Vermont Space Grant Consortium
University of Vermont, Lead Institution
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(802) 324-8206
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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 Vermont Space Grant Consortium is a Capability Enhancement Consortium funded at a level of $430,000 for fiscal year 2012.

PROGRAM GOALS

Goals of the Vermont Space Grant Consortium (VTSGC) during the third year of our current five-year award included continuing to develop our network of colleges and universities, industries, and other organizations interested in strengthening mathematics and science so as to increase interest and capabilities in aeronautics, space and related fields in the State of Vermont. The VTSGC has sought to encourage students at all levels from K-12 through university and graduate school to take more mathematics and science, to make connections with NASA, and to consider 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 priority for the VTSGC during the period of this award has been to enhance research infrastructure in Vermont, especially the capability to engage in research of an interdisciplinary nature. These goals and objectives, as well as the methods to be used to achieve them, are detailed in the VTSGC's Strategic Plan. A copy of the VTSGC's Vision Statement, Mission Statement and Strategic Plan can be seen on the VTSGC's website at the URL given above.

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

Several illustrations will highlight the contributions made by VTSGC programs to the three outcomes that guide NASA's Education Portfolio. As a first illustration, after an extensive university-wide review and evaluation of existing research activity, the University of Vermont (UVM), the Lead Institution in the VTSGC, is currently in the process of implementing a Transdisciplinary Research Initiative (TRI). Within this initiative, UVM's initial strategic goal is to develop a small number of "Spires of Excellence" to expand, coordinate, and leverage research capability in areas at the intersection of important State and National interest where UVM already has significant research assets. Of particular relevance to NASA research priorities is the new TRI Spire in Complex Systems. Prof. Chris Danforth, an applied mathematician with strong links to NASA collaborators at NASA Goddard, whose research involves reducing uncertainty in weather and climate model forecasts, is Associate Director of the UVM Complex Systems Center and is playing a leading role in the development of the Complex Systems TRI Spire. To continue our support of this new opportunity for both research and human resource development, the VTSGC awarded a second, follow-on Graduate Research Fellowship to Prof. Danforth's Ph.D. student, Nicholas Allgaier, in our 2012 Graduate Fellowship Competition. This graduate research support has allowed Mr. Allgaier to continue his thesis research on a topic for which Prof. Danforth was awarded a Research Minigrant in our 2010 Faculty Research Competition. This Minigrant included funding for travel to NASA Goddard to visit Dr. Robert Cahalan, Head of the Climate and Radiation Branch at GSEC. Previous VTSGC seed funding awarded to Prof. Danforth allowed this faculty researcher to obtain preliminary research results that have now led to a large NSF grant. At this stage, Prof. Danforth himself has "graduated" from our seed funding competitions and will be securing follow-on funding for his research program through regular competitive channels. However, by providing this research support for his graduate student, who is now in the final stages of his thesis research and is expected to graduate with his Ph.D. in May of 2014, the VTSGC has not only been able to further support state research infrastructure development, but we have contributed to the development of the STEM workforce in a discipline needed to achieve NASA's strategic goals (Outcome 1, *Employ and Educate*), and have facilitated the development of new NASA-relevant STEM educational opportunities for students and faculty (Outcome 2, *Educate and Engage*).

A second illustration of how VTSGC programs benefit NASA's Education Outcomes comes from our Higher Education Programs and involves continuing support for undergraduate student engineering teams. Supported teams during the current reporting period include the new Lunabotics Team in the School of Engineering (SoE) at the University of Vermont (UVM). This team is composed of five students (one female, four male) and has two faculty mentors. The goal of this project is to produce a lunar rover, a "lunabot," weighing less than 80Kg and fitting dimension constraints, in meters, of 1.5Lx.75Wx.75H. The rover will operate in a 7.38x3.88 meter arena of a crushed lava basalt aggregate called Black-Point 1 (BP-1) that simulates the density and abrasive nature of lunar soil. Starting from one end of the arena, the rover must navigate through an obstacle course of craters and debris to the mining area on the opposite end. BP-1 must then be extracted from the arena and deposited into a storage bin called the

"lunabin" back on the starting side of the arena. The rover will have two 10 minute attempts to deposit as much BP-1 in the lunabin as possible with a requirement of no less than 10Kg per attempt. The rover should operate with some level of autonomy while still communicating with the user through IEEE 802.11 b/g wireless standards. The design should address the abrasive and fine characteristics of the simulant both on the surface and in the air. An interesting feature of this project is that the above description, which appears in the Team's December 2012 Progress report, is quite different than the original concept that was put forward when this project began at the start of the Fall Semester. As would be the case for a "real world" effort, aspects of the original plan were determined to be unrealistic, inefficient, or overly costly as the development work progressed, and appropriate adjustments were continually made to enable the team to overcome difficulties while remaining on track to achieve overall project goals (Outcome 3, *Engage and Inspire*).

A final illustration of the benefit to NASA Education Outcomes of our programs involves the VTSGC Awards Night Ceremony held in November last year. Students, their parents, and representatives of NASA, VTSGC affiliates, local school boards, and the State of Vermont attended this yearly ceremony, which honors students supported by the VTSGC's Fellowship/Scholarship, Higher Education, and Research Infrastructure programs. The 2012 Awards Night program included presentations by a students who participated in both a VTSGC-supported 2012 NASA Summer Internship Program and several supported mentored undergraduate research projects, as well as demonstrations by supported student teams, such as the UVM Alternative Energy Racing Organization (AERO) Team and the Norwich Autonomous Underwater Robotic Vehicle (AUV) Team. The Keynote Speaker was David Rosage of the University Affairs Office at NASA Goddard. Prof. Carl Brandon of Vermont Technical College also spoke on recent developments in the Vermont CubeSat Lunar Lander Project, which involves all of the VTSGC's academic affiliates and is currently working to prepare a one-unit CubeSat for a 2013 launch date awarded by NASA that will test the navigation system for the full three-unit Lunar Lander CubeSat package in Earth orbit. Our Awards Night generated considerable publicity for both the VTSGC and NASA in local media across the entire state and helped to highlight strategic partnerships with formal and informal STEM education providers, promote our efforts to advance STEM literacy, and raise awareness of NASA's mission among both Vermont's education community and the General Public (Outcome 3).

