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.

North Carolina Space Grant Consortium (NCSG)
Lead Institution: North Carolina State University
Director: Christopher S. Brown
Telephone Number: 919-515-4240
Consortium URL: http://ncspacegrant.org
Grant Number: NNX10A168H

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

PROGRAM GOALS

NCSG's goals and objectives (listed below) are part of the Consortium's five-year strategic plan (FY2010-14), and are aligned with NASA's Education Framework:

- Goal 1: To deliver a competitive Fellowship/Scholarship program that provides research and education opportunities to students in science, technology engineering, and mathematics disciplines at NCSG Affiliate institutions (NASA Outcome 1). Objectives: (1.1) Support Graduate Research Fellowships/Undergraduate Research Scholarships; (1.2) Support Undergraduate Scholarships; (1.3) Support Community College Scholarships; (1.4) Support STEM Teacher Education Scholarships; (1.5) Ensure competitive distribution of F&S funds; (1.6) Leverage support from industry, research organizations, and other Space Grant partners for other F&S projects.
- Goal 2: To strengthen North Carolina's aerospace-related research infrastructure and capabilities (NASA Outcome 1). Objectives: (2.1) Provide start-up funding to early career faculty; (2.2) Encourage research collaborations between faculty and NASA centers/industry; (2.3) Ensure competitive distribution of research funds.
- Goal 3: To provide groups of students with opportunities to engage in NASA-mission and STEM-based academic research and coursework (NASA Outcomes 1 and 2). Objectives: (3.1) Engage student groups in NASA-related research/design projects; (3.2) Develop STEM courses

aligned with NASA's research direction and corresponding Mission Directorates; (3.3) Ensure competitive distribution of higher education funds.

- Goal 4: To deliver activities that facilitate the National Space Grant College and Fellowship Program's focus on involving underrepresented groups and persons with disabilities in all higher education program areas (NASA Outcome 1-3). Objective: (4.1) Pursue and increase the participation of women, underrepresented minorities, and persons with disabilities in NC Space Grant program areas of Fellowship/Scholarship, Student Research and Course Development, and Research Infrastructure.
- Goal 5: To equip NC pre-service and in-service educators with tools to inspire the future STEM workforce to pursue education and careers in aerospace-related fields (NASA Outcome 2). Objectives: (5.1) Provide professional development opportunities for precollege educators; (5.2) Ensure competitive distribution of precollege education funds.
- Goal 6: To increase interest in and understanding of NASA-mission and STEM activities by inspiring and engaging individuals of all ages throughout North Carolina (NASA Outcome 3). Objectives: (6.1) Provide professional development opportunities for informal educators; (6.2) Ensure competitive distribution of informal education funds.
- Goal 7: To expand the geographic diversity and awareness of NC Space Grant. Objectives: (7.1) Increase the number of Affiliates and Partners; (7.2) Increase the funding base for NCSG to allow for expanded programming; (7.3) Increase public awareness of NCSG activities.

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

Outcome 1 – Fellowship, Scholarship, and Internship

Excerpt from 2014 NCSG/LORD Corporation Intern Brad Murphy:

"This internship has provided me with the opportunity to meet and network with a diverse group of people from all sectors of the professional engineering world. Through this program, I have received and accepted a full time offer from LORD Corporation as a Systems Engineer, conditional on my graduation in December of 2014 from NCSU. This internship provided me an opportunity to apply the fundamentals I learned in my undergraduate education. Overall, I believe this program was an essential part of my education and growth as a professional."

Outcome 1 – Higher Education

The following letter was sent to NCSG Director Dr. Brown from Mark Meno (Research and Engineering Group Head, NAVAIR FRC-East/In-Service Support Center) and Bill Fortney (Eastern NC Regional Director of Engineering, NCSU) following the first bi-annual Aircraft Readiness Engineering Workshop in June 2014:

"The 2014 Aircraft Readiness Workshop leadership team says "Thank You!" for sponsoring this event which truly was a week to remember for the twenty participants. Any of these engineering students, from six states and eleven Universities, could be one of the next generations of engineers to join the North Carolina aviation support team, and your willingness to support this workshop helped us prepare them for this challenge. The vision, financial support, and administrative guidance provided by NC Space Grant allowed us to give these students great insights into how exciting and meaningful engineering support work is in military aviation. You can be proud that your vision to create this workshop resulted in an event that did make a difference in the lives of many young people and did help to shape some of the future aviation support engineers. We look forward to continuing this partnership."

PROGRAM ACCOMPLISHMENTS

Outcome 1: Employ and Educate

Fellowship, Scholarship, and Internship Programs

NCSG competitively awarded 67 fellowships, scholarships, and internships to students attending NCSG Affiliate institutions.

- Awarded 14 Graduate Research Fellowships, 12 Undergraduate Research Scholarships, and 8 NASA Internships to students representing 7 university Affiliates. Nine of these research projects had significant partnerships with NASA centers that included a NASA research mentor and students working on-site at: Ames (NASA Academy), Goddard (Internship), Johnson (Internship), Kennedy (Internship), Langley (NASA LARSS), and NASA Headquarters.
- Awarded 12 industry internships: NC Space Grant continued its partnership with the LORD Corporation to offer a 10-week summer internship program for 12 undergraduate and graduate students. LORD is a worldwide leader in aviation.
- Awarded 5 Undergraduate Scholarships and 16 Community College STEM Scholarships, enabling lower division students an opportunity to explore STEM-related research on their respective campuses.

NCSG Fellowship and Scholarship programs contributed to NCSG Goal 1. Objectives 1.1, 1.3, 1.5, and 1.6 were met in FY14. Objective 1.2 was below target due to a reduction in the number of competitive applications received for the FY14 Undergraduate Scholarship Program. Objective 1.4 was not implemented in FY14 due to a lack of funding beyond the base award.

Higher Education Programs

The NCSG higher education portfolio includes: Senior Design and Team Competition Program; NASA Reduced Gravity Student Flight Opportunities Program; Aircraft Readiness Engineering Workshop; and Affiliate-Supported Higher Education Projects. These programs, engaged 127 graduate/undergraduate students. NCSG Higher Education programs contributed to NCSG Goal 3; Objective 3.1 was exceeded four fold, Objectives 3.2 and 3.3 were met.

Senior Design and Team Competition Program: In FY14, NCSG offered two competitive higher education grant programs: Senior Design and Team Competition, emphasizing workforce development through the incorporation of interdisciplinary research collaboration. Thirteen competitive awards were granted in FY14. Senior Design projects include: VIKING-BOT Autonomous Mobile Robot Senior Design (ECSU); IEEE Capstone (UNC-C); Robotic Mining Capstone (UNC-C); Forty-Niner High Power Rocketry Senior Design (UNC-C); High Powered Rocketry Senior Design (NCSU); Near Space Balloon Senior Design (UNC-C). Team Competition projects include participation in the following: American Society of Mechanical Engineers, Human Powered Vehicle Challenge East (ECU); Association for Unmanned Vehicle Systems International's 18th Annual International RoboSub Competition (NCSU); Association for Unmanned Vehicle Systems International's Student Unmanned Air Systems Competition (NCSU); Institute of Electrical and Electronics Engineers, SoutheastCon Hardware Competition (UNC-C); NASA RockSatC Competition (Mitchell Community College); NASA Robotics Mining Competition (UNC-C); NASA Student Launch (NCSU and UNC-C).

NASA Reduced Gravity Student Flight Opportunities Program - Weightless Lumbees: NCSG provided support for the UNC-Pembroke microgravity research team (Weightless Lumbees, 4 undergraduates) to the design, develop, build and fly their experiments in July 2014.

