

Vermont Space Grant Consortium
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Consortium URL: vt.spacegrant.org
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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 2013.

PROGRAM GOALS

Consortium Goals and SMART Objectives from your 2010 base proposal and budget (or as amended in subsequent submissions)

Goals of the Vermont Space Grant Consortium (VSGC) 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 VSGC 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 VSGC 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 VSGC 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 VSGC's Strategic Plan. A copy of the VSGC's Vision Statement, Mission Statement and Strategic Plan can be seen on the VSGC's website at the URL given above.

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 2013, highlighting student and/or project accomplishments. Specify alignment to an Outcome.

Several illustrations will highlight the contributions made by VSGC 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 VSGC, has moved to implement 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 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 VSGC awarded a second, follow-on Graduate Research Fellowship to Prof. Danforth's Ph.D. student, Nicholas Allgaier, in our 2013 Graduate Fellowship Competition. This graduate research support has allowed Mr. Allgaier to continue his thesis research on a topic for which Prof. Danforth was originally 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 VSGC 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 the Fall of 2014, the VSGC 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 involves the bioengineering research initiative recently undertaken at the University of Vermont, wherein a doctoral level graduate program in bioengineering has been implemented. Associated with this initiative has the hiring of new tenure-track STEM faculty. The VSGC has supported, through fellowship and faculty pilot grant funding, two recent hires in the Mechanical Engineering Program whose bioengineering research has relevance to NASA. A Space Grant Fellowship has

been awarded to a female Masters student, Meredith Koch, for her project entitled "Mechano-transduction mechanisms for orthopedic tissue maintenance" under the guidance of Prof. Rachel Oldinski. A second year of faculty pilot grant was awarded Prof. Mary Dunlop for her project entitled "Toward modular biofuel export control systems and aeronautics and space applications." We are pleased to mention that Prof. Dunlop has recently been informed that she is the recipient of a National Science Foundation CAREER award. Each of these cases is supporting the development of a STEM workforce in the area bioengineering with relevance to NASA areas of interest (Outcome 1, *Employ and Educate*).

A third illustration of how VSGC programs benefit NASA's Education Outcomes follows 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. The Lunabotics Design Competition is a national competition sponsored by NASA with final competitions held at NASA KSC in the spring. This team was 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 Final Progress report and YouTube video presentation (see <https://www.youtube.com/watch?v=tpkuQOT2m3w>), 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*). As a consequence of this positive first experience, in 2014 a second team has formed for Lunabotics 2.0 and plans to participate in the KSC competition next year.

A final illustration of the benefit to NASA Education Outcomes of our programs involves the VSGC Awards Night Ceremony held in October last year. Students, their parents, and representatives of NASA, VSGC affiliates, local school boards, and the State of Vermont attended this yearly ceremony, which honors students supported by the VSGC's Fellowship/Scholarship, Higher Education, and Research Infrastructure programs. The

2012 Awards Night program included presentations by a students who participated in both a VSGC-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 VSGC'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 VSGC 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

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

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)*

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 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 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 VSGC 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 VSGC 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 VSGC and VT-NASA EPSCoR in this area. Our local faculty research awards have often been jointly funded by the VSGC and VT-NASA EPSCoR, resources for local VT-NASA EPSCoR projects have been augmented by VSGC 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 VSGC Minigrants.

The primary program used by the VSGC 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.

Four new faculty research grants were awarded by the VSGC during the past year as a result of our 2013 Faculty Research Competition. Three of these awards were Small-Scale Grants, and one was a Research Minigrant. The three funded Small-Scale Grants in FY 2013 were awarded to Prof. Mandar Dewoolkar, Prof. Mary Dunlop, and Prof. Jeff Frolik, all of the UVM School of Engineering, along with Prof. Josh Bongard of the UVM Computer Science Department who was a Co-PI with Prof. Frolik. The FY 2013 Research Minigrant was awarded to Prof. Jeff Frolik of the UVM School of Engineering.

