

Vermont Space Grant Consortium
University of Vermont, Lead Institution
Dr. William D. Lakin, Director
(802) 656-1429
URL: <http://www.vtspacegrant.org>

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 \$535,000 for fiscal year 2008.

PROGRAM GOALS

Goals of the Vermont Space Grant Consortium (VSGC) during the fourth 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 above.

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

Several illustrations will highlight the contributions made by VSGC programs to the three outcomes that guide NASA's Education Portfolio. As a first illustration, the University of Vermont (UVM), the Lead Institution in the VSGC, is currently in the process of upgrading its present Masters-level program in Biomedical Engineering to a Bioengineering Program that will grant doctoral degrees. Full approval for this new Ph.D. program is expected shortly, and once approved this program will have access to institutional resources, such as research support for graduate students. Discussions between VSGC Director William Lakin and Bioengineering Program Director James Iatrides indicated that UVM faculty associated with this interdisciplinary program were very interested in establishing NASA connections and advising graduate students on research aligned with new and continuing NASA research priorities and technical needs. As a result of these discussions, the VSGC awarded a special 12-month Graduate Research Assistantship to Mr. Ben Walter, a new student enrolling at UVM to major in Bioengineering. Mr. Walter is now conducting research under the direction of Prof. Iatrides on the "Mechanics and remodeling of the injured intervertebral disc under simulated hyper and hypogravity environments."

A second illustration of how VSGC programs benefit NASA's Education Outcomes comes from our Higher Education Programs and involves support for the Autonomous Underwater Vehicle (AUV) Project at Norwich University, a VSGC affiliate. The student engineering team (11 members) involved in this project is developing a robot vehicle that will be 100% self-controlled and capable of navigating through a series of predefined tasks without human intervention. This project, which was initially supported using ESMD Higher Education funding, was so popular and successful that the VSGC provided follow-on funding in 2008 from our main NASA award. In July 2008, the Norwich Team, accompanied by faculty mentor Ronald Lessard, competed their vehicle against teams from 24 other engineering programs from all over the world in San Diego California in the International AUVSI Competition, an activity that promotes development of the intelligent machines needed to solve problems of future generations. Design problems overcome by the student team during the course of developing the Norwich AUV may be applicable to a future NASA mission planned to seek signs of life below a 3 to 5 kilometer thick ice sheet on the surface of the Jovian moon Europa. VSGC support for AUV has benefited both Outcome 1 and Outcome 2 of the NASA Education Goals. In addition, a 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.

A final illustration of the benefit to NASA Education Outcomes of our programs involves the VSGC Awards Night held on October 9, 2008. Students, their parents, and representatives of 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 2008 Awards Night program included presentations by Vermont students who participated in VSGC-

supported NASA Summer Internships and mentored undergraduate research projects as well as demonstrations by supported student teams, and it featured a display of the Norwich Autonomous Underwater Vehicle. It is a measure of the statewide impact and recognition VSGC programs have now achieved that both Vermont's Governor, Jim Douglas, and Vermont's Lieutenant Governor, Brian Dubie, the current President of the Aerospace States Association, attended the 2008 ceremony, asked to speak, and helped to present award certificates.

PROGRAM ACCOMPLISHMENTS

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

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. Vermont's NASA EPSCoR Program shares this goal. There is close cooperation between the VSGC and VT-NASA EPSCoR in this area, and several participants involved in VT-NASA EPSCoR's currently funded research projects 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 \$25,000 for more mature research projects, particularly those where a NASA contact has already been made, 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.

Seven new faculty research grants were awarded during the past year as a result of our 2008 Faculty Research Competition and Postdoctoral Fellowship Competition. Five of these awards were new Small-Scale Grants, one was a Postdoctoral Fellowship Award, and one was a Research Minigrant that supported a summer REU. Two additional research projects were also supported in 2008 using supplemental funding from the VSGC's Consortium Development Award.

Vermont's NASA EPSCoR Program currently supports much of Vermont's academic faculty research in areas of interest to NASA. However, 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 2008 base budget and Consortium Development proposals shows that nearly all targets for the current reporting period have been met or exceeded. The combined target for faculty awards in these FY 2008 proposals was four Small-Scale Grants and two Research Minigrants and one Postdoctoral Fellowship in the general competitions. As noted above, five Small-Scale Grants, one Minigrant, and one Postdoctoral Fellowship were supported by the VSGC. As was pointed out earlier, these Research Grants will help to build and strengthen research ties between Vermont's academic faculty and NASA. Since one of the faculty PIs named in our FY 2006 Annual Report is a member of an underrepresented group, the 5-year diversity target in our FY 2005 proposal for participation of underrepresented faculty in the VSGC's Research Infrastructure Programs has already been exceeded. This is a major achievement since data from the UVM Office of Institutional Studies shows that of the 974 full-time faculty members at UVM in 2005, only 10 (1.03%) were underrepresented minorities in STEM areas that might be of interest to NASA, and thus eligible for VSGC research support. Two female faculty members are Co-Principle Investigators on the projects detailed above. Thus, the VSGC has now met our target of awarding at least two faculty research grants to women during the 5-year period of our current award.