Aircraft Readiness Engineering Workshop: NCSG, in collaboration with Connecticut Space Grant, NC State University, Craven Community College, United States Marine Corps and the Naval Air Systems Command Fleet Readiness Center-East, conducted the first bi-annual Aircraft Readiness Engineering Workshop in Havelock, NC in June 2014. Twenty engineering students from six states (AL, DE, CT, FL, NC and WV) and eleven colleges/universities participated in the intensive week-long program; Students gained practical experience working directly with Department of Defense engineers at Marine Corps Air Stations in Cherry Point and New River.

Affiliate Supported Higher Education Projects: NCSG Affiliates (Duke University, NC A&T State University and UNC-Chapel Hill) leveraged support for course development and student team competitions on their respective campuses (to date, 33 students have been supported through Affiliate Higher Education Projects; projects conclude June 30, 2015).

Research Infrastructure Programs

NCSG research infrastructure programs include competitive opportunities for early career faculty (New Investigator Program) and students (Affiliate Supported Research Infrastructure Projects). These programs, which are discussed below, engaged 94 graduate/undergraduate students, and contributed to NCSG Goal 2. Objectives 2.1-2.3 were met.

New Investigator Program: Ten 'New Investigator' awards were competitively granted to early career university faculty who are conducting research that is directly aligned with NASA's research direction. All projects involved undergraduate and/or graduate students, which provided practical training to students as well as opportunities to present research at professional conferences (20 students engaged through New Investigator projects).

- *Plasma-Based Integrated Suction/Blowing Actuator for High-Speed Propulsion,* Dr. V. Narayanaswamy, Assistant Professor, Department of Mechanical and Aerospace Engineering, NC State University. One graduate and one undergraduate student engaged.
- *Modeling and Fabrication of Microscale Wire Grids for Co-Located Transparent Antennas and Solar Cells,* Dr. Jacob Adams, Assistant Professor, Department of Electrical and Computer Engineering, NC State University. Two undergraduate students engaged.
- *Multifunctional Compliant Structures for Hybrid Wind and Solar Energy Harvesting on Mars,* Dr. Matthew Bryant, Assistant Professor, Department of Mechanical and Aerospace Engineering, NC State University. Three undergraduate students engaged.
- *Simulation Studies of Membrane-based Acoustic Metamaterials as a Future Noise Insulation Material* Dr. Yun Jing, Assistant Professor, Department of Mechanical and Aerospace Engineering, NC State University. One graduate student was engaged as part of his dissertation.
- *Development of Tethered CubeSat Program,* Dr. Mark Pankow, Assistant Professor, Department of Mechanical and Aerospace Engineering, NC State University. Four undergraduate students engaged.
- *Inter-Satellite Communications In Autonomous Small Satellite Networks,* Dr. Fatemah Afghah, Assistant Professor, Department of Electrical and Computer Engineering, NC A&T State University. One graduate student engaged.
- *Numerical Modeling of Constitutive Behavior of Ice at High Strain,* Dr. Trisha Sain, Assistant Professor, Department of Mechanical Engineering, NC A&T State University. One graduate and one undergraduate student engaged.

- *Radiation and the Survival of Ancient Life,* Dr. Regina DeWitt, Assistant Professor, Department of Physics, East Carolina University. One graduate and one undergraduate student engaged.
- *Multiscale Analysis of the Impacts of Forest Invasive Disease on Wildfire Burn Severity Using Landsat Imagery, MASTER Airborne Simulator Data and Machine Learning,* Dr. Gang Chen, Assistant Professor, Department of Geography and Earth Sciences, UNC-Charlotte. One graduate and one undergraduate student engaged.
- *Developing a Global Lightning Dataset from Remote Sensing Observations,* Dr. Brian Magi, Assistant Professor, Department of Geography and Earth Sciences, UNC-Charlotte. One graduate student engaged.

