Massachusetts Space Grant Consortium
Massachusetts Institute of Technology (Lead Institution)
Professor Jeffrey A. Hoffman, Director
617-452-2353
http://web.mit.edu/masgc/www/index.shtml
Grant Number:NNX10AT92H

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 MA Space Grant Consortium (MASGC) is a Designated Consortium funded at a level of $575,000 for fiscal year 2011.

PROGRAM GOALS

Outcome 1 Goals and Objectives: Contribution to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals.

1.1 Faculty and Research Support – Provide support to faculty, researchers and post-doctoral fellows by supporting students to work with them on research projects.
1.2 Student Support – Provide NASA competency-building education and research opportunities by way of research fellowships to the maximum number of Massachusetts students, as possible, to prepare them for employment at NASA, the aerospace industry, and higher education.
1.3 Student Involvement in Higher Education – Provide opportunities for groups of post-secondary students to engage in authentic NASA-related mission-based R&D activities, by recruiting the best students from our consortium to participate in NASA programs.
1.4 Course Development – Develop and put into practice university-level academic course resources at MASGC affiliate institutions.
1.5 Targeted Institution Research and Academic Infrastructure – Leverage research funding in the state to enable institutions to conduct cutting edge research and development work for NASA.

Outcome 2 Goals and Objectives:

Attract and retain students in STEM disciplines through a progression of educational opportunities for students and teachers.

2.1 & 2.2 Educator Professional Development (short- and long-term) – Provide continuing in-service opportunities to help teachers maintain competency in STEM instruction and encourage teachers to incorporate STEM instruction in their classrooms.
2.3 Curricular Support Resources – Ensure that Massachusetts's teachers and students know how to access the wealth of available NASA educational materials.
2.4 Student Involvement (K-12) – Encourage and enable students to feel a personal connection with NASA missions.
2.5 Diversity – Extend Space Grant programs and opportunities to the broadest possible cross-section of the Massachusetts population, particularly encouraging, participation by women and minorities.

Outcome 3 Goals and Objectives:

Build strategic partnerships and linkages between STEM formal and informal education providers that promotes STEM literacy and awareness of NASA's mission.

3.1 Resources – Assist our informal education affiliates in enhancing STEM proficiency, publicizing STEM career opportunities, and educating about NASA's mission activities.
3.2 Professional Development for Informal Education Providers –Recognize the important role played by informal educators by supporting them as we do teachers in incorporating STEM activities into their programs.
3.3 Informal Education Provider Involvement Opportunities – Help MASGC's outreach partners present the full breadth and depth of NASA's missions to Massachusetts's informal educators.

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

OUTCOME 1

Higher education is at the top of our priorities and received the largest allocation in our budget. We award almost all higher education funding as fellowships, given directly to students, which avoids institutional overhead charges. Although our proposed amount for fellowships is in excess of the mandatory requirements by Space Grant, it is the wisest use of Space Grant resources, given the large higher education establishment in Massachusetts. Further, faculty, researchers and post-doctoral fellows in Massachusetts have traditionally been extremely successful in attracting NASA research funding. Therefore, MASGC has made a major policy decision not to act as an alternate source of direct NASA research funding for faculty. This policy meets the needs of our members as evidenced by the following excerpt from the annual report of Worcester College, one of our smaller members, which serves the immigrant and rural populations in western MA:

"SPACE GRANT PROGRAM SUPPORTS RESEARCH OPPORTUNITIES FOR STUDENTS"

