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

PROGRAM GOALS

The Colorado Space Grant Consortium had four primary goals for the year as part of a five-year strategic plan developed to enhance the overall student experience and better equip the student for the workforce.

These four primary goals were:

1. Increase diverse student participation in hands-on space hardware programs.
2. Sustain four stages of hands-on programs for COSGC students.
3. Create and support opportunities for COSGC students to work with engineers and scientists form Colorado aerospace companies.
4. Partner COSGC students and program with faculty and industry experts and their research through space hardware missions, seed grants, and research grant opportunities.

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

Outcome 1:

- CO Space Grant at Colorado School of Mines developed a new summer undergraduate research program. Students worked with faculty and industry mentors on 1) In-Situ Resource Utilization research focused on Mars tectonic activity beneath the surface; and 2) Measure of fuel in a fuel tank in microgravity using acoustic resonance modes.
- Students at Community College of Denver (CCD) launched the institution's first balloon payload as part of the statewide DemoSat program. The inaugural program paves the foundation for a continuing balloon payload program at CCD.

- Students at Colorado State University (CSU) developed a hovercraft as a demonstration of a rover-like vehicle for planetary exploration. The project was filmed by the Discovery Channel and featured on their television program.

PROGRAM ACCOMPLISHMENTS

Goals stated as SMART Goal Metrics from the COSGC 2010 Proposal are indicated in parenthesis at the end of each line item - including the page number from the proposal where each may be located.

NASA Outcome 1:

COSGC Goal 1 (Diversity)

- All COSGC students who received scholarships participated in hands-on, space hardware programs at their respective institutions, or with industry partners.
    - **26%** of scholarships were awarded to women (Goal: 33.7%, p. 9)
    - **11%** of scholarships were awarded to minority students underrepresented in STEM disciplines. (Goal: 19.5%, p. 9)

COSGC Goal 2 (Fellowship/Scholarship & Higher Education)

- All COSGC institutions awarded a minimum of **30%** of their FY 2011 funding directly to students in the form of scholarship awards. (Goal: 30%, p.10)
- **156** scholarships were awarded to COSGC undergraduate and graduate students in FY 2011. All awardees were engaged in hands-on space focused projects including laboratory research, observatory explorations, robotics projects, short and long duration balloon payloads, sounding rocket payloads, CubeSat payloads, and low Earth orbiting satellite missions. (Goal: 45, p.10)
- **250** undergraduate and graduate students engaged in hands-on space focused projects as credit students, volunteers or in project-focused courses. (Goal: 120, p.16)
- COSGC maintained all four stages of the SHOP (Staged Hands-On Program) approach to student experiences within the COSGC academic network.
    - In FY 2011 all COSGC institutions of higher education facilitated hands-on, space focused student projects that fall within the *Staged Hands-On Program* approach to student experiences outlined in the COSGC Strategic Plan: **15** facilitated at least one introductory (or "Walk) level student project (Goal: 17, p.16); **6** facilitated at least one beginning/intermediate (or "Run") level students project (Goal: 4, p.16); **3** facilitated one intermediate/advanced (or "Jump") level project (Goal 2, p.16); and **1** facilitated an advanced (or "Fly") level project.

COSGC Goal 3 (Research Infrastructure)

- **12** students participated in EduSourcing internships at Lockheed Martin, Black Sun Solar, and Southwest Research Institute. (Goal 4, p.12)

COSGC Goal 4 (Research Infrastructure)

- **2** seed grants were awarded to junior faculty for research at Colorado State University. (Goal: 4, p.12)

- **5** COSGC institutions facilitated research projects for students to work in collaboration with industry and/or academic mentors. (Goal: 4, p.12)
- **20+** students participated in research projects for credit or as volunteers. (Goal: 10, p.12)

NASA Outcome 2: (Precollege)
- **56** teachers participated in **5** weeks of training at the Space Foundation's summer Space Across the Curriculum courses. (Goal: 170 teachers; 7 weeks, p.17)
- **0** pre-service teachers engaged in curriculum building activities. (Goal: 2, p.17) Note: There was a change of affiliate director at the proposing institution. The new AD has changed the program accordingly, including shifting focus to engineering students not pre-service educators. This was detailed in the 2011 Statement of Work.

