

The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD – this document) 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.

Minnesota Space Grant Consortium
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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 Minnesota Space Grant Consortium is a Designated Consortium funded at a level of \$575,000 for fiscal year 2014.

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, and 3)

- Outcome 1: MnSGC is now running, not just hosting, the Space Grant Midwest High-Power Rocketry Competition. The competition is now nationwide and a total of 18 teams, all sponsored by their state's Space Grant, are participating in 2014-2015. One MnSGC affiliate, U of MN – Duluth, expanded from 1 to 2 rocket teams this year.
- Outcome 1: In part because of engagement with the MnSGC, St. Catherine University (an all-women's university) has now decided to expand their physics curricular offerings, with high-altitude ballooning incorporated into several classes, to the point of offering a full-fledged, on-campus physics major.
- Outcome 2: Four different MnSGC institutions that do high-altitude ballooning with college students now regularly engage middle school age teachers and students as well, with more than 10 middle schools and 4 Boy Scout troops involved this year.

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 0.8%, Pacific Islander 0.1%, African American 14.4%, and Hispanic 4.6%, for a total of 19.9% (round up to 20%)) and 50% for women students annually.

Results: Partially achieved. Of 45 total out-of-class higher education participants, 12 were women (27%) and 5 were from underrepresented groups (11%). We need to continue our emphasis on recruiting and engaging women and underrepresented students in these out-of-class opportunities.

Objective 1.1.B: Involve underrepresented groups in research programs to at least a minimum percentage equal to Minnesota demographics for enrollment in higher education (20% – 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: Raw participation numbers achieved; demographic percentages nearly achieved. Of 51 total research stipends awarded, 25 were given to women (49%) and 8 were given to students from underrepresented groups (16%).

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, 51 undergraduate students received research stipends in 2014-2015. An additional, 2 graduate students did research at the lead institution but were funded with fellowship 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 fellowships or directly.

Results: Partially achieved. At the lead institution 1 Ph.D. student from the School of Physics and Astronomy (SPA) plus 1 Masters student in Aerospace Engineering and Mechanics (AEM) were partially supported with fellowships to do research. Both students did research under advisers with strong formal relations with NASA Centers.

Objective 1.2.C: Provide seed funding to assist investigators with 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: Not achieved. The MnSGC has supported young faculty participating in NASA Center collaborations, most recently Apparel Design Professor Lucy Dunne at the U of MN – Twin Cities whose wearable technology work with JSC continues. However no collaborations involving young faculty and NASA Centers were established this past year. We continue to encourage young MnSGC faculty to focus their research on NASA priorities and offer to support them and help them make contacts with NASA Centers and with other faculty who 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 (20% – see Objective 1.1.A above) and make 50% of scholarship/fellowship awards to women students annually.

Results: Achieved. Of 68 total fellowships and scholarships that were awarded, 37 were given to women (54%) and 26 were given to students from underrepresented groups (38%).

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, except for the Consortium-wide scholarship program which has been discontinued since all affiliates now award their own scholarships. Of 68 total fellowship/scholarship awards, 45 were made to undergraduates by MnSGC affiliates (i.e. not by the lead institution and not to students attending institutions outside the MnSGC) and 13 went to undergraduates at the lead institution. As mentioned above, the MnSGC also partially supported 2 graduate students with fellowships. Eight more undergraduate students received awards for summer 2014 internships at NASA Centers. Several students received awards in more than one category.

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 8 Minnesota students were partially-supported by the MnSGC at NASA Center internships during the summer of 2014.

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. Five (out of nine) aerospace senior design projects during 2014-2015 were sponsored, in part, by industry or government.

Historical 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. An update: The U of MN – Twin Cities is now in their fourth year 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. Aerospace-related student hardware projects in high-altitude ballooning, NASA-scale ballooning (payload-building), high-power rocketry, and RC aircraft programs are operating at 7 institutions within 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. An update: Bemidji State University, working with Central Lakes Community College in Brainerd, plus Augsburg College and St. Catherine University, both in the Twin Cities, now have established high-altitude ballooning programs.

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. An update: Three MnSGC institutions, plus one non-MnSGC Community College, are entering rockets in the 2014-2015 Space Grant Midwest Regional Rocketry Competition. One additional team, from the lead institution, plans to attend the Utah rocketry competition in June 2015.

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. The MnSGC supports freshman seminars on high-power rocketry and RC aircraft as well as aerospace senior design projects at the U of MN – Twin Cities (the lead institution of the MnSGC) and at U of MN – Duluth (an affiliate institution). The MnSGC also supported another 8 courses at 3 other institutions around the consortium in physics, geology, environmental studies, introductory engineering, astronomy, earth science, and STEM teacher education.

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 update: The RC aircraft freshman seminar was successfully offered for a fifth time in the spring of 2015 at the lead institution.

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 on-going high-power rocketry programs and both built rockets for the Spring 2015 First Nations Rocketry Competition sponsored by the WI Space Grant.

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. An update: LLTC is continues to participate annually in the First Nations Rocketry Competition.