Massive plumes of antimatter exist in the Milky Way. Scientific teams around the globe are working to understand the origin of this material and its role in the creation of the galaxy. One related research project has taken place at WSU, with support from NASA's National Space Grant College and Fellowship Program.For several semesters, Associate Professor of Physics Sudha Swaminathan, Ph.D., worked with chemistry major Wyatt Merrill '11 to study positronium, an "exotic atom" that contains an orbiting electron and its corresponding antiparticle, a positron. When the electron and positron collide, they annihilate each other, releasing their energy in the form of gamma rays. Swaminathan and Merrill focused on calculating the rate of this phenomenon, information that may be relevant to the emission of gamma rays near the center of the Milky Way. Their project is one of several undergraduate research projects at WSU that have received Space Grant Program funding. The research experience at WSU helped Space Grant participants Wyatt Merrill (I) and Stephen Glynn gain acceptance to graduate school.Worcester State was accepted into the program in 2009, when it became a member of NASA's Massachusetts Space Grant Consortium. Swaminathan and Associate Professor of Physics Francisco Lamelas, Ph.D., were instrumental in facilitating the University's entry into the consortium and they serve as WSU's representatives in the MA Space Grant Consortium. Education is an important part of NASA's overall mission, Lamelas noted. "One of the strengths of the Space Grant Program is that grants go directly to students. This enables them to focus on their research." Research requires a significant commitment of time, Swaminathan explained. "Many of our students have jobs and family responsibilities. These grants give them a chance to concentrate on research, which is tremendously important when they apply to graduate school. To be competitive, they need more than a high GPA. Their resumes are much more impressive if they can cite actual research experience. We are building a culture of student research at Worcester State. She concluded, "The Space Grant Program plays an important role in supporting research opportunities for talented students."

Instead of funding a small number of large research grants (formerly done as sub-contracts to a few MASGC affiliates), MASGC now distributes most of its research and higher education funding as small research fellowship grants to students, each of whom is sponsored by a faculty member or researcher at an affiliate institution. This makes the maximum impact in meeting the objectives of this outcome as evidenced by the following student testimonials:

My summer research experience last summer was made possible by the Space Grant consortium, and reaffirmed my commitment and passion for science and math literacy in the youth of our country. Though my research was not directly related to this idea, learning about my own professional capabilities through this experience led me to believe in myself and that I could make a good teacher. Molly Williams, Senior, Mt. Holyoke Community College

The summer of my freshman year, I was awarded space grant funding for an internship with Dr. Gopal Narayanan at UMASS Amherst helping to prepare a data analysis package for UMASS's LMT (Large Millimeter Telescope). That summer I learned quite a bit about how data is collected, how it is stored, and how it used to perform research. This opportunity allowed to me have a great experience and helped to bolster my resume and letters of recommendation. The summer of 2011, I was accepted to the Bucknell University Physics & Astronomy REU. At Bucknell I worked with Dr. Katelyn Allers performing a infrared study on a sample of Brown Dwarfs with signatures of youth in their spectra. It was an amazingly successful summer, as I had the chance to travel to the January AAS 219th meeting in Austin Texas to present a poster on my research. Consequently, my poster and presentation was judged in the undergraduate Chambliss Astronomy Student Achievement competition and I was awarded an Honorable Mention. The experiences I gained from both summers were career shaping to say the least. This summer I took a turn from astronomy and was fortunate enough to be accepted for a medical physics internship at the Mayo Clinic in the Rochester, MN radiation oncology department. As I enter my senior year I am looking to complete my degree in both Physics and Astronomy and wish to apply to Medical Physics graduate school. I cannot be certain I would be where I am today if it were not for the initial opportunity the MA Space Grant Consortium allowed me three years ago. I am very grateful for my opportunities and hope that this funding will be available to high achievement students in MA in the future.
Joe Lyons, Senior, University of Massachusetts/Amherst

The Space Grant funding allowed me to work alongside my advisor, Dr. Khanna, throughout my Master's Program. It gave me an opportunity to experience how physics research is done, analyzed, and polished into a published paper. Particularly important was the summer funding. It provided a means for me to devote all my time into working with Dr. Khanna instead of wasting a summer away from cutting edge research to earn money for rent, food, and other necessities. The funding has assisted and encouraged me onward to a lifelong career in science.
Michael DeSousa - Masters, UMass/Dartmouth

PROGRAM ACCOMPLISHMENTS

Specific MASGC accomplishments relating to the Outcome 1, 2 & 3 are as follows:

OUTCOME 1

- Support of 50 students from 13 academic affiliates across the state. 17 (34%) of these were female.
- Recruiting and supporting 6 students for internships at NASA centers and JPL.

In keeping with MASGC's philosophy of trying to use Space Grant funds to enable students to do things that they could not do without Space Grant, MASGC initiated a student travel grant program several years ago. The program provides small grants, up to per student, for domestic travel to conferences where the students are presenting talks or posters and where

faculty research grants do not cover travel support for undergraduates. This program has grown in popularity, and we have increased the line item budget for this activity each year for the past several years. This year, MASGC provided travel support for 9 students, including 5 females, 1 Hispanic and 1 Afro American. The conferences at which students presented their work included Space 2011, SPIE Smart Structures/NDE, and IEEE Aerospace. This year, for the first time, we extended travel support to students participating in competitions (SAE Aero Design Competition in Marietta, GA) and in scientific activities (Solar Eclipse expedition).

