The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD – this document) 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.

Nebraska Space Grant Consortium
Lead Institution: University of Nebraska at Omaha
Director: Dr. Scott Tarry
Telephone Number: (402) 554-3772
Consortium URL: ne.spacegrant.org
Grant Number: NNX10AN62H

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 Nebraska Space Grant Consortium is a Designated Consortium funded at a level of $575,000 for fiscal year 2014.

PROGRAM GOALS

Goal 1: To deliver a fellowship program that offers aerospace-related research opportunities to diverse student populations at Space Grant academic affiliates throughout Nebraska. Contribute to the STEM workforce pipeline by providing a progression of educational opportunities for talented Nebraska students, preparing them to pursue careers in aerospace science and industry.

Select Goal 1 Outcome Indicators:

- 100% of active academic affiliates will receive at least 1 fellowship each year.
    - 73% so far, with awards at Metropolitan Community College and Chadron State College pending
- A minimum of 5 interns placed each year.
    - Funding offered to 5 interns to be placed this year

- At least 2 new courses related to aerospace science and engineering are developed each year, and 5 courses are revised to enhance NASA-related content.
    - At least 2 new courses and 6 revised courses; the period of performance has not concluded
- Support at least 5 teams of Nebraska students engaged in aerospace-related competitions each year.
    - At least 7 teams supported this year
- Develop and implement 3 new programs over the next five years for a progression of STEM opportunities for faculty and students.
    - At least 3 new programs implemented
- 45% of Space Grant significant awardees who graduate and enter the workforce as their next step, will be employed by NASA, aerospace contractors, universities, or other educational institutions.
    - 50% of those who graduated and entered the workforce are employed in STEM aerospace, and 50% are employed in STEM non-aerospace (FY13 data as FY14 is not yet available)
- 45% of Space Grant significant awardees who graduate will pursue an advanced STEM degree.
    - 50% of those graduating are pursuing advanced STEM degree (FY13 data as FY14 is not yet available)
- Fellowship awards to women and minorities meet or exceed the state enrollment percentages in STEM fields.
    - 46% female, 28% underrepresented
- 50 underrepresented students will be served in the higher education programs.
    - At least 78 underrepresented students; the period of performance has not concluded

Goal 2: To raise the aggregate quality and quantity of Nebraska's aerospace research endeavors to the highest level of national competitiveness.

Select Goal 2 Outcome Indicators:

- 90% of research mini-grant awards will be endorsed by a NASA collaborator, or aligned with the NASA Vision, Mission Directorates, or NASA Center priorities.
    - 100% were aligned with NASA's vision, Mission Directorates, or NASA Center priorities, and 63% had a NASA partnership
- 75% of research mini-grant awards will include at least 1 student research experience.
    - 87.5% included a student research experience
- 60% of student researchers will pursue a higher academic degree in a STEM-related field, or employment in a STEM-related field following their research experience.
    - Data provided above
- 50% of funded researchers will submit an application for continued funding of their research elsewhere.
    - To date, 75% of researchers submitted a proposal and the period of performance has not concluded

- At least 1 publication will result from each funded project.
    - To date, 75% of research projects resulted in a publication and the period of performance has not concluded

Goal 3: To strengthen the Nebraska STEM education base from elementary through university levels with emphases on NASA content, teacher training, and delivery to underrepresented groups.

Goal 3 Outcome Indicators

- Support 4 teacher workshops each year that offer NASA content-based education resources or demonstrate how to incorporate NASA resources in the classroom
    - Through the NESA program alone, more than 20 presentations have been delivered
- Engage 1,000 Nebraska K-12 students annually
    - To date, 1,238 students have been engaged and the period of performance has not concluded

Goal 4: To increase public support for NASA through informal education and spreading NASA's mission to Nebraska citizens and beyond.

Goal 4 Outcome Indicators

- Support at least 3 informal education activities per year that align with NASA's informal education goals and required criteria, with priority to those activities that: 1) target underrepresented students; 2) provide professional development opportunities for informal education provider; or 3) incorporate NASA data or NASA materials for programs and exhibits.
    - At least 6 information education activities were supported

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

Provide concise, meaningful highlights or anecdotes (no more than three) that are directly related to work completed in 2014, highlighting student and/or project accomplishments. Specify alignment to each of the three Outcomes.

Outcome 1: NASA Nebraska Space Grant funding supported the work of Dr. Jack Gabel and the astrophysics research group at Creighton University. Specifically, the group is involved in two projects involving studies of mass outflow systems in Active Galactic Nuclei (AGN): 1) analysis of ultraviolet spectral data from NASA's Hubble Space Telescope, and 2) analysis of infrared spectra obtained from the data archive of NASA's Spitzer Space Telescope. The funding for this project supported the research efforts of two undergraduate students to analyze data and to support the travel of a third student to present his work at the American Astronomical Society meeting. The funding has positioned Dr. Gabel to apply to the JPL Summer Faculty Fellowship program to work with Dr. Daniel Stern, a research scientist in the Astrophysics and Space Sciences Division at JPL. A journal article is being prepared for submission to the Astrophysical Journal for publication. Additionally, the project provided the foundation for a proposal

through NASA's Astrophysics Data Analysis Program that will be submitted in the next cycle.

Outcome 1: Nebraska's RockSat-X team, in collaboration with the University of Colorado-Boulder (CU Boulder) and the Air Force Research Lab, designed and built a sounding rocket payload that tested the crystallization of Sodium Acetate Trihydrate in microgravity. Students traveled to collaborate with CU Boulder students and to the Wallops Flight Facility for Testing in June and final integration in August. The sounding rocket with the payload experiment aboard launched successfully in April 2015. The crystallization in microgravity experiment will expand our understanding of the mechanisms and character of crystallization processes in space. This understanding could help form the basis of future microgravity manufacturing processes. Projects such as these provide Nebraska students access to perform space science.

Outcome 2: Dr. Jeff Keyte focused the College of St. Mary Science Outreach Program on 12 elementary schools within five miles of the campus. College of St. Mary undergraduate students provide hands-on activities in elementary school classrooms. The program is promoted on the website where teachers can select an activity that fits their curriculum and request a visit. The undergraduate student leaders coordinate the visit with the teachers and schedule undergraduates on the team to deliver the activity. Previous students developed the activities and current students modify and adapt them to classroom needs. This project aligns with NASA's objectives of STEM promotion by introducing students to hands-on science prior to the "middle school effect" of decreasing interest in science. The project funding supports undergraduate student stipends and consumable supplies for the activities. This year, more than 873 elementary students were served by 14 participating undergraduate students. The program has gained support from a private donor and aims to include a teacher training workshop in the future.

PROGRAM ACCOMPLISHMENTS

Refer directly to the consortium goals and SMART objectives in your 2010 base proposal when describing your accomplishments.

Outcome 1: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals:* (Discussion of achievements and progress related to your Fellowship, Scholarship, Internship, Higher Education and Research Infrastructure programs). *(Employ and Educate)*

Some successes stories this year include:

Dr. José Baca, UNO Computer Science, is researching a compact and semi-autonomous robotic solution for addressing muscular atrophy for astronauts in long-term space missions. The proposed solution is based on the development of a modular robotic system that can be used to provide muscular strength training to astronauts. Muscle atrophy and degeneration is a critical problem facing astronauts engaged in long term space missions, such as on the ISS. To minimize muscle atrophy and maintain muscle in space, it is necessary to combine an adequate diet with intensive exercise, particularly

strength training exercises (pushing or pulling against resistance). The target demonstration application relates the use of ModRED to perform essential and potentially new modular robot configurations that can be used to exercise muscles while the system is inside the ISS. The objective of creating new configurations is to create a system capable of stimulating the muscles by the effect of pushing or pulling against resistance. The capability of a system to be used simultaneously in different applications and tasks such as exploration of unknown environments and also as a muscular training system, while inside the space station, brings clear advantages in terms of payload criteria and versatility. This project has resulted in several publications already.

Dr. Jing Zeng's higher education project at the University of Nebraska-Lincoln (UNL) emphasizes improved undergraduate and graduate student understanding of NASA's earth observations, and weather and climate through classroom teaching and student research at UNL. This project improves general university courses related to remote sensing and climate through incorporation of NASA content. These courses, which educate students about climate change, are unique at UNL. The students are highly motivated and interested in satellite remote sensing and climate change studies. The work focuses on image enhancement, image classification, filtering image noise, etc. NASA experts provide technical support for some of the lectures. In the online course, narrated videos are being created and published on the course website. Two current courses have revised curriculum: METR 465/865 and METR180. Additionally, one new course is approximately halfway developed at the time of this report.

The Nebraska Space Grant is partnering with female student groups to foster more participation from women in the fellowship program and in student-led competition teams. The UNL Chapter of the Society of Women Engineers and UNO's Women in STEM group are just two examples.

Comments from student final reports:
"This project gave me deeper insight on the weather correlations that we have from the reservations alongside state, national and global temperatures and precipitation. It also made my partners and I more conscientious about the weather on a day-to-day basis and what we could change. I have enhanced my research skills and data gathering."

"I am an intern at NASA Langley Research Center. The project I'm working on is to create the hardware and programing for a GPS-Emulator for Generalized Autopilots. This work is critical for testing Unmanned Aerial Systems at the Autonomy Incubator."

"I am still in my doctoral program and I am about to defend my proposal this month. The proposal is closely related to my NASA projects and I am very happy to have had the chance to work on this research thanks to NASA's support. The project concerns bioinformatics and protein development."

"This NASA project has enriched my education by teaching me how to design an experiment and payload in such a way that it will be able to withstand extreme loadings.

It has enriched my employment opportunities by assisting me in getting an internship at NASA's Kennedy Space Center."

"I believe this experience is the primary reason I got my internship last summer."

"I firmly believe that this project is why I was so successful in getting admitted into graduate school."

"This NASA project gave me the experience I needed to be selected as part of NASA's Pathways program. I now have the very real opportunity to become a full-time employee for NASA at the Kennedy Space Center."

"I think that because of my involvement in the team, I was offered my co-op at Altec Industries this next semester."

"The skills I have gained working on this project are invaluable to my career."

"This is helping fund my M.S. thesis. It is giving me the opportunity to explore the sciences in-depth and the results will directly impact people in wildfire-prone areas. After I continue on for my Ph.D., I plan on working at NASA Goddard as part of Charles Ichoku's fire research group."

Outcome 2: *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty:* (Discussion of achievements primarily focused on your Higher Education programs not discussed in Outcome 1 and your Precollege programs). *(Educate and Engage)*

Project HALON (High Altitude Learning Over Nebraska) provides a unique opportunity for students in Nebraska to get hands-on experience with a mission that takes their research project to the edge of space. The project leverages experience with high altitude weather balloons to develop an experimental platform that allows high school student teams to create their own sensor packages for flight. During the project, students learned the Space Systems Engineering process to propose, design, develop, and test their experiments before launch. Undergraduate students from UNL and the University of Nebraska at Omaha (UNO) developed a data acquisition system for the experiments and served as mentors for the high school teams. To participate in Project HALON, teams had to design their experiments to meet all launch criteria and pass a Preliminary Design Review, Critical Design Review, Test Readiness Review, and Flight Readiness review. Participating institutions included Metro Community College, UNL, UNO, Peter Kiewit Institute, Bellevue West High School, Omaha North High School, and US STRATCOM. Two undergraduate students presented the results at the 2015 Spring Simulation Multi-Conference in Alexandria, VA. The project also included collaboration with the UNO College of Education. Mr. Derrick Nero provided valuable subject matter expertise and advice on the potential impact of Project HALON in STEM curriculum development.

Ganesh Naik, College of St. Mary, was funded for his project, Integrating STEM Based iOS and Android Mobile Tools Into Classroom Instruction. The goal of the project was to enhance the classroom experience of undergraduate students by using new, interactive, STEM based iOS and Android mobile applications. Through this project, STEM based iOS and Android mobile applications for the following science and sustainability concepts were identified and integrated in the course curriculum: Earth's climate, structure of an atom, periodic table of elements, chemical bonding, organic reactions, spectroscopic data of organic and inorganic compounds, and more.

Outcome 3: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission:* (Achievements and progress of Informal Education programs). *(Engage and Inspire)*