1.2 Undergraduate Scholarship and Graduate Research Fellowship Competitions:

Results of the sixteenth Vermont Space Grant Undergraduate Scholarship Competition were announced in May 2008 with undergraduate scholarships awarded for the 2008-2009 academic year. In the general competition, nine 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, four additional VSGC Native American Undergraduate Scholarships were also awarded to outstanding scholars of Abenaki heritage. Nine of these thirteen scholars were women. This exceeds both the target of 41% undergraduate scholarships awarded to women contained in our FY 2008 proposal and the target of 25% awarded to members of underrepresented groups. All supported undergraduate students are being closely tracked and appear to be making excellent progress toward their baccalaureate degrees.

Three additional special scholarships of \$1,500 each were awarded during the current reporting period to students in the Aviation Technology School of the Burlington Technical Center, a VSGC affiliate. This 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.

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.

Graduate Research Fellowships that supported six graduate students were competitively awarded for the 2008-2009 academic year. This meets the target of our FY 2008 proposals. Two of the six supported students are women. At 33%, the results for women awarded VSGC Graduate Fellowships during the present reporting period are slightly under the goal of at least 40% given in our FY 2008 proposal. However, it should be noted that 60% of VSGC Graduate Fellowships were awarded to women in the last reporting period, so we fully expect to meet or exceed our goal for participation by women in this program over the full five-year period. The VSGC is also well on its way to meeting our target of awarding two Graduate Fellowships to members of an underrepresented group during the 5-year period of our current award as one Graduate Fellowship has already been awarded to a member of an underrepresented group. This is a realistic target as only 2% of the UVM graduate students in STEM departments are underrepresented minorities who are U.S. citizens.

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 just concluded reporting period, three supported activities in this category were the UVM Alternative Energy Racing Vehicle (AERO) Student Team, Norwich University's Autonomous Underwater Robotic Vehicle (AUV) Team and Vermont Technical College's CubeSat Project.

Prof. Carl Brandon, Chair of the Vermont Technical College (VTC)'s Aeronautical Engineering Department, is the faculty mentor for the Vermont CubeSat Project. This project, aligned with the "Crawl, Walk, Run, and Fly" concept, is sponsored and coordinated by the VSGC. CubeSat miniature satellites and payloads are flown aboard balloons, rockets, and the shuttle. The CubeSat in Vermont's project is a 10cm X 10cm student built satellite. This project provides students with the technical expertise they will need to build larger satellites. The VSGC's 2008 Program Project Grant to VTC and Prof. Brandon provided funding for additional development of VTC's Student Satellite Project Lab. This funding has further enhanced the new VTC Associates Degree Program in Aeronautical Engineering Technology that was developed as a result of interactions between VTC and the BTC Aviation Technology School through participation in the VSGC network. This project to date has attracted significant in-kind donations of software (over \$2 million), including donations of multiple copies of the Satellite Tool Kit from Analytical Graphics, Inc.

Prof. Jeff Frolik of UVM's Department of Electrical and Computer Engineering and Prof. Ronald Lessard of Norwich University's Department of Electrical Engineering are the faculty mentors for the AERO and AUV Student Teams, respectively. The 2008 Program Project Grants for these engineering design teams provided follow-on funding for design efforts initiated with ESMD-Space Grant awards. During the past year, prototype vehicles designed, built, and tested by both of these student teams successfully competed in national engineering competitions. The achievements of the UVM AERO Team are especially noteworthy. The new AERO hybrid vehicle, which uses both gas and lithium batteries and burns gas more efficiently through regenerative braking, was the recipient of three awards at the 2008 International Formula Hybrid Competition, including the Most Innovative Design and the Best Hybrid-in-Progress, Chrysler's Best Hybrid System Engineering Award.

In 2008, the VSGC participated in the Undergraduate Student Research Program (USRP) by supporting a Summer Student Internship at Marshall Space Flight Center. Benjamin Dimiero, a Mechanical Engineering major at Norwich University, worked with Marty Kress of the MSFC's National Space Science and Technology Center on a project titled "Cryoflex Foam Stress Analysis."

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 faculty-mentored undergraduate research projects while strengthening faculty research efforts and building ties to NASA. Of the six undergraduate students participating in these research projects, two were women.

