Department of Energy, Environmental, and Chemical Engineering
  Department of Mechanical, Aerospace, and Structural Engineering
- St. Louis Science Center (SLSC)
  James S. McDonnell Planetarium

Associate Members:

- St. Louis Astronomical Society (WashU-EPSci)

- St. Louis Gifted Resource Council (WashU-EPSci)
- Spaceweek-St. Louis (WashU-EPSci)
- Columbia Aeronautics and Space Association (UMC)

Affiliate Candidates:

- Lincoln University of Missouri
- St. Louis University
- Truman State University