The Edgerton Explorit Center in rural Aurora, Nebraska was funded for the Wacky Wednesday Afterschool Robotics Challenge. Wacky Wednesdays are an afterschool program offered from 2:15 p.m.-6:00 p.m. during the school year for pre-school through fifth-grade students in Hamilton County, Nebraska. The program uses middle and high school students as mentors. Students are challenged to design, build, and program robots that move using motors with curriculum that includes NASA's Robotic Alliance Program resources. Students must apply mathematics and science knowledge to create robots in an informal education setting. Next, students add sensors to their robots to control the robot's behavior and measure, graph, and analyze sensor data. In the final component, students learn to design, build, and program robotics systems built from several subsystems. The curriculum included an opportunity for students to explore, plan, and develop solutions to some of the challenges NASA engineers and scientists are working on today. While 220 students took part in the Wacky Wednesday program throughout the year, there was a core group of 45 Wacky Wednesday students who participated in the robotics program for the entire 36 weeks. These students received over 30 hours of classroom instruction. Exit surveys showed that all the students had a comprehensive understanding of robotics and were utilizing the skills they had learned. The students also indicated in the exit surveys that they had a stronger interest in science after going through the program and were interested in continued participation in the 2015-2016 school year. The educators worked on educating students on these areas of the National Science Standards throughout the program, and saw significant gains in student knowledge base in these areas: 1. Science as inquiry, 2. Physical science, 3. Life science, 4. Earth and space science, 5. Science and technology, 6. Science in personal and social perspective, and 7. History and nature of science. They also incorporated these areas of the Nebraska State Science Standards into the curriculum: 1. Inquiry, the Nature of Science and Technology; 2. Force and Motion; 3. Energy; 4. Structure and Function of Living Systems; and 5. Earth and Space Sciences.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Diversity**: *of institutions, faculty, and student participants (gender, underrepresented, underserved)*

Faculty and students at Nebraska Indian Community College (NICC), a Tribal College, continue to pursue research and fellowship opportunities through the NASA Nebraska Space Grant. Another affiliate, the College of St. Mary, is a female only institution. We have a diverse composition of affiliates, including 3 community colleges, 3 Ph.D. granting institutions, and 4-year state and private colleges. Our affiliates are located statewide, including the underserved panhandle of Nebraska. To date in FY 14, 46% of the fellowship awards were to females and 30% to underrepresented students. Through our fellowship program, we strongly encourage women, minorities, and persons with disabilities to apply. Recently, our office has made several trips to NICC to promote opportunities in the upcoming annual fellowship and mini-grant competition.

- **Minority-Serving Institution Collaborations:** *Summarize interactions with MSIs within the consortium, and describe projects/activities.*

The NICC Weather Stations and Climate Change Research Project has increased the research capabilities for all three NICC campuses. Weather Stations were set up at each NICC campus where the students, and their faculty mentor, Hank Miller, have been collecting data from all three stations. Five NICC students have been comparing the current data they collected to historical data from NOAA. They have compiled the data and are sharing it with their communities on the reservations. This project has generated increased interest among NICC students. Several new students are getting involved this coming year and they hope to add additional sensors to the weather stations to increase their research capabilities.

- **NASA Education Priorities:** *Accomplishments related to the "Current Areas of Emphasis" stated in the 2010 Space Grant solicitation. Report on areas that apply to work proposed in your proposal and budget.*

  - Authentic, hands-on student experiences in science and engineering disciplines – the incorporation of active participation by students in hands-on learning or practice with experiences rooted in NASA-related, STEM-focused questions and issues; the incorporation of real-life problem-solving and needs as the context for activities.

Nebraska's Design, Build, Fly (DBF) team designed and manufactured a remote-controlled plane capable of completing one ground mission and three flight missions for the annual AIAA DBF competition. The students performed research and testing to optimize the design of the aircraft, and they worked with local companies in order to secure funding for materials and parts. Once the design was finalized, the students produced a comprehensive report detailing the design and manufacturing process of the aircraft in addition to its final predicted mission capabilities. Finally, those predicted capabilities were put to the test at the annual Cessna/Raytheon Missile Systems Student DBF competition, which was held in Tucson, Arizona.

One of the student team leaders shared her perspective on participating in the program: Participating in DBF through my college career has been one of the most positive

experiences in my life. I know that it would not be possible without continued support from Nebraska Space Grant. It has allowed me to gain hands-on experience, pursue my aerospace interests, and gain experience leading a design team. Also, I'm sure it has helped me secure my internships at Spirit AeroSystems, NASA Glenn, and get into my Ph.D. program. My time with DBF has undoubtedly strengthened my desire to pursue aerospace engineering as my career.

- Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise. Capabilities for teachers to provide authentic, hands-on middle school student experiences in science and engineering disciplines (see above).

The Nebraska Education Space Ambassadors (NESA) are teachers trained in NASA content and then deliver that content to other teachers across the state. This year, the NESA teachers convened at the Nebraska Star Party in Valentine, Nebraska for training. They received one-on-one telescope and observation training with telescopes they brought from their school districts, as well as the amateur astronomers' large telescopes. They attended astronomy field schools where they reviewed astronomical concepts and conducted curriculum sharing.

- Aeronautics research – research in traditional aeronautics disciplines; research in areas that are appropriate to NASA's unique capabilities; directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen).