During the current reporting period, the VSGC also supported three 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. The three URECA! projects funded by the VSGC all involved research topics that are aligned with NASA research priorities.

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:

To provide an additional educational opportunity for engineering students at the Senior and Graduate levels, in 2008 the VSGC provided support from our Consortium Development funding to develop a new course titled “Wavelets in Complex Systems.” This course, developed by Prof. Gagan Mirchandani of UVM’s School of Engineering, will become part of SoE’s “Curriculum 21” revision, a school-wide effort to completely revamp, modernize, and make more relevant the ABET-approved undergraduate education curriculum at UVM. Through exposure to numerous examples taken from NASA projects and included in the course material, students will be given 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.

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 recently became 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.

Two events coordinated by UVM’s College of Engineering and Mathematical Sciences (CEMS) that involved the VSGC occurred in 2008: 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 2008 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.

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 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. David Rosage, PE, Director of the NASA Academy and NASA Robotics Academy for the Office of Higher Education at NASA Goddard Space Flight Center was invited to Vermont in 2008 as the Keynote Speaker for the VSGC’s Annual Award Ceremonies. His participation in this event as well as surrounding activities and meetings helped to facilitate opportunities and interactions between GSFC and Vermont students, teachers, and academic researchers.

The VSGC was recently 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 a recent VASE review and revision of Vermont’s official Science and Technology Plan.

The VSGC is also involved with the NASA Explorer School in Orleans, Vermont. In October, Ms. Zeno helped coordinate a Parents’ Night and NASA 50th Anniversary celebration held at the school. The anniversary celebration included a display of lunar rock samples. During the past year, Ms. Zeno also met with NASA Aerospace Education Specialist Peggy Maher to explore the initiation of possible partnerships between the Orleans NASA Explorer School and informal education providers at the Fairbanks Planetarium and Museum. The potential for identifying UVM faculty mentors for school projects was also discussed.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- **Longitudinal Tracking:** Total awards = 71; Fellowship/Scholarship = 48, Higher Education/Research Infrastructure = 23; 8 of the total awards represents underrepresented minority F/S funding. 1 student has accepted a STEM position in an aerospace industry, while 10 have graduated and are pursuing advanced STEM degrees.

- **Course Development:** One new course for UVM's School of Engineering (SoE) was developed with VSGC funding by Prof. Gagan Mirchandani. This course, titled "Wavelets in Complex Systems," has become part of the new SoE curriculum and will be taken by seniors and graduate students.
- **Matching Funds:** During the last complete grant year, the ratio of matching funds to NASA funds was 1.657 to 1.

Minority-Serving Institutions: Vermont has an exceptionally homogeneous population. Demographic tables from the 2000 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 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 in our Undergraduate Scholarship Program and each year helps us to attract talented students of Abenaki Heritage to our 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, 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 work on the assembly and calibration of CricketSat temperature sensors as well as conducting flights.

IMPROVEMENTS MADE IN THE PAST YEAR

Two changes made during the past year demonstrate the VSGC's commitment to the practice of "continuous process improvement" in the mounting of our spectrum of programs. In 2005, the pool of applicants for VSGC Undergraduate Scholarships was disappointingly small. An extensive discussion with the VSGC's Board of Advisors uncovered a problem with publicizing these scholarships at affiliate institutions. More extensive distribution of the competition announcement plus the addition of several reminder announcements produced a larger applicant pool in 2006, but in 2007 the applicant pool unexpectedly contracted to a new low. Research revealed that the stipend for our merit-based scholarships, which had not increased in five years, was at a level that did not inspire student interest. The advertised stipend for our 2008 competition was accordingly raised, which produced the largest pool of quality applicants in the history of our yearly Undergraduate Scholarship Competition.

A second improvement during the past year involved our Research Infrastructure Programs. VSGC awards in this area have traditionally supported academic faculty researchers and graduate research assistants. For the first time last year, the VSGC advertised a competition to fund a Postdoctoral fellow to provide more advanced assistance for a faculty researcher engaged in a research project aligned with new or continuing NASA research priorities or technical needs. As has been previously noted, a proposal from Prof. Chris Danforth for a Postdoctoral Assistant was funded in this competition. Prof. Danforth's recent research progress report on his project, titled "Modeling of Climate Regime Change in Chaotic Convection," indicates that the addition of a Postdoctoral Assistant to his research team is producing significant results. Among other factors, it has allowed increased use of the facilities at the new Vermont Advanced Computing Center. NASA provided much of the start-up funding for this new statewide computing facility.

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. 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 VSGC and NASA thus have 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 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 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. Industrial affiliates of the VSGC include Triangle Metal Fabrications of Milton, VT and Microstrain, Inc. of Williston, VT. Both of these companies have provided significant support and training for VSGC-supported student engineering teams.