Affiliate Supported Research Infrastructure Projects: All thirteen NCSG Affiliates provided awards through local competition to 75 students to participate in STEM-related research through research assistantships under the supervision of a faculty /industry mentor. Research was either conducted on campus, at collaborating universities (Clemson University, Indiana University, and University of Kansas), NASA Centers (Glenn and JPL), or at other science facilities (Pisgah Astronomical Research Institute, Wright Patterson Air Force Base).

Outcome 2: Educate and Engage

Two 'K-12 Professional Development' awards were competitively awarded in FY14. Funded projects involved collaboration with partners to achieve its strategic goals of equipping the future STEM workforce and enhancing precollege educator knowledge of STEM content. NCSG precollege education programs contributed to NCSG Goal 5; Objectives 5.1 and 5.2 were met.

- *First in Flight: A Kenan Fellow Program Partnership* Dr. Elaine Franklin, Kenan Fellows Program, NC State University. NCSG teamed with the Kenan Fellows Program to support middle school teacher Allison Stewart to design a series of activities for public libraries and middle schools themed around the science of flight.
- *NC STEM High School Externship Program,* Dr. Mark Jolly, Mechanical Research Manager, LORD Corporation. NCSG provided funds to LORD to leverage support for two high-school teacher externships during the summer of 2014. .

Outcome 3: Engage and Inspire

Five 'Informal Education and Public Outreach' awards were competitively awarded through partnerships with informal education venues and community groups. Participant data for these activities were not available at the time of this report (FY14 projects conclude June 30, 2015). NCSG informal education and public outreach program contributed to NCSG Goal 6; Objectives 6.1 and 6.2 were met.

- *A NASA Inspired Outreach Program for North Carolina American Indian Youth,* Dr. Tim Ritter, UNC-Pembroke. This program provides outreach to American Indian communities and economically challenged regions of North Carolina. NCSG funds were used to expand outreach efforts of the "Weightless Lumbees" into other underserved areas of the state.
- *Science Saturday Program on Space Biology, Materials, and Medicine,* Dr. Roger Narayan, NC State University. This project features a series of monthly lectures and scientific demonstrations led by NCSG-funded faculty.
- *NC Science Festival's Statewide Star Party,* Mr. Jonathan Frederick, NC Science Festival, Morehead Planetarium and Science Center at UNC-Chapel Hill. NCSG continued its partnership with the NC Science Festival and funded the SSP event to be held April 24-25, 2015. Funds will support 35 star party events across NC (approximately 4,000 participants).

- *Integrating NCCU Telescopes into the Durham Department of Parks and Recreation (DPR) Outdoor Astronomy Program,* Dr. Diane Markoff, NC Central University. A suite of new programs have been developed to enhance astronomy education in the community.
- *Using Sensor-Based Learning Modules as a Catalyst for Student Engagement and College Readiness in Northeastern North Carolina,* Dr. Kuldeep Rawat, Elizabeth City State University. Thirteen students attended a summer workshop to learn about scientific sensors and research applications.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

Diversity: Of the 12 NCSG university affiliates, four are Minority Serving Intuitions. Furthermore, the NC Community College System is an Affiliate and is comprised of 58 two-year associate degree granting institutions. All students and faculty attending a NCSG Affiliate institution were eligible to compete for NCSG support in FY14.

Of the 308 students supported in FY14 through Fellowship/Scholarship/Internship, Higher Education, and Research Infrastructure programs, 79 (25.7%) went to students from historically underrepresented minority groups and 107 (34.9%) to females *(NCSG Goal 4, Objective 4.1).* NCSG minority student participation (25.7%) does not meet the target of 28.3% set by the NCSG FY2010-14 Strategic Plan (and based on the enrollment percentage of minority students in NC as published in the National Center of Education Statistics Digest).

