

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 (MOSGC)** is a Program Grant Consortium funded at a level of **\$535,000** for fiscal year 2008.

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, Internship, and Higher Education programs strongly address the objectives of NASA's Education Outcome 1. In 2008-2009 there were 64 directly supported students participating in independent research and hands-on scientific and engineering group projects. An additional 97 indirectly supported students participated in ten Higher Education projects funded by the MOSGC. The Consortium exceeded the most recent NCES NASA-targeted underrepresented minority statistic for all Missouri Institution higher learning of 15.9% with an average targeted minority participation of 21.9% for the directly supported students in these two programs, the highest achieved by the Consortium to date. Female participation continues to be a challenge with 31.5% of the Fellowship, Scholarship, and Internship students being women. This value drops to 29.7% when directly supported Higher Education students are taken into consideration. The Consortium will continue to strive to increase its recruitment and retention of women in order to meet or exceed its stated goal of 40%.

Some particularly exciting Outcome 1 anecdotes are as follows:

As of 1 February 2009, two MOSGC-supported students from Washington University in St. Louis (Fiona Turett & Ryan Hacala) have already received and accepted space STEM employment (at NASA JSC and Johns Hopkins APL, respectively).

Fiona Turett has also earned two prestigious scholarships – one from the NASA MUST program and the second from the Astronaut Scholarship Foundation.

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.

Washington University Doctoral candidate Nancy Akerman gave an invited talk, "Chemolithotrophic Energy and Archaeal Communities in Arsenic-rich Shallow-sea Hydrothermal Sediments of Papua, New Guinea", at the 18th Annual V.M. Goldschmidt Joint Conference of the Geochemical Society and the European Association of Geochemistry held in Vancouver, Canada, July 13-18, 2008.

Outcome 3: Engage and Inspire

Of the five Public Education and Outreach programs supported by the MOSGC, there have been a total of approximately 4,500 participants in 2008 so far, with an additional 2630 expected to participate through the end of the year. 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

Fellowship/Scholarship/Internship Programs

The Missouri Space Grant Consortium has been conducting a very successful fellowship, scholarship, and internship program; providing graduate and undergraduate training through student research and contributing to the national workforce. The competitive selection of participants is primarily based upon academic achievement and research project merit. This year, 43% the annual program participants were graduate students and 57% were undergraduate students. Students are supported to perform independent 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 training through student research 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 2008 a total of 54 students were supported from which 26% were from underrepresented minorities, one was a student with disabilities, and 31.5% were female students. While the minority participation by far exceeds the latest NCEES statistic of 15.9% for Missouri, an increase of about 10% for female participation needs to be achieved through the improved recruitment and retention of 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.

Undergraduate Research Internships: Summer and academic year undergraduate internships are distributed among Consortium Members and are available to undergraduates in programs of study that relate to one or more of the NASA Mission Directorates. The students who have been selected by the Consortium 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 2008, Missouri Space Grant supported students have produced a total of 24 journal and conference publications and 36 other publications so far.

During the past year the Consortium produced two Ph.D. dissertations and eleven M.S. theses in areas that are of importance to NASA. These efforts were supported in part by NASA Field Research Centers.

NASA Field Research Center and Corporate Summer Programs- In 2008, five Missouri students participated in NASA Center summer programs at the Marshall Space Flight Center. Furthermore, the Consortium Affiliate at UMSL and MEMC Electronic Materials in St. Peters, MO, jointly sponsored a Corporate Summer Internship student at MEMC in 2008.

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). To date, eleven students have been awarded MS degrees, five have received PhD degrees, and two more PhD candidates are nearing degree completion in the NSEI. Clearly this program is making an impact in providing advanced engineering education to Hispanic Americans.

Higher Education Programs

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 on the Affiliate campuses and thereby makes opportunities available 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 activities in 2008-2009:

- Society of Automotive Engineers' (SAE) AeroDesign East Competition Team- The AAVG Society of Automotive Engineers' (SAE) AeroDesign East competition aircraft is on schedule for completion weeks before the competition in Marietta, GA from April 3-5. Major design work was concluded before the semester break, and detailed design work is in progress. At the conclusion of last semester, a design review was held to allow the team's advisors and pilots to offer suggestions to the design. Major concerns were the landing gear and its attachment to the fuselage, the structure of the fuselage at the wing attachment point, and tail boom attachment.
- University Student Launch Initiative Competition Team- The AAVG NASA University Student Launch Initiative project is also progressing on schedule. The rocket design is finalized, and the team is awaiting the return of quotes prior to placing the order for major components. The Payload, a 4-channel strain measuring system, has been designed, parts have been ordered, and a proof of concept was constructed last semester. The proof of concept was successful, and it is now being upgraded from a one-channel system into the full 4-channel flight ready system. FEA work to validate test flight findings is currently underway. Rocket construction is simpler than Aircraft construction, and the team is anticipating completion in the first week of March. Prior to this flight, ejection tests will be performed to validate explosive charge sizing. This completion date will allow the team to test fly in one of the several sanctioned high power rocketry launches in March. The USLI rocket competition will be held on April 18th, 2009, in Huntsville Alabama
- Miners in Space- The mission of the MS&T Miners in Space Team is to advance the fields of science and engineering and to educate and fuel interest in those fields. They accomplish this by conducting one or more experiments in a reduced gravity environment. This uncommon environment attracts interest from students and professionals of all ages while the experiments yield practical benefits.
- *Society of Flight Test Engineers (SFTE)*- The goal of the design project for the Society of Flight Test Engineers for the Fall 08 - Spring 09 academic year is the design, construction, and testing of two laboratory experiments. This project is designed to introduce new topics to the aerospace engineering department's junior and senior class experimental methods courses. The SFTE will work closely with faculty and staff to insure that the labs are concise, reliable, enjoyable, and reinforce the educational experience of students. The two topics chosen for this project consist of longitudinal stability and rocket propulsion. These topics were originally contemplated by the AE 282 class of 2008. As part of the curriculum the students were assigned the task of designing their own laboratories.
- *Akoya NanoSat Competition Team* The 2008-2009 Activities for the Akoya Nanosatellite Competition team centered on analysis, integration and test of the Akoya host spacecraft and the two Bandit drones. Students presented their work at two design reviews: the Protoqualification Review in August 2008 and the Flight Competition Review in January 2009. Students delivered fully-functional proto-flight hardware (i.e., hardware ready for preliminary environmental testing), and took 2nd place in the finals of the Nanosat-5 competition.
- *C-9 Reduced Gravity Student Flight Opportunity Team*- The C-9 Activity is to submit a flight proposal under NASA's Reduced Gravity Office as part of their "Microgravity University" activity. They were selected for one flight in 2008 and that work was supported under the Consortium Development Competition Award (CDCA). Six students participated in the project; two senior members of the student satellite team served as project mentors/coaches (but were not responsible for day-to-day decision making or experiment development), while the other four were first- and second-year undergraduates. Four of the six team members were women. At the end of the project, two of the four new team members continued their work on the spacecraft project as deputy managers for their respective specialties; each will become the lead for their activity at the end of the 2008-2009 school year.
- *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 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 under the supervision of a senior faculty member.

Pre-college Education Programs

- High School Summer Internships
- Classroom Visits
- Unisphere Planetarium Program
- Summer Space Academy
- High School Educator Training Project
- Introduction to Aerospace Engineering
- Space Explorers

Public Service Programs

Of five supported programs, there have been a total of approximately 4,500 participants in 2008 so far with an additional 2630 expected to participate through the end of the fiscal year. With the matching funds provided by the Consortium 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 Baker Observatory, Telescope Observing Sessions, Monthly Lectures, and a Space Science Information Service.

PROGRAM CONTRIBUTIONS TO PART MEASURES

Longitudinal Tracking: The Missouri Consortium's present approach to track students from FY05 onward has been highly successful, with current and 'next-step' status of 98% of the students that have received significant support is known, and 99% of those are either continuing in their present degree program, have graduated and are pursuing an advanced STEM degree, or are employed in some STEM-field related capacity. Using the presently requested data for the 147 students supported from FY06 through FY08, the statistical breakdown is as follows:

- 40 are still enrolled from FY06-FY07 (27%)
- 62 are still enrolled from FY08 (42%)
- 23 have graduated and are pursuing an advanced STEM degree (16%)
- 3 have graduated and are seeking STEM employment (2%)
- 10 are employed STEM fields by aerospace contractors (7%)
- 4 are employed in non-aerospace STEM field positions (3%)
- 1 is employed in a K-12 STEM field academic position (1%)
- 3 are employed in post-secondary STEM field academic positions (2%)
- 1 is pursuing a non-STEM advanced education (1%)

At this time, none of the Consortium's FY06-FY08 students have gone on to work directly for NASA. However, as of 1 February 2009, two MOSGC-supported students from Washington University in St. Louis (Fiona Turett & Ryan Hacala) have received and accepted space-related STEM employment at NASA JSC and Johns Hopkins APL, respectively. Furthermore, a recent doctoral graduate and current post-doctoral researcher at the University of Missouri – Columbia is diligently seeking employment at the Johnson Space Center.

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 ten 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 pursued at Washington University in St. Louis. 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 1.1:1. The actual cost share match will be determined at the end of the current fiscal year. To date, the MOSGC has leveraged over \$74,000 in other federal funds, 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 identified an HBCU minority serving

institution, Lincoln University in Jefferson City, MO, as a prime candidate for solicitation of undergraduate research internships in the 2009-2010 academic year.

IMPROVEMENTS MADE IN THE PAST YEAR

- As indicated in the Higher Education Section of this report, additional resources were allocated this year to new projects that focus on involving more students in research, design, and hands-on experiences. For instance, a new team, “The Society of Flight Test Engineers Chapter at the Missouri University of Science & Technology”, was funded to design, build, and test a new experimental arrangement for a laboratory course. Other examples of the effort to improve experiential learning include the expansion of the hardware-based student projects at Washington University in St. Louis.
- New resources were allocated to engage undergraduate students to educate and inspire pre-college students. A primary example of this effort involved hands-on activities and demonstrations at the Girl Scout Inventure University program at the University of Missouri in Kansas City. Three female undergraduates (one African American) and 35 female pre-college students participated in this program, with 31% of them either ethnic minority or physically challenged.
- The Consortium allocated new resources to develop a new initiative that focused on student participation in corporate sponsored summer internships. As part of a pilot project for this program, one student has been placed in a co-sponsored corporate internship each summer for the past three years at MEMC Electronic Materials, Inc. in St. Louis in collaboration with the MOSGC Affiliate at the University of Missouri – St. Louis. The long-range plans for this endeavor are being developed and will engage and support undergraduate students in meaningful industrial experiences.
- The Consortium also improved recruitment strategies, which led to the placement of more students at NASA Centers for summer internships. As a result, in 2008, seven Missouri students participated in NASA Center summer programs.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The Missouri Space Grant Consortium is composed of six Affiliates with an even balance of science and engineering disciplines that have specialization in research areas of interest to NASA. Each Affiliate 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. While budget constraints have to date have generally limited the expansion of the Consortium to include new Affiliates, the University of Missouri – Kansas City is presently an ‘Affiliate Candidate’ and final consideration for acceptance as a permanent member will be made by the MOSGC Executive Board in April, 2009. 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 and Associate Members, 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) – [Affiliate Candidate]
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 (EECE)
Department of Mechanical, Aerospace, and Structural Engineering (MASE)
- 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)