Missouri Space Grant Consortium
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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 $430,000 for fiscal year 2013.

PROGRAM GOALS

The mission of the Consortium is being accomplished through the following goals and 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, & 3)

Outcome 1: Employ and Educate

The Missouri Consortium's Fellowship & Scholarship, Higher Education, and Research Infrastructure programs specifically address the objectives of NASA's Education Outcome 1. In FY 2013 there were 53 directly supported students participating in independent research, course development, and laboratory development. There were an additional 86 indirectly supported students that participated in engineering design team and scientific research group Higher Education projects funded by the MOSGC.

Fellowships & Scholarships

Former Missouri Space Grant Graduate Fellow Dr. David Peaslee completed NASA's 3-year Harriett G. Jenkins Pre-doctoral Fellowship at the University of Missouri – St. Louis and received his doctoral degree in December 2013.

Higher Education

Saint Louis University's student-built satellite "COPPER" was launched on November 19, 2013, from Wallops Flight Facillity as part of the ELaNa-IV mission on board an Orbital Sciences Minotaur-1 rocket. Along with 27 other cube-sats that were secondary to the primary ORS-3 military satellite payload, COPPER was deployed at an altitude of approximately 300 miles.

Outcome 2: Educate and Engage

Of the nine Pre-College Education programs supported by the MOSGC in FY 2013, there were a total of 38 teacher and 1358 student participants. Projects meant to bring excitement and education to the pre-college participants include Classroom Visits, Planetarium Programs, Summer Space Academy, High School Summer Internships, Introduction to Aerospace Engineering, and Space Explorers, Inc. Many of these programs are minority student focused with an

average of ~40% of the participants being from NASA-targeted under-represented minorities and ~50% female.

High School Internships at University of Missouri - Columbia
Katy Shi, a senior at Rock Bridge High School in Columbia, MO, has been admitted into an engineering program at Stanford University. Katy participated in a High School Summer Internship at the University of Missouri - Columbia.

Outcome 3: Engage and Inspire
Of the seven Public Education and Outreach programs supported by the MOSGC, there were a total of 6000 participants in FY 2013. 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

Outcome 1: ***Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals:***
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, 30% the annual program participants were graduate students and 70% 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.

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.

Scholarships: "A Bridge to the Stars: Astro 101" at the University of Missouri – Kansas City is an inner city high school student scholarship program that provides low-income and under-represented minority students full scholarships (tuition, fees, course materials, and transportation) to enroll in an interactive

Introduction to Astronomy course. This unique opportunity offers real-life college experience, university credit for a freshman science course, and a support system of dedicated undergraduate Bridge Mentors to ensure success.

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 directly with faculty to develop, maintain, and enhance the capability to perform cutting-edge research at the Consortium's affiliate institutions.

Robotic Autonomous Telescope: Astronomy researchers at Missouri State University are in the process of commissioning a telescope to be used for remote and automated operations, chiefly for a sky survey project, but also for enhancing astronomy laboratories. This project includes the installation of a telescope, dome, weather station, and various webcams for remote and automated operation. There would also be Polish students working with the data (particularly for the Polish project) and there is some hope of initiating an exchange of students between the two programs. The telescope is currently partially operational and should be fully operational within the year.

Higher Education Research 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 three NASA Center summer interns in FY2013.

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 FY2013, Missouri Space Grant's directly supported students produced a total of 29 journal and conference publications.

Furthermore, four students will be awarded MS degrees and three will earn PhD degrees this fiscal 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 2013-2014:

- S*ociety of Automotive Engineers (SAE) AeroDesign West Competition* – A team of students from the Missouri S&T Advanced Aero Vehicle Group will compete in the advanced aircraft class at the SAE Aero West competition in Fort Worth, Texas, on March 28-29, 2014. 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.

- *NASA Student Launch Rocketry Challenge* – A team of students from the Missouri S&T Advanced Aero Vehicle Group will design and build a reusable, high power rocket targeting an altitude of less than 20,000 ft AGL while carrying a hazard detection camera, analyzer, and transmitter. This year, launch day is scheduled for May 31, 2014, at the Bonneville Salt Flats in Tooele County, Utah.

- *University Rover Challenge* – The Mars Rover team from Missouri S&T will join the competition at the Mars Desert Research Station in Hanksville, Utah on May 29-31, 2014.

- *Student-Built Satellites*
  Missouri S&T's Satellite Team (M-SAT) placed second in the Nanosat-7 Program's Microsat division in 2013 and is presently preparing for the Nanosat-8 competition.

Saint Louis University's Space Systems Research Laboratory presently has three active student-built satellite projects:

COPPER is a 1U CubeSat to flight-test the use of a commercial microbolometer (long-wave infrared imager) for Earth observing and space situational awareness. COPPER was SSRL's entry in the AFRL University Nanosat-6 competition and was launched on November 19, 2013, from Wallops Flight Facility as part of the ELaNa-IV mission on board an Orbital Sciences Minotaur-1 rocket. Copper travelled along with 27 other cube-sats that were secondary to the primary ORS-3 military satellite payload and was deployed at an altitude of approximately 300 miles.

Argus is a 2U CubeSat developed in partnership with Vanderbilt University to improve modeling of the effects of radiation on modern space electronics. It is SSRL's entry in the AFRL University Nanosat-7 competition, and was selected by NASA to launch in July 2014 as part of the ELaNa-VII mission.

Rascal is a 6U mission to demonstrate key technologies for proximity operations and space situational awareness. Rascal has been selected by NASA to fly in 2015-2016.

- *Micro-Gravity Flight Opportunities* – The Miners in Space reduced gravity flight team from Missouri S&T flew and evaluated their cardio resuscitation device in the microgravity environment aboard NASA's Weightless Wonder out of Houston, TX, on June 6, 2013.

- *The "Pathfinder" Collegiate Undergraduate Program* – The Pathfinder Program for Environmental Sustainability 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 at research sites in Hawaii, Spain, or the Mojave Desert to introduce students to issues surrounding environmental sustainability and the duty to preserve the environment for future generations.

- *Continuing the Multidisciplinary Astrobiology Research Community at Truman State University* – 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 TSU. 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.

- *Curriculum Development* – An undergraduate student will assist a faculty member in the department of Earth and Planetary Sciences at Washington University in St. Louis as a Teaching Assistant for the development and implementation of an Introduction to Structural Geology course.

- *The 23rd MOSGC Annual Spring Meeting* will be held on April 25-26, 2014, on the Missouri S&T campus. This meeting will feature oral and poster presentations from the Consortium's Fellowship & Scholarship, Research Infrastructrure, Higher Education, and Pre-College students.

Outcome 2: ***Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty:***

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 2013 is as follows:

- *High School Summer Internships*
- *Classroom Visits*
- *Planetarium Programs (UMSL, SLSC)*
- *Columbia Area Space Association*
- *Summer Space Academy*
- *Introduction to Aerospace Engineering*

Highlighted K-12 Program Projects:

Classroom Visits - Missouri State University supported visits by faculty, researchers, and/or advanced students to K-12 school classes in the Southwest Missouri area to present illustrated talks on astronomy, space research and other NASA related activities. MSU also sponsored a Science Explorer Club at Willard Intermediate School for 5th grade students. The club served 12-15 students who

were interested in science. During this year, they created two scale solar system models- one at Willard Intermediate School (as part of the Science Explorers Club) and the other at Ozarks East Elementary School.

CASA is a hands-on in-class and after-school science club that runs a 6 day 5 night space simulation each year in a student built lab at Hickman High School in Columbia. MO. By using communication skills, group work, and problem solving skills; students in grades 6-12 command the mission from lift off to landing. Students learn NASA systems in order to staff mission control, video production, public affairs office, astronauts, and 'ninjas' (who interject problems to solve). CASA also offers a weekend SCUBA experience where students can learn how to use the SCUBA equipment and then repair a satellite underwater for 4 hours as well as an opportunity to fly Cessna airplanes at Skyhaven Airport. This year's Mission 2614 focused on a colony and a remote mining outpost on Mars utilizing the space station simulator and a separate outpost building with robotic rovers moving around the buildings on the planet.

Unisphere Traveling Planetarium Program for Underserved Minorities - The Saint Louis Science Center delivered planetarium programs to schools utilizing a Unisphere portable planetarium. A staff member presents the program with content covers Missouri education standards involving the relationship of Earth and sky, solar system objects, and constellations.

The St. Louis Gifted Resource Council offers *Space Academy* as part of its summer program. Space Academy is a three-week, full-day program for about 150 elementary and middle school gifted children. Its activities are centered on topics relating to the solar system and to space travel.

Girls Rock-It in Space - The Challenger Learning Center of St. Louis implemented a week-long spring break camp for participants ages 7-15 who are involved with Girls Incorporated. The program consisted of a week-long program of activities that were designed to inspire the future generation of skilled, knowledgeable, diverse, and high-performing professional scientists, engineers, technologists and educators. The activities that the participants were engaged in were aligned with state education standards and priority areas of interest to NASA and NASA's Education Outcomes in underserved communities,

Outcome 3: ***Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission***

Informal Education Programs

Of the nine MOSGC supported Informal Education programs in FY 2013, there was a total of 6,000 participants. 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:

- *Telescope Observing Sessions* at MSU, UMKC, UMSL and SLSC.
- *Monthly Aerospace Lectures*
- *Space Science Information Service*

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Student Data and Longitudinal Tracking:**
  - 53 Total Direct Student Awards
  - 17 Fellowship/Scholarship Awards
  - 2 Research Infrastructure Assistants
  - 34 Higher Education Internships
  - 86 Indirectly Supported Higher Education Engineering Design Team and Scientific Research Group Students
  - 2 of the total direct awards to underrepresented minority F/S students.
  - 5 of the total direct awards to underrepresented minority HE and RI students.
  - 2 graduate and 2 undergraduate students will graduate and seek STEM employment
  - 3 graduate and 3 undergraduate students will move on to advanced education opportunities in NASA-related disciplines.

- **Minority-Serving Institution Collaborations:**
  The Missouri Consortium continues to support activities at Lincoln University of Missouri in Jefferson City. This year's undergraduate independent research topics included an investigation into the 'Purification of Wastewater from Research Facilities Using Palladium Nanoparticles' and the development of a process for the 'Fabrication of More Efficient Solar Cells Utilizing Nanotechnology'. Affiliate/Associate partnerships to involve Harriet-Stowe College in St. Louis are still under consideration. Since Harriet-Stowe does not offer technical programs, STEM cross-over opportunities in education, journalism, web design, and graphic arts are being investigated.

- **NASA Education Priorities:**
  As indicated by the above program accomplishments, the Missouri Consortium's efforts are aligned with NASA's education priorities, which include STEM workforce development, student-led projects, intensive summer learning opportunities for middle school teachers/students, and opportunities to develop and strengthen ties to NASA Centers and/or Mission Directorates.

  Each of the specific NASA Education Priority related projects supported by the Consortium are given below:

- All MOSGC supported Fellowship and Scholarship, Higher Education, and Research Infrastructure projects provide authentic, hands-on experiences for students in science and engineering disciplines.
  F/S: Nine projects Affiliate/Associate Institutions.
  HE Internships: Eight projects at Affiliate/Associate Institutions plus one project for NASA Field Research Center summer internships.
  RI Assistantships: Eight projects at Affiliate/Associate Institutions.
  HE Indirect support for five engineering design teams at two Affiliate/Associate Institutions (MS&T and SLU). Two scientific research groups at two Affiliate/Associate Institutions (TSU and WashU-EPSci).

- The diversity of institutions supported by the Consortium varies widely in both economic and ethnic population bases. The state's only HBCU offering STEM degrees, Lincoln University of Missouri, supports undergraduate scholarships and internships under the supervision of three faculty members. The diversity of the Consortium's faculty is generally consistent with the faculty diversity within the participating institution's departments.

- Middle school teacher engagement in hands-on curriculum enhancement capabilities through exposure to NASA-related scientific and technical expertise: Three projects at three institutions (MSU, UMSL, CLCSL).

- Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers are provided at four institutions (MST, MSU, UMC, UMSL).

- Community College engagement is under development at Washington University in St. Louis. Other opportunities are being explored at MST, UMKC and UMC.
- Aeronautics Research, in traditional aeronautics disciplines, is primarily being performed by F/S and HE students under faculty mentorship at MST, UMC, and Wash-MEMS. One on-going HE/RI project that is being pursued at WashU-MEMS is geared to directly address a fundamental research need of the Next Generation Air Transportation System (NextGen).

- One HE Internship project at MSU and one HE Scientific Research Group project at WashU-EPSci pursue Environmental Science and Global Climate Change research and activities to better understand Earth's environments.

- The enhancement of the capacity of the Consortium's institutions to support innovative research infrastructure activities is being pursued at four of the participating universities (MST, MSU, UMSL, and WashU). One project specifically intended to enable early career faculty to focus their research toward NASA-related priorities are being supported at WashU-EPSci.

IMPROVEMENTS MADE IN THE PAST YEAR

The Missouri Consortium's Executive Board elevated HBCU Lincoln University of Missouri to permanent Affiliate status. By integrating with the newly established NASA-EPSCoR Missouri network, a much broader reach of the Consortium is being achieved.

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 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
- 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 Physics and Astronomy
- 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
- Lincoln University of Missouri (HBCU)
  Department of Life and Physical Sciences

Consortium Associate Members:

- Challenger Learning Center of St. Louis
- St. Louis University
  College of Engineering, Aviation and Technology
- Truman State University
  Department of Physics
  Department of Chemistry
  Department of Biology
- William Jewel College
  Department of Physics

Affiliate Associate Members (Associate's Affiliate):

- St. Louis Astronomical Society (WashU-EPSci)
- St. Louis Gifted Resource Council (WashU-EPSci)
- Spaceweek-St. Louis (WashU-EPSci)
- The Space Museum of Missouri (WashU-EPSci)
- Columbia Aeronautics and Space Association (UMC)
- Drury University (MS&T)

The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD) and the Office of Education Performance Measurement System (OEPM) report. The former is primarily narrative and the latter data intensive. Because the reporting timeline cycles are different, data in the two reports may not necessarily agree at the time of report submission. OEPM data are used for official reporting.