NASA Outcome 3: (Informal Education)
- Students and faculty at Pikes Peak Community College are collaborating with the Colorado Springs Astronomical Society to provide observatory viewing and star parties throughout the year for local schools and the general public. A total of **160+** members of the general public (of all ages) attended the events. (Goal: 1 activity with 30 participants, p.18)
- **70+** COSGC students facilitated **25** K-12 hands-on science and engineering activities, engaging **447** young students. These service-learning efforts support hands-on programs in order to promote well-rounded COSGC graduates by engaging young engineers with the wider community. (Goal: 1 activity with 30 participants, p.18)

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Student Data and Longitudinal Tracking:** Total FY 2011 awards = 156, all of which are categorized as Fellowship/Scholarship awards.
    - 17 awarded to minority students underrepresented in STEM fields
    - 40 awarded to women
        - 8 students are pursuing graduate studies
        - 2 are employed in the aerospace industry
        - 21 are employed in K-12 academic field in STEM disciplines
        - 118 students are still enrolled in their degree programs
- **Diversity:**
    - COSGC includes:
        - 4 Minority Serving Institutions
        - 5 two-year colleges
        - 3 four-year baccalaureate colleges
        - 3 four-year baccalaureate through masters institutions
        - 5 universities through PhD
        - 1 non-profit organization
    - 26% of 156 scholarships were awarded to women
    - 11% of 156 scholarships were awarded to minority students underrepresented in STEM disciplines.
    - 81% of 156 scholarships were awarded to undergraduate students
    - Of the 250 students participating in Higher Education projects, who did not receive fellowship/scholarship awards:

    - 28% were women
    - 15% were students from populations underrepresented in STEM disciplines
- Of 35 faculty involved:
    - 18% were women
    - 3% were underrepresented

- **Minority-Serving Institutions:** COSGC has **4** MSIs engaged as active members of the consortium: Adams State College, Community College of Denver, Pueblo Community College and Trinidad State Junior College. Each of these institutions received 2011 funding to support hands-on programs on their campuses. All institutions participated in the 2011 COSGC Annual Meeting. In addition, students from all institutions participate in statewide COSGC programs (Robot Challenge and DemoSat). Adams State College has been the organizing entity for the Colorado Robot Challenge, which is celebrating its 6th year in 2012.

- **NASA Education Priorities:**

a. <u>Authentic hands-on student experiences in science and engineering.</u>

- Students at **11** COSGC campuses participated in the Colorado Robotics Challenge by designing and building autonomous robots: Adams State College, Colorado Mesa University (formerly Mesa State College), Trinidad State Junior College, Colorado State University, University of Northern Colorado, Community College of Aurora, University of Colorado at Boulder, Pueblo Community College, Colorado State University – Pueblo, Fort Lewis College and Metropolitan State University of Denver.
- Students at **11** COSGC campuses participated in the statewide DemoSat program – building short-duration balloon payloads: Pikes Peak Community College, Trinidad State Junior College, Colorado State University, University of Northern Colorado, Colorado School of Mines (2 teams), Community College of Denver, Metropolitan State College of Denver (8 teams), University of Colorado at Boulder (12 teams), Colorado State University - Pueblo, Western State College, and Fort Lewis College.
- Students at **2** COSGC institutions successfully launched sounding rocket payloads as part of the national RockSat collaboration at NASA's Wallops Flight Facility: University of Northern Colorado and University of Colorado at Boulder (2 teams).
- Students at Community College of Aurora designed, tested, built and flew an experiment as part of NASA's Reduced Gravity Education Flight Program.
- