Missouri Space Grant Consortium
Lead Institution: Missouri University of Science & Technology
Director: Dr. S. N. Balakrishnan
Telephone Number: 573-341-4675
Consortium URL: http://www.mosgc.org/
Grant Number: NNX15AK03H

LOB: NASA Internships, Fellowships, and Scholarships; Stem Engagement; Institutional Engagement; Educator Professional Development

A. 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 $570,000 for fiscal year 2017.

B. 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 Directly Supported Participants
  - Number of Graduate and Undergraduate Degrees
  - Diversity of Directly Supported Participants
  - Number of NASA Field Research Center and Corporate Internships
  - Number of Journal Articles and Conference Papers Published
  - Number of Student Research Groups and Engineering Design Teams
  - Number of Teachers and Students Participating in Pre-College Programs
  - Number of Persons Served in Informal Education Programs

C. PROGRAM/PROJECT BENEFITS TO PROGRAM AREAS

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 FY2017 there were 98 directly supported students participating in independent research, course development, and laboratory development. There were an additional 153 indirectly supported students that participated in six engineering design team and scientific research group Higher Education projects funded by the MOSGC.

Outcome 2: Educate and Engage

Of the five Pre-College Education programs supported by the MOSGC in FY2017, there were a total of 63 (10 EPD, 36 interactive, 17 engagement) events with 110 K-12 teachers and 4620 students participating. Many of these programs are minority student focused with an average of 33% of the participants being from NASA-targeted under-represented minorities and 47% female.

Outcome 3: Engage and Inspire

There were 6 Informal Education projects supported in FY2017, with a total of 5 informal educators, 26 additional direct participants and, 2734 indirect participants. 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.

D. 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, 24% the annual program participants were graduate students and 76% 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. The ultimate 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.

The students' research accomplishments will be showcased at the 27th MOSGC Annual Spring Meeting, which will be held on April 20-21, 2018, on the Missouri S&T campus. This meeting will feature oral and poster presentations from the Consortium's Fellowship & Scholarship, Research Infrastructure, Higher Education, and Pre-College students.

- NASA Internships, Fellowships, and Scholarships:
  Both undergraduate and graduate students are competitively selected to participate in NASA Field Research Center Internships and Academies. These students travel to NASA Centers to perform independent research under the guidance and mentorship of professional engineers and scientists. The Missouri Consortium supported one summer intern at Marshal Space Flight Center in FY2017.

  The Missouri Space Grant Consortium's undergraduate scholarships and graduate fellowships are competitively awarded to students pursuing independent faculty-mentored research in aerospace and space related science and engineering. Programs of study must relate to one or more of the NASA Mission Directorates. There were 37 undergraduate and 15 graduate students supported with fellowships and scholarships in FY2017.

- Higher Education Projects:
  - Summer and academic year Higher Education internships are competitively awarded to students to pursue faculty-mentored programs of study that relate to one or more of the NASA Mission Directorates at the Affiliate Institutions. There were 36 undergraduate and 6 graduate students employed by the Consortium's Affiliates and Associates to perform independent hands-on research projects in FY2017.

  The Affiliates and Associates of the 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, indirect support was provided to eight design team and scientific research groups on the Affiliate and Associate campuses; thereby opening opportunities for 153 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.

- Student-Built Satellites
  The M-SAT Satellite Research Team from Missouri S&T is working on The Advanced Propulsion Experiment (APEX), which was accepted into the Air Force's Research Laboratory's University Nanosat 9 program in January of 2016. The APEX mission will serve as a Technology Demonstration Mission for a single, successfully integrated multi-mode propulsion system that can operate in either chemical mode or electrical mode. This integrated propulsion system will use the same ionic liquid monopropellant for both modes. The benefit of this innovation is that it allows for wide flexibility in the mission by allowing a variable amount of propellant to be budgeted toward either mode as mission needs arise.

  M-SAT was also accepted in January 2016 to the NASA Undergraduate Student Instrumentation Project (USIP) which gives undergraduate students 18 months (starting in September 2016) to design, test, build and deliver a satellite. Upon completing this process within the given timeframe, The USIP spacecraft is guaranteed a launch to Earth orbit. M-SAT plans to use this opportunity to complement the APEX program. Because of the limited timeframe, a simplified version of the APEX mission will be designed and flown to identify and address high risk aspects of the satellite.

  There are two Student CubeSat missions being pursued at Saint Louis University. The purpose of this project is to train students in the design, analysis, testing and operation of real-world spacecraft, adhering to NASA standards for quality and mission assurance. This is accomplished by developing and fielding CubeSats that are competitively launched through the NASA Educational Launch of Nanosatellites (ELaNa) program. To date, SLU has secured 4 NASA launch slots, and allowed them to leverage a fifth, external opportunity. For FY2017, they will deliver their third mission (COPPER-2) for launch (January 2018) and flight operations, and build the Argus re-flight for delivery and launch in 2018.

- Saint Louis University students are also involved in the annual *Student Unmanned Aerial System (SUAS) Competition* is hosted by the Seafarer Chapter of the Association for Unmanned Vehicle Systems International (AUVSI). This competition serves to stimulate and foster student interest in UAS and is designed to provide an ideal opportunity for students to gain valuable complementary, multi-disciplinary and systems engineering knowledge. The focus of this competition is to engage students in systems

engineering and creating a total solution to complex, potentially real world problems. In order to address this, the student teams would have to design, develop, and fabricate an unmanned aerial system capable of completing specific autonomous operations, including takeoff, navigation, Sense, Detect and Avoid, among others, subject to several constraints on time and other mission parameters as well as analyze and validate its performance through flight test demonstration.

Another student design team at Saint Louis University is working to enhance educational and research use of remote sensing data from unmanned aircraft systems (UAS) to increase efficient data collection, fusion of data from multiple sensors and post-flight processing to simplify agricultural monitoring. Predictive monitoring of crop responses to abiotic stress using field and airborne remote sensing data are. This project includes field and airborne hyperspectral data, and crop phenotyping and physiological analysis.

- A new Student Rocket Competition Team is being supported at Saint Louis University to participate in the 2017 Experimental Sounding Rocket Competition. They are designing and building payloads to fly on suborbital rockets. This team is expanding its membership to include students from outside of engineering (Math, Chemistry, Computer Science and Business).
- The *Multidisciplinary Astrobiology Research Community at Truman State University* – continues to capitalize on the momentum created by the prior funding and the creation of the *Center for Astrobiology* to continue the activities of the multidisciplinary astrobiology research community. Following the highly successful model from previous years, teams will pursue astrobiology research projects, participate in weekly community-building events, and take a field trip to an astrobiology-related research site. This project will support the activities of the vigorous and productive astrobiology research program at Truman, strengthen the new Center for Astrobiology, and inspire students from a range of science disciplines to consider careers in astrobiology.
- 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. The "Astrobiology Seminar Course" is be a one-credit-hour course that meets once per week. This course is discussion-based and focuses on current topics relevant to astrobiology. These discussions are based on recently published papers and books.

- Research Infrastructure Projects:
  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. There were three research assistantships awarded this year.

- 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.

- Precollege Projects:
  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 following five K-12 Projects supported in FY2017 involved a total of 110 K-12 teachers, 28 informal educators, and 4620 direct and indirect student participants:

  - *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 15-20 students who were interested in science. During this year, the PhysBiz outreach project provided interactive science activities for 2nd and 4th grade students at several schools within the Springfield Public School District.

  - The Challenger Learning Center's *Educator Scholarship Program* is providing up to 70 elementary and middle-school educators with the knowledge, resources, and tools to help their students be innovative, successful, and lifelong learners by increasing students' knowledge of and interest in science and engineering. The professional development workshops are designed to enhance educators' capabilities of utilizing NASA's scientific and technical expertise through exposure to NASA resources provided to them during professional development workshops. In addition, the Challenger Learning Center's newest mission, *Earth Odyssey*, which is available for student groups to participate in, directly connects to NASA's Area of Emphasis of Environmental Science and Global Climate Change.

  - The *5th Grade Planetarium Program* at the University of Missouri in St. Louis works with the Saint Louis City and County schools to bring students to their

campus for demonstrations and a planetarium show. In May of 2015, UMSL began a new program utilizing a Spitz SciDome planetarium projector, located in the Research building on the UMSL campus.

- The Metropolitan Community College – Kansas City is developing a program for "Enhancing Collaborations with The Kansas City FIRST (Robotics) Tech Challenge". They have strengthened their connections with a local informal education provider, inspiring and educating students at both the high school and community college level through expanded participation in local robotics competitions. This work, along with participation in a small competition, will develop a cadre of interested and experienced college students to be familiar enough with the equipment to serve as competent mentors for local teams. The Kansas City FIRST Tech Challenge (FIRST Robotics) regional planning committee will supervise a mini-competition at the MCC – Business & Technology campus. Competitors will include local high school FTC teams and two college-age teams. The competition will use FTC equipment but will be based on previous FIRST Robotics Competition games scaled down to an appropriate field size.

  MCC students were encouraged to network with the high school FTC coaches at the event, with the goal that MCC students sign up in the VIMS volunteer management system on the FIRST website, and then volunteer with a local high school FTC team that is in need of mentors. Recruitment for college and high school teams occurs in April and May. The MCC students built their robots over the summer semester at the MCC- BT fab lab and the competition and networking events were held in August 2017.

- Informal Education Projects:
  The Consortium supported 6 Informal Education programs in FY2017, in addition to 45 Telescope Observing Sessions being held at MSU, UMKC, UMSL.

  - The Warkoczewski Public Observatory (the 'Warko', WPO), located on the UMKC campus and the Powell Observatory Complex (POC) owned and operated by the Astronomical Society of Kansas City (ASKC) has been a key focal point of astronomy education and public outreach (EPO) efforts in the Greater Kansas City Metropolitan Area for over 44 years. The ASKC will make a major public effort to educate the general public about the 2017 Great American Total Solar Eclipse and promote the safe observing of this important event whether in the path of totality or not, general astronomy, space exploration and related sciences. This event featured a series of well-advertised public lectures including Dr. Angela Speck of the University of Missouri-Columbia (MU) as well as Dr. Madhulika Guhathakurta from NASA's Heliophysics Sciences Division and other members of the ASKC. Such public events are an effective tool for communicating the joy and impact of NASA-related science to interested citizens and the importance of the Sun and the knowledge gained by studying a Total Solar Eclipse (TSE) and typically unobservable features of the Sun including the corona.

- The Moberly Area Community College is endeavoring to establish, build, and develop links between Moberly Area Community College (MACC), Truman State University (TSU) and local organizations such as the Adair County Public Library and the Kirksville R-III public schools. They reached out to K-12 & college students, their families, and members of the public in astronomy and science related intellectual and practical activities through their "Solar Eclipse 2017: Engaging the Kirksville Community" project. The total solar eclipse of 21st of August 2017 was a once-in-a-lifetime opportunity to connect students, faculty, and the general public in topics related to astronomy and science in the Kirksville area. The eclipse path cut diagonally across Missouri, and Kirksville witnessed a 98% obscuration. They held a series of events as a lead up to the eclipse to create awareness and generate excitement about astronomy and science in the community. On the day of the eclipse, they set up solar scopes at various locations across Kirksville and distributed solar glasses for safe viewing of the eclipse.

E. PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE GOALS

Include summary data for the bulleted list below:

- **Diversity**:

  The Affiliates, Associates, and other partners are geographically distributed relatively uniformly throughout the state, yielding a wide range of demographic diversity. The most recently published NASA-targeted minority participation from the National Center of Education Statistics for all postsecondary institutions in Missouri for Fall 2014 was 18.7% (please see NCES Table dt15_306.60). The directly supported MOSGC students in FY2015 were comprised of 45% females and 33.7% NASA-targeted minorities.

  The Missouri Consortium continues to support activities at Lincoln University of Missouri in Jefferson City (HBCU). This year's independent research program at LU involved three graduate and eight undergraduate directly supported students. Research topics included investigations into the use of 'Carbon Composites for Space Craft' and 'The Effect of Space on Food Contaminates'; along with the development of a process for the 'Use of Algae Bio-fuel in Space Vehicles'.

  The Consortium is also continuing to support a partnership between Saint Louis University and Harris-Stowe State University. This project involves training underrepresented students with data visualization tools. Students will be introduced remote sensing concepts and data from satellites and UAS systems, and explore the possibilities for 360-degree visualization of UAS datasets for agricultural and environmental studies using a low-cost wearable Virtual Reality (VR) platform.

- **Office of Education Annual Performance Indicators**: Provide numerical values for consortium contributions to API's.
  - API ED-15-1 ___76____ (Number of NIFS to racially or ethnically underrepresented students, women, and persons with disabilities.)

- API ED-15-2 ___110___ (Number of educators.)
- API ED-15-4 ___88____ (Number of informal education events.)
- API ED-15-5 __4620__ (Number of K-12 students.)

F. IMPROVEMENTS MADE IN THE PAST YEAR

The Missouri Space Grant Consortium is always looking to extend the reach of NASA Space Consortium funds to a wider region in the state. A Community and Technical College Initiative was launched during the last year. This is the most significant initiative undertaken by the MOSGC in several years. This initiative was conceived to bring in students from the two year colleges in the state to expose them to STEM area projects that might motivate them to pursue: 1. A four year degree and 2. A STEM area degree.

G. CURRENT AND PROJECTED CHALLENGES

The response rate to the first solicitations for proposals for the new Community Technical College Initiative was not as good as anticipated. Announcements for this opportunity were distributed through the MOSGC Affiliate and Associate network as well as the state college and university research office network. Only two proposals were received: Moberly Area Community College (MACC) and Metropolitan Community College – Kansas City (MCCKC). The successful response from the MACC builds on an existing connection with Truman State University; a Consortium Associate. This effort will be continued in FY2018, with a more direct approach from the Consortium Affiliates and Associates to establish contacts with their local community and technical colleges; in addition to a new general solicitation distribution through the existing networks.

A big part of the challenge is to motivate and encourage the community and technical college professors to take an interest in this opportunity. Typically, the two year college instructors have heavy teaching and service loads, taking on the extra challenge with an MOSGC supported project is perceived as an extra load for them who are already pressed for time.

During the upcoming year, it is considered important to visit colleges having science, math, engineering and technology programs and talk to the instructors to motivate how they can align possible projects with MOSGC funds to education and training of their students. Direct, in-person contact may prove worthwhile to improve participation from community and technical colleges.

Additionally, we plan to consult with the Community and Technical College officials and instructors to see whether some specific project-based competition would spur more participation in this program. Furthermore, we will consult with the Space Grant Consortia in other states to get more ideas on how to increase participation from community and technical colleges.

H. PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The Missouri Space Grant Consortium is composed of the Lead Institution, six Affiliates, four Associates, and two Community Colleges with a fairly 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 Mechanical Engineering and Material Science
- Lincoln University of Missouri (HBCU)
  - Department of Life and Physical Sciences

Associate Members

- Challenger Learning Center of St. Louis
- St. Louis University
  - College of Engineering, Aviation, and Technology
  - Center for Sustainability
- Truman State University
  - Department of Physics
  - Department of Chemistry
  - Department of Biology
- Astronomical Society of Kansas City

Community and Technical Colleges

- Moberly Area Community College
- Metropolitan Community College – Kansas City