- The Small-Scale grant awarded to Prof. Dewoolkar was entitled "Mechanical Characterization of a Low Strength Material for Rover Mobility Testing and Comparison to Martian Terrain" and include support for the research of M.S. student Michael Edwards in Mechanical Engineering. The overarching goal of

this project has been to characterize the Fillite material used by NASA in support of analyzing their current model rover experiments and future numerical modeling efforts. Mr. Edwards has made significant progress in his research and will be finishing his master's thesis by the late spring of 2014. The work also involved collaborators at NASA Glenn Research Center, Dr. Juan Agui, Mr. Colin Creager, and Dr. Allen Wilkinson, who assisted in defining the scope of work and provided Fillite material for testing.

- The Small-Scale grant awarded to Prof. Mary Dunlop, an early-career faculty member in UVM's SoE, was entitled "Toward Modular Biofuel Export Control Systems for Aeronautics and Space Applications." This grant includes embedded graduate student support for a MS student in Mechanical Engineering (William Turner). This project is actually a second-year continuation of her Small-Scale Grant Award in 2012. In these efforts Prof. Dunlop is using this VSGC 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. To date, this effort has produced one journal article that is currently in peer review.
- The Small Scale Grant awarded jointly to Prof. Jeff Frolik and Prof. Josh Bongard was entitled "Swarm Intelligence - Adaptive Multi-Agent Robotics" and included funding for William Baker, a MS student in Electrical Engineering. During the fall of 2013, an opportunity arose for Mr. Baker to participate in an engineering internship in Germany. The start of the project has thus been delayed until January 2014 and, as such, the research is just beginning. A full reporting of this project will be presented in next year's annual report. With that caveat, the proposed work will investigate heterogeneous swarm robotics as a means to carry out exploratory missions in unknown terrain. Multiple mobile sensing and actuating robots provide a means to interact with the environment. Collaboratively, these robots can, for example, determine locations where the environmental conditions warrant extended observation. They will explore the synergy of multiple, mobile platforms interacting with even a larger number of static sensing platforms. This work extends earlier/ongoing NASA and VSGC-sponsored work at the University of Vermont (UVM) investigating the use mobile platforms (e.g. CubeSats and micro aerial vehicles (MAV)) for environmental monitoring as a complement to static wireless sensor network deployments. The

prior work considered a single mobile platform deployed for the purpose of being a data “mule”. The mule then either returns the data directly to the end user or transmits the data over a high power radio link. In short, the mobile platform performed service functions for the static sensing network. In the proposed new work, the roles are reversed, as multiple mobile platforms are engaged in autonomous discovery of an unknown environment and deploy static sensors at locations of interest for sensing, navigation or communication purposes.

- The Research Minigrant from the VSGC’s 2013 Faculty Research Competition was awarded to Prof. Jeff Frolik of UVM’s SoE. This minigrant provided materials and supplies support for the second-generation senior capstone design project “ZEV 2.0 Autonomous Zero Emissions Vehicle”. The objective of this project was to continue the development of a zero emissions vehicle for the purpose of transporting scientific equipment across snowpacks. This vehicle is being developed by leveraging UVM’s Capstone Design program for electrical and mechanical engineering. Between fall 2011 and spring 2012 four engineering seniors (three mechanicals and one electrical) developed an architecture for the system and created a prototype. For this reporting period, three additional mechanical engineering students revised/improved the prototype’s drive train and power system. The resulting vehicle will be leveraged for a foundation of future student and research projects.

It should be noted that all of the projects funded in our 2013 Faculty research Competition include the participation of undergraduate student researchers and/or graduate students. 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 VSGC.

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 VSGC 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 VSGC’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, three Small-Scale Grants and one Research Minigrant were supported by the VSGC during the current reporting period. However, it is worth mentioning that this shortcoming was compensated by the availability of residual NASA EPSCoR Research Infrastructure Development (RID Phase III) funds; these funds allowed for the funding of additional projects under the EPSCoR mechanism and thus

further highlights the possible synergy between the Space Grant and NASA EPSCoR programs.

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 three Faculty Investigators involved in these locally funded research projects, one was female (33%), which is reasonably close to our target of 40% in this area. In our FY 2012 APD Report, 60% of awards went to female faculty. Therefore, over the last two years we have exceeded the average target of 40% and we fully expect to meet our overall target over the five-year period of this funding cycle. None of the Faculty Investigators supported this year are members of a recognized minority group that is underrepresented in STEM disciplines; however one of the three faculty awardees is of Asian heritage. As 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 2013 with undergraduate scholarships awarded for the 2013-2014 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, an additional VSGC Native American Undergraduate Scholarships was also awarded to outstanding scholars of Abenaki heritage. Two of these five scholars were women. Thus, our target of 40% undergraduate scholarships awarded to women contained in our FY 2010 proposal was met; further, 20% were awarded to members of underrepresented groups. 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 VSGC affiliate. One of these three scholarships was awarded to a female student. This student, Bettina Edelstein, gave a well-received presentation in February 2014 at the National Council of NASA Space Grant Directors' Meeting in Crystal City VA. 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 power-frame 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 VSGC's normal Undergraduate Scholarship Competition. To address the special needs of this affiliate, these scholarships were first authorized by the VSGC'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.

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 VSGC 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.

A total of four Graduate Research Fellowships were awarded that fully supported graduate students for a 12-month period including the 2013-2014 academic year were competitively awarded in the VSGC's 2013 Graduate Research Competition. This is in alignment with the target of four full-time awards stated in our FY 2010 base budget proposal. Support for three additional Graduate Research Fellowships, one full-time and one part-time, was embedded in Small-Scale Grant awards. Of these nine awards, only one went to a female student (11%) and thus the target goal of 40% awarded to female graduate students was not met during this reporting period. 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, the only graduate program in Vermont, has few graduate students from recognized underrepresented groups in STEM, and none of the graduate students supported in FY 2013 from our base budget funding is a member of an underrepresented group.

Our graduate fellowship program continues to produce excellent outcomes. All graduate students awarded VSGC Graduate fellowships during the present reporting period are making excellent progress toward earning their degrees. A specific case worth mentioning is Amanda Machamer, a VSGC Fellowship recipient from the past reporting period. Ms. Machamer, who is currently finishing her MS degree in Mechanical Engineering this semester at UVM, is also a senior airman in the Vermont Air National Guard; in November 2013 it was announced that Ms. Machamer was the selected as the 2013 Airman of the Year by the Vermont Air National Guard.

1.3 Higher Education Programs:

In 1996, the VSGC 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 VSGC'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 were the faculty advisors for the initial UVM/SoE Capstone Student Engineering Project. They have continued on in this capacity for a second-year team in Lunabotics that is currently working on a second-generation design.

The achievements of the UVM AERO Team provide an additional example of how VSGC 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. 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. The AERO student group's activities this past year focused on the development, build, and test of an all-new, all-electric formula SAE compliant racecar. The team competed at the 2013 Formula Hybrid International Competition held in May in the New Hampshire International Speedway. After a series of presentations, design judgments, and driven events the team garnered 2nd place in the all-electric category. This was the first time the team was able to compete in every aspect of the competition in their six years of attending. In addition, their vehicle, CleanSpeed, posted the fast all-electric acceleration and autocross times. VSGC support for this organization enabled them to purchase a new battery system, one they will be reusing for the 2014 competition. The success of the competition, along with having a fully functional vehicle to demonstrate, enabled the club to recruit over 25 new members (mostly first years) in fall 2014. The organization has over 30 active students and efforts have been split between updating the CleanSpeed vehicle (new frame, suspension and controls) and developing an all-new hybrid vehicle (GreenSpeed 4) for the 2015 competition.