Furthermore, the percentage of female participants supported (34.7%) fell short of the 55% target set by the NCSG FY2010-14 Strategic Plan (Outcome Indicator: 55% of awards will be made annually to female applicants). The 55% target was derived from the enrollment of female students in NC degree-granting institutions as published by the National Center for Education Statistics). This strategic target, however, is not reflective of the number of female students enrolled in STEM degree programs. *Note: Data reflected in this report may not represent all students engaged. Final data reports will be provided by Affiliates at the conclusion of their projects (June 30, 2015).*

Minority-Serving Institution (MSI) Collaborations: NCSG has 4 MSIs that are active Affiliates of the consortium: Elizabeth City State University, NC A&T State University, NC Central University, and Winston-Salem State University. Each of these universities received funding from NCSG to implement programs on their campuses.

- ECSU: thirteen Affiliate Supported Research Scholarships were awarded to minority students to work alongside a faculty mentor in a research lab (Outcome 1); one ECSU student participated in the 2014 Aircraft Readiness Engineering Workshop (Outcome 1); competitively awarded a NCSG Senior Design grant to support a team of three students to design and develop an autonomous mobile robot (Outcome 1); competitively awarded a NCSG Informal Education and Public Outreach grant to offer a summer workshop for high school students (Outcome 3).
- NCA&T: one student was competitively awarded a NCSG Undergraduate Research Scholarship for the 2014-15 academic year; thirteen Affiliate Supported Research Scholarships were awarded to minority students to work with a faculty mentor in a research lab; ten students were engaged in NCSG-supported senior aerospace design activities provided support for an engineering capstone project focusing on fluids education; two female faculty were

competitively awarded NCSG New Investigator early career faculty grants. *All activities contribute to Outcome 1*.

- NCCU: one student was competitively selected as a NCSG/LORD Corporation Summer Intern in summer 2014 (Outcome 1); five Affiliate Supported Research Scholarships were awarded to minority students to engage in hands-on research activities mentored by faculty (Outcome 1); competitively awarded a NCSG Informal Education and Public Outreach grant to develop a collaborative astronomy program with Durham Parks/Recreation (Outcome 3).
- WSSU: NCSG provided support for one student to participate in the NASA LARSS program in summer 2014; nine Affiliate Supported Research Scholarships were awarded to minority students to work alongside a faculty mentor in a research lab; and six students were provided support to present their research at professional conference. *All activities contribute to Outcome 1*.

NASA Education Priorities: NCSG accomplishments related to the "Current Areas of Emphasis" include:

- Authentic, hands-on student experiences in science and engineering disciplines: project examples described in 'Program Accomplishments – Outcome 1.'
- Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise: 1 project funded that supported middle school professional development (described in 'Program Accomplishments – Outcome 2').
- Summer opportunities for secondary students on college campuses: NCSG did not perform any programs in this area of emphasis in FY14.
- Community Colleges: NCSG offers the competitive Community College Scholarship program to students attending any NC campus and are majoring in a STEM discipline. NCSG also supports student teams from Mitchell Community Colleges to participate in national competitions (described in 'Program Accomplishments – Outcome 1').
- Aeronautics research: Faculty at NC A&T State University are actively engaged in research related to NASA's Next Generation Air Transportation System and engage students in research activities (through collaborations at NASA Glenn Research Center and the Air Force Research Laboratory at Wright Patterson Air Force Base). NCAT's NASA funded Center for Aviation Safety conducts engineering research and education to address the challenges of NASA's Aeronautics Research Mission Directorate's Fundamental Aeronautics and Aviation Safety Programs.
- Environmental Science and Global Climate Change: NCSG provided funds to support two 'New Investigators' faculty research projects that are directly tied to environmental science and global climate change studies that utilize NASA data and resources (see 'Program Accomplishments – Outcome 1').
- Enhance the capacity of institutions to support innovative research infrastructure activities: the NCSG 'New Investigator' program is designed to strengthen North Carolina's aerospace-related research infrastructure by providing startup funding to early career university faculty who are conducting research that is directly aligned with NASA's Strategic Framework. Ten projects were awarded in FY14 (described in 'Program Accomplishments – Outcome 1').