Dr. Dennis Alexander's research includes fabricating water-repellant, superhydrophobic metal surfaces capable of withstanding extreme temperatures and long missions which is an essential, though difficult, challenge when fabricating materials with advanced thermal properties. Efficient thermal management is critical to nearly every NASA mission and often limits system capabilities. However, interactions with NASA contacts have revealed that most coatings fail at either high temperatures or are lose functionality too quickly to be practically useful. There is therefore a critical need to develop durable, high-temperature superhydrophobic metallic surfaces for advanced thermal management systems at NASA.

- Environmental Science and Global Climate Change – research and activities to better understand Earth's environments.

Dr. Jing Zeng's research, Continuing Study of the Relationships between Crop and Precipitation, Photosynthetically Active Radiation in Nebraska Area, examines the relationship between precipitation, radiation, and agricultural productivity. This is an important task for the applied science at NASA, and especially for the state of Nebraska, a major agricultural state. The results from this study can be used to forecast annual agriculture yield and help policy makers to make better decisions. The research results from this project will be presented in journal papers and presented in conferences. It is hoped the results will be used to secure future funding from NASA, NSF, USDA, and DOE since the study of precipitation and radiation energy is highly related to the regional agricultural production and are highly encouraged research programs supported by

NASA, NSF, and USDA. This research has already resulted in at least 2 grants from NASA and 1 from UCAR.

IMPROVEMENTS MADE IN THE PAST YEAR

***Succinctly** describe improvements and/or adjustments made last year that demonstrate significant change(s) within the consortium. The improvements and/or adjustments that brought about change may have been in management, resource allocation, project design, project evaluation, etc.*

Nebraska is eager to join other states in using the CubeSat platform as the host for STEM education and outreach programs as an enabler for space-centered technology demonstrations and scientific experiments. In pursuit of this goal, a team of researchers and educators are working to establish the Space Technology and Exploration Lab (STELa), which represents an ambitious and collaborative effort of the NASA Nebraska Space Grant and EPSCoR programs. This work builds on Project HALON (High Altitude Learning Over Nebraska), which was funded by a mini-grant from the NASA Nebraska Space Grant. STELa will serve as the home base for CubeSat development efforts. STELa will support a progression of student-led research, design, fabrication, and testing experiences starting with high altitude ballooning and culminating with the design, development, testing, and launch of Nebraska's first nanosatellite via the NASA CubeSat Initiative.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

List the institutions that comprise the consortium; include the name, type of institution, key characteristics, and role in consortium activities/operations.

Academic affiliates of the Nebraska Space Grant Consortium include:

- Chadron State College, 4-year public college and graduate degree granting institution
- College of St. Mary, 4-year private college, all women's institution
- Creighton University, 4-year private university and graduate degree granting institution
- Hastings College, 4-year private college
- Little Priest Tribal College, 2-year public community college, Tribal college
- Metropolitan Community College, 2-year public CC, over 110 off-site locations
- Nebraska Indian Community College, 2-year public CC, Tribal college
- University of Nebraska – Lincoln, 4-year public university and Master's and Ph.D., graduate degree granting institution, Flagship of the University of Nebraska system
- University of Nebraska at Kearney, 4-year public university and graduate degree granting institution
- University of Nebraska at Omaha, 4-year public university and Master's and Ph.D. degree granting institution, Lead institution for Space Grant

- University of Nebraska Medical Center, 4-year public university, Master's and Ph.D. granting medical institution
- Western Nebraska Community College, 2-year public CC

Industry, government, and non-profit affiliates and partners include:

- 99th Pursuit Squadron Civil Air Patrol: Offers informal aerospace education outreach targeted to underrepresented populations
- CALMIT- Center for Advanced Land Management Information Technologies: Research projects and internships in the field of agricultural remote sensing
- Girl Scouts: Offers informal aerospace education targeted to female populations
- Nebraska 4H: Projects in robotics, agriculture, and geospatial research
- Nebraska Department of Aeronautics: State government division that offers internships and projects in aeronautics
- Nebraska Department of Education: Lead organization for the Summer of Innovation grant
- Nebraska Academy of Sciences: Partner in delivering annual research conference
- Nebraska Aviation Council: Includes representatives of aeronautics industry throughout the state; developer of the Nebraska STARBASE Rocket Team
- Strategic Air and Space Museum: Foremost aviation museum in the Midwest; offers informal STEM programming
- Tuskegee Airmen: Offers internships and aeronautics outreach targeted to underrepresented populations