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.

Pennsylvania Space Grant Consortium
Lead Institution: The Pennsylvania State University
Director: Dr. Christopher H. House
Telephone Number: 914-865-8802
Consortium URL: http://pa.spacegrant.org
Grant Number: NNX10AK74H

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

PROGRAM GOALS

PSGC Goals: (1) Develop and promote opportunities for students to participate in research and discovery, including student flight projects; include programs with a focus on enhancing the participation of students from underrepresented groups. (2) Provide graduate and undergraduate training in NASA-related fields through the mechanism of fellowship and scholarship awards; increase the number of awards to students from underrepresented groups. (3) Support the development of interdisciplinary courses, curricula, and workshops, including introductory courses designed for undergraduate students not majoring in scientific or technological disciplines. (4) Model diversity in space grant leadership, programs, and activities; implement programs targeted at increasing the retention rate of students from underrepresented groups in science and engineering. (5) Provide information and programs to increase access to the excitement, knowledge, and technology from America's earth, air and space programs; establish PSGC as a viable state resource and catalyst for aerospace research, education, and economic development. (6) Cultivate a statewide network of partners from universities, industry, museums, science centers, state and local agencies to pursue aerospace research, education, and economic development goals. (7) Develop earth, air, and space programs to enhance public scientific literacy and to complement community needs.

FY 2014 SMART Objectives: Our target was to award 50 PSGC fellowships and scholarships. We intended to award ten statewide scholarships to support interns at NASA Centers. We planned to award 45 research scholarships to first-year, female, and minority undergraduate students to gain hands-on laboratory experiences with an underling objective of having 65% female and 30% underrepresented minority participation. We expected to support ten students in the Abington College Undergraduate Research Activities (ACURA) project, and ten for the National Radio Astronomy Observatory (NRAO) project at Penn State Abington. We expected to support five undergraduates at Franklin and Marshall College and Gettysburg College performing undergraduate research in the National Undergraduate Research Observatory (NURO) program. We aimed to have a total of 65 students participate in student space hardware programs (e.g. Student Space Programs Laboratory). We expected to have 20 student participants in the NASA-supported Penn State Flight Vehicle Design and Fabrication (FVDF) course. We aimed to support five West Chester University STEM majors in an undergraduate research program, and two HBCU students in our Lincoln University Environmental Sciences Research project. About 15% of awards from each program were expected to be allocated to underrepresented minorities. We aimed to continue our mini-grant program by supporting four early career scientists and initializing two new higher education programs. Our goal was to have a total of 115 in-service educators participate in teacher professional development workshops. Through our precollege programs, we expected 25 high school and >75 middle school student participants. Finally, we aimed to support four PSGC community events.

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

PSGC Benefit to Outcome 1

Students at Temple University flew a suborbital payload that sampled the atmosphere at various altitudes. One of these students is now employed at Kennedy Space Center as a contractor with Craig Technologies.

PSGC Benefit to Outcome 1

Students at Montgomery County Community College applied a new superhydrophobic coating to electronics and avionics used in VTOL UAVs and tested the modified UAVs with their electronics and avionics totally exposed to the elements. This work aims to fill a need for VTOL UAVs to fly in inclement weather, while training the next generation of engineers.

PSGC Benefit to Outcome 1

Students with the Penn State Lunar Lion team did fundamental design and development of a prototype lunar landing craft that uses four engines to descend to the lunar surface. Rejecting the original designs for hydrozene monopropellant thrusters and having already tested “green” bipropellant engines (methane plus oxygen), the students found their own better solution. They decided to investigate using four 100 lbf high-test hydrogen peroxide monopropellant engines. The student not only analyzed the program requirements and presented a plausible solution, but also then found an off-the-shelf provider of such engines that appear to meet the specifications from a Mexican supplier. By the end of summer 2014, the students were successfully testing and even modifying the sourced hydrogen peroxide engines.

PSGC Benefit to Outcome 1

Students at Penn State are designing, building, and deploying a modular 408 MHz Radio Interferometer. The students fished and deployed the first of their telescopes, and then began similar work on a their second smaller telescope. The students formed a new club called "Applied Physics Club" to ensure the student-led work continues for years.

PSGC Benefit to Outcome 2

A pre-college team of six student from the Iroquois school district (ranging in age from 5th grade to 8th grade) will have their experiment on the international space station (ISS). The student project was the winning design from a competitive process involving over 70 student teams (over 400 students engaged). The student payload is part of SSEP's Mission-7 involving 25 student experiments from across the nation.

PROGRAM ACCOMPLISHMENTS

Outcome 1: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals (Employ and Educate):*

In relation to FY 2014 SMART goals, we are proud to report that our university and college programming (F/S, HE, RI) totals 421 individual participants. This includes 247 participants in 11 unique student hands-on science or engineering programs, and 148 awarded fellowships, scholarships and internships to students in STEM fields. Of the total participants, 51 were underrepresented minority students, and of the fellowships and scholarships 30 of the 148 were awarded to under represented minority students. In FY2014, we had six continuing mini grant awards and one new one minigrant, which was awarded to Montgomery County Community College for an authentic VTOL UAV engineering project. The PSGC mini-grant program awards competitive grants to faculty, researchers, post-doctoral fellows, and graduate students in an effort to build NASA competency in the areas of education and research. Additionally, PSGC revised four pre-existing courses.

In terms of our specific targets for our fellowship and scholarship programs, we exceeded our goal and awarded 55 PSGC statewide fellowships and scholarships with 25% of awards granted to underrepresented minorities. We exceeded our undergraduate research scholarship target with 43 new WISER/MURE/FURP researchers and 35 returning scholars. We did not meet the specific target of 30% minority participation; however, >90% of the scholarships were granted to underserved students in STEM (82% female and 17% minority). We exceeded our NASA center internship award goal with 11 total students supported throughout the country, and we made a strong effort to offer internship funding to students from underrepresented groups with the percentage at 63% women awardees and 27% underrepresented minorities. We also provided four students with summer internship funding to participate in the X-Prize Lunar Lion spacecraft project. Our overall underrepresented minority participation in fellowship and scholarship programming was 20%, exceeding our state's growing diversity population percentages.

In terms of our specific targets for our higher education programs, we exceeded our target with 39 students in the ACURA program, providing hands-on research and creative discovery for Penn State Abington undergraduate students that heighten interest in STEM areas, resulting in 48% female participation (but only 10% participation by underrepresented

minority students this year, short of our targets). Ten ACURA students also participated in the NRAO project that consisted of a four day research trip to the National Radio Astronomy Observatory at the Green Bank Telescope. Students of this program are highly engage. This year the students observed 21 centimeter radiation from hydrogen gas in the Milky Way and other sources. All of the students who participated in this program are intending to continue their majors in a STEM discipline. At Franklin and Marshall and Gettysburg colleges, NURO met its target with five students involved in undergraduate research. Work done by undergraduate students this year included on-going photometry of variable stars.

The PSGC-supported higher education student space hardware programs, including Penn State Students Systems Laboratory, Penn State University Student Launch Initiative, Penn State Flight Vehicle Design and Fabrication course, Temple University Student Space Exploration and Embedded Systems Laboratory, Drexel University Space Systems Laboratory and Gannon University's high-altitude balloon student laboratory, greatly surpassed the overall student involvement targets with participation numbers totaling more than 195 participants. Attracting female student involvement in these hands-on engineering programs remains to be a challenge. Community college support in FY2014 meet our metric with the support of two Montgomery County Community College students to work on an authentic VTOL UAV engineering project.

In terms of our specific metrics for our West Chester University program, we exceed our targets with 16 STEM students involved in undergraduate research, particularly in the fields of Geology & Astronomy and Physics. This program places high emphasis on increasing the number of women in these departments with the goal of women in STEM continuing into graduate programs.

In FY2014, we had four continuing awards to support early career scientists. Postdoctoral students Jeff Havig and Trinity Hamilton (Penn State) continued work on an artificial hot spring. David Watts (Penn State) worked on vegetation changes in West Greenland. James Chen (Altoona) worked on the fluid dynamics of vortex formation, and Tim Sichler (Wilkes barre) worked on a novel low Earth orbit satellite design.