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. The Office of Aeronautics at MNDOT offered their annual short-duration teacher workshop entitled *Aerospace Camp for Teachers* to 6 in-service teachers, but no additional ad-hoc teacher workshops were offered past this year. Post-workshop participation rate was 100% for the MNDOT workshop.

Historical 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: Achieved. An update: This year St. Catherine University helped with a ballooning initiative at 2 middle schools and the U of MN ran a ballooning program for 4 troops of Boys Scouts, mostly middle-school age and mostly underrepresented.

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: Partially achieved. Three MnSGC affiliates work regularly with teachers and students from about five pre-college schools on high-altitude ballooning and other aerospace topics in the Twin Cities area (with additional engagement in greater MN).

This year only one metro school served 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: Achieved. Informal education activities were offered by ten 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 but the affiliates that were able to do so all reported more than 75% of the participants agreed the activities were valuable to them.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Diversity:**

The 14 MnSGC affiliates range from a small tribal 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 higher education institution. Affiliates are located in all geographical areas of Minnesota. Five affiliate directors are female. This year we met our participation goals for underrepresented students in Scholarships/Fellowships, but not in Higher Education (out-of-class activities) nor in Research. We met our participation goals for women students in Scholarships/Fellowships and Research, but not in Higher Education (out-of-class activities). We continue to work with our affiliates to pursue ways to increase diversity across all MnSGC activities.

- **Minority-Serving Institution Collaborations:**

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 to compete in the First Nations Tribal Rocketry competition annually since the spring of 2012. Their team does STEM outreach to Boys and Girls Clubs in their community.

- **NASA Education Priorities:**

- 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 7 MnSGC institutions.

- 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: Students from eleven middle schools, one high school, and four Boy Scout troops participated in MnSGC balloon flights this year. Three Twin Cities middle schools from two different school districts are now starting to provide their own high-altitude ballooning flights, in consultation with the MnSGC. We helped one other middle school design a vertical wind tunnel.

- Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers.

Results: The MnSGC does not currently offer any programming in this area.

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

Results: High-power rocketry programs continue at our two community college/tribal college affiliates, LLTC and FDLTCC. Bemidji State University is working with Central Lakes Community College in Brainerd, which is not a MnSGC affiliate, on a joint high-altitude ballooning program. Century (Community) College, also not a MnSGC affiliate, is sending students to the

U of MN – Twin Cities for UAV internships and also fielding a rocket in the 2014-2015 Space Grant Midwest Rocketry Competition that we are running.

- 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: Professor W. Garrard, Director of the MnSGC, has been working on research on mathematical modeling of aerodynamic flutter for use in design of feedback control for aerodynamic flutter of advanced transport aircraft. This project is closely allied with research sponsored by NASA Armstrong.

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

Results: Bemidji State University offered multiple curricular-based and research activities in Environmental Science and Global Climate Change.

- Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities.

Results: The MnSGC supported NASA-related research by early-career faculty at Bethel University (Physics), St. Catherine University (Biophysics), Concordia College (Physics), and Bemidji State University (Biology).

IMPROVEMENTS MADE IN THE PAST YEAR

- The U of MN – Twin Cities enhanced its relationship with a non-affiliate community college by offering 2 community college students summer research internships in the Aerospace Engineering and Mechanics Department's UAV lab. This is a result of the (separately-funded) MnSGC Community College Quadrotor Design Competition.
- The X-ray navigation research effort flown on HASP has now evolved into a project to develop a prototype cubesat involving Aerospace Engineering senior design students and Experimental Methods physics students at the U of MN – Twin Cities. We are currently exploring ways to engage students from other institutions as well.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

- Augsburg College: M.S.-granting, private; Undergrad. Research, Higher Ed., Informal Ed.
- Bemidji State U (BSU): M.S.-granting, public; Undergrad. Research, Higher Ed., Pre-College
- Bethel U: M.S.-granting, private; Undergrad. Research, Higher Ed.
- Carleton College: 4-year, private; Undergrad. Research, Informal Ed.
- Concordia College: 4-year, private; Undergrad. Research, Higher Ed., Pre-College, Informal Ed.
- Fond du Lac Tribal and Community College (FDLTCC): 2-year, public community college (combined with a 2-year tribal community college); Higher Ed., Pre-College
- Leech Lake Tribal College (LLTC): 2-year, tribal community college; Higher Ed.
- Macalester College: 4-year, private; Undergrad. Research

- MN Dept. of Transportation (MNDOT): State agency; Pre-College, Informal Ed.
- Southwest Minnesota State U (SMSU): 4-year, public; Pre-College, Informal Ed.
- St. Catherine U (AKA St. Kates): M.S.-granting, private (main campus is women-only); Undergrad. Research, Higher Ed., Informal Ed.
- U of MN – Duluth (UMD): M.S.-granting, public; Undergrad. Research, Higher Ed.
- U of MN – Twin Cities (UMTC): Ph.D.-granting, public; Consortium Administration, Undergrad. and Graduate Research, Higher Ed., Pre-College, Informal Ed.
- U of St. Thomas (UST): M.S.-granting, private; Undergrad. Research, Informal Ed.