- "Modern Space Science and Engineering" seminar series open to all member institutions of MASGC. Through weekly seminars, students gain familiarity with the broad variety of scientific and technology experiments being carried out in space. They learn about the complex engineering required to implement these experiments and appreciate the interaction of science and engineering in the space enterprise. Students attend the seminars for academic credit or as auditors.
  The speakers and titles of the talks were:

  - Prof. Larry Young, MIT Aero/Astro – "Artificial Gravity and Human Missions to Mars"
  - Prof. Jeffrey Hoffman, MIT Aero/Astro – "The Hubble Space Telescope – Past, Present and Future"
  - Prof. Thomas Herring, MIT EAPS – "Geodesy from Space"
  - Jennifer Green, MIT Aero/Astro – "Lunar Exploration from a Logistics Perspective"
  - Prof. Jeffrey Hoffman, MIT Aero/Astro – "EVA – Walking and Working in the Vacuum of Space"
  - Dr. Charles Czeisler, Harvard Medical School/Boston and Women's Hospital – "Sleep Disorders Related to Space Flight"
  - Prof. Paulo Lozano, MIT Aero/Astro – "Advanced Electric Propulsion for Space Exploration"
  - Prof. Ben Weiss, MIT EAPS – "The Ancient Lunar Magnetic Field"
  - Prof. Richard Binzel, MIT EAPS – "Asteroids and NEOs: Hazards or Resources?"
  - Dr. Giovanni Fazio – Smithsonian Astrophysical Observatory – "Spitzer Infrared Great Observatory"

  Ed Hodgson – HSSS "Space Suit – Spacecraft"

  - Prof. Nicole Viola – Polytechnic of Turin, Italy – "Nanosatellites, Cubesats and Space Education in Italy"
  - Prof. Sara Seager, MIT EAPS – Exoplanets (Results from Kepler)

- Co-sponsoring 12-part STEM series at the Roxbury Community College, which is attended by minority students to expose them to various STEM disciplines including aerospace.

- Supporting the NASA-OLIN Research program. 8 undergraduate Olin College engineering students participated in this program where they hear about a variety of

possible projects from NASA scientists. Students select four projects. Each student works in a four-student team on each of two different projects. The program provides an opportunity for students to apply their skills to real-world problems. The work done by students can be continued in a following summer or put into everyday use at Goddard and other NASA facilities.

- Supported a team of WPI students in the 2012 Society of Automotive Engineers (SAE) Aero Design East competition in Marietta, Georgia. The Aero Design® East Competition is an aircraft, design, build, defend and fly competition between international collegiate teams. This year Canada, China, Poland, India, Venezuela, Brazil, Turkey, and the USA were represented. World-class organizations also participate including Lockheed Martin, SAE International, Autodesk, & FAI Materials. The competition challenges engineering students to conceive, design, fabricate and present a radio-controlled aircraft that can take off and land while carrying the maximum cargo. The students follow a design process much like what is used in the engineering industry.
  The WPI Team was ranked 6th out of 26 teams in the micro-aircraft class. Their high ranking is impressive given that this is the first time WPI has participated at the AeroDesign East and competed against 'legacy' and experienced teams.

- The Consortium is supporting 5 pre-service teacher Interns, currently undergraduate and graduate students at the Framingham State University. They will work with the Framingham Public School students under the direction of the Challenger Center. All interns will be encouraged to attend NASA ERC workshops and explore and use NASA education materials throughout the year. In addition, interns will be invited to attend and present at the annual Massachusetts Association of Science Teachers Conference in November.

OUTCOME 2

- MASGC supported the opening of a NASA Education Resource Center at a consortium member, Framingham State University (FSU). The Co-Director made a presentation about Space Grant activities in MA. Two MA legislators, Senator Karen Spilka and Representative Chris Walsh, along with MA Department of Education representatives, attended. The guests recognized the importance of NASA teacher resources that will be available to the entire state to help both STEM curriculum development and teacher professional development. Senator Spilka addressed the audience and underscored the need for more STEM teachers in Massachusetts.

