Pennsylvania Space Grant Consortium (PSGC)
Lead Institution: The Pennsylvania State University
Director: Dr. Christopher House
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PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Pennsylvania Space Grant Consortium (PSGC) is a Designated Grant Consortium funded at the level of $575,000 for fiscal year 2011.

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 2011 Targets: Our target was to award 50 PSGC fellowships and scholarships. We intended to award eight statewide scholarships to intern at NASA Centers, and four Lehigh University student scholarships in collaboration with NASA Goddard Space

Flight Center. We aimed to support two Historically Black Colleges and Universities (HBCU) students at Cheyney University enrolled in the Bachelor of Science Geographic Information Science program. We planned to award 55 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/or Gettysburg College performing undergraduate research in the National Undergraduate Research Observatory (NURO) program. We aimed to have a total of 55 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. 13.8% 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. Our goal was to have a total of 118 in-service educators participate in teacher professional development workshops (e.g. GLOBE). Through our precollege programs, we expected 25 high school and >75 middle school student participants. Finally, we aimed to support five PSGC community events.

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

Outcome 1 Highlights

I have learned more from Sailplane than any other class I have taken. It is a great opportunity to get hands on learning and understand how and why things work the way they do. It is great experience in terms of understanding engineering concepts you learn in other classes and applying them to aerospace. It also gives you design and building experience that you cannot get anywhere else before you get into the real world. Sailplane is the best experience besides internships to benefit your future in an engineering career. - Christy Lihn, 2011 Advanced Flight Vehicle Design and Fabrication (Sailplane), General Atomics Aeronautical Systems Inc. - Flight Technologies and Software Engineering Intern.

Outcome 2 Highlights

The Space Grant program was fantastic, in short. It opened many new doors for me in terms of exploration, interests, and academic focus. I also got to meet many new people with different backgrounds and specialties, and it was great to hear their stories and journeys. In terms of education, this experience really helped me understand what I really enjoyed about chemical engineering, research, and processes. Though I didn't really understand everything that happened due to my inexperience, my mentors and research groups really helped me understand the importance and impact of the work that we were doing. This was really great as even though I didn't really get the intricate details, I was able to appreciate the thought and effort put behind all the research that we were participating in. It also opened many doors for me by helping me see what I enjoyed

about engineering and chemistry. It helped me find a really cool interest - nanomaterials/catalysis - that I really want to learn more about in the future. - Richard Sim, 2011 WISER/MURE/FURP.

The instructors' tremendous knowledge, presentation, the eagerness to share their experiences and knowledge with us was amazing. Their energy and ideas motivated me to even learn more and take it to the classroom to make my students excited about science. - Anonymous STEM Educator, 2011 Astrobiology Workshop at Penn State.

PROGRAM ACCOMPLISHMENTS

In relation to our overall goals, we are proud to report that our college programming (F/S, HE, RI) totals 570 individual participants. This includes 195 participants in 12 different student hands-on engineering programs, and 190 awarded fellowships, scholarships and internships to students in STEM fields. 77 of the total awards were granted to underrepresented minority undergraduate and graduate students. Additionally, PSGC developed one new course and revised eight pre-existing courses. From Outcome 1 (educate and engage), 129 students took their next step in FY11 (SG participation supported from FY06-FY11 funds).

In terms of our specific targets for our **Fellowship and Scholarship** programs, we exceeded our goal and awarded 62 PSGC fellowships and scholarships with 24% of awards granted to underrepresented minorities. With 12 interns supported at NASA centers and six funded participants in the Lehigh University internship collaboration with Goddard Space Flight Center, we surpassed both targets. 33% of the 18 interns supported are underrepresented minorities. We exceeded our undergraduate research scholarship target with 50 new WISER/MURE/FURP researchers and 66 returning scholars. With the growth of the undergraduate research program, we did not meet the specific target of 30% underrepresented minority awards, but 92% of the scholarships were granted to underserved students in STEM (76% female and 16% minority, non-repeating). Two HBCU minority students received monetary scholarships to participate in Cheyney University Geographic Information Science research internships, meeting the specific target.

In terms of our specific targets for our **Higher Education** programs, we exceeded our target with 69 students in the ACURA program, with 32% from underrepresented minority populations. 14 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. 71% of NRAO scholars were underrepresented minorities, far exceeding our target of 13.8%. At Franklin and Marshall and Gettysburg colleges, NURO exceeded its targets with seven students involved in undergraduate research. Our student space hardware programs, including Penn State Students Systems Laboratory, Penn State University Student Launch Initiative, Temple University Student Space Exploration and Embedded Systems Laboratory, and the newly affiliated Drexel University Space Systems Laboratory, greatly exceeded the overall student involvement targets with a total of 146 participants. However, only 9% of these students were women, significantly missing our target of 20%. These results underscore the challenges of

promoting hands-on engineering experiences to female students when programs grow quickly in size, and suggest that PSGC needs to continue to focus on this issue. Lastly, the FVDF course exceeded its participant target with 32 enrolled students, but just fell short of the diversity metric with 19% women.

In terms of our specific targets for our **Research Infrastructure** programs, we exceeded our targets for our West Chester program with 12 STEM students involved in undergraduate research. Our Lincoln University Environmental Sciences project met its target of two student participants, both of which were female underrepresented minorities. Our mini-grant program funded two early career scientists, but did not meet the target of four junior faculty supported with FY 2011 base funding. We anticipate additional seed grant funding aimed to support early career faculty in FY 2012.

Precollege programming supported a total of 290 in-service educators. With regards to our specific targets, we exceeded our objectives for Philadelphia Robotics, Penn State Science Workshops for Educators, and Pittsburgh University GLOBE workshops with 174 enrolled in-service teachers. Over 40% of these teachers served classrooms with >50% minority populations and 80% of teachers reported using the course content after one year. Susquehanna University's Saturday Science program met its workshop target by holding 12 meetings in the fiscal year, and exceeded its participant targets with 104 K-12 student participants, 85 parents involved, and 35 pre-service teacher participants. The Temple University Introduction to Electrical Engineering course did not meet its student target with 20 high school participants; however, the program continues to be an excellent project for pre-college diversity with 21% female and 32% minority participation. Finally, we met our target by funding five PSGC community events, reaching out to over 2,000 total participants.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Student Data and Longitudinal Tracking:

Total awards = 570; Fellowship/Scholarship = 190, Higher Education/Research Infrastructure = 380; 35 of the total award represent underrepresented minority F/S funding. During the FY11 program year 23 are pursuing advanced degrees in STEM disciplines, 10 accepted STEM positions at NASA contractors, 37 accepted STEM positions in industry, 1 accepted a position at NASA, 1 accepted a STEM position in K-12 academia, 19 accepted STEM positions in academia, and 38 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing while the received their Space Grant award.

- Diversity:

PSGC strives to reach out to, welcome, and include the broadest range of students possible in all of our programming. Recruitment emphasis is placed on underserved and underrepresented populations within STEM disciplines. Many of our affiliate institutions have an extremely diverse student body, and awards are advertised to target underrepresented groups including, Women in Science & Engineering and the National Society of Black Engineers. Additionally, several initiatives are in place to advance these diversity efforts, such as collaborations with community colleges throughout the state,

outreach events focused on increasing underserved and underrepresented student involvement in STEM-related fields, and free science enrichment programs to low-income families. Internal PSGC programming focuses primarily on recruitment and retention of underrepresented students by offering research internships with high award emphasis on early-college-level women and minority undergraduates in STEM. Such diversity efforts resulted in a total of 241 women and 77 underrepresented minorities involved in college-level programs consortium-wide, totaling a combined percentage of 50% underserved higher education participation in FY 2011. Underserved students receiving direct monetary awards totaled 77%.

- Minority-Serving Institutions:

Cheyney University of Pennsylvania is the oldest of the Historically Black Colleges and Universities in America. The mission of Cheyney University is to provide a higher education option to students of lower income and of African American heritage. The university specifically targets these students when advertising all academic programs including fields of significance to NASA and PSGC. Lincoln University, another HBCU, is nationally recognized for African American undergraduate students receiving degrees in the physical sciences, computer sciences, biological and life sciences. Most of the students (95%) in the School of Natural Sciences and Mathematics are minority, and over 65% of these students are female. PSGC funding focuses on supporting student research in environmental sciences as well as providing scholarships and internships for underrepresented students. In FY 2011, PSGC supported two female minority Lincoln University students for an environmental science research scholarship program. One student presented a poster at the Annual Chemical Society conference in April 2012. In addition, this student was selected to participate in an astrobiology field course, funded by PSGC, in May 2012.

- NASA Education Priorities:

PSGC programming efforts serve all NASA Education current areas of emphasis.

With several projects dedicated to undergraduate research and space hardware development, we supported 452 undergraduate and graduate students in authentic, hands-on experiences in science and engineering disciplines. Examples of these programs include Gettysburg and Franklin & Marshall Colleges' National Undergraduate Research Observatory, where students conduct field work in astronomy, answering real research questions by actively observing, processing data, and conducting analysis, with the goals of recruitment and retention of physics majors and cultivating interest in STEM-related fields post-graduation.

Programming that engages middle school teachers in hands-on curriculum enhancement expanded in FY 2011. PSGC funded seven STEM workshops targeted toward middle school educators. In addition, higher education projects such as the Penn State University Student Launch Initiative and the Drexel Space Systems Laboratory incorporated outreach events into their engineering tasks where university students presented material related to rockets and science to middle school audiences, encouraging young students to consider engineering careers and providing teachers with information to take back to their classrooms.

Temple University's program in electrical engineering is a summer opportunity for high school students to participate in a five-week course in Electrical and Computer Engineering. The goals of this program are to encourage secondary school students to enter the higher educational system, and to introduce students to the field and profession of engineering. PSGC supported 20 high schools students at Temple University in this program during FY 2011, with 32% student participation from underrepresented minority groups. Students worked on the design and build of an autonomous robotic system and participated in a competition that was filmed by both Philadelphia Channel 6 ABC News affiliate and also the Temple University News. The Penn State Student Space Systems Laboratory is also actively involved with secondary student opportunities. The lab hosted 40 high school students to talk about space systems and engaged the students in a hands-on soldering demonstration and discussion of general Electrical Engineering topics.

Community college partnerships have developed in FY 2011. The Lehigh University undergraduate and graduate research program signed the first articulation agreement in the history of Lehigh University with a community college, and is currently working on two more. Three undergraduate minority and female Mechanical Engineering and Chemical Engineering students from the partner community college are currently involved in undergraduate research with Lehigh faculty. Plans are in place to expand these efforts.

Many PSGC programs are committed to aeronautics research in suit with NASA's unique capabilities. One example of an aeronautics focused program is the University Student Launch Initiative (USLI). The USLI program includes several opportunities for the students to interact with NASA personnel in areas of shared interest. The students' primary motivation is the deepening of their aerospace engineering skills and capabilities. They gain tremendously from working together on other teams, putting their aerospace engineering training to the test, and learning how to develop a complex project along systems engineering precepts.

Research and activity projects with an emphasis on environmental science and global climate change are in place at Lincoln, Penn State, and Susquehanna universities. Lincoln University is designed to increase the number of minority students entering graduate school and enhance Lincoln's Environmental Science program. In order to promote research, Space Grant offered two student scholarships in the 2011 academic year and secured summer internships for the students. Penn State's Summer Science Workshop program held a climate change workshop that supported 11 in-service educators, and the Center for Science and the Schools hosted one workshop on climate developments, supporting 21 educators. Finally, Susquehanna University's Saturday Science program held a two-session unit dedicated to global climate change that involved hands-on science activities and mini-projects for rural elementary- and middle-school students.

As previously described, PSGC has great efforts in place to increase diversity in student participants, faculty, and affiliate institutions. We will continue partnerships with HBCUs in Pennsylvania and maintain high focus on supporting underserved and underrepresented students in STEM disciplines.

Involvement with Drexel University has impacted the final area of emphasis – the enhancement of institutions to support innovative research infrastructure activities to

enable early career faculty to focus their research toward NASA priorities. PSGC support of the Drexel Space Systems Laboratory is helping to cultivate future leaders in space technology by providing support for innovative space systems engineering research.

IMPROVEMENTS MADE IN THE PAST YEAR

In FY 2011, PSGC continued its effort to engage active and continuous involvement of all affiliate institutions. These efforts resulted in an enhanced management structure of effective reporting and successful programmatic outcomes. The lead institution maintains strong focus on National Space Grant goals and objectives, and ensures impacts are aligned with NASA's Strategic Plan and the needs of Pennsylvania. STEM workforce development projects have increased in FY 2011 with expanding programming in space technology and engineering-related higher education activities. The space systems laboratories, high-altitude ballooning projects, microgravity research, and RockSat involvement has greatly increased the number of university-level students continuing through the NASA-STEM pipeline.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

Higher Education Institutions Receiving Funding (4-year): *Lead Institution:* The Pennsylvania State University; *Affiliate Institutions:* California University of Pennsylvania, Carnegie Mellon University, Cheyney University (HBCU), Drexel University, Franklin & Marshall College, Gettysburg College, Lehigh University, Lincoln University (HBCU), The Pennsylvania State University – Abington, Susquehanna University, Temple University, University of Pittsburgh, University of Pittsburgh ERC, West Chester University; *Mini-Grant Recipients:* Gannon University, The Pennsylvania State University – Wilkes-Barre.

Higher Education Institutions Not Receiving Funding: *STEM Education Network Partners:* Duquesne University, East Stroudsburg University, Louisiana State University HASP Program Office, The Pennsylvania State University Applied Research Laboratory, Swarthmore College, University of Delaware, University of Pennsylvania.

Government Institutions (Federal, State, Local): *Teacher Professional Development Workshop Partners:* Aerospace Education Services Project, NASA Astrobiology Institute, NASA Goddard Space Flight Center, NASA Swift Mission, National Science Foundation; *Higher Education Partners:* Department of Public Safety (Philadelphia, Washington, Westmoreland), Microgravity University, NASA Ames Research Center, NASA Columbia Scientific Balloon Facility, NASA Glenn Research Center, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, NASA Johnson Space Center, NASA Kennedy Space Center, NASA LARSS, NASA Marshall Space Flight Center, NASA Wallops Island Flight Facility, NOAA National Weather Service.

Industry: *Affiliate:* NASTAR Center; *Corporate Partner Funding Source:* The Aerospace Corporation, American Aerospace Advisors, Boeing Corporation, Lockheed Martin Space Systems, Pratt & Whitney, Raytheon Corporation, SMART Group, Specialty Rings Manufacturing, Stratostar.

Other Non-Profit Organizations: *STEM Education Network Members:* Academic Space Alliance (Bald Eagle, Bellefonte, Penns Valley School Districts), Astronomical

Society of the Pacific, Center for Science and the Schools, Centre County 4-H, Centre Region YMCA, Challenger Learning Center, Girl Scouts of Eastern Pennsylvania, Hatsboro-Horsham School District, National Alliance of State Science and Math Coalitions, National Society of Black Engineers, Palmyra Cove Nature Park, Selinsgrove Area School District, Solar System Ambassadors, Solar System Educators, Pennsylvania STEM Initiative, Philadelphia School District.

Other Organizations: *STEM Public Outreach Partners:* Bellefonte Art Museum for Centre County, The Carnegie Science Center, The DaVinci Center, The Discovery Space of Central Pennsylvania, The Franklin Institute, Juniata College, Penn State Public Broadcasting, Space Telescope Science Institute, The Whitaker Center; *Higher Education Partners:* Colorado Space Grant Consortium.