

Delaware Space Grant Consortium
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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 DE Space Grant Consortium is a Program Grant and Capability Enhancement Consortium funded at a level of \$430,000 for fiscal year 2012.

PROGRAM GOALS

Utilize NASA funds to serve students and teachers in the State of Delaware in a variety of educational and training projects in areas which are related to STEM-G. At the college level, provide fellowships and scholarships to students attending 2-year and 4-year colleges throughout the State and to aid in professional development of STEM-G related educators. Enhance research opportunities on and off-campus, during the academic year and summer. Recruit and provide support for the education and training of professionals especially women, underrepresented minorities, and persons with disabilities for careers in fields which will meet NASA's needs in the 21st century.

As an indication of the program goals which have been achieved, we may cite results from our Longitudinal Tracking: the percentage of students who have been successfully tracked through their next career step versus their last year of SG support, we can report that this percentage is 82% for 2006 and 64% for 2007, 80% for 2008, and 100% for 2009, 2010, and 2011. Figures are not available yet for 2012: all participants are still enrolled. A total of 85% of students significantly supported by DE Space Grant went onto next steps in STEM disciplines.

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

Provide concise, meaningful highlights or anecdotes (no more than three) that are directly related to work completed in 2012, highlighting student and/or project accomplishments. Specify alignment to an Outcome.

(1) In the area of Research Infrastructure Development (RID: Outcome 1), DESGC provided RID funding in FY12 to Dr. Chandran Sabanayagam for a completely new aspect of research in the state of Delaware. The goal is to develop a CubeSat microscope to characterize proteins related to the survival, adaptation and evolution of the worm *Caenorhabditis Elegans* in space. Dr. Sabanayagam was on the faculty at Delaware's HBCU (Del State Univ) when he first received DESGC support for one of his grad students and is now at DE Biotechnology Institute in Newark DE. The goal is to develop the hardware and software of an integrated life-support system and microscope imaging platform to monitor gene expression levels of *C. elegans* in low Earth orbit. The microscope will obtain images at 50x magnification with a CCD camera, using low power-consuming LED illumination sources. Images of green fluorescent protein (GFP) biomarkers expressed by the worms will be obtained. A microfluidic life-support chip will be developed for *C. elegans* (each about 1 mm long) that will allow long-term (over 9 months) autonomous feeding, sorting, and imaging of many generations of the animals, followed by telemetry of data to ground stations. Eight independent life-support systems will be fabricated onto a 6 cm diameter "worm chip" for independent replicates or to analyze different animal strains. Following the award of DESGC/RID funds to Dr. Sabanayagam, he was subsequently successful in obtaining 2 years of additional funding for his work from NASA's ASTID program (Astrobiology Sci. and Tech. Instrum. Dev.). No DE institution has previously built a CubeSat, so DESGC is pleased to help Dr. Sabanayagam achieve this goal.

(2) Also as a first for Delaware in FY12 (in Outcome 2), a 6-member team of undergraduate students from Delaware Technical Community College (DTCC) was selected by NASA to perform a physics experiment ("Vertical Projectile Motion with Drag") aboard the variable-gravity plane known as G-FORCE ONE. On the DTCC campus in Stanton DE, the students on the team were drawn from 4 separate departments: Biological Sciences, Computer Information Science, Middle School Math and Science Education, and Math Secondary Education, with advice from 2 faculty members. The team developed their experimental set-up, consisting of a projectile launcher with photogate, a laser pointer for alignment, a data-logger, an accelerometer, and a video camera. NASA provided a glove box to house the experiment on board the aircraft. DESGC provided funds to cover 50% of the travel and housing costs during the team's trip to Johnson Space center. Splitting up into a Red team and a Green team, the DTCC students performed their experiment on 2 separate flights, each consisting of 40 parabolic paths over the Gulf of Mexico. Since returning, the team has reported on their experiences in a number of venues, including at the Delaware Aerospace Education Foundation (operated by DESGC's Outreach leader Dr. Stephanie Wright), the Annual Research Symposium of DESGC, and at a meeting of the Amer. Assoc. of Physics Teachers, where the team leader, Mr. Depto, won a prize for best student paper.