- The Co-Director worked with the Science Club for Girls, a program for inner city minority girls. MASGC shared in the funding of rocket workshops for 15 girls, with local industry.

- MASGC has had a long-standing relationship with Parametric Technology Corporation (PTC), whose world headquarters are in Needham, MA. PTC makes the

well-known Pro-Engineer CAD/CAM software and sponsors a great many educational activities to encourage student participation in design activities. On 4 April, 2012, PTC sponsored a symposium for ~100 Eastern Massachusetts education executives (mostly superintendents of school systems and school principals) to present the possibilities for using student versions of ProEngineer and other software in middle school and high school design activities. This software, which PTC provides free of charge, is extremely useful in the engineering lessons that Massachusetts requires all middle and high schools to include in their curricula. One use of the software, the Real World Design Challenge, is described below. The MASGC director, Jeffrey Hoffman, delivered the keynote address for the symposium.

- Parametric Technology Corporation (PTC) sponsors an annual "Real World Design Challenge" (RWDC), in which high school students nationwide are given an aeronautics problem requiring the use of CAD and other software to perform a tradeoff analysis among several systems on a specified kind of aircraft. Winners from each state are invited to the national finals in Washington, D.C., held early each April. This year, as in the past two years, MASGC provided judges, both faculty and graduate students, for the Massachusetts competition.

- MASGC has been working for over a year with the Museum of Science to create a teacher training program that is coordinated with shows in the Museum's newly renovated planetarium. The idea is to develop enrichment programs related to the Planetarium shows that will deepen teachers' knowledge of the subject matter dealt with in the shows, so that they are better able to answer students' questions and to incorporate the shows into their curricula. Most of the past year was spent conducting surveys of teachers to find out what format would be most useful. We have now settled on half-day workshops, where local scientists will deliver lectures related to the subject of the Planetarium show, conduct workshops, and answer teachers' questions. MASGC will provide stipends to participating teachers and will recruit speakers from among MASGC affiliates. Plans are underway to hold the first training session in the fall of 2012.

OUTCOME 3

Participating in the Massachusetts STEM Summit. The Co-Director serves on the Planning Committee. Last year's event was the eighth, and had to be cut off at 500 attendees, limited by the size of the venue! Throughout the day, plenary sessions and panel presentations addressed the plans and goals of STEM education, bringing leaders from the state's education, business and government sectors together to share information and ideas on topics in early to higher, formal and informal education, as well as address workforce development and other policy issues faced by the Commonwealth.

- Partnering with NASA contractors and a number of aerospace companies to obtain industry internships for students in the summer. This is critical both for practical education for our students and for the workforce needs of the aerospace industry. MASGC advertises internship opportunities and helps recruit students.

- MASGC Annual Public Lecture, which brings prominent aerospace personalities and issues for information and discussion for consortium members and the general public. Each year, MASGC arranges public lectures on current topics in space science and engineering. For two decades, the consortium has invited notable figures from NASA, academia or industry to speak on various state-of-the-art aspects of aerospace. In particular, to increase public awareness of and enthusiasm for NASA activities, MASGC sponsors at least one astronaut visit to the greater Boston area every year. This year, we were pleased to have Dr. Greg Chamitoff present a public lecture entitled "Completing Assembly of the International Space Station: the Final Mission of Space Shuttle Endeavour". 88 people attended Dr. Chamitoff's lecture, including 24 females and 6 underserved minorities.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- **Student Data and Longitudinal Tracking**:

Starting in 2006, MASGC has begun longitudinal tracking of students who have participated in the Consortium's programs. We have added extra time for support staff in our budget to support this activity. So far, most of our awardees are still in school. However, we have been tracking our students' career plans to get an estimate of whether they have plans for research, education or employment in space-related areas. Of the 384 students who have graduated, 189 are pursuing advanced STEM-related degrees, 22 are actively seeking STEM employment, 47 are employed by aerospace contractors, 34 are employed in non-aerospace STEM positions, 8 are employed by NASA/JPL, 6 are employed in K-12 STEM, 26 are employed in "other" STEM academic fields and 52 in non-STEM employment.

- **Diversity:**

MASGC has continued to work with three smaller or state institutions: UMass, Dartmouth, Bridgewater State and Worcester State as consortium members. We believe that this extends our reach across the state to a different group of student demographics, which helps the consortium to reach rural, and immigrant communities, and, those that do not have the benefits of contacts with aerospace activities available in and around Boston.

- **Minority-Serving Institutions:**

The Consortium's members include Roxbury Community College (RCC), the state's only designated "minority-serving institution". Therefore, MASGC offered fellowships and a STEM seminar series to RCC students, to encourage them to enter the aerospace workforce pipeline. About 30 students have attended the individual seminars at RCC. We have also recruited and funded a student from Roxbury Community College to spend the summer at MIT/Draper Lab with the intention that the student will be convinced to go on for a 4-year college program in engineering.

- **NASA Education Priorities**

The Consortium is engaged in STEM activities at the entire level of the education pipeline, precollege through university. Summer research opportunities for students on college campuses and NASA Centers with the objective of increased interest in STEM careers, as described in Outcome 1, continues to be the largest portion of our budget in keeping with the needs of the state. The consortium attempts to spread the funding to the maximum number of members with particular emphasis to the smaller institutions in order to maximize diversity of student participants and faculty mentors.

The Consortium competed successfully in NASA's 2010 Summer of Innovation program. This has helped us to create ties amongst the middle school programs conducted by our members and with the state. The consortium has continued to build on these partnerships and our pre-college activities described above in Outcome 2, in the areas of hands-on rocketry and engineering design challenges, have been strengthened by these associations.

Massachusetts has only one officially designated Minority Serving Institution, Roxbury Community College (RCC). RCC is a consortium member and MASGC supports a summer fellowship as well as STEM seminars at the college as described above. Attracting community college students to space-related activities is challenging, because space is a field of endeavor most of the students have not thought about. Therefore, the consortium makes an effort to expose the students to aerospace, in addition to bio-tech and robotics which are the two big industries in the state.

IMPROVEMENTS MADE IN THE PAST YEAR

The Consortium has also renewed its contact with Northeastern University and has a new representative in order to create greater involvement by the university in space grant activities. MASGC has also added MA College of Liberal Arts as a new consortium member in order to support graduate research in astronomy at the College.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

Currently, the Massachusetts Space Grant Consortium has 19 academic affiliates and 3 institutional (outreach) affiliates, covering the entire state from Cape Cod to the Berkshires. Members are listed below, together with the name of each affiliate's representative to MASGC:

Academic Affiliates

Massachusetts Institute of Technology, Lead	Professor Jeffrey Hoffman
Amherst College (Amherst)	Professor Daniel Wang*
Boston University (Boston)	Professor Supriya Chakrabarti
Bridgewater State University (Bridgewater)	Professor Martina Arndt
College of the Holy Cross (Worcester)	Professor Matthew Koss
Framingham State University	Ms Mary Linscombe
Harvard University (Cambridge)	Professor Jonathan Grindlay
Mount Holyoke College (South Hadley)	Professor Darby Dyar
Northeastern University (Boston)	Professor Alain Karma
Olin College (Needham)	Professor Christopher Lee
Roxbury Community College (Boston)	Dr. Tala Khudairi
Tufts University (Somerville)	Professors Chris Rogers and Danilo Marchsini
University of Massachusetts (Amherst)	Professor Robert Hyers
University of Massachusetts (Dartmouth)	Professor Robert Fisher
Wellesley College (Wellesley)	Professor Kim McLeod
Williams College (Williamstown)	Professor Jay Pasachoff
Worcester Polytechnic Institute (Worcester)	Professor Nikolaos Gatsonis
Worcester State University (Worcester)	Professors Sudha Swaminathan and Frank Lamelas
Massachusetts College of Liberal Arts	Dr. Vladimir Strelnitski

*Professor Wang also represents the Five-College Astronomy Department, which in addition to Amherst, Mount Holyoke and UMass, also includes Hampshire and Smith Colleges. MASGC's long-term goal is to make Hampshire and Smith full affiliate members in their own right, but this has not yet occurred.

Institutional Affiliates (Outreach)

Museum of Science (Boston)	Mr. Paul Fontaine
Christa McAuliffe Center (Framingham)	Ms Mary Liscombe
Clay Center Observatory (Brookline)	Mr. Ronald Dantowitz

The representative of each organization acts as a liaison for MASGC at their institution, which includes publicizing Space Grant activities and helping to screen and nominate students and programs for MASGC funding.