PROGRAM ACCOMPLISHMENTS

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

In order to provide NASA-related competency-building education and research opportunities for students and faculty researchers, the VTSGC has strived to make significant achievements and progress in our Research Infrastructure, Fellowship/ Scholarship and Higher Education programs. These are described in detail under the following three sub-headings:

1.1 Research Infrastructure:

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. Vermont's NASA EPSCoR Program shares this goal. There is close cooperation and coordination between the VTSGC and VT-NASA EPSCoR in this area. Our local faculty research awards have often been jointly funded by the VTSGC and VT-NASA EPSCoR, resources for local VT-NASA EPSCoR projects have been augmented by VTSGC Graduate Research Fellowship awards, and several Science PI's for VT-NASA EPSCoR's research team projects that are currently funded by National NASA EPSCoR Research Competition awards initiated their research projects using VTSGC Minigrants.

The primary program used by the VTSGC to promote the development of Vermont's research infrastructure 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 grants of up to $5,000 to initiate research projects and collaborations with NASA colleagues and Small-Scale Grants of up to $30,000 for more mature research projects, particularly those where a NASA contact has already been established, are available to faculty researchers through this competition. Potential uses of Research Minigrants include seed money to explore initiating NASA-related research projects, travel to a NASA Center to establish contact or collaborate with an appropriate NASA colleague, bringing a distinguished visitor or research collaborator to Vermont for a short visit, and summer support of an undergraduate or graduate student. The more extensive Small-Scale Research Grants may contain summer faculty research salary or research support for a graduate student. Small-Scale Grants typically contain travel funds to visit a NASA Center to establish or strengthen NASA collaboration, and a further expectation is the submission of a research proposal for follow-on funding from non-Space Grant and non-EPSCoR sources. For both Minigrants and Small-Scale Grants, significant cost share is required from the PI's home department or institution to demonstrate support for and a commitment to the research project.

Five new faculty research grants were awarded by the VTSGC during the past year as a result of our 2012 Faculty Research Competition. Four of these awards were Small-Scale Grants, and one was a Research Minigrant. The four funded Small-Scale Grants in FY 2012 were awarded to Prof. Doug Fletcher, Prof. Rachael Oldinsky, and Professor Mary Dunlop, all of the UVM School of Engineering, and Prof. Leslie-Ann Dupigny-Giroux of UVM's Department of Geography. The FY 2012 Research Minigrant was awarded to Prof. Darren Hitt of UVM's School of Engineering.

The Small-Scale grant awarded to Prof. Fletcher includes support for the Ph.D. research of Prof. Fletcher's graduate student, Andrew Lutz. Prof. Fletcher reports that Mr. Lutz has made substantial progress in his research during the present reporting period. He has

conducted multiple test campaigns in the 30 kW Inductively Coupled Plasma Torch Facility at the University of Vermont that involve characterization of graphite sample erosion rate and atomic species fluxes in the reacting boundary layer for different plasma tests. This work involved checking the repeatability of surface erosion rates in dilute mixtures to enable longer test times for the laser spectroscopic measurements. In addition, a detailed investigation of the diffusion process near a reacting surface has been undertaken to complement the experimental work. This activity is aimed at ensuring that the maximum amount of information will be obtained from experiments. Much of this work was reported in a recent paper that was presented by Mr. Lutz at the AIAA General Sciences Meeting (2013) held in Dallas. This supported activity has also involved extensive NASA contacts. Members of the HIADS group from NASA Langley Research Center visited Prof. Fletcher's laboratory to discuss measurements on carbon and SiC materials with Dr. Fletcher, Mr. Lutz, Dr. Meyers and Mr. Owens of UVM. The NASA visitors included Dr. F. McNeil Cheatwood, Dr. Anthony Calomino, Dr. Walter Bruce, Dr. Alireza Mazahari and Dr. Stephen Hughes.

Prof. Rachael Oldinsky is an early-career faculty member who is currently in the second year of her initial appointment as an Assistant Professor in UVM's SoE. The primary purpose of the Small-Scale Grant awarded to Prof. Oldinsky was to allow her to establish contacts with potential NASA collaborators so that she can expand her research program into areas that are aligned with NASA research priorities. This award also included research support for the M.S. research of Prof. Oldinsky's graduate student, Meredith Koch. Initial research results from this supported project include the design of a mechanical bioreactor to be used to investigate osteochondral tissue engineering for regenerative medicine applications. Prof. Oldinsky and Ms. Koch have jointly written a review article addressing the need to engineer a device to study the culture environment of cells and tissue in addition to studying the effect of culture dynamics on the mechanical properties of engineered tissues. This review article was submitted to the journal of Tissue Engineering in February. In addition, specifications have been submitted to a professional design engineer and an electrician to finalize the design of the mechanical bioreactor. Briefly, the bioreactor will consist of a strain-controlled actuator that will apply a sinusoidal unconfined compressive load to an array of samples (24-well plate, 24 samples, 6 unloaded, 18 loaded) at 1Hz. A 20N load cell will be used to assess the development of osteochondral tissue (cartilage and bone). The change in elastic moduli values of the engineering tissue will be correlated with changes in the load application (e.g. strain (10-15%), step-wise vs sinusoidal lab application, time of load application).

Prof. Mary Dunlop is also an early-career faculty member in UVM's SoE. Prof. Dunlop is using this VTSGC funding in her research exploring the design of a modular, predictable biofuel export system as a step towards synthetic biology in space. Renewable fuel production is an area where synthetic biology has the potential to significantly impact NASA through extending mission duration by harnessing solar energy. Renewable fuel production in orbit is of particular interest because microorganisms can harvest solar power, or residuals from waste, and convert it into fuel. Development of this technology could extend missions or support longer-term planetary

settlement. Significant prior research has examined the topic of biofuel production in ground-based studies. However, work on the effects of microgravity is just beginning. A major challenge in the design of engineered biological systems, whether in space or terrestrial environments, is the need for reliable, modular parts that behave in a predictable fashion. This has proved to be a major obstacle in biochemical engineering, and is an area where synthetic biology is beginning to see results. Prof. Dunlop is conducting a pilot study to test the modularity of two well-characterized biological components that are part of biofuel production and export circuits. To date, this effort has produced one peer-reviewed publication, and a second paper is in preparation. A proposal for follow-on funding has been submitted to the Pew Charitable Trusts Scholars Program in the Biomedical Sciences. One undergraduate student researcher (female) who worked with Prof. Dunlop on this project graduate from UVM with her BS in Mechanical Engineering in 2012 and is now in PhD program at U Mass Amherst. Two other undergraduate students (male) continue to work on this project.

The fourth Small-Scale Grant awarded in our 2012 Faculty Research Competition supports a collaboration between Prof. Leslie-Ann Dupigny-Giroux of UVM's Department of Geography and her research collaborators at NASA's Jet Propulsion Laboratory on the use of multiangular, polarized and hyerspectral imagery to snow cover and wetlands field sites. This project is a capacity building effort to enhance Prof. Dupigny-Giroux's field mapping capacity in Vermont and to strengthen her existing collaborations with the NASA Jet Propulsion Laboratory on the use of multi-angle, multi-polarized remotely sensed imagery from the AirMSPI (Airborne Multiangle SpectroPolarimetric Imager) device. This project involves three separate but interrelated tasks: a) JPL flights of the AirMSPI sensor on the ER-2; b) Visits to JPL and c) Fieldwork in Vermont to take place at the same time as the JPL flights in the western US. Since, in addition to being a faculty member at UVM, Prof. Dupigny-Giroux is also the Vermont State Climatologist, this project has also created new links between the VTSGC and Vermont State Agencies. Further, this project involves a Vermont private sector collaborator and STEM curriculum development. Prof. Dupigny-Giroux continues to work with Archimedes Aerospace LLC of Montpelier, VT on the use of data acquired from an unmanned aerial vehicle (UAV) version of the AirMISR technology for use in her Satellite Climatology and Land-surface processes (advanced remote sensing seminar) GEOG 281, being offered this semester (Spring 2013). John Hanning and Jason Cooper of Archimedes Aerospace will be providing multiangular imagery of Vermont wetlands, acquired in February 2013, for the GEOG 281 to classify as part of graded assignments for this class. This will allow them to move beyond the global scale MISR imagery (already available from existing collaborations with JPL) to Vermont-specific high spatial resolution UAV imagery.

The Research Minigrant from the VTSGC's 2012 Faculty Research Competition was awarded to Prof. Darren Hitt of UVM's SoE. This Minigrant contained partial summer research support for Dr. Will Louisis, a former graduate student of Prof. Hitt, who was recently (with VTSGC GRA support) awarded his Ph.D. and is currently a Lecturer in Mechanical Engineering in UVM's SoE. Last year, Prof. Hitt was the Science PI for one of the two Vermont proposals submitted to the 2012 NASA EPSCoR Research

Competition. Although Prof. Hitt's proposal, entitled "A NanoSat-Based Approach to Space Debris Mitigation," was not funded in that competition, comments by the NASA reviewers indicated that Prof. Hitt's concept was strong. Given the importance of this topic to NASA, and the potential for this project to be successful in a future NASA EPSCoR research Competition, the proposal review panel for our local Faculty Research Competition recommended that this $5,000 Research Minigrant be awarded as a means of helping to keep this project active while obtaining additional preliminary results regarding "Evolutionary Algorithms for Optimizing Orbital Trajectories of Formation-Flying Spacecraft." The success of this desired outcome can be judged by the fact that a revised and updated proposal written by Prof. Hitt was recently chosen in Vermont's local selection competition to be Vermont's submission to the 2013 NASA EPSCoR Research Competition. This Minigrant provides one example of the way in which Vermont's Space Grant Program and NASA EPSCoR Project are closely coordinated and mutually supportive.

It should be noted that all five of the projects funded in our 2011 Faculty research Competition include the participation of undergraduate student researchers, graduate students, or a Postdoctoral Fellow. Promoting Human Resource Development by creating additional opportunities for students to work one-on-one with faculty researchers on projects that are strongly aligned with NASA research priorities or technical needs is a major objective of the VTSGC.

Vermont's NASA EPSCoR Program currently supports much of Vermont's academic faculty research in areas of interest to NASA. However, as indicated by the above awards, the VTSGC remains an active participant in efforts to expand and enhance Vermont's NASA-related research infrastructure and build further research ties between Vermont's academic faculty and NASA.

A comparison of the progress reported above with the SMART goals and objectives described in the VTSGC's FY 2010 proposal package for the current funding cycle shows that targets for the current reporting period have mostly been met. The target range for faculty awards in our FY 2010 proposal included four Small-Scale Grants and two Research Minigrants. As noted above, four Small-Scale Grants and one Research Minigrant were supported by the VTSGC during the current reporting period. As was pointed out earlier, these Research Grants will help to build and strengthen research ties between Vermont's academic faculty and NASA. Of the five Faculty Investigators involved in these locally funded research projects, three are women (60%). This exceeds our target of 40% in this area. In our FY 2011 APD Report, our 40% target was not met, but we noted that we fully expect to meet our overall target over the five-year period of this funding cycle. Our funding results this year show that we are, indeed, on track to do this. None of the Faculty Investigators supported this year are members of a minority group that is underrepresented in STEM disciplines. However, because statistics show that Vermont has an exceedingly small number of STEM faculty members from underrepresented groups, our goal in this area is, again, a five-year, rather than a year-to year, target.

1.2 Undergraduate Scholarship and Graduate Research Fellowship Competitions:

Results of the eighteenth Vermont Space Grant Undergraduate Scholarship Competition were announced in June 2012 with undergraduate scholarships awarded for the 2012-2013 academic year. In the general competition, five merit-based scholarships were awarded to outstanding Vermont students who will be attending Vermont institutions of higher learning throughout the state. Through a Memorandum of Understanding with the Abenaki Tribal Council of Vermont, three additional VTSGC Native American Undergraduate Scholarships were also awarded to outstanding scholars of Abenaki heritage. Five of these eight scholars were women. Thus, both our target of 40% undergraduate scholarships awarded to women contained in our FY 2010 proposal, and our target of 25% awarded to members of underrepresented groups were significantly exceeded. All supported undergraduate students appear to be making excellent progress toward their baccalaureate degrees.

Three additional special scholarships of $2,500 each were awarded during the current reporting period to students in the Aviation Technology School of the Burlington Technical Center, a VTSGC affiliate. One of these scholars was a Medalist in the 2012 National Skill's USA Competition. The BTC Aviation Technology School has a 100% employment record, and graduates of its program, which is one of the premier programs in North America that train certified aviation and powerframe technicians, are usually offered employment either before or within hours of graduation. Because 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. To address the special needs of this affiliate, these scholarships were first authorized by the VTSGC's Board of Advisor in 2003 as part of our efforts to develop and expand the scientific and technical workforce needed in the future by NASA and aerospace companies in the private sector.

One VTSGC special scholarship was awarded in this reporting period to support a student summer internship at a NASA Center. In this internships, Mr. Thomas Manton, Jr., a student in the Electromechanical Engineering Program at Vermont Technical College (VTC), worked with Jeanette Plante of GSFC, Manager of NASA's Workman Standards Program in the Safety and Missions Assurance Directorate, to test electronics, instruments, hardware, and software for quality and reliability. Both Thomas Manton and Jeanette Plante attended the VTSGC's 2012 Awards Night and gave presentations on their projects.

In terms of graduate fellowships, the University of Vermont is the only comprehensive institution in the entire State granting graduate degrees in mathematics, science and engineering. This fact explains why the VTSGC Graduate Research Fellowships have been for graduate study at UVM. Fortunately, UVM's graduate programs in mathematics, science and engineering are strong and thriving, especially in the biomedical and remote sensing areas that form the research focus of NASA-related research in Vermont. It is important to note that our graduate awards have a strong research component and are not simply pure fellowships. Recipients work with UVM

researchers who have, or are developing links to NASA, and the awards usually contain a summer research stipend as a component.

Seven Graduate Research Fellowships that fully supported graduate students for a 12-month period including the 2012-2013 academic year were competitively awarded in the VTSGC's 2012 Graduate Research Competition. This exceeds the target of four full-time awards stated in our FY 2010 base budget proposal. Support for two additional Graduate Research Fellowships was embedded in Small-Scale Grant awards. Three one of the nine total supported students are women. Consequently, the results for women awarded VTSGC Graduate Fellowships during the present reporting period are slightly under our goal of 40% awarded to female graduate students. Unfortunately, we have still not made progress toward meeting our target of awarding two Graduate Fellowships to members of an underrepresented group during the 5-year period of our Space Grant award. Potential faculty mentors are always strongly encouraged to propose GRA funding for women, members of underrepresented groups, and persons with disabilities in our yearly Graduate Research Competitions. However, despite this encouragement, UVM has few graduate students from recognized underrepresented groups in STEM, and none of the graduate students supported in FY 2012 from our base budget funding is a member of an underrepresented group.

Our graduate fellowship program is producing excellent outcomes. All graduate students awarded VTSGC Graduate fellowships during the present reporting period are making excellent progress toward earning their degrees.

1.3 <u>Higher Education Programs:</u>

In 1996, the VTSGC initiated a category of awards called Undergraduate Program Projects to fund many of our efforts in Higher Education. In the current reporting period, three supported activities in this category were the UVM Alternative Energy Racing Organization (AERO) and Lunabotics Student Teams, and Norwich University's Autonomous Underwater Robotic Vehicle (AUV) Student Team.

The efforts of the UVM Lunabotics Team have already been noted at the start of this progress report as one example of how the VTSGC's Higher Education programs benefit NASA's Education Outcomes. Prof. Darren Hitt of UVM's Mechanical Engineering Program and Prof. Steven Titcomb of UVM's Electrical Engineering Program are the faculty advisors for this UVM SoE Capstone Student Engineering Project.

Professors Danner Friend and Jacques Beneat of Norwich University's Departments of Mechanical Engineering and Electrical and Computer Engineering are the faculty advisors for the Norwich AUV Student Teams. The 2012 Program Project Grants for this engineering design team provided additional follow-on funding for design efforts that were first initiated a number of years ago with ESMD-Space Grant awards. Prototype vehicles designed, built, and tested by this student team have successfully competed in national engineering competitions.

One of the main objectives of the 2012 AUV project was to make improvements to the previous autonomous underwater vehicle design by redesigning the mechanical components in two different areas. The first area was to design and test a better watertight hull to house the electrical components, and the other focus area was to improve the design and mounting of the thrusters for propulsion. The previous AUV's hull had experienced continual issues with leaking, and an improved watertight hull was successfully designed and did not leak during underwater tests. The hull was designed for ease of assembly/disassembly and provided enough space to accommodate future changes in the size and placement of the electronics. The previous AUV's propulsion design had incorporated variable angle thrusters that had the capability of rotating to allow for a more variable control of the AUV's motion. An assessment of the previous design revealed major shortcomings in the function of the variable angle thrusters. An alternate variable thruster design was considered, but it was decided that it would be too complex and costly to implement in the current project. The decision was made to incorporate a more traditional and simpler fixed thruster design. The team designed and tested a new method for mounting the four horizontal thrusters and demonstrated in water tests that the thrusters functioned sufficiently. A design concept was presented for future mounting of the vertical thrusters. Finally, from consultations with Green Sea Systems of Richmond, VT, the team was able to establish a working knowledge of common practices in the underwater vehicle industry in order to better meet current and future goals of the Norwich AUV. This effort has led to a new hands-on educational opportunity for Norwich undergraduates. Green Sea Systems has become very interested in offering summer internships to Norwich students in the area of unmanned sea vehicles. An additional crosscutting feature of this project is an interaction of team members with 7th graders and their parents at the U32 School in Norwich, Vermont. This interaction not only has encouraged the 7th grade students to take more mathematics and science but also has promoted an increased awareness of NASA and its mission in the larger Norwich community

The achievements of the UVM AERO Team provide an additional example of how VTSGC Higher Education efforts benefit NASA Education Outcomes. Prof. Jeff Frolik of UVM's Department of Electrical and Computer Engineering is the faculty advisor for this undergraduate student engineering team. To date, fifty active student members have participated in this team's various vehicle development projects. Participation in team activities has provided a pathway to professional employment in Green Energy areas. Recent AERO alumni now work for GM's hybrid drivetrain division, Vermont alternative energy developers, and hybrid vehicle startup companies in New England. The club participates in the SAE/IEEE-sponsored Formula Hybrid International Competition (FHIC) with a unique, all-wheel-drive parallel hybrid racecar. VTSGC funding this reporting period was primarily been used to support the purchase and/or fabrication of the high-voltage electrical accumulator (i.e., battery packs) as the team prepared its next generation vehicle for a May 2012 competition. The club has utilized nanophosphate lithium ion systems and more recently lithium iron phosphate systems.

Other Higher Education activities supported by the VTSGC during the present reporting period enhanced the baccalaureate experience of undergraduate students at Vermont colleges and universities through funding one-on-one faculty-mentored undergraduate research projects while strengthening faculty research efforts and building ties to NASA. Of the 12 undergraduate students participating in these research projects, 5 were women. This represents a significant advance over the number of female students who have participated in our supported mentored undergraduate research projects in the past. One of the participating female students is also a member of an underrepresented group in STEM. Of the six faculty mentors involved in these research projects, two were women, and one is a member of an underrepresented group.

At St. Michael's College (SMC) in Colchester, VT, Prof. Zsusanna Kadas has coordinated mentored undergraduate research projects on topics of interest to NASA involving students in STEM disciplines during the academic year or the summer. Prof. Kadas is the SMC representative to the VTSGC's Board of Advisors. During the current reporting period, two mentored undergraduate research projects were active at SMC. These projects involved faculty mentors and students in SMC's Departments of Biology, Mathematics and Psychology. Prof. James Byrne coordinates a similar program of mentored undergraduate research at Norwich University. Prof. Byrne is a Vice Provost at Norwich and Norwich's representative to the VTSGC Board of Advisors. During the current reporting period, two mentored undergraduate research projects were active at SMC. One of these projects was associated with the Norwich AUV team effort, while a second project was associated with the Vermont CubeSat Lunar Lander Project. At Vermont Technical College (VTC), Prof. Carl Brandon, the VTC representative to the VTSGC's Board of Advisors, also mentored a CubeSat-related undergraduate project. This effort is focused on preparing for the upcoming launch of a 1-U CubeSat that will test elements of the full 3-U Lunar Lander CubeSat Package's autonomous navigation system in orbit. Tasks included in this project have been a vibration test for the 1-U CubeSat at BAE Systems in Nashua, NH on February 14, 2013 and a vacuum-thermal bake out at the University of New Hampshire on February 18-19, 2013.

During the current reporting period, the VTSGC has not supported, as we normally would, any mentored undergraduate research projects in the UVM Ureca! Program, coordinated by the Dean of the UVM Honors College. The aim of this program is to provide undergraduate students in all disciplines at UVM an opportunity to engage in a mentored research experience that is "over and above" the research component of a course taken for academic credit. The Ureca! Competition is structured so as to model a real life grant cycle and involves a student-written research proposal, evaluation of proposals by panels of experts, panel review reports, announcement of awards, work on the actual research project with a faculty mentor, and writing a final report detailing research results. None of the student projects submitted to the 2012 Ureca! Competition were sufficiently aligned with NASA research priorities or technical needs that they qualified for VTSGC support. This is highly unusual, as in previous years two to four proposed Ureca! Projects were deemed eligible for VTSGC support. However, a Ureca! Project funded by the VTSGC in 2011, conducted by UVM Engineering student Meghan Thompson and entitled "Flume Experiment of Effects of Variable Shapes of Engineered

Log Jams on River Morphology and Erosion," remained active during the current reporting period, and is continuing to produce interesting research results.

Because of the importance of tracking the outcomes of VTSGC support to students, we have contracted with the National Space Grant Foundation to conduct our Longitudinal Tracking of students. Detailed longitudinal tracking data provided by the Foundation for 2012 is presented in the section of this report that gives Program Contributions to PART Measures. However, comments collected from students during the course of compiling the VTSGC's 2012 Longitudinal Tracking data indicate that our Higher Education programs appear to have had a significant impact in encouraging supported students to pursue STEM careers. Answers to the question "How did participation in these programs impact your education and life?" included:

> "The space grant program has made it much easier financially to attend college and particularly to continue from my 2 year program at VTC to my 4 year program at UVM. It is definitely one of the reasons I was able to continue on in my education. It has allowed me to continue taking classes in mechanical engineering and has kept me interested in the field of engineering as a whole." (Cody Jackson, 2011 Vermont Space Grant Scholarship-Vermont Technical College and UVM)
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> "It helped me to focus completely on my studies without the need to get a part time job in order to support myself as a non-traditional student." (Leigh Tintle, 2011 Vermont Space Grant Scholarship-Vermont Technical College)
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> "Receiving the Space Grant encouraged me to continue my education in mathematics." (Brittany Baker, 2009 Vermont Space Grant Scholarship-Saint Michael's College)

A further indicator of Program Accomplishments contributing to Outcome 1 is also given in data provided by the National Space Grant Foundation. This tracking indicates that 7 students whose participation in our programs was significantly supported by the VTSGC in FY 2006 to FY 2012 took a "next step" during the current reporting period. In particular, in the FY 2012 program year, 2 of these students are now pursuing an advanced degree in a STEM discipline, 4 have accepted STEM positions in industry, and 1 went on to a position in a non-STEM discipline.

Outcome 2: ***Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty (Educate and Engage)***

VTSGC activities this past year in our Higher Education and Precollege programs that contributed to this outcome are described in the following two sub-headings:

2.1 Higher Education Programs:

Components of several of the VTSGC programs described above give undergraduate students in STEM disciplines a greater appreciation for the breadth and depth of NASA's mission, as well as an appreciation for the challenges presented by NASA-related research. In particular, as mentioned previously, faculty investigators in most of our FY 2012 Faculty Research Awards have actively engaged their undergraduate students by involving them in significant ways in their funded research projects. VTSGC research support thus provides new educational opportunities for these students and strengthens both the desire to pursue a career in a STEM discipline and, in some cases, the desire to go on to earn an advanced degree. The mentored undergraduate research projects described in the section above also directly educate and engage students at both a research university and two primarily undergraduate institutions in a way that would not be possible without VTSGC sponsorship.

In FY 2012, the VTSGC was instrumental in providing multiple avenues for Vermont students to explore a progression of educational opportunities that could lead to a career in a STEM discipline. In particular, during the current reporting period, the VTSGC provided support for two Capstone Senior Engineering Design Projects in the School of Engineering at UVM. The first of these is the UVM Lunabotics Project that has been previously been described in detail. The student team assembled for this project consisted of five senior undergraduate mechanical engineering students (1 female and 4 male). Prof. Darren Hitt and Prof. Steven Titcomb of UVM's School of Engineering are the faculty coordinator for this design project. The second Capstone Senior Engineering Design Project, coordinated by Prof. Jeff Frolik of UVM's School of Engineering is designing a "Zero-emissions vehicle for Frozen Landscape scientific studies." The goal of this project is to develop aspects of a zero emission vehicle for NASA scientists that can be used for transporting scientific payloads across the frozen landscape of Greenland. This area has been declared an emissions-free zone due to the need to preserve scientific data. Currently, the only method of transportation is skiing, which is physically demanding, and makes carrying equipment difficult. The new vehicle must be capable of safely handling a 25Kg load with a size of 0.5m x 0.5m x 0.5m without sinking into the snow. It must also maintain traction on ice, and its energy accumulator must be readily converted to accommodate a 50Km range over a 24-hour period. In addition, it must also incorporate autonomous navigation so it can meet scientists at their study destination. This includes both the ability to follow a pre-programmed route, and the capability of avoiding any obstacles it may come across. The vehicle must be compact in size so that it can be loaded onto a cargo plane for transportation to Greenland. It must also be designed to travel across ice and windblown snow with a density of 250/400 kg/m^3, and a depth of 20cm. Operation temperatures can reach a minimum of -20 ˚C, and it must be able to handle the grades and harsh weather conditions of Greenland. The vehicle should also be easy to use and operate for scientists with little to no training. The controls must be designed for use while wearing gloves, and basic maintenance such as changing batteries and loading and unloading should take into account the same considerations. Michael Combariate of NASA Goddard is a NASA point of contact for this project.

2.2 Precollege Programs:

Vermont is a small, predominantly rural state without a well-developed statewide research culture. There are only 82 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. Our data shows that the summer enrichment programs we have partially supported during the course of our training grant, particularly the Summer Mathematics Institute (which has now become a part of the Governor's Summer Institutes in Science and Mathematics) and an underrepresented minority component for the UVM College of Engineering and Mathematics Summer Enrichment Program in Science and Technology, have been successful in motivating precollege students from across the State. Further, the positive publicity in the press generated by these programs has increased the visibility of NASA throughout the State and facilitated our efforts at both the higher education and research infrastructure levels. The VTSGC is a founding member of the Vermont-NASA Educational Cooperative (VNEC), a group of organizations with ties to NASA and agendas that involve education at the K-12 level. We also helped to promote an interest in science among Vermont's Middle School students by our participation and support in the Junior Solar Sprint program, a project for students in grades 5 through 8 involving the design, building, and racing of mini solar/electric cars. Our Program Coordinator, Ms. Laurel Zeno has acted as Northern Vermont Area Coordinator for this program. VTSGC participation in this event includes donation of the Trophies and Certificates as well as help with the fundraising from the private sector that makes this event possible.

Two events coordinated by UVM's College of Engineering and Mathematical Sciences (CEMS) that involved the VTSGC occurred in 2012: Design Technology And Society Connection (TASC) and E-Week. Design TASC is held annually at UVM. The purpose of this competition is to give teams of high school students the challenge and satisfaction of designing, building, and testing a device to perform a specified task. The program begins in September and culminates in December when schools bring teams (maximum of five students per team) to UVM to display the devices they have created. The 2012 E-Week was held in February at the Vermont Air National Guard's Burlington facility with approximately 500 students from 35 elementary, middle and high schools in attendance. Activities included building a pasta bridge, an edible car, design of a hangar roof truss, and wind turbine and passive helicopter drop competitions. The VTSGC mounted an exhibit showcasing our programs at these events and also provided a small amount of funding support. Other precollege programs in which the VTSGC was involved during the present reporting period included the Governor's Youth Leadership Conference and the ACE Camp run by VT Department of Transportation and Aviation.

As a CAPENS Consortium, the VTSGC expends only a small percentage of our own funding on precollege activities. Our strategy in this area is to work whenever possible through affiliates such as the Vermont State Mathematics Coalition, the Fairbanks and Montshire Museums, and the Franklin Northwest Supervisory Union Indian Education

Office. However, through the donated time of the Director and program staff and our collaboration with these affiliates, the VTSGC has been able to establish a strong presence in the state and region in the K-12 arena.

Outcome 3: ***Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission (Engage and Inspire)***

3.1 General Public and External Relations Programs:

To give NASA programs prominent exposure in the state and help engage and inspire the next generation of STEM practitioners, the VTSGC invites special guests to Vermont to address local audiences. NASA representatives who visited Vermont in FY 2012 included Dr. David Rosage and Jeanette Plante, both of NASA Goddard. Dr. Rosage and Ms. Plante were speakers at the VTSGC's 2012 Awards Night Ceremonies. Their participation in this event, as well as surrounding activities that included the VTSGC Student Poster Session and a seminar held the following day, helped to facilitate opportunities and interactions between GSFC and Vermont students, teachers, and academic researchers.

The VTSGC has been named a full member of the Vermont Academy of Science and Engineering (VASE), a component of the Vermont Technology Council that advises the State of Vermont on science and technology policy. Consortium Director William Lakin was invited to participate in the last VASE review and revision of Vermont's official Science and Technology Plan, and Program Coordinator Laurel Zeno represents the VTSGC at the quarterly meetings of the Council.

Additional outreach within the State has come from the VTSGC's interactions with civilian aviation interests and the Civil Air Patrol in Vermont. Vermont's former Lieutenant Governor, Brian Dubie, a commercial airline pilot and past National Chair of the Aerospace States Association, expressed a particular interest in this portion of the VTSGC's activities before leaving office in late 2010. Mr. Dubie remains a member of the VTSGC's Board of Advisors. The VTSGC's Program Coordinator, Ms. Laurel Zeno, is our point person for interactions in this area. Ms. Zeno is a member of the Aero Club of New England and serves as the VTSGC's representative on the Board of Burlington Technical Center's Aviation Technology School. The VTSGC has played a key role in promoting the expansion of the Aviation Technology School's facility at the Burlington Airport. Indeed, we are one of a group of stakeholders that submitted a successful proposal to the State for funds to support an expansion. The proposed new facilities will not only benefit the Aviation Technology School, but will also be used by students in Vermont Technical College's new Aerospace Engineering Technology major, a degree program that owes its existence to an interaction of VTC and BTC through the Vermont Space Grant network. The VTSGC has also interacted with the NASA Explorer School in Orleans, Vermont.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Student Data and Longitudinal Tracking: The data presented below for Total Awards to students during the FY 2012 program year indicates that these awards were made through our Fellowship and Scholarship Programs. However, it should be noted that our Graduate Fellowships have a strong Research Infrastructure component. In particular, graduate students awarded VTSGC Fellowships work directly with their faculty advisors on research projects that are aligned with new and continuing NASA research priorities. VTSGC Graduate Fellowships thus support our mandate as a CAPENS Consortium to promote the development of Research Infrastructure. The VTSGC fully recognizes the importance of providing the National Program with accurate data that longitudinally tracks students supported by our programs. Therefore, we have contracted with the National Space Grant Foundation to longitudinally track students who have received significant awards in past program years. FY 2012 tracking data provided by the Foundation is as follows:

  Total awards = 21; Fellowship/Scholarship = 21, Higher Education/Research Infrastructure = 0; 7 of the total award represent underrepresented minority F/S funding. During the FY12 program year 2 students are pursuing advanced degrees in STEM disciplines, 4 accepted STEM positions in industry, and 1 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: Promoting diversity in all portions of our program is a key goal of the VTSGC. Solicitations and announcement of opportunities always contain a section that strongly encourages the participation of women, members of underrepresented groups, and persons with disabilities, and this formal encouragement is supplemented by the personal efforts of the VTSGC Director. Data has been presented in the sections above for each of the individual components of our program that compares outcomes during the current reporting period with the targets for diversity contained in our 2010 proposal. This data indicates significant successes in a number of areas of our program. For example, one student participant in a supported mentored undergraduate project, as well as one of the faculty mentors, is a member of an underrepresented group. Targets for participation by women were exceeded in both our Undergraduate Scholarship and Mentored Undergraduate Research Projects. In the Undergraduate Scholarship Competition, five of eight awards went to women, and, in addition, 37.5% of the awardees were members of an underrepresented group. In the supported Mentored Undergraduate Research Projects, 42% of the participating students were women, while 33% of the faculty advisers were women. It should be noted that this year we also exceeded our target for awarding faculty research grants to women. In our 2012 Faculty Research Competition, 60% of our local research grants were awarded to women.

- Minority-Serving Institution Collaborations: Vermont has an exceptionally homogeneous population. Demographic tables from the recent US Census show that only 2.3% of Vermont residents identify themselves as members of an underrepresented minority in STEM areas while data from the National Center of Education Statistics Digest indicates that only 2.5% of students enrolled in Vermont (in-state and out-of-state) are Black, Hispanic, or Native American. Vermont has no minority-serving higher educational institutions, or indeed any higher educational institutions with a significant percentage of minority student enrollment. As will be noted shortly in the Program Partners Section, one VTSGC strategy for promoting diversity in our programs involves a strong working relationship developed over the past ten years with the Franklin Northwest Supervisory Union Indian Education Office, the Education Arm of the Abenaki Tribal Council of Northern Vermont. The FNWSUIEO, which is now a VTSGC affiliate, cooperates closely with the VTSGC and each year helps us to attract talented students of Abenaki Heritage to our Undergraduate Scholarship application pool. Indeed, in our affiliate structure, the FNWSUIEO plays a role similar to a "Tribal College." A second part of the VTSGC's strategy for promoting diversity in our programs involves developing relations with minority-serving institutions out-of-state. In particular, the VTSGC has worked through the New York Space Grant Consortium to conduct joint weather balloon launches with Medgar Evers College, part of the City University of New York for the Central Brooklyn community. In joint CricketSat workshops for undergraduate students, Vermont and New York students work on the assembly and calibration of CricketSat temperature sensors as well as conducting flights. Although not directly related to Space Grant, Vermont's recent 2012 NASA EPSCoR Minority Serving Institutions Faculty Engagement award also involved arranging collaborative research projects between researchers at UVM and research collaborators at CCNY, another part of the City University of New York that is a recognized MSI.

- NASA Education Priorities: A number of the accomplishments detailed above are directly related to the "Current Areas of Emphasis" stated in the 2010 Space Grant solicitation. These include:

  VTSGC support for two capstone undergraduate engineering design projects (Greenland Robot Tractor and Lunabotics) and three student engineering teams (AERO at UVM, AUV at Norwich, and CubeSat at VTC) provided authentic, hands-on student experiences in science and engineering disciplines based on real-life NASA research and technology needs.

  Our support for an underrepresented minority component for the UVM College of Engineering and Mathematics Summer Enrichment Program in Science and Technology provided a summer opportunity for secondary students on a college campus with the objective of increased enrollment in STEM disciplines or interest in STEM careers while simultaneously promoting VTSGC Diversity goals.

  Continued VTSGC support for faculty and students (both undergraduate and graduate) involved in the "Vermont Frozen Landscape Monitoring Project"

addressed the priority related to Environmental Science and Global Climate Change by promoting research and activities to better understand Earth's environments.

Funding awarded to Vermont's NASA EPSCoR project in FY 2007 produced a significant advance in Vermont's research infrastructure with the development over the last few years of a 30 kW Inductively Coupled Plasma (ICP) facility at UVM to study the ablation of aerospace materials used in heat shields under atmospheric reentry conditions. As a result of the close cooperation and coordination of the VTSGC with VT-NASA EPSCoR, a Graduate Fellowship was awarded by the VTSGC in this reporting period to a student who is working with Prof. Douglas Fletcher, a Professor at UVM, on this ablation project. VTSGC Graduate Fellowship funding last year also helped support a graduate student working with Prof. Yves Dubief on computational aspects of ablation, and this support has helped this early career faculty researcher to focus his research program toward NASA priorities. Prof. Dubief is now the Science PI on Vermont's 2011 NASA EPSCoR Research Award, which will use advanced numerical methods to continue studies of ablation. Small-scale grants awarded in 2012 by the VTSGC to Prof. Mary Dunlop and Prof. Rachael Oldinsky, two recently hired faculty members in UVM's SoE, will likewise allow these early career faculty members to explore the initiation of research aligned with new and continuing NASA research priorities.

IMPROVEMENTS MADE IN THE PAST YEAR

During the 2011-2012 academic year, the VTSGC commissioned a study by Dr. Jeffrey Benay, a member of the VTSGC Board of Advisors and a past Chair of the Governor's Commission on Native American Affairs who is also a Partner in J & J Educational Consultants of Fairfax, Vermont and an internationally recognized expert in STEM program evaluation design and implementation. The aim of this study was to assess the impact and outcomes of our funding in program components that involve undergraduate and graduate student participation. In addition to gathering standard evaluation metrics, such as presentations given, degrees conferred, and papers written, a new aspect of this evaluation and assessment plan was seeking to determine the "delta" in both interest in NASA and the motivation to pursue an aerospace-related career created by interactions between the students and the VTSGC through our programs and projects. Quantitative methods alone are not adequate for this determination, and Dr. Benay employed an integrated "systems" matrix that draws on a myriad of qualitative and quantitative methodologies (mixed method evaluation plan). Within this framework, the use of interviews with students provided raw data that was transcribed and analyzed to yield measures of the efficacy of our programs in terms of our impacts on students, faculty, and the NASA-related community. In addition, site visits and material review assisted in the formation of an ongoing, fluid evaluation process that examined the overall planning, implementation, and outcomes of the SMART objectives for this project. Both formative and summative evaluation cycles promoted dynamic communication feedback loops that served to keep all stakeholders abreast of the grant's progress.

When Dr. Benay and his research associate, Ms. Gyan Baird, delivered their assessment report, two findings were a cause for concern. In the first finding, students reported that they did not feel that participation in VTSGC programs was connecting them directly to NASA. To help address this finding, we are now in the process of implementing a procedure that will automatically send out the frequently issued NASA Express Messages that detail NASA opportunities for the education community to all students participating in the VTSGC's supported programs. Not only should having access to these messages put students in closer contact with NASA and increase appreciation for the breadth of NASA's mission, but also it will alert our students to additional opportunities for participation in NASA events that are aligned with their specific interests. In the second finding, student sentiment indicated that our merit-based Undergraduate Scholarships were now considered not overly attractive because the dollar amount of the associated stipends was too low. The dollar level of these stipends had not been increases for some time. To address this issue, Dr. Benay recommended that we consider doubling the stipend for our merit-based undergraduate scholarship awards, from $2,500 to $5,000, and conserve the budget allocation for this program by halving the number of scholarships awarded each year. Based on student interviews, his judgment was that this adjustment would increase student interest in our VTSGC Undergraduate Scholarship Competition, improve the size and quality of the applicant pool, and lead to support for stronger, more highly motivated, scholars. This recommendation has now been discussed and formally approved by the VTSGC's Board of Advisors, and it will be implemented for the 2013 Undergraduate Scholarship Competition. The description of the 2013 Competition on the VTSGC's website, as well as the 2013 Scholarship Application Form, have been revised to reflect this change.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The University of Vermont is the VTSGC's Lead Institution and Fiscal Agent, and we are based in UVM's College of Engineering and Mathematical Sciences. 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), one of this country's premier programs leading to FAA Airframe & Powerplant Certification. The VTSGC and NASA thus have a presence at academic institutions throughout the state.

Other educational organizations that are VTSGC affiliates are the Vermont State Mathematics Coalition, the Fairbanks Museum and Planetarium, the Montshire Museum, and the Franklin Northwest Supervisory Union Indian Education Office (FNWSUIEO). The Vermont State Mathematics Coalition is an affiliate composed of teachers at all levels, school board members, representatives from state agencies, and private sector representatives who are concerned with advancing Vermont's STEM education base.

The linkage of this coalition with the statewide Space Grant network allows the VTSGC to be a stakeholder in K-12 education with only a small outlay of our own funding. 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 FNWSUIEO promotes the educational objectives of the Abenaki Tribal Council of Northern Vermont. As Vermont has no Minority Serving Institutions, or indeed any Higher Educational institution with a significant percentage of students from underrepresented minorities, the active participation of the FNWSUIEO as a full affiliate in our network greatly enhances our goal to engage diverse populations in VTSGC programs. Industrial affiliates of the VTSGC include Triangle Metal Fabrications of Milton, VT and Microstrain, Inc. of Williston, VT. Both of these companies have provided significant support and training for VTSGC-supported student engineering teams.

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.