IMPROVEMENTS MADE IN THE PAST YEAR

- NCSG developed a new position (0.75 FTE) for Partnership and Resource Development in order to enhance the awareness about the NCSG program and build authentic partnerships

among NASA's Office of Education and NASA Space Centers, other federal agencies, private sector, and formal/informal education entities across the state and beyond.

- In FY14, NCSG leveraged $150,000 beyond its core Fellowship and Scholarship funding to support student internships at NASA centers and in aerospace industry.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

NCSG has an organizational structure that enables each Affiliate member to play a significant role in project development and implementation of programs. Overall direction, policies, rules of governance, and budgetary priorities are established through consensus by the Consortium Executive Board, which consists of the NCSG Director and Campus Directors from each of the following thirteen Affiliate institutions:

- *Appalachian State University* is a 4-year, Baccalaureate and Master's degree granting public university that facilitates programs that contribute to NASA Education Outcomes 1-3.
- *East Carolina University* is a 4-year, Baccalaureate, Master's and PhD degree granting public university that facilitates programs that contribute to NASA Education Outcomes 1-3.
- *Elizabeth City State University* is a 4-year, Baccalaureate degree granting public HBCU that facilitates programs that contribute to NASA Education Outcomes 1 and 3.
- *Duke University* is a 4-year, Baccalaureate, Master's and PhD degree granting private university that facilitates programs that contribute to NASA Education Outcome 1.
- *NCA&T State University* is a 4-year, Baccalaureate, Master's and PhD degree granting public HBCU that facilitates programs that contribute to NASA Education Outcomes 1 and 3.
- *NC Community College System* is comprised of 58, 2-year Associate degree granting institutions across the state. The NCCCS facilitates programs that contribute to NASA Education Outcomes 1 and 3.
- *NC Central University* is a 4-year, Baccalaureate and Master's degree granting public HBCU and facilitates programs that contribute to NASA Education Outcomes 1 and 3.
- *NC State University* is a 4-year, Baccalaureate, Master's and PhD degree granting public university that facilitates programs contributing to NASA Education Outcomes 1-3.
- *UNC-Asheville* is a 4-year, Baccalaureate degree granting public university that facilitates programs that contribute to NASA Education Outcomes 1.
- *UNC-Chapel Hill* is a 4-year, Baccalaureate, Master's and PhD degree granting public university that facilitates programs that contribute to NASA Education Outcomes 1-3.
- *UNC-Charlotte* is a 4-year, Baccalaureate, Master's and PhD degree granting public university that facilitates programs that contribute to NASA Education Outcomes 1-3.
- *UNC-Pembroke* is a 4-year, Baccalaureate and Master's degree granting public university and facilitates programs that contribute to NASA Education Outcomes 1-3.
- *Winston-Salem State University* is a 4-year, Baccalaureate degree granting public HBCU and facilitates programs that contribute to NASA Education Outcome 1.

Partnerships with industry, government and nonprofit agencies help NCSG achieve its strategic goals and objectives. Consortium partners include:

- *LORD Corporation:* NCSG partners with LORD to offer the NCSG/LORD Corporation Summer Internship program. Since 2008, 53 students have participated in the program, which is fully funded by LORD (contributes to NASA Education Outcome 1).
- Kenan Fellows Program for Curriculum and Leadership Development: NCSG partners with the KFP to implement NASA-based Fellows projects (contributes to NASA Education Outcome 2).

- *Pisgah Astronomical Research Institute:* NCSG partners with PARI to provide opportunities for students to conduct astronomical and/or engineering-based research projects (contribute to NASA Education Outcome 1).
- *NC Museum of Natural Sciences*: NCSG partners with NCMNS to support a student internship in the Astronomy & Astrophysics Research Lab; NCSG also participates in NASA-related events including Astronomy Days (contribute to NASA Education Outcomes 1 and 3.