Outcome 2: *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty (Educate and Engage):*
Precollege programming supported a total of 220 in-service educators. With regards to our specific targets, we exceeded our objectives for Penn State Science Workshops for Educators and Pittsburgh University GLOBE workshops with 112 enrolled in-service teachers. The NASTAR Center educator workshops remain a successful area of K-12 development, supporting 56 in-service educators in aerospace-related, curriculum development workshops. NASTAR summer science camps supported 130 pre-college students, primarily at the middle school level. Susquehanna University's Saturday Science program met its workshop target by holding 12 meetings in the fiscal year, and exceeded its participant targets with 35 K-12 student participants and 3 pre-service teacher participants. The Saturday Science program trains pre-service teachers in STEM areas as they prepare for careers in education, using program resources in Susquehanna University classes. The Temple University Introduction to Electrical Engineering course did not meet its student target with 14 high school participants.

In general, this program continues to be an excellent project for pre-college diversity with over half of the total participants from underrepresented minority populations. PSGC also supported one Pennsylvania school district in the Student Spaceflight Experiments Program (SSEP), helping bring authentic learning experiences to K-12 students as they design and propose real microgravity experiments to fly in low Earth orbit to the International Space Station. Over 1,246 pre-college students participated in the Mission 4 SSEP program from Iroquois school district.

Outcome 3: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission (Engage and Inspire):*
The PSGC met its targets for Outcome (3) by funding six community events. Events included annual family science exhibitions at local elementary and middle schools, and activities related higher education and research projects including classroom visits, science cafes, and STEM career informational gatherings. Partly encompassed in this total, higher education programs, including the Lehigh Hopper and the Penn State Lunar Lion team, incorporate outreach components to their projects. For example, students from the Lehigh Hopper project gave presentations at the DaVinci Science Center.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Diversity**:

Fellowship and Scholarship = 30 students from underrepresented minority groups out of 148 awards (20%); and 96 female students out of 148 awards (65%)

In all programming combined (FS, HE, & RI) = 51 students from underrepresented minority groups out of 421 participants (12%); and 155 female students out of 421 participants (37%)

Additionally, a high number of our participants come from underserved rural populations throughout Pennsylvania.

- **Minority-Serving Institution Collaborations:**

In our consortium, we have two HBCUs (Lincoln University and Cheyney University). Both of these schools offer PSGC scholarships to deserving students so that the students can gain valuable, authentic research experience at their home institution. In FY2014, Lincoln awarded three scholarships (75% female), and Cheyney awarded four scholarships (25% female). In addition to these on-going programs, in FY2014, we used some of our mini-grant funding to allow the Penn State Department of Biochemistry and Molecular Biology to partner with several other minority serving institutions (Tuskegee University, Savannah State University, and University of Puerto Rico at Cayey) to offer quality, authentic summer research experiences to deserving students. In FY2014, this program awarded four such summer internships (50% female).

- **NASA Education Priorities:**

  - 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.

Most of the PSGC programing falls under this category of authentic, hands-on student experiences in science and engineering. In total, we had 421 students involved in such programs. These include science research at Penn State, University of Pittsburgh, California University of Pennsylvania, Cheyney University, Carnegie Mellon University, Lincoln University, Franklin and Marshal College, Gettysburg College, Penn State-Abington, and West Chester University. Additionally, we have a number of student engineering programs focused on space-related hardware development. These include Penn State, Drexel University, Lehigh University, Gannon University, Temple University, Penn State Wilkes Barre, and Montgomery County Community College.

  - 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).

We offer a number of teacher professional development workshops with a focus on engaging middle school teachers. These include ones offered at Penn State and our affiliate NASTAR.

  - Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges.

We have initiated new programming at Montgomery County Community College. There students applied a new superhydrophobic coating to electronics and avionics used in VTOL UAVs and tested the modified UAVs with their electronics and avionics totally exposed to the elements. This work aims to fill a need for VTOL UAVs to fly in inclement weather, while training the next generation of engineers.

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

We have an on-going mini-grant for the study of vegetation changes in West Greenland.

- Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities.

In FY2014, we had four continuing awards to support early career scientists. Postdoctoral students Jeff Havig and Trinity Hamilton (Penn State) continued work on an artificial hot spring. David Watts (Penn State) worked on vegetation changes in West Greenland. James Chen (Altoona) worked on the fluid dynamics of vortex formation, and Tim Sichler (Wilkes Barre) worked on a novel low Earth orbit satellite design.

IMPROVEMENTS MADE IN THE PAST YEAR

We have added Montgomery County Community College and Gannon University as affiliates. In our office, both Heather Nelson and Allison Fox have transitioned to new employment opportunities outside of Space Grant. For example, Heather Nelson is now University Outreach Manager at Blue Origin.