Other Higher Education activities supported by the VSGC 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 seven undergraduate students participating in these mentored research projects, two were female (28%), including one underrepresented group member. This continues our trend of successfully recruiting female student in our supported mentored undergraduate research projects. 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 VSGC's Board of Advisors. During the current reporting period, one mentored undergraduate research project was active at SMC with student Ashley Armstrong. Entitled "Looking for Heavy Elements in Young Galaxies" this work was under the mentorship of Prof. John O'Meara in the Department of Chemistry & Physics. This work has been a study of the occurrence and abundance of different atoms and ions in clouds of gas in the spectra of 20 quasars (QSOs) containing absorption over the range $1.6 < z < 4$. They are concerned with identifying different absorption species in order to understand the conditions of galaxy formation in the early universe through an understanding of the interactions between the intergalactic and interstellar mediums, as mediated through gas in the circumgalactic halos surrounding galaxies. This task is accomplished through the techniques of quasar absorption line spectroscopy, and specifically the identification of CIV absorption doublets in those spectra. Among the outcomes of this work have been a site visit to NASA GSFC and a journal article submission to the Astrophysical Journal.

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, which is supported under the VSGC Mentored Undergraduate Program. The 2013 funding 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 in past years have successfully competed in national engineering competitions. One of the main objectives of the 2013 AUV project involved the research, building, and testing of a wireless monitoring system that could both observe and if necessary control the AUV from a shore computer suitable for navigation under the ice crust. The primary undergraduate responsible for this year's work was Kenneth Owens. The system developed was based on a Linux operating system. C-code was developed for the control commands of the AUV motors based on compass readings and preprogrammed maneuvering path. The application of this research allows for an open source system that can be easily adapted to transmit more data and even live video or data collected from any other experimental equipment that could be placed on the AUV itself. Kenneth Owens presented a talk on "Norwich's AUV Wireless Communication System", at the Vermont Space Grant Awards Ceremony, September 25, 2013.

At Vermont Technical College (VTC), Prof. Carl Brandon, the VTC representative to the VSGC's Board of Advisors, has served as a mentor for a CubeSat-related undergraduate project. Known as the "CubeSat Lunar Lander Project" that was originally initiated by a VSGC/CDC grant in 2009, this project supported five undergraduates, including one female, during the current reporting period. Most of the effort this year was devoted to completing work on the hardware and software for the ELaNa IV CubeSat that was launched November 19, 2013 from the Wallops Island Flight Facility. This exciting development represented the first CubeSat launched from the State of Vermont. Following the launch, the VTC CubeSat was able to establish ground-based communication, including ham radios in Argentina and Italy. In addition to the research,

there was all the administrative work to prepare for the launch. There were bi-weekly teleconferences with the ELaNa IV team, NASA and the Air Force (who supplied the launch). Updated monthly separate PowerPoint reports for the ELaNa IV supervisors at Cal Poly and the Air Force and an updated Microsoft Project report on scheduling of all aspects of the project. Approval for the satellite by the FCC (who has statutory authority for all nongovernmental spacecraft) had required multiple documents. Students worked on the software for the radio communication protocol, the GPS interface, the power system, radio activation and communication protocols and antenna deployment, GEONS (GPS Enhanced Onboard Navigation System from NASA Goddard Space Flight Center), camera operation, the onboard SD card file system and the overall control program.

During the current reporting period, the VSGC 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, and 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 2013 URECA! Competitions were sufficiently aligned with NASA research priorities or technical needs that they qualified for VSGC support. This is the second year in a row that this has occurred and is highly unusual; in previous years two to four proposed URECA! Projects were typically deemed eligible for VSGC support.

Because of the importance of tracking the outcomes of VSGC 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 VSGC'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. Some notable responses to the question "How did participation in these programs impact your education and life?" included:

"It helped me pay for it, gave me contact to groups I am working with now at NASA." (Ryan Crocker, 2008 NASA EPSCoR Fellow-University of Vermont, 2009 NASA EPSCoR Fellow-University of Vermont, 2010 Vermont Space Grant Fellow-University of Vermont)

"The space grant program gave me a basic understanding of the aerospace manufacturing industry, allowing me to more readily adapt to the work environment and expectations of my current position at UTC." (Lucas Faryniaz, 2011 Vermont Space Grant Fellow-University of Vermont)

“The Space Grant program has had a profound impact on my life and has provided the opportunity to successfully obtain my educational goals. The program provided crucial financial support and connections, without which further education would not have been possible. It also facilitated the direct aerospace experience required to secure a job immediately following graduation. I hope the NASA Space Grant program continues to advance lives and educations for generations to come.” (Nicholas Vachon, 2009 NASA EPSCoR Fellow-University of Vermont, 2011 Vermont Space Grant Fellow-University of Vermont, 2012 Vermont Space Grant Fellow-University of Vermont)

“VSGC played a great role in my education. The research opportunities available to me through VSGC were critical to my growth as an engineer, and a professional. I am not really working in nano-technology, but am now working in the aerospace industry and the research I was involved in certainly improved my writing skills, organization, and scientific approach to problems.” (Evan Malina, 2009 Vermont Space Grant Scholarship-University of Vermont)

Still helping me get my PhD (Nicholas Allgaier, 2008 Vermont Space Grant Fellow-University of Vermont, 2009 Vermont Space Grant Fellow-University of Vermont, 2010 Space Grant Fellow-University of Vermont, 2011 Vermont Space Grant Fellow-University of Vermont, 2012 Vermont Space Grant Fellow-University of Vermont)

“Allowed me to work less and pursue research.” (Katie Bedard, 2010 Vermont Space Grant Scholarship-University of Vermont, 2011 Vermont Space Grant Scholarship-University of Vermont, 2012 Vermont Space Grant Scholarship-University of Vermont)

“It allowed me to achieve my childhood dreams.” (Walten Owens, 2011 Vermont Space Grant Fellow-University of Vermont)

“The Vermont Space Grant, made finishing my associates degree possible as well as giving me the opportunity to work at NASA again last summer.” (Thomas Manton, 2012 Vermont Space Grant Scholarship-University of Vermont)

A further indicator of Program Accomplishments contributing to Outcome 1 is also given in data provided by the National Space Grant Foundation, namely: During the FY13 program year 2 students are pursuing advanced degrees in STEM disciplines, 1 accepted a STEM position with a NASA contractor, 10 accepted STEM positions in industry, 1 accepted a STEM position in K-12 academia, 1 accepted a STEM position in academia; 7 went on to positions in non-STEM disciplines.

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

VSGC 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 VSGC 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 2013 Faculty Research Awards have actively engaged their undergraduate students by involving them in significant ways in their funded research projects. VSGC 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 VSGC sponsorship.

In FY 2013, the VSGC 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 VSGC 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 "ZEV 2.0: Zero-emissions vehicle for Frozen Landscape scientific studies." The goal of this project has been 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/m³, 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. The current ZEV 2.0 project has focused on revising and improving the ZEV 1.0 prototype's drive train and power system. Michael Combariate of NASA Goddard has served as 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. VSGC 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 VSGC 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. VSGC 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 VSGC occurred in 2013: 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 2013 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 VSGC mounted an exhibit showcasing our programs at these events and also provided a small amount of funding support. Other precollege programs in which the VSGC 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.

New to our 2013 activities was an additional pre-college program for STEM high school instructors. The VSGC sponsored the participation of a science teacher from a Vermont high school to attend the **2013 LEGO Summer Engineering Institute** for Educators held at Tufts University in Boston. Educators attending this week-long institute received hands-on experience in incorporating LEGO Mindstorm robotics kits into their high school engineering/science curricula. This institute/workshop was the direct outcome of planning during a 2012 Northeast Region of the National Space Directors in Burlington, VT. Mr. Tim Ziegler, a physics teacher at Stowe High School, was selected as the attendee and he reported a wonderful experience that he described as an invited speaker at the VSGC Awards Night Ceremony last fall.

Finally, as a CAPENS Consortium, the VSGC 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 VSGC has been able to establish a strong presence in the state and region in the K-12 arena.

MENTION THE SUMMER INSTITUTE

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 VSGC invites special guests to Vermont to address local audiences. As a guest speaker for the fall VSGC Awards Ceremony, the VSGC invited Dr. David Atkinson, a Professor of Electrical Engineering at the University of Idaho and a Senior Research Fellow at NASA/JPL. Dr. Atkinson presented a talk entitled "Exploring Saturn with Shallow Probes". He participated not only in the VSGC ceremony, but also in the surrounding activities that included the VSGC Student Poster Session and a research seminar held earlier during day at the University of Vermont. This outreach helped to facilitate opportunities and interactions between NASA and Vermont students, teachers, and academic researchers. We should also note that, typically, invitations have also included NASA officials; however, due to the federal sequestration in 2013 this was not possible

The VSGC 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. Erstwhile 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 VSGC at the quarterly meetings of the Council.

Additional outreach within the State has come from the VSGC'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 VSGC's activities before leaving office in late 2010. Mr. Dubie remains a member of the VSGC's Board of Advisors. The VSGC'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 VSGC's representative on the Board of Burlington Technical Center's Aviation Technology School. The VSGC 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 VSGC has also interacted with the NASA Explorer School in Orleans, Vermont.

Finally, in the late fall of 2013 Director Darren Hitt was approached by the board of directors for the VT Challenger Learning Center initiative based in Franklin County Vermont (<https://www.challengervt.org>). Hitt was requested, on behalf of the VSGC, to lend his expertise, guidance, and assistance in moving this initiative forward.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Student Data and Longitudinal Tracking:** Number of program student participants employed by NASA, aerospace contractors, universities, and other educational institutions; Number of undergraduate students who move on to advanced education in NASA-related disciplines; Number of underrepresented and underserved students participating.
(Example: Student Data and Longitudinal Tracking: Total awards= 200; Fellowship/Scholarship= 120, Higher Education/Research Infrastructure= 80; 90 of the total awards are underrepresented minority F/S funding; 10 students have accepted STEM positions in an aerospace industry, while 3 have graduated and are pursuing advanced STEM degrees.)
- **Minority-Serving Institution Collaborations:** Summarize interactions. Reference the names of projects with MSI collaborations.
- **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.
 - Diversity of institutions, faculty, and student participants (gender, 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 (see above).
 - Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers.
 - Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges.
 - 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).
 - Environmental Science and Global Climate Change – research and activities to better understand Earth's environments.
 - Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities.
- Student Data and Longitudinal Tracking: The data presented below for Total Awards to students during the FY 2013 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 VSGC Fellowships work directly with their faculty advisors on research projects that are aligned with new and continuing NASA research priorities. VSGC Graduate Fellowships thus support our mandate as a CAPENS Consortium to promote the development of Research Infrastructure. The VSGC 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 2013 tracking data provided by the Foundation is as follows:

Total awards = 13; Fellowship/Scholarship = 13, Higher Education/Research Infrastructure = 0; 1 of the total award represent underrepresented minority F/S funding. During the FY13 program year 2 students are pursuing advanced degrees in STEM disciplines, 1 accepted a STEM position at a NASA contractor, 10 accepted STEM positions in industry, 1 accepted a STEM position in K-12 academia, 1 accepted a STEM position in academia, and 7 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 VSGC. 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 VSGC 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. In our Undergraduate Scholarship Competition, a total of five scholarships were awarded of which two recipients were female and one was Native American. Three Workforce Development Scholarships were awarded to students in the Aviation Technology Program at the Burlington Technical Center (BTC), including one female. This student, Bettina Edelstein, gave a well-received presentation in February 2014 at the National Council of NASA Space Grant Directors' Meeting in Crystal City VA. Further, the faculty mentor at VTC is a member of an underrepresented group. Within the Mentored Undergraduate Projects and Senior Design Teams supported, four female undergraduates were involved. And finally, within the Graduate Fellowships, a two of the five fellowships awarded went to female students. In the 2013 Faculty Research Competition, 33% of our local research grants were awarded to female faculty members.
- 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 enrollments. As will be noted shortly in the Program Partners Section, one VSGC 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 VSGC affiliate, cooperates closely with the VSGC 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 VSGC’s strategy for promoting diversity in our programs involves developing relations with minority-serving institutions out-of-state. In particular, over the years the VSGC 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 have worked 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 the University of Vermont 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:

VSGC support for two capstone undergraduate engineering design projects and three mentored-student engineering teams provided authentic, hands-on student experiences in science and engineering disciplines based on real-life NASA research and technology needs. The capstone design projects were at the University of Vermont and included the “Greenland Robot Tractor” and “Lunabotics”, the latter referring to the NASA-sponsored national design competition for an autonomous lunar mining vehicle. The mentored engineering teams included the Alternative Energy Racing Organization (AERO) at the University of Vermont, an Autonomous Underwater Vehicle at Norwich University, and a CubeSat team at Vermont Technical College.

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 VSGC Diversity goals.

Continued VSGC 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.

The VSGC also sponsored the participation of a science teacher from Stowe High School to attend the 2013 LEGO Summer Engineering Institute for Educators held at Tufts University in Boston. Educators attending this week-long institute

received hands-on experience in incorporating LEGO Mindstorm robotics kits into their high school engineering/science curricula. This institute/workshop was the direct outcome of planning during a 2012 Northeast Region of the National Space Directors in Burlington, VT.

VSGC 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 VSGC to Prof. Mary Dunlop and Prof. Rachael Oldinski, 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

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.

During FY 2013 there was a change in the VSGC Director from its founding director William Lakin to Darren Hitt. During this period of transition, opportunities for significant changes and improvements were necessarily limited as the new Director was very much occupied with learning the complexities of this position. Nonetheless, three specific developments are worth noting:

- The VSGC made the decision to become active in social media as a means for disseminating NASA-related news and information, as well as advertising various opportunities for internships, fellowships, summer programs and research funding. Twitter was selected as the most appropriate form of social media for most effectively the undergraduate and graduate student populations. The VSGC Twitter feed (@VT_SpaceGrant) has already established 42 followers, including several state Space Grants, the National Space Grant, the American Institute of Aeronautics & Astronautics among others. At the National Council of NASA Space Grant Directors' Meeting in spring 2014, the VSGC was informed that it was among the top three most active Space Grants involved in social media; Director Hitt also participated on a panel discussion of social media usage.
- To improve longitudinal tracking of VSGC former students, the Consortium also became active in the use of the LinkedIn social media. This application is an excellent means for automatically tracking professional updates of our former students.

- At both the fall 2012 and spring 2013 National Council of NASA Space Grant Directors' Meetings, the VSGC sponsored student attendance and oral presentations. At the Charleston meeting in October 2013, the student participant was M. Ryan McDevitt, a Ph.D. student in Mechanical Engineering from the University of Vermont. At the Crystal City meeting in February 2014, the student participant was Bettina Edelstein, a student in the Aviation Technology Program at the Burlington Technical Center.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION:

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

Other educational organizations that are VSGC 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 VSGC 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 VSGC programs.

Continuing industrial affiliates the VSGC include Triangle Metal Fabrications of Milton, VT; LORD/Microstrain, Inc. of Williston, VT. Both of these companies have provided significant support and training for VSGC-supported student engineering teams. During the past year the VSGC has also added Archimedes Aerospace LLC of Burlington, VT as a new affiliate. This successful small business was a 2012 recipient of a VT/NASA EPSCoR-sponsored SBIR Phase 0 grant and has developed close ties with the VSGC since that award.

The National Space Grant Office requires two annual reports, the 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.