(3) Paul Spencer and Tyler Davidson, students from another campus of DTCC (in Georgetown DE), were supported in summer 2012 by DESGC as summer interns on the Marine Studies campus of Univ of Delaware, under the mentorship of Oceanography Prof. George W. Luther III. The goal of the project (under heading Outcome 2) was aimed at contributing to a team of graduate students and researchers who were developing and manufacturing a semi-automated electromechanical system to collect multiple samples of organisms *in situ* at thermal vents on the ocean floor. The method was to gather nanoparticle concentration and composition, and to collect more distinct samples of various iron pyrites particles by filtering the sea-water on location. The filtered particle sizes were designed to be 200 nanometers, 2 microns, and 10 microns. The greatest challenge in the design comes from the depth at which the measurements are to occur: more than 3000 meters below sea level, where pressures are about 5000 pounds per sq. inch. To control the flow of sample fluid at such extreme pressures, a solenoid pinch valve was used, but there are no commercially available valves suitable for seawater at 3000 meters. The project required the design and fabrication of a special valve encased in a mineral oil housing with a pressure equalization port to protect it from seawater, followed by testing of the system. By the end of the summer internship, the fabrication and testing were complete. The *in situ* measurements were to be remotely operated via the Jason underwater research vessel. After the DTCC students had returned to college for the fall semester, the instrument was taken out for sea trials in October 2012 by Dr. Luther. Starting from the Azores, the research vessel Knorr travelled to the Mid-Atlantic ridge to test the thermal vents there. On Oct 23, Dr. Luther sent the following e-mail to Mr Spencer and Mr Davidson: “**Congratulations! Your filtration survived well at over 3600 meters depth today. There were no electrical faults and the housing maintained pressure**”. Samples of iron/sulfur particles obtained by the instrument near the thermal vents are currently being analyzed. It has been especially valuable for the DTCC students to have a chance to collaborate with a scientist of Dr. Luther’s stature: the American Chemical Society has announced that Dr. Luther is the 2013 recipient of the Geochemistry Division Medal, the highest honor of the Division, given every other year to recognize outstanding achievements in the field. Mr Spencer gave a well-received oral presentation about his work at the Mid-Atlantic Regional SG Meeting in Philadelphia in Sept 2012.

PROGRAM ACCOMPLISHMENTS

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

Administration

A major change occurred in FY12 when a new Associate Director joined DESGC with a specific task allotted: improve our Diversity statistics. He is Dr. Chad Starks, an African-American recently (Sept 2012) appointed to the faculty at Delaware State University (Delaware’s HBCU). Although Dr. Starks is not involved in STEM fields professionally, his rapport with African-American students, and his enthusiasm for academic life, makes him ideal for reaching out to underrepresented minorities (UMs), and drawing them to DESGC to take advantage of the funding opportunities offered by NASA in the state of DE. Dr. Starks attended his first DESGC Advisory Board meeting on March 8, 2013,

where he convinced all in attendance with his persuasiveness and commitment to drawing African-American students into STEM fields.

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, Higher Education and Research Infrastructure programs). *(Employ and Educate)*

(1) Graduate fellowships

Seven graduate fellowships were awarded in a competitive process in May 2012. One award went to a female student at Del State U (our HBCU), the remainder to UD (to the departments of Chemical Engineering, Geography, Oceanography, Geology, Marine Biosciences, and Physics and Astronomy). Three of the 7 awardees were female.

In addition, one graduate student (Asia Downtin: African-American female) was supported in Geography as a teacher in training to bring NASA-related material into the classroom.

Metric (Number of grad students supported): In Year 3 of our FY10 base proposal, DESGC had set as a goal full funding for 4.5 graduate fellows plus 0.5 grad students supported by Bartol Research funding. **We exceeded this goal. ++**

Metric (Diversity, gender): Of the 8 graduate students supported in FY12 by DESGC, four (50%) were female. **We exceeded NASA's goal for female representation (40%). ++**

Metric (Diversity, ethnicity): In FY12, only one of our 8 grad awards (13%) was African-American. According to NCES data, the total percentage of African-American minorities enrolled in DE colleges is 21.8%. **We did not satisfy this goal. –**

(2) Undergraduate Summer Research

Metric (DESGC support of undergraduates performing summer research on affiliate campuses): In Year 3 of our FY10 proposal, our goal had been to offer DESGC support to 5 summer research students on affiliate campuses. **In FY12, we exceeded this goal.** By leveraging with faculty sponsored research funds, DESGC was able to support 8 undergraduates in summer research in FY12. ++

Metric (DESGC Summer research Program for undergraduates at NASA Centers). In FY10/Year 3, we proposed that DESGC would support one student in a summer program at a NASA center. **In FY12, we greatly exceeded this goal:** in FY12, three students were funded by DESGC at NASA centers, one at Goddard SFC, one at Johnson Space Center, and one at Ames Research Center. ++

Metric (Diversity, gender): Among the 11 students in FY12 Undergrad Summer Research programs, two (18%) were female. **We did not satisfy NASA's goal of 40% females. -**

Metric (Diversity: students with disability): Among the 11 students in FY12 Undergrad Summer Research programs, one was a student who is classified by Univ of DE as having a learning disability. **We exceeded our expectations in this area.** ++

Metric (Diversity, African-Americans): Among the 11 students in FY12 Undergrad Summer Research, two (18%) were African-American. **We did not satisfy the goal of reaching the DE state percentage of African-Americans in college (21.8%),** although we came close. –

A contributing factor to this low number is that students at Del State Univ (Delaware's HBCU) have access to a large and active NASA-University Research Center (URC) for Applied Optics for Space Science: with a large amount of Grant funding at the URC (\$5 million in total), there are many opportunities for undergrads from Del State to get summer research experience without help from DESGC.

(3) Research Infrastructure Development

In this section, we report on (a) the grant of DESGC/RID funds which was awarded in FY12 to Dr. Chandran Sabanayagam, originally at Del State University and now at Delaware Biotechnology Institute in Newark DE. Also discussed in this section is (b) the process of strengthening our research links with NASA centers and (c) strengthening research links with industry.

(a) Dr. Sabanayagam is a biophysicist who joined the University of Delaware two years ago. His research interest includes studying molecular motors such as DNA polymerase and viral terminase, and developing new light microscopy instruments for the biomedical field. Space research is a new field of research for Dr. Sabanayagam, and funds from the RID grant were used to startup a new project in nanosatellite instrumentation development for NASA's Astrobiology and Space Biology programs. He is developing a CubeSat microscopy microlab to investigate how molecular and cellular processes are affected by microgravity through imaging model microorganisms in low Earth orbit. The specific goal of the experiment is to characterize proteins related to the survival, adaptation and evolution of the microscopic worm (*Caenorhabditis Elegans*) in space. Currently, a nanosatellite microscopy module has not been demonstrated in space, so this represents a potential transformative technology in gravitational research. A significant portion of this research involves designing microfluidic devices that can cultivate various organisms such as *C. elegans* (each about 1 millimeter long), bacteria and yeast, on board the satellite. Dr. Sabanayagam used the RID seed grant to purchase a CO2 laser cutter, which is used by many researchers to fabricate microfluidic devices in polymethylmethacrylate (PMMA) thermoplastics. The laser tool enables the fabrication of microfluidic devices—from concept to functioning prototypes—in *one day*, as opposed to using soft lithography techniques that involves *days to weeks* for processing and furthermore requires some device preparation in a cleanroom environment. Other key equipment purchased includes: a plasma cleaner used to bond PMMA parts together, a computer-controlled fluid delivery system, and a spin coater to create polymer films. Dr. Sabanayagam is very active in Astrobiology and Space Biology research. After receiving RID funds from DESGC, he was awarded a grant from NASA's Astrobiology Science and Technology Instrument Development (ASTID) program to develop a TRL4

scanning fluorescence microscope CubeSat. The original research proposal included developing a microfluidic “worm chip” and engineering new strains of *C. elegans* that contain fluorescent biomarkers to putative gravity-responsive genes; however, these elements of the proposal had to be descoped to respond to a lower level of funding than requested. The RID seed grant enabled Dr. Sabanayagam to push forward and design the microfluidic components of the CubeSat microscope. As a member of the Delaware Biotechnology Institute’s Bioimaging Center, he has access to various fluorescence microscopes which he uses to observe *C. elegans* in various microfluidic prototypes. Last year Dr. Sabanayagam submitted a grant to the NASA Space Biology program to study the effects of altered gravity in ground-based experiments of *C. elegans*—this proposal involved the extensive use of PMMA microfluidic devices. Currently, Dr. Sabanayagam is preparing a submission to the NASA SmallSat Technology Partnerships program with partners from Goddard Space Flight Center and Ames Research Center to increase the fluorescence scanning CubeSat microscope to TRL5. This proposal will place more emphasis on developing microfluidics with partners from ARC.

At the Annual DESGC Research Symposium in April 2013, Dr. Sabanayagam reported on the progress he has made in developing the “worm chip” with independent chambers for multiple worms, each about 1 mm long.

(b) Strengthening links with NASA Centers

Metric (Goddard): In Year 3 of our DESGC FY10 proposal, we had proposed to support at least one DESGC student at GSFC. **In FY12, we achieved this goal**, sending one student (Sharnita James, African American female) to GSFC. +

Metric (Langley): In year 3 of our DESGC FY10 proposal, we had proposed to have at least one undergrad summer researcher from DE work at Langley. **In FY12, we did not meet this goal.** –

Metric (Johnson): We had not planned in Year 3 of our DESGC FY10 proposal to have a student at Johnson Space Center. But in FY12, DESGC supported Brian Greenly, an engineering student from DE’s HBCU (Del State Univ), to spend the summer at NASA/Johnson. **We exceeded our goal in this category.** ++

Metric (Ames): In FY10, there was no plan to send students to NASA/Ames in Year 3. But a UD student (Christine Gregg, Mech. Engineering) applied to NASA/ARC and was accepted into a summer research program. **We exceeded our goal in this category.** ++

Metric (Diversity, gender): of the NASA Center grants awarded by DESGC in FY12, 67% were awarded to females. **We exceeded NASA’s goal of female representation.** ++

Metric (Diversity, underrepresented minorities): of the NASA Center grants from DESGC in FY12, 33% were awarded to African-Americans. **We exceeded NASA’s goal of African-American representation (22% in DE).** ++

(c) Strengthening research links with Industry

Metric: In Year 3 of our DESGC proposal in FY10, we had not planned anything in particular to strengthen the links between DESGC and industry. But in FY12, graduate student Kate Gurnon (UD Chemical Engineering), for a second year, won a competitive DESGC Grad Fellowship to study the possibility that shear-thickening fluids (STF) might help protect astronauts from micrometeoroid impacts. One of DE's nationally known industries, ILC Dover (maker of space suits for US astronauts), continued to be actively involved in collaboration with Kate and her advisor (Dr. Norman Wagner). **We exceeded our goal in this area. ++**

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*)

Outcome 2: Higher Education

(a) DESGC Graduate Student in Geography Teacher Training.

Metric: In Year 3 of DESGC's FY10 proposal, the budget provided funding for a grad student in UD's Geography Dept to be used to expand NASA-based teaching resources (specifically satellite imagery) for classroom teachers in DE in support of DE's geography standards. In FY12, Asia Downtin (African-American female) was supported with DESGC higher-ed funding for this task. **We satisfied this metric +.**

(b) DESGC funding for Community College students in rocket/balloon launch programs.

Metric: In Year 3 of FY10 proposal, our goal was to provide rocket-launch funding to 2 students at DE's 2-year college (DTCC). In FY12, we provided DESGC funds to two DTCC (Dover) students, one in Computer Network Engineering (to graduate in fall 2013), and one in Electrical/Electronic Engineering (to graduate in spring 2013). These funds enabled the students, in the company of their professor Dr. Lester Link (Chair of Electronic Technology at DTCC Dover) to attend Rock-On at NASA's Wallops Island launch facility. The students presented a poster on their work at the Annual Research Symposium in April 2013. **We satisfied this goal. +**

(c) Undergraduate tuition scholarships

Metric (Number of awards): The goal in our Year 3 DESGC base proposal was to spend a total of \$7,500 for undergraduate tuition scholarships (UTS) to three students at DTCC (Delaware's Community College) and \$21K for seven awardees at non-DTCC campuses. In FY12, we awarded 3 UTS to DTCC students. **We satisfied the metric for DTCC students. +**

As regards UTS for non-DTCC students, **we exceeded the metric for the Year 4 proposal for non-DTCC students:** DESGC in FY12 provided UTS to 13 students at non-DTCC schools. ++

Metric (Distribution among affiliates): Of the 3 DTCC students, 1 award went to the Stanton campus and 2 went to the Georgetown campus. As regards the 13 non-DTCC

awardees, one was at Del State (our HBCU), 2 were at Wesley College, one was at Wilmington University, eight were at UD, and one was at Villanova. **We satisfied the goal of distributing UTS widely among affiliates.** +

Metric (Diversity, ethnicity): The percentage of underrepresented minorities (UMs) in DE colleges is close to 25%. **We failed to achieve this metric in UTS awards in FY12:** of the 16 awardees, only two (13%) were UMs (one African-American at Wilmington U, one Hispanic at Wesley College). -

Metric (Diversity, gender): Of the 16 UTS awardees in FY12, six were female, a percentage (38%) which is slightly below NASA's goal (40%), although depending on allowable range, our results might be considered as satisfying the goal. Depending on the allowable range, **we may not have satisfied NASA's goal for female awardees in this category.** -

Metric (DTCC Diversity): Our two-year affiliate Delaware Technical Community College (DTCC), although not officially an MSI, includes a more representative population of underrepresented minorities among the student body on its State-wide campuses than UD. In FY12, the DESGC goal was to have at least one UM supported with UTS at DTCC, but none of the 3 awardees was UM. **We failed to achieve this metric.** -

Metric (DSU Diversity): The goal for DESGC in FY12 was to have at least one UM undergrad tuition scholar at Del State Univ (Delaware's HBCU). Although DESGC *did* award a UTS to a student at Del State Univ, she was not an UM. **We did not satisfy this metric.** -

Outcome 2: Pre-college Programs.

DESGC Programs which are aimed at professional development of teachers are operated by Dr. Stephanie Wright, founder and CEO of the Delaware Aerospace Educational Foundation (DASEF). Founded in 1989, DASEF is an independent non-profit education organization which functions to raise the visibility and value of K-12 STEM education so as to meet intellectual and workplace needs of the future. DASEF implements successful programs using proven instructional strategies to motivate, engage, educate and inspire students from diverse backgrounds and communities in Delaware. DASEF's vision is driven by the belief that "Wisdom Begins with Wonder." Capitalizing on natural curiosity through activities that include a problem solving component enriches the learning process for participants. Since 1989, DASEF has established itself in Delaware as an innovative and progressive organization with the vision and resources required to link contemporary aeronautic, space, and engineering themes with traditional school subjects to increase interest in science and technology.

Dr. Wright's programs which were operated with DESGC support in FY12 were as follows.

Rocketry Challenges for Teachers: This Statewide rocketry program is designed to assist teachers as they use rocketry as the unifying theme for teaching STEM and non-

traditional career choices, skills and technology. Challenge packages and rocketry curriculum are sent to teachers in all schools in the state of Delaware. This program includes a "teacher self-training" based on the NASA Rocketry Book to teach the Laws of Physics and a "how to guide" to construct the various rockets. Approximately 15 educators from 14 schools and home schools within the State of Delaware and 8 CAP squadron leaders participated in the annual Rockets for Schools program held on May 5 at Cape Henlopen State Park. 96 student and cadets participated. 200 general public were at the event.

Mentors for Rocket Program: A segment of the Rocket Program partners with undergraduates in the Mechanical Engineering Department at the University of Delaware worked with and mentored students in learning the Laws of Physics as they built and launched rockets. The ME students shared their reasons for entering the field of engineering and served as role models to the younger students. This is an annual program coordinated by the ASME at the University of Delaware. The DESGC assisted with funding for materials, rockets and room rental.

STEM Curriculum for Teachers: This program is designed to assist teachers as they use STEM curriculum in their classrooms during the school year. STEM Curriculum is distributed to participating teachers in Delaware. This program includes a "teacher self-training" based on the NASA materials and curriculum handbooks that focus on specific STEM materials. All teachers accompanying field trips to the Outpost are given teacher packets containing NASA materials. Mailings are sent and distributed to all schools at least once a year. Approximately 1,175 educators from 96 schools within the State of Delaware were served through this program.

Delaware Aerospace Academy: (DAA) In operation since 1990, the objective of the DAA is to provide hands-on training and experiences through our Destination academies in related activities and fields. Throughout the week, students in grades 1 - 10 are continually challenged to think, create, solve, build, and work cooperatively. Curriculum used in the academies is standards based and designed to integrate the study of science, technology, engineering, and mathematics using Earth and Space Education as the unifying framework. Current STEM/NASA themes and content are integrated into the curriculum and participants and staff are informed of current NASA opportunities, mission activities programs and opportunities throughout the year. In 2012, 270 students participated and 17 teachers and undergraduates were mentored.

Professional Development Workshop (February 7): During this session, educators looked back at the Earth and out into the Universe. They experienced the StarLab, observed the stars in the Mountjoy Observatory using DASEF's 16" Meade Telescope. Each educator constructed their own Galileoscope telescope and viewed the constellations and planets. NASA materials and resources were distributed.

Earth Systems Workshop (May 30): A 3-hour evening program for K-8 teachers at DASEF's Environmental Outpost in Smyrna, DE, included instruction in remote sensing of the earth, and introduction to DASEF's Planet Earth Outreach program.

The Universe Beyond Your Eyes Workshop (October 7): A 6-hour program for Science and Technology teachers of grades K-8 at the Environmental Outpost in Smyrna, DE. The day's activities included a science content presentation about discoveries from Hubble Space Telescope and demonstrations of inquiry-based, classroom activities. During the demonstrations participants explored topics such as Light and Color, Infrared Light, Optics and Galaxies. Participants also developed an understanding of how technology is essential to scientific progress, and related the significance of the electromagnetic spectrum to astronomy. Educators received a free sample packet of Hubble curriculum support tools for their classroom.

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)*

Outcome 3: Informal Education

DESGC offers the following informal education opportunities to engage and inspire.

Goddard Space Flight Center Forum (March 13): Dr. Stephanie Wright led a one-day trip for 21 Delaware teachers to tour GSFC to provide exposure and experiences to support the enhancement of knowledge and skills, and to provide access to NASA information in science, technology, engineering, mathematics, and geography.

National Air and Space Museum's Udvar-Hazy Center (May 12): Dr. Stephanie Wright led a one-day trip for 25 Delaware K-12 teachers to tour the National Air and Space Museum's Udvar-Hazy Center in Chantilly, Virginia.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

1. Student Data and Longitudinal Tracking:

Total awards = 34; Fellowship/Scholarship = 23 (16 undergrads, 7 grads), Higher Education = 1 (grad); Summer Research Awards = 10. Of the 34 awards, 33% were made to females, and 15% to underrepresented minorities. During the FY12 program year 7 students are pursuing advanced degrees in STEM disciplines, 6 accepted STEM positions in industry, 2 accepted STEM positions in academia, and 4 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing when they received their Space Grant award.

2. Minority-Serving Institution Collaborations: Summarize interactions. Reference the names of projects with MSI collaborations.

In the state of DE, Del State Univ (DSU) is the only officially listed MSI (it is an HBCU). In FY12, there have been two important developments in the interaction between DESGC and DSU.

First, since Director Mullan took over DESGC in 2005, there have been productive and cordial contacts between DESGC and DSU via the long-serving affiliate representative Dr. Nouredine Melikechi. Since 2005, Dr. Melikechi has seen to it that DSU has garnered funding not only in all of the categories of student awards (undergrad tuition, summer research, grad fellowships) but also in the faculty categories as well (DESGC/RID, and NASA/EPSCOR). However, over the years since 2005, Dr. Melikechi has been steadily rising up thru the administration of DSU: he is now Dean of the College of Math, Sci, and Tech., and also Vice President for Research, Innovation and Economic Development. As a result, Dr. Melikechi requested during FY12 to be replaced as affiliate rep at DSU by Dr. Hacene Boukari, a professor in the Dept of Physics and Pre-Engineering. As a previous winner of a NASA/EPSCOR/DE seed grant award, Dr. Boukari is well aware of the funding opportunities provided by NASA in the state of DE. The DESGC Director looks forward to a productive collaboration with Dr. Boukari.

Second, because of the difficulties that DESGC has had recently in fulfilling the NCES demographic statistics as regards Diversity, the Advisory Board of DESGC has recommended that a second contact be established between DESGC and DSU. The specific purview of the second contact is to address the Diversity deficit which the NASA/SG Manager's Office at NASA/HQ has identified in operations at DESGC. The unusual aspect of DESGC's second point of contact at DSU is that the faculty member in question (Dr. Chad Starks) is *not* involved in a STEM field. He has a faculty appointment in the Dept of Sociology and Criminal Justice. However, he has an extensive interest in encouraging African-Americans to undertake the challenges of STEM education so that they can take their rightful place in NASA's future workforce. His rapport with undergraduate students and high school students is remarkable. As a result, in January 2013, Director Mullan visited Dr. Starks in his office at DSU in Dover to invite him formally to become an Associate Director of DESGC. Dr. Starks agreed to take on this role. His commitment to DESGC is shown by the fact that he has already attended DESGC's Annual Research Symposia in 2012 and 2013, sitting thru the entire sessions on both occasions, even though the subject matter of the presentations is in all cases far outside his area of professional expertise. Dr. Starks has agreed to use his faculty position at DSU to encourage students on that campus to become actively involved in applying for DESGC funds. The DESGC Advisory Board looks forward to a productive relationship with Dr. Starks, with the expectation that DESGC may once more achieve levels of diversity which are consistent with the NCES demographic statistics for students at degree-granting institutions in the state of DE.

Although **DE's 2-year college system (DTCC)** is not formally an MSI, the percentages of UMs on DTCC campuses are larger than on the campus of the largest university in the state (UD in Newark). As a result, DESGC hopes to improve its Diversity statistics by ensuring that students at DTCC are actively engaged in DESGC applications. Especially helpful in this regard is the DESGC affiliate rep. at the Georgetown campus of DTCC (Dr. Doug Hicks), who runs summer camps entitled "Top Engineer" for high school students with an emphasis on UMs.

3. 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.*

DESGC accomplishments: (i) A team of 4 undergrad students from the Stanton campus of DE’s 2-year Community College (DTCC) used DESGC funding to build an experiment and flew it on two flights of NASA’s zero-g aircraft. (ii) 2 students from another campus of DTCC (in Dover) used DESGC funding to participate in RockOn!, building a payload which was carried into space by a rocket launched from Wallops Island. (iii) Two students from another DTCC campus (Georgetown) did a summer internship (with DESGC funding) where they worked on fabricating a detector to pick up small particles at deep-sea thermal vents. (iv) A Mech. Engineering student from UD worked at NASA/Ames in summer 2012 on a DESGC-internship, where she measured the acoustic field around obstacles in a wind tunnel. (v) A Chem. Engineering graduate student with DESGC fellowship funding from UD worked with the leading US manufacturer of space suits: her goal is to incorporate shear-thickening fluids which could afford extra protection against meteoroid impacts. (vi) An undergrad in UD’s Elec Engineering department used DESGC summer intern funds to evaluate if advanced computing techniques could be used to sharpen digital images made by telescopes in space. (vii) A grad student in Marine Studies at UD went in Oct-Nov. 2012 on an expedition on the research vessel Knorr to the Mid-Atlantic ridge to recover samples of bacteria which thrive on iron near thermal vents: these bacteria may contain information about how the earliest life on Earth may have accessed food. (viii) A grad student in Oceanography used an underwater robot to track sharks off the East Coast of USA by listening for signals emitted by previously tagged sharks. (ix) A grad student at Del State Univ is working on the properties of a powerful laser such as one on the Mars Curiosity Rover which allows rock composition to be sampled remotely by means of Laser Induced Breakdown Spectroscopy (LIBS).

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

Among the consortium members of DESGC, we note that Delaware’s HBCU (Delaware State University) has an enrollment which is 63% female and 73% underrepresented minorities. Wesley College enrollment is 56% female and 34% underrepresented minorities. Delaware Technical and Community College (DTCC) average enrollment is 61% female and 31% underrepresented minorities. Wilmington University enrollment is 66% female and 21% underrepresented minorities. The University of Delaware’s undergraduate enrollment is 57% female and 11% underrepresented minorities; graduate enrollment is 50% female and 6% underrepresented minorities. During FY12, 28% of

the students receiving direct financial support from DESGC (grad fellows, undergrad scholarships, summer interns) were female and 21% were underrepresented/underserved.

- *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.*

Work in these areas was undertaken in FY12, with funding from DESGC, by Dr. Stephanie Wright. For descriptions, see pp. 8-10 above.

- *Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers.*

Delaware Futures is an organization which places at-risk high school students in college research groups for a period during the summer so that the students can be encouraged to continue in STEM education. DESGC Assoc. Director Michael Shay, who has in the past already supported one such student, will use DESGC funds to support a new student in summer 2013.

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

Connections between DESGC and all 4 campuses of the Community College system (DTCC) in the state of DE are excellent. Affiliate reps on each campus keep their students well informed about DESGC funding opportunities. From each of the campuses, we cite the following as examples: (a) Georgetown campus: 3 students in FY12 had DESGC-supported summer research internships; (b) Stanton campus: 6 students were supported by DESGC to participate in NASA's zero-g flights; (c) Dover campus: two students plus a faculty member participated in RockOn! at Wallops Island launch facility; (d) Wilmington campus: the affiliate rep serves as a reviewer of NASA/EPSCOR proposals in the state of DE.

At a SG Regional meeting in Delaware, a memorable role model for Community College students addressed the assembly in FY10. He is Asst Professor Matt Oliver who operates the underwater robot mentioned in the paragraph above dealing with Hands-on experiences. In 2010, Dr. Oliver won a Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the U.S. government on young professionals in the early stages of their independent research careers, and he won a Sloan Research award in 2012. The relevant information which emerged at the SG Regional meeting in DE was this: Dr. Oliver's college career started off in Community College.

- *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).*

No efforts along these lines occur in DE.

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

The NASA program known as NASA Innovations in Climate Education (NICE) is managed by VA Space Grant. A researcher on the faculty at Delaware's HBCU (Del State Univ) won a NICE award in 2011 to study global climate change: but this was not channeled thru DESGC. Instead, Director Mullan was informed of the award by VA SG Director Mary Sandy after the award was made. DESGC claims no credit for this award.

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

On pp. 5-6 above, we have described how DESGC funds in FY12 were awarded for Research Infrastructure Development to an early career faculty member Dr. Sabanayagam, originally at DE's HBCU, but now a UD researcher at DE Biotechnology Institute in Newark DE. These funds are being used to develop a Cube-Sat experiment dedicated to astrobiology. This is the first time that a Cube-Sat project has emerged from an institution in the state of DE. Dr. Sabanayagam has already been successful in garnering other funds from NASA for support in this satellite project. Expectations are high for future involvement of students in this novel research infrastructure in our state.

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.

The major changes in resource allocation were made by DESGC in FY12 include the following:

(i) For the first time, a non-STEM faculty member (Dr. Chad Starks) was invited to serve as an Associate Director of DESGC: the reason for this significant adjustment had to do with the finding by NASA/SG at HQ that DESGC is not achieving satisfactory numbers of underrepresented minorities (UMs) to participate in the Direct Student Support category. Dr. Starks, who has recently been appointed to a faculty position at DE's HBCU (Del State Univ), is committed to encouraging African-American students to respond to DESGC's invitations to apply for student funding in undergrad tuition scholarships, grad fellowships, and summer research internships.

(ii). For the first time in the state of DE, funds were made available in FY12 by DESGC for an early-career researcher (Dr. Sabanayagam) to develop the infrastructure to build a Cube-Sat. If this experiment works out successfully, DE can hope in the future to have hands-on opportunities for students to work on satellite fabrication. This would truly be a break-through for students in the state.

(iii) In FY12, DESGC funded a larger number (3) of DE Community College (DTCC) students than ever before to participate in summer research internships at college campuses in the state. In previous years, almost all of the summer research interns have been students at 4-year colleges. The success which DESGC has had in attracting Community College students to participate is largely due to conscientious affiliate reps on the various DTCC campuses who have the best interests of their students at heart.

(iv) In FY12, DESGC repeated its previous record number of students funded to do summer research internships at NASA centers: three DE students were funded in FY12, one each at GSFC, JSC, and ARC.

(v) Increased funding of graduate fellows, raising the stipend to \$27,000, which is higher than DESGC has ever awarded in the past: this led to an upsurge in the number of applications for DESGC-funded graduate fellowships and to an increase in the severity of the competition for those fellowships.

(vi) The DESGC Annual Research Symposium was held on April 12, 2013 in a centrally located conference room on UD's Newark campus and was open to the community. It was attended by a record number (73) of students and faculty. The diversity of the DESGC program was much in evidence at the Annual Symposium: among the nine oral presentations, 3 were given by women, one of whom is a graduate student at DE's HBCU (Del State Univ). One of the speakers from DE's Community College team who flew in the zero-g aircraft is Hispanic-American.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

(1) 4-year academic institutions:

(a) The lead institution of DESGC is the University of Delaware [UD]. UD is classified by the Carnegie Foundation for the Advancement of Teaching as a research university with very high research activity, a designation accorded to fewer than three percent of the more than 4,200 degree-granting institutions in the USA. Currently, UD has 17,484 undergrads and 3,654 grad students enrolled, and offers bachelor degrees in all STEM-G subject areas. Most of the DESGC graduate fellows are UD students from a variety of colleges: Arts & Sciences (Departments of Physics/Astronomy and Geography), Engineering (Department Chemical & Biomedical), and Earth, Ocean & Environment. UD undergraduates from a variety of colleges have benefitted from DESGC-funded tuition scholarships and summer research opportunities. Researchers in various colleges (Engineering, Earth, Ocean & Environment, Arts & Sciences) and the Delaware Biotechnology Institute [DBI] have benefitted since 2005 from DESGC Research Infrastructure (RID) Funds.

(b) Delaware State University [DSU], an MSI, has 3,955 undergrads, 470 grad students, and offers bachelor degrees in at least one STEM-G area. The student body is 73% underrepresented minorities. One of the FY12 DESGC grad fellows is a DSU student

(Ms. Alissa Mezzacappa). One DSU undergrad was awarded a DESGC tuition scholarship in FY12.

(c) Swarthmore College [1,545 undergrads] offers bachelor degrees in at least two STEM areas. 21% of the student body are underrepresented minorities, and 51% are female.

(c) Wilmington University [9,371 undergrads, 6,295 grads] offers a range of bachelor degrees which includes one or more of the STEM-G disciplines. In FY12, one WU undergrad (African-American female) was the recipient of a DESGC tuition scholarship. WU's student body is 66% female and 21% underrepresented minorities.

(d) Wesley College [2,210 undergrads, 216 grads] offers a range of bachelor degrees in the STEM-G disciplines. 34% of the student body are underrepresented minorities, and 56% are female. In FY12, DESGC supported two undergrads (including one female, one Hispanic) with tuition scholarships.

(f) Villanova University [6,584 undergrads, 3,526 grads] is a DESGC affiliate in the southeastern corner of PA. In FY12, one undergrad was the recipient of a DESGC tuition scholarship. 50% of the student body is female.

(2) 2-year Academic Institutions

Delaware Technical Community College (DTCC), has a total of 15,000 students on four campuses distributed widely across the State. The average student body includes 31% underrepresented minorities and 61% female. In FY12, three DTCC students received DESGC-funded tuition scholarships.

(3) Delaware AeroSpace Education Foundation (DASEF) is an enterprise founded in 1989 by Dr. Stephanie Wright (at one time, Delaware's Teacher in Space) to create an exceptional learning environment that inspires children and their families with an appreciation of the Earth and its place in the universe. DASEF has contributed to the academic development of over 300,000 students, educators, and the general public through the delivery of context-based activities consistent with current aerospace research and development.

(4) Industrial affiliates: ILC Dover (makers of space suits for NASA), E.I. DuPont de Nemours, and ATK (Thiokol) Elkton supply active members to DESGC's Advisory Board. Activities of these board members include reviewing applications for DESGC Graduate Fellowships and providing a detailed statistical analysis of the results to ensure a lack of bias among reviewers.

Sum total of plus and minus. How well did DESGC do in achieving metrics proposed for FY12? Number of plusses: 27; number of minuses: 8; percentage of plusses = 77%

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