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 Minnesota Space Grant Consortium is a Designated Consortium funded at a level of $575,000 for fiscal year 2011.

PROGRAM GOALS
Outcome 1 – Higher Education: Contribute to the development of the STEM workforce in disciplines needed to achieve NASA’s strategic goals.

Goal 1.1: Enhance diversity in the STEM workforce by providing research and higher education opportunities to women students and students from underrepresented groups.

Goal 1.2: Contribute to the STEM workforce by providing research and higher education opportunities to high-performing undergraduate and graduate students attending MnSGC institutions.

Goal 1.3: Enhance diversity in the STEM workforce by providing scholarship and fellowship support to women students and students from underrepresented groups.

Goal 1.4: Contribute to the STEM workforce by providing scholarship and fellowship support to high-performing undergraduate and graduate students attending MnSGC institutions, including support for students to participate in NASA Center internships.

Goal 1.5: Contribute to the STEM workforce by enhancing higher education opportunities for high-performing undergraduate and graduate students attending MnSGC institutions through aerospace design projects and student satellite projects.

Goal 1.6: Contribute to the STEM workforce by promoting higher education course development in areas of interest to NASA at MnSGC institutions.

Goal 1.7: Enhance diversity in the STEM workforce by promoting research and/or higher education programming at tribal college affiliates of the MnSGC.
Outcome 2 – Elementary and Secondary Education: Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty.

Goal 2.1: Enhance the teaching of STEM topics, especially in schools with high underrepresented populations, by supporting precollege teachers through a variety of aerospace-related professional-development opportunities.

Outcome 3 – Informal Education: Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA’s mission.

Goal 3.1: Promote familiarity with, and interest in, aerospace and space-related STEM fields and career opportunities by offering a variety of informal education activities around the state.

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

• Outcome 1: Expanded engagement of Native American college students in high-power rocketry teams, with 5 of 6 teams from Minnesota this year having Native American participants. One all-Native team at Leech Lake Tribal College (LLTC) and one nearly-all-Native team, the American Indian Society of Engineers and Scientists (AISES) team, at the U of MN – Twin Cities. Native student participation on teams that built 2 rockets at Fond du Lac Tribal and Community College (FDLTCC) plus a USLI team led by a Native American student at the U of MN – Twin Cities.

• Outcome 1: Space-Grant-funded research students at affiliate institutions that do not have aerospace or engineering departments are having increased success in landing aerospace-related employment. Bethel University and the University of St. Thomas report that they have each placed one alumnus recently at NASA Glenn and at Lockheed Martin respectively.

• Outcome 2: This was the second year of our Middle School High-Altitude Ballooning Initiative (MSHABI), with 8 middle schools building payloads flown in the spring of 2012. Of those, 2 schools liked the program so much after their spring 2011 flights that they built additional sets of payloads last summer and fall which the MnSGC helped fly. Two school districts are now looking into how we can help them learn to fly their own high-altitude balloon missions in the future.

PROGRAM ACCOMPLISHMENTS

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

Goal 1.1: Enhance diversity in the STEM workforce by providing research and higher education opportunities to women students and students from underrepresented groups.

Objective 1.1.A: Involve underrepresented groups in out-of-class higher education programs to at least a minimum percentage equal to Minnesota demographics for enrollment in higher education (Native American 1.3%, African American 8.9%, and Hispanic 2.3%, for a total of 12.5%) and 50% for women students annually.
**Results:** Partially achieved. Of 94 total out-of-class higher education participants, 27 were women (29%) and 14 were from underrepresented groups (15%). This indicates that we need to put renewed emphasis on recruiting and engaging especially women students in these out-of-class opportunities.

**Objective 1.1.B:** Involving underrepresented groups in research programs to at least a minimum percentage equal to Minnesota demographics for enrollment in higher education (12.5% – see Objective 1.1.A above) and award 50% of the research stipends to women. This year we plan to fund a minimum of 4 students from underrepresented groups and 15 women students to participate in research annually.

**Results:** Partially achieved. Of 57 total research stipends awarded, 26 were given to women (46%) but none were given directly to students from underrepresented groups. In fact 3 underrepresented male students (5%) were involved in research activities but they were funded through scholarship/fellowship means (Space Grant and match scholarships) rather than by direct research stipends. This year we did well engaging women research participants but we need to work harder, especially to recruit underrepresented students to our undergraduate and graduate research activities.

**Goal 1.2:** Contribute to the STEM workforce by providing research and higher education opportunities to high-performing undergraduate and graduate students attending MnSGC institutions.

**Objective 1.2.A:** Offer high-quality research experiences for at least 38 undergraduate students across the MnSGC annually that motivate students to work in areas of direct interest to NASA and NASA contractors or to pursue graduate studies in aerospace science and engineering.

**Results:** Achieved. In all 57 students received research stipends in 2011-2012. An additional 8 graduate students did research at the lead institution but were funded through fellowship/scholarship awards instead of with programmatic research stipends.

**Objective 1.2.B:** Fund graduate-level research in aeronautics and space physics in areas in which the Principal Investigators have strong, formal relationships with NASA Centers by funding at least 2 Ph.D. students, 1 in Aerospace Engineering and 1 in Space Physics annually, as well as at least 4 additional graduate students in aerospace science, engineering, and/or related fields through the fellowship budget or directly.

**Results:** Achieved. At the lead institution 4 Ph.D. students and 1 Masters student from the School of Physics and Astronomy (SPA) plus 1 Ph.D. student and 2 Masters students in Aerospace Engineering and Mechanics (AEM) were partially supported with fellowships to do research. All students worked on research under advisers with strong formal relations with NASA Centers.

**Objective 1.2.C:** Provide seed funding to assist investigators will little or no previous contact with NASA develop collaborative programs with Centers and Directorates. Expect at least 1 young investigator will be partially funded annually to seek collaborative contacts with appropriate NASA Centers.

**Results:** Achieved. Professor Lucy Dunne at the U of MN Twin Cities has established a new collaboration with JSC on spacesuit design that is impacting
both her research and a class she teaches on wearable technology. We continue to encourage young faculty across the MnSGC to consider focusing their research on NASA priorities and to make contacts, both at NASA Centers and among more-senior faculty in the state who already have NASA connections.

**Goal 1.3:** Enhance diversity in the STEM workforce by providing scholarship and fellowship support to women students and students from underrepresented groups.

**Objective 1.3.A:** Provide scholarships (and fellowships) for underrepresented students to at least a minimum percentage equal to the most recent Minnesota demographics for enrollment in higher education (12.5% – see Objective 1.1.A above) and make 50% of scholarship/fellowship awards to women students annually.

**Results:** Partially achieved. Of 92 total fellowships and scholarships that were awarded, 35 were given to women (38%) and 29 were given to students from underrepresented groups (32%).

**Goal 1.4:** Contribute to the STEM workforce by providing scholarship and fellowship support to high-performing undergraduate and graduate students attending MnSGC institutions, including support for students to participate in NASA Center internships.

**Objective 1.4.A:** Offer opportunities for all qualified students at our affiliates to participate in the MnSGC Fellowship and Scholarship Program annually by providing (a) at least 30 institution-specific undergraduate scholarships, (b) at least 4 Consortium-wide undergraduate scholarships, and (c) at least 2 graduate student fellowships (partial support).

**Results:** Achieved. Of 92 total fellowship/scholarship awards, 51 were made to undergraduates by MnSGC affiliates (i.e. not by the lead institution and not to students attending institutions outside the consortium) and 16 went to undergraduates at the lead institution. We also gave out 7 Consortium-wide scholarships (4 to undergraduate students at affiliates). As mentioned above, we also partially supported 8 graduate students with fellowships. Not included in these totals are another 12 students who received “scholarship” awards for summer internships at NASA Centers. Some students received awards in more than one category. For example, one student at FDLTCC received an affiliate scholarship, a Consortium-wide scholarship, and also did a NASA Center summer internship. Another student, at Carleton, did a NASA internship, received an affiliate scholarship, and also a Higher Education stipend.

**Objective 1.2.2.B:** Offer scholarship support for at least 6 students to participate in NASA summer internships and other activities at NASA Centers annually. (Note that since final internship selections are made by the Centers, we cannot guarantee that this many Minnesota students will actually receive offers from NASA Centers.)