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.

- **The Pennsylvania State University**: Lead institution; 4-year University. Manages undergraduate and graduate student scholarships and fellowships, undergraduate research programs, , K-12 educator professional development workshops, public outreach events, and hosts three unique space systems laboratories and flight courses; mini grant recipient.
- **California University of Pennsylvania**: Affiliate; 4-year university. Manages atmospheric sciences/remote sensing research group.
- **Carnegie Mellon University**: Affiliate; 4-year university. Manages "Go Research!" summer undergraduate research program; involved in Lunar Lion X-Prize team internship.
- **Cheyney University (HBCU)**: Affiliate; 4-year university. Manages undergraduate scholarship program.
- **Drexel University**: Affiliate; 4-year university. Operates Drexel Space Systems Laboratory.
- **Franklin & Marshall College**: Affiliate; 4-year university. Manages the NURO undergraduate research in astronomy program.
- **Gannon University**: Affiliate; 4-year university. Operates Gannon University High-altitude Balloon Program.
- **Gettysburg College**: Affiliate; 4-year university. Manages the NURO undergraduate research in astronomy program.
- **Lehigh University**: Affiliate; 4-year university. Manages undergraduate and graduate student and NASA explorers schools project; mini grant recipient for the hopper spacecraft simulator project.
- **Lincoln University of Pennsylvania (HBCU)**: Affiliate; 4-year university. Administers undergraduate student scholarship.

- **Montgomery County Community College**: Affiliate; community college. Involved in projects and activities in collaboration with the Temple University Space Systems Laboratory.
- **NASTAR Center**: Affiliate; industry. Manages STEM education programs for student and teachers.
- **Penn State University – Abington**: Affiliate; 4-year university. Manages undergraduate research program, ACURA; facilitates radio astronomy investigations program at the National Radio Observatory.
- **Susquehanna University**: Affiliate; 4-year university. Operates Saturday Science program for pre-service educators and K-12 students.
- **Temple University**: Affiliate; 4-year university. Manages the Student Space Exploration and Embedded Systems Laboratory, summer program in electrical engineering for high school students, and undergraduate scholarship program.
- **University of Pittsburgh**: Affiliate; 4-year university. Manages NASA Space Grant fellowship program for undergraduate students; Education Resource Center elementary and middle school GLOBE program.
- **West Chester University**: Affiliate; 4-year university. Manages the undergraduate research program to increase numbers in STEM majors.

- **Academic STEM Alliance (Bald Eagle, Bellefonte, Penns Valley Area School Districts)**: Program partner; K-12 school district. Involved in Centre County pre-college and informal education programs.
- **The Aerospace Corporation, Ball Aerospace, Boeing, and Lockheed Martin**: Industry partners. Involved in Penn State student projects.
- **Carnegie Science Center**: Program partner; museum. Involved in new educator workshops starting next FY.
- **Center for Science and the Schools**: STEM education network member. Involved in educator professional development workshops at Penn State University.
- **The Franklin Institute**: Program partner; museum. Involved in activities related to the Drexel Space Systems Laboratory.
- **NASA Ames Research Center**, **NASA Glenn Research Center, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, NASA Kennedy Space Center, NASA Langley Research Center, and NASA Marshall Space Flight Center**: Program partners; government institutions. Hosts students for summer internships.
- **National Center for Earth and Space Science Education (NCESSE)**: Mini grant recipient; STEM education network. Involved in SSEP projects.
- **National Radio Astronomy Observatory**: Program partner; government facility. Hosts undergraduate research in astronomy for Penn State Abington teams.
- **The Pennsylvania State University – Altoona**: Mini grant recipient; 4-year university. Mini grant award for oscillating cylinder project.
- **The Pennsylvania State University – Wilkes Barre**: Mini grant recipient; 4-year university. Mini grant award for Low Earth Orbit Satellite program.
- **Penn State Public Broadcasting**: STEM public outreach partner. Involved in marketing and outreach for informal education events and programs.

- **Philadelphia Area School District**: Program partner; K-12 school district. Involved in Temple University Space Systems Laboratory projects.
- **Selinsgrove Area Intermediate School**: Program partner; K-12 school. Involved in Susquehanna University Saturday Science program.
- **Selinsgrove Area School District**: Program partner; K-12 school district. Involved in Susquehanna University Saturday Science program.