A. 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 VT Space Grant Consortium (VTSGC) is a Capability Enhancement Consortium funded at a level of $570,000 for fiscal year 2016.

B. PROGRAM GOALS

The overall goal of the VTSGC during Year 2 of our three-year award was to foster the growth of science/mathematics/engineering (STEM) education and research within our jurisdiction’s network of colleges and universities, industrial partners, science museums organizations. Specific goals included increasing capabilities and promoting interest in aeronautics, space science and engineering, and related fields within the State of Vermont. The VTSGC has sought to encourage students at all educational levels ranging from K-12 through undergraduate and into graduate school to take pursue more studies in STEM areas, making connections with NASA, and to pursue careers in scientific and technical fields. Through our Undergraduate Scholarship, Graduate Fellowship, and Higher Education Programs, the VTSGC has addressed critical pipeline issues, helped train the next generation of professionals, and has especially encouraged women, members of underrepresented groups, and persons with disabilities. As a Capability Enhancement Consortium, a concurrent priority for the VTSGC is to strive to simultaneously enhance research infrastructure in Vermont.
Within the NIFS category, specific metrics include the annual awarding of (6) undergraduate scholars, (3) workforce development scholarships, (8) graduate fellowships and the support of (3) NASA internships. The Higher Education goals feature support for (3) interdisciplinary engineering design teams and (3) mentored undergraduate research experiences for undergraduates. In order to support the Capability Enhancement mission for the VTSGC, approximately (3) small scale research grants and/or research mini-grants are planned annually. Finally, for K-12 programs, the VTSGC provides annual scholarships support for local high school STEM summer institutes, program support for two museum partners, and sponsorship of K-12 STEM teacher(s) to attend professional development workshops. A specific diversity goal for female student participation has been set at 40%.

C. PROGRAM/PROJECT BENEFITS TO PROGRAM AREAS

Several examples, cited below, highlight the contributions made by VTSGC programs to the three outcomes that guide NASA’s Education Portfolio (i.e. Outcomes #1-3).

Ms. Stephanie Wood, a graduate student in mechanical engineering at the University of Vermont, was a VTSGC Graduate Fellow in AY15-17. Her outstanding work in orbital mechanics models for small body mission resulted in multiple archival publications. In the summer of 2016, she was selected for an internship at the United Launch Alliance (ULA) in Denver, CO and will be formally joining ULA as a mission design engineer post-graduation in June 2017. Another example is Mr. Justin Dao, a AY15-16 VTSGC graduate fellow in electrical engineering at the University of Vermont. He now works at Santa Barbara Focalplane in Goleta, CA and develops Focal Plane Arrays for space and defense; further, he works closely with NASA’s Jet Propulsion Laboratory to develop infrared detectors and various detector assemblies. (Outcome 1, Employ and Educate).

Another illustration is the initiation of a VTSGC-sponsored CubeSat launch initiative at the University of Vermont in FY17 via the undergraduate engineering capstone design program. Of particular note is one design team that has produced a mechanism for mechanically deploying a “solar sail” from a 10cm satellite module that will be used to accelerate the deorbiting of small satellites. This work has led to the submission of a patent disclosure and the plan is to eventually submit this technology for a future ELANA launch opportunity. (Outcome 2, Educate and Engage).

A final illustration is the creation of a new week-long residential Astronomy Summer Institute for high school STEM students. A direct outcome of a collaboration between the Governor’s Institutes of Vermont and the VTSGC, this program was highly successful in its inaugural offering and attracted a student population with 60% females. (Outcome 3, Engage and Inspire).
D. PROGRAM ACCOMPLISHMENTS

D.1 NASA Internships, Fellowships, and Scholarships

Scholarships. Results of the annual Vermont Space Grant Undergraduate Scholarship Competition were announced in April 2016 with undergraduate scholarships awarded for the 2016-2017 academic year. In the general competition, six merit-based scholarships were awarded to outstanding Vermont students who will be attending Vermont institutions of higher learning throughout the state. Among these, 83% of the scholarships were awarded to female students, far exceeding the target of 40% outlined in our SMART goals. Further, 33% were awarded to Native Americans. All supported undergraduate students appear to be making excellent progress toward their baccalaureate degrees.

Three additional work-force scholarships of $2,500 were awarded during the current reporting period to students in the Aviation Technology Program at Burlington Technical Center. As the school calendar for this program differs significantly from the usual academic year, students in this program cannot reasonably compete in the VTSGC’s normal Undergraduate Scholarship Competition.

Graduate Fellowships. A total of 11 Graduate Research Fellowships were awarded that provided support to graduate students for a 12-month period including the 2016-2017 academic year. Of these, nine were full time awards and two half-time awards. This exceeds the target of eight full-time awards (or the equivalent thereof) in our joint base/augmentation budget for Year 2. Four of the awards went to female students this year (40%), which corresponds with our stated target level. One of the students self-identified as a member of an underrepresented group and one self-identified as having a disability. Our graduate fellowship program continues to produce excellent outcomes. All graduate students awarded VTSGC Graduate fellowships during the present reporting period are making excellent progress towards earning their degrees. It is worth mentioning that among this pool of awardees was the first graduate student from Vermont Technical College, who introduced their first graduate program in computer engineering in Fall 2016.

NASA Internships. Three students from the VTSGC participated in NASA internships during the summer of 2016. Two of the internships were at NASA Goddard Space Flight Center and the third was at NASA Langley Research Center. All students were male, and one was a member of an underrepresented group.

Student Workshops. The VTSGC sponsored three students to attend the annual “Rock On!” workshop at NASA Wallops in June 2016. This workshop is co-sponsored by the Colorado and Virginia SGCs. Two of the students were from the University of Vermont and one was from Norwich University; one of the three students was female (33%). The VTSGC also supported one student from Norwich University to attend the Aircraft Readiness Engineering Workshop in North Carolina; this workshop is co-sponsored by the North Carolina and Connecticut SGCs.

D.2 Higher Education Projects:

Engineering Senior Design Teams. In Year 2, the VTSGC supported three senior undergraduate engineering design teams; one team was from Norwich University (Northfield,
VT) and two were from the University of Vermont. The Norwich students initiated a new design program to participate in NASA’s annual Robotic Mining Competition at Kennedy Space Flight Center. During this past year, the team began a design of a new robotic vehicle with plans to have to robot ready to compete beginning in the Spring 2018 competition. There are four team members, of which one is female (25%). At the University of Vermont, the VTSGC sponsored two design teams focused on cubesat technology development. The first project involved the design of a solar sail that can be mechanical deployed from a 10 cm cube; the second team focused on a novel microfluidic heat exchanger system for cooling higher performance electronics on cubesats. Together, these cubesat design teams consisted of 11 students, with one female participant (9%).

Mentored Undergraduate Research. The base proposal provides support in Year 2 undergraduate research projects distributed between three VTSGC academic affiliate institutions: Saint Michael’s College, Norwich University, and Vermont Technical College. At Norwich University, there were two projects sponsored entitled “Integrated 3D Printer/Recycler for In-Space Manufacturing” and “The Stellar Winds of Massive Stars.” These projects supported four undergraduates, including one female (25%). At Vermont Technical College, five students were supported to conduct flight software research related to NASA’s Lunar IceCube Mission under the mentorship of Prof. Carl Brandon. One of the five students was female (20%) and Prof. Brandon is of Hispanic descent. Saint Michael’s College sponsored one project entitled “Total Conversion of Mixed Algae Lipids to Biofuels over Heterogeneous Catalyst” that supported a single female student (100%).

D.3 Research Infrastructure Projects

As a Capability Enhancement Consortium, a priority goal of the VTSGC is increasing Vermont’s Research Infrastructure in areas aligned with new and continuing NASA research priorities and technical needs. The primary program is our yearly “Faculty Research Proposal Competition.” This competition is open to all full-time Vermont researchers at any Vermont college or university. Research Minigrants of up to $5,000 are available to initiate research projects and collaborations with NASA colleagues. Travel Minigrants of up to $2,000 are available to support faculty visits to NASA Centers for the purpose of exploring new contacts and collaborations or fostering existing ones. Finally, a small number of Small-Scale Grants of up to $30,000 are available to faculty researchers for more mature research projects, typically wherein a NASA contact or collaborator has already been established.

In FY16 there was one small-scale grant for $20,000 awarded to an Electrical Engineering faculty at the University of Vermont entitled “High Accuracy Ranging and Beamforming Radar for Space Debris Detection and Anti-Collision for Formation Flying Small Satellites.” One research minigrant for $6,000 entitled “Utilization of Martian/Lunar Regolith as Construction Material for Building on Mars/Moon in Support of NASA In-Situ Resource Utilization Initiative” was awarded to a University of Vermont junior faculty in Civil engineering; this award included summer salary for an undergraduate research assistant. Finally, travel minigrants were awarded to two highly productive VTSGC Graduate Fellows (one male, one female) as supplemental awards to their projects “Bubble Nucleation and Growth
Behaviors in an Outer Space Environment” and “Graph-Theoretical Design Strategies for Self-Assembly”, respectively. The travel awards permitted the graduate fellows to attend top conferences in their respective areas and present their research.

D.4 Pre-College Projects

Vermont is a small, predominantly rural state without a well-developed statewide research culture. There are 83 public high schools and 66 private high schools in the entire state, and, in many school districts, students are not fully aware of opportunities for scientific and technical careers. VTSGC precollege programs are able to access Vermont students at a key location in the pipeline leading to professional careers.

As a CAPENS Consortium, the VTSGC expends only a modest percentage of our funding on precollege activities. Therefore, our strategy in this area is to partner in K-12 activities whenever possible through state affiliates and other entities specializing in pre-college programs. Specific partners include: the Governor’s Institutes of Vermont the Vermont State Mathematics Coalition, the Fairbanks Museum & Planetarium, the Montshire Museum of Science. Through these partnerships, along with the donated efforts of the Director and Program Coordinator the VTSGC has been able to establish a strong presence in the state and region in the K-12 arena.

Specific Pre-College programs supported under FY16 include the Governor’s Institutes of Vermont (GIV) Summer Engineering Institute and Summer Mathematics Institute at the University of Vermont, and the new Astronomy Institute at Lyndon State College. Both of these programs are residential and provide intensive one-week STEM experiences for high school students. The Mathematics Institute had 32 participants in the summer of 2016 with 50% of those being female. The Engineering Institute had 84 participants with 32% of those being female. The Engineering Institute also featured a new “track” in Aerospace Engineering in 2016, the result of coordinated efforts between the directors of the GIV and the VTSGC. Also, 11% of the GIV students overall self-identified as non-Caucasian.

In addition to these existing GIV programs, the VTSGC Director and Program Coordinator worked closely with the GIV Director and astronomers within the “Northeast Kingdom” region of Vermont to create a new GIV Institute in Astronomy that rolled out in the summer of 2016. The Astronomy Institute was housed at Lyndon State College and partnered with the Fairbanks Museum & Planetarium, a VTSGC affiliate, and the Northern Skies Observatory (Peacham, VT). This institute was very successful and the Astronomy Institute enrolled 25 students of which 60% were female.

Two annual pre-college STEM design competitions coordinated by UVM’s College of Engineering and Mathematical Sciences that involved the VTSGC also occurred in FY16: the FIRST Tech Challenge and the Aiken/Technology and Society Connection (TASC). The VTSGC maintained an exhibit at the FTC this year showcasing our programs and promoting STEM careers. During Aiken/TASC competition. Finally, the VTSGC sponsored the Vermont Teacher of the Year (Montpelier, VT) to attend the Space Camp in Huntsville, Alabama, during the Summer of 2016. This sponsorship is part of the annual VTSGC effort to support K-12 STEM teacher professional development.
D.5 Informal Education Projects

Efforts of the VTSGC in this area in FY16 were largely coordinated through the two VTSGC museum affiliates – the Fairbanks Museum and Planetarium and the Montshire Museum of Science. Both of these organizations have established national reputations for providing high quality informal education resources to Vermont students and their parents. Their contributions to informal education activities are summarized below.

The Fairbanks Museum & Planetarium inspires appreciation for the natural world and motivates the stewardship of a healthy planet. One of its most distinctive programs has been astronomy, utilizing a wide-range of opportunities to educate students, adult learners, and the greater public in the areas of fundamental knowledge, as well as current events and developments. Important resources that sustain this program include: The Lyman Spitzer Jr. Planetarium and its associated exhibit gallery, supported by audio-visual media, as well as ten professional and student grade telescopes for outreach visual astronomy programs; the Exploration Station, including hands-on exhibits and a 60”-diameter interactive OmniGlobe; and a partnership with the Northern Skies Observatory in nearby Peacham, VT offers the ability to be remotely operated for observing and imaging. In FY16, the Fairbanks Museum estimated that approximately 8,000 students were reached directly through classes, the planetarium, and programs like our annual Space Camp, and our joint effort with NSO in holding a Governor’s Institute of Vermont on Astronomy.

The Montshire Museum of Science provides a variety of STEM programming for families, teachers, and students as part of the Vermont Space Grant Consortium. The Montshire Museum offers a menu of one-hour inquiry-based workshops for visiting students to the Museum. A special suite of four workshops focus on earth processes and climate science are aimed at students in grades 5–8. During 2016, these programs were presented to 23 classes. The Museum also provided 30 one-hour long space science workshops focusing on descriptive astronomy during 2016. In addition to the student programs at the Museum, Montshire staff traveled to 10 different schools throughout Vermont bringing day-long earth and space science programs to students living in rural communities. Family activities to the Montshire aligned with the Museum’s Space Grant program including an Earth and Space special event day on January 30, 2016 with guest earth scientists and astronomers presenting hands-on family science activities to over 500 visitors. A Climate Science special event day on November 5, 2016 was held at the Museum that included opportunities for 734 visitors to learn about climate research and even touch an actual ice core collected in Antarctica by climate scientists. Overall, 3,585 students, teachers, and family members engaged in extended space and earth science activities through Montshire’s VTSGC supported programs.

In broader terms, the VTSGC takes a multi-faceted and “opportunistic” approach to promoting public and external relations. For example, to promote NASA programs in the state and help engage and inspire the STEM students, the VTSGC annually invites and/or co-sponsors special guest speakers to address local audiences in seminars/colloquia. A second means of engagement is through VTSGC-operated booths at local technology events and K-12 STEM competitions. Examples from 2016 included the “Manufactured in Vermont” Expo, the Vermont
Chamber of Business & Industry Expo, and the Vermont FIRST Robotics Competition. The purpose of such activities is to increase the VTSGC’s visibility and public awareness of its programs.

E. PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE GOALS

Diversity Overview. Solicitations and announcement of opportunities always contain a section that strongly encourages the participation of women, members of underrepresented groups, and persons with disabilities; this formal encouragement is supplemented by the personal efforts of the VTSGC Director and Program Coordinator.

Diversity Statistics - NIFS. In the Undergraduate Scholarship Competition, there were six awards given and, of these, five were female (83%), two were Native American (33%). Among the ten full-time equivalent Graduate Fellowship awards given, four of the awardees were female (40%), one was a member of an underrepresented group (10%) and one reported a disability (10%). One of the three NASA interns was a member of an underrepresented group (33%). Among the five student and teacher workshop participants, two were female (40%).

Diversity Statistics - Higher Education Projects. There was a total of 25 students supported in the higher education projects. Among these, 5 participants were female (20%).

Diversity Statistics - Research Infrastructure Projects. Within the limited Research Infrastructure Projects area, one of the two Graduate Fellow Travel Awards went to a female student, or 25% of total awards made in this area.

Minority-Serving Institution Collaborations. Less than 5% of Vermont residents identify themselves as members of an underrepresented minority and the state has no minority-serving higher educational institutions. One VTSGC strategy for promoting diversity in our programs involves a strong working relationship Title VII Indian Education Program for Franklin County Public Schools, the “education arm” of the Abenaki Tribal Council of Northern Vermont. This entity, which is also a VTSGC affiliate, cooperates closely with the VTSGC and each year helps us to attract talented students of Abenaki heritage to apply to our Undergraduate Scholarship application pool.

Office of Education Annual Performance Indicators:

° API ED-15-1 __18^1_________ (Number of NIFS to racially or ethnically underrepresented students, women, and persons with disabilities.)
° API ED-15-2 __100^2_________ (Number of educators.)
° API ED-15-4 ___5__________ (Number of informal education events.)
° API ED-15-5 __12,000^3_______ (Number of K-12 students.)

Notes on API’s: ^1Breakout of diversity numbers are 13 females; 4 underrepresented groups; 1 with disability; ^2Educator estimates from our affiliate Montshire Museum of Science, no demographics available; ^3K-12 student numbers are based on supported outreach programs at the Fairbanks Museum (8,000), the Montshire Museum (3,585) and summer programs of the Governor’s Institutes of Vermont summer Astronomy Institute (25), Engineering Institute (84) and Mathematics Institute (32). Demographic breakout is not available for the museums, however the GIV programs had 41% female participants.
F. IMPROVEMENTS MADE IN THE PAST YEAR

The most noteworthy improvement during the past year has been the strengthening of collaborations with the Governor’s Institutes of Vermont (GIV). The GIV is a non-profit, summer enrichment program in Vermont for high school students that empowers young people with intensive, hands-on learning experiences in college settings. As a direct result of this collaboration, a new weeklong residential Astronomy Summer Institute was realized in the Summer of 2016 and held at Lyndon State College. The new institute was a tremendous success and will become a regular offering in future years. Another outcome was the addition of a new “aerospace engineering track” to the existing GIV Summer Engineering Institute held at the University of Vermont. This track had been requested by high school students interested in engineering for some time, and in 2016 it was realized through the joint efforts of the GIV and VTSGC.

G. CURRENT AND PROJECTED CHALLENGES

None at this time.

H. PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The University of Vermont is the VTSGC’s Lead Institution and Fiscal Agent. The primary academic affiliates include: St. Michael’s College, a Liberal Arts college in Colchester, VT; Norwich University, a comprehensive school with engineering programs in Norwich, VT; Vermont Technical College (VTC), part of the Vermont State College System in Randolph, VT; and the Aviation Technology School of the Burlington Technical Center (BTC). Other educational organizations that are VTSGC affiliates are the Vermont State Mathematics Coalition (VSMC), the Fairbanks Museum & Planetarium, the Montshire Science Museum, and the Title VII Indian Education Program for Franklin County Public Schools. The Fairbanks Museum and Planetarium and the Montshire Museum are both informal education providers with highly successful, nationally acknowledged programs serving the general public. The Title VII Indian Education Program promotes the educational objectives of the Abenaki Tribal Council of Northern Vermont. Industrial affiliates of the VTSGC include: Triangle Metal Fabrications of Milton, VT; LORD/Microstrain, Inc. of Williston, VT; Archimedes Aerospace LLC of Montpelier, VT; Mansfield HeliFlight of Milton, VT; and GreenScale Technologies of South Burlington, VT. The industrial partnerships with Archimedes Aerospace and GreenScale Technologies have been particularly useful in providing strong support of undergraduate research and engineering capstone design project activities.