**Results:** Achieved. A total of 12 Minnesota students were partially-supported by the MnSGC at NASA Center internships during the summer of 2011.

**Goal 1.5:** Contribute to the STEM workforce by enhancing higher education opportunities for high-performing undergraduate and graduate students attending MnSGC institutions through aerospace design projects and student satellite projects.
Objective 1.5.A: Support the aerospace design program at the U of MN – Twin Cities by providing at least 5 aerospace design projects sponsored by industry or government annually.

Results: Achieved. Eight out of 14 aerospace senior design projects during the academic year of 2011-2012 were sponsored by industry or government.

Objective 1.5.B: Engage a new industrial partner, ASTER Labs, in the development of instrumentation for at least 1 student-launched flight project.

Results: Achieved. The U of MN – Twin Cities is developing a HASP ballooning payload to study X-ray communication and navigation and ASTER Labs, a small start-up company, is involved in providing external mentoring for the student team.

Objective 1.5.C: Participate in the National Space Grant Student Satellite Program by maintaining at least 3 different types of active student aerospace hardware programs involving students from at least 3 different institutions in the MnSGC annually.

Results: Achieved. High-altitude ballooning, high-power rocketry, and suborbital rocketry (payload-building) programs are developing or in place at a total of 7 institutions in the MnSGC.

Historical Objective 1.5.D: Expand student-led high-altitude ballooning and/or suborbital programs to at least 1 additional affiliate in 2010-2011.

Results: Achieved. Bemidji State University, working with Central Lakes Community College in Brainerd, has developed a high-altitude ballooning program of in-class use, with two flights so far. Admittedly, this initiative is not yet “student-led.”

Historical Objective 1.5.E: Support participation in the NASA’s USLI (University Student Launch Initiative (high-power rocketry) program) by community college students. Expect at least 1 faculty/student team to attend a USLI workshop and participate in the subsequent rocket competition in 2010-2011.

Results: Achieved. Special funding was extended to Inver Grove Community College (IGCC) – not an affiliate of the MnSGC) to send 1 faculty member and 2 students to a USLI workshop after which they took a rocket to the spring 2011 USLI national rocketry competition. Institutional changes at IGCC prevented them from continuing the program the following year but the U of MN (not a community college) represented Minnesota at the USLI competition in spring 2012 instead.

Goal 1.6: Contribute to the STEM workforce by promoting higher education course development in areas of interest to NASA at MnSGC institutions.

Objective 1.6.A: Support undergraduate Higher Education activities at MnSGC affiliates by providing support for at least 5 new or ongoing courses or academic programs annually.

Results: Achieved. MnSGC supported freshman seminars on high-altitude ballooning and RC aircraft as well as the aerospace senior design class at the U of MN – Twin Cities (lead institution). Another 12 courses around the consortium were also supported, in physics, geophysics, introductory engineering, astronomy, robotics, and planetary geology.
Historical Objective 1.6.B: Develop new educational opportunities using radio controlled (RC) model aircraft design/build/ fly programs. Expect course development will begin for a new freshman seminar in this area at the lead institution in 2010-2011.

Results: Achieved. An RC aircraft freshman seminar was offered in the spring of 2011 and again in the spring of 2012 at the U of MN – Twin Cities.

Goal 1.7: Enhance diversity in the STEM workforce by promoting research and/or higher education programming at tribal college affiliates of the MnSGC.

Objective 1.7.A: Enhance STEM educational opportunities at tribal college affiliates by facilitating at least 1 research or higher education program at both LLTC (a tribal college) and FDLTCC (formerly a tribal college) annually.

Results: Achieved. Both LLTC and FDLTCC have active high-power rocketry programs and send teams to the First Nations Rocketry Competition sponsored by the WI Space Grant. FDLTCC has used Space Grant funding to develop and offer a robotics course as well.

Historical Objective 1.7.B: Support participation in high-power rocketry by tribal college students. Expect at least 1 high-power rocketry team to be operational at a tribal college (LLTC) starting in 2010-2011.

Results: Achieved. LLTC is now participating in the Tribal College category of the First Nations Rocketry Competition. In addition, the AISES chapter at the U of MN – Twin Cities has also formed a high-power rocket team and has entered that AISES category of that same competition twice.

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

Goal 2.1: Enhance the teaching of STEM topics, especially in schools with high underrepresented populations, by supporting precollege teachers through a variety of aerospace-related professional-development opportunities.

Objective 2.1.A: Improve the formal and informal teaching of science and mathematics at the precollege level by offering at least 2 formal short-duration programs annually in which at least 50% of the participating teachers subsequently use the materials/activities in their own teaching.

Results: Partially achieved. Only 1 short-duration teacher workshop was offered to in-service teachers this year by the MnSGC, a Science Fair Participation workshop by BSU. This was an alternative workshop, executed after their planned workshop on ballooning didn’t fly (so to speak). This workshop engaged 6 in-service teachers and 9 pre-service teachers. The post-workshop participation rate was 5 of 6 (83%) among the in-service teachers.

Objective 2.1.B: Offer additional summer short courses and/or workshops annually, especially for middle school educators and/or students at several venues in Minnesota. Expect workshops or short courses specifically for middle school educators and/or middle school students will be delivered or developed at a minimum of 3 locations in 2010-2011.

Results: Essentially achieved. In the summer of 2011 MNDOT offered their annual ACE Camp for Teachers on aerospace topics to 15 teachers, mostly from middle school, 70% of whom used the materials in the first year after the workshop. The U of MN – Twin Cities continued to work with teachers and
students from 9 local middle schools on high-altitude ballooning activities, culminating in flights of science payloads from 8 schools in April 2012. Astronomy instruction has also been provided to middle school students by one affiliate (Carleton College). Another affiliate (St. Kates) ran a ballooning program for local 4-H educators and students, mostly middle-school age.

**Objective 2.1.C:** Promote the teaching of mathematics, science, and pre-engineering by working with teachers from at least 3 schools annually that serve primarily underrepresented students, to familiarize them with aerospace curricula.

**Results:** Achieved. Two MnSGC institutions work regularly with teachers and students from 10 schools in the Twin Cities metro area on high-altitude ballooning and other aerospace topics. Of these, 3 schools serve predominantly underrepresented students.

**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)

**Goal 3.1:** Promote familiarity with, and interest in, aerospace and space-related STEM fields and career opportunities by offering a variety of informal education activities around the state.

**Objective 3.1.A:** Promote aerospace and space related sciences through informal education activities around the state annually. Survey a representative sample of participants and expect that at least 75% of respondents agree that the informal education activities were valuable to them (or to their groups, if they are a group leader).

**Results:** Essentially achieved. Informal education activities were offered by 5 different institutions in the MnSGC this past year, with the U of MN – Twin Cities offering multiple activities. Not all activities were done in contexts where it was practical to formally survey attendees. The affiliates that were able to do so all reported that more than 75% of the participants agreed the activities were valuable to them.

**PROGRAM CONTRIBUTIONS TO PART MEASURES**

- **Student Data and Longitudinal Tracking:**
  
  Note: These values pertain only to students supported in FY11 who are classified as “significantly-supported.” Total awards = 54; Fellowship/Scholarship = 29, Higher Education/Research Infrastructure = 25. Of the total awards, 4 represent underrepresented minority Fellowship/Scholarship funding (1 actually a graduate fellowship to do Research) and 2 represent underrepresented minority Higher Education funding.

  During the FY11 program year 13 students being longitudinally tracked began pursuing advanced degrees in STEM disciplines, 1 accepted a STEM position in the aerospace industry, and 7 accepted non-aerospace STEM positions (4 were computer-related). The remaining students in our longitudinal tracking pool have not yet received the degree they were pursuing when they received their most recent Space Grant award.

- **Diversity:**

  The 14 MnSGC affiliates range from a small tribal community college to one of the nation’s largest Ph.D.-granting public universities. One affiliate is a State Agency
and one is a women-only institution. Affiliates are located in all geographical areas of Minnesota. Five affiliate directors or co-affiliate directors are female. In many categories we achieved our goals for participation of underrepresented minority students but we remain below our objective metrics for female student participants. We continue to work with our affiliates to pursue ways to increase diversity across all MnSGC activities.

- **Minority-Serving Institutions:**
  We currently have one minority-serving institution, Leech Lake Tribal College (LLTC). They are an active participant and have been using MnSGC funding to provide scholarships to their students and to fund a high-power rocketry team that built their first full-size rocket during 2011 – 2012 academic year. That rocket team also provided STEM outreach to Boys and Girls Clubs in their community.

- **NASA Education Priorities:**
  
  o **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.

  **Results:** Aerospace hardware student-led teams and class projects bring hands-on NASA experiences to students at 9 different Minnesota colleges, 8 at MnSGC schools and 1 at a non-MnSGC school but inspired by a MnSGC ballooning class.

  o **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).

  **Results:** Our middle school ballooning initiative is engaging teachers and their students at 9 middle schools in and around the Twin Cities in (amateur) spacecraft building and (near-)space flight.

  o **Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges.**

  **Results:** High-power rocketry and robotics programs are now well-established at our two community college/tribal college affiliates, LLTC and FDLTCC. Bemidji State University is working closely with Central Lakes Community College in Brainerd, not a MnSGC affiliate, in their high-altitude ballooning program.

  o **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).**

  **Results:** One Aerospace Engineering Ph.D. student (an African American) worked on computational hypersonics. Two Aerospace Engineering Masters Students worked on NextGen, one studying aircraft safety and the other working on “green” aircraft designs.

  o **Environmental Science and Global Climate Change – research and activities to better understand Earth's environments.**

  **Results:** Course development and/or course offerings in Environmental Science and in Global Climate Change occurred at 2 MnSGC affiliates in 2011-2012. We
are also collaborating with U of MN professor Gillian Roehrig and her Global Climate Change Education (GCCE) NASA grant for teachers at tribal reservation schools.

- Diversity of institutions, faculty, and student participants.
  **Results:** See Diversity section above.

- Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities.
  **Results:** See Objective 1.2.C above.

### IMPROVEMENTS MADE IN THE PAST YEAR

- Expansion of high-power rocketry activities at three MnSGC institutions, including a new freshman seminar on high-power rocketry under development at the lead institution, with a total of 6 high-power rocket student teams building rockets during the past year, 5 of which included Native American students.

- Research and Higher Education initiatives with women and underrepresented faculty as PIs. New projects now underway with these PIs include participation in HASP (NASA-scale ballooning), apparel design students applying their wearable technology fabrics to spacesuit design, cosmochemistry analysis of lunar samples, and experimental fluid mechanics.

- Increased participation in student aerospace hardware competitions, with MnSGC-supported teams going to the SAE Heavy Lift Competition (2 teams), the USLI Rocketry Competition (1 team), the Midwest Regional/Collegiate Rocketry Competition (2 teams), and the First Nations Rocketry Competition (1 AISES team and 2 teams in the Tribal College category).

- Broadening of our middle school high-altitude ballooning initiative beyond the single-payload per school (which served 9 schools this year), with 2 middle schools running additional payload-build programs (total of 12 payloads built and flown) plus two school districts looking into learning to fly high-altitude payloads for themselves.

### PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

- Augsburg College: M.S.-granting, private institution; Undergraduate Research, Informal Education
- Bemidji State University (BSU): M.S.-granting, public; Undergraduate Research, Higher Education / Pre-College
- Bethel University: M.S.-granting, private; Undergraduate Research
- Carleton College: 4-year, private; Undergraduate Research, Informal Education
- Concordia College: 4-year, private; Undergraduate Research, Higher Education
- Fond du Lac Tribal and Community College (FDLTCC): 2-year, public community college (combined with a 2-year tribal community college); Higher Education
- Leech Lake Tribal College (LLTC): 2-year, tribal community college; Higher Education
- Macalester College: 4-year, private; Undergraduate Research
- Minnesota Department of Transportation (MNDOT): State agency; Pre-College
- Southwest Minnesota State University (SMSU): 4-year, public; Pre-College, Informal Education
- St. Catherine University (St. Kates): M.S.-granting, private (main campus is women-only); Undergraduate Research, Higher Education, Informal Education
- University of Minnesota – Duluth (UMD): M.S.-granting, public; Undergraduate Research
- University of Minnesota – Twin Cities (UMTC): Ph.D.-granting, public; Consortium Administration, Undergraduate and Graduate Research, Higher Education, Pre-College, Informal Education
- University of St. Thomas (UST): M.S.-granting, private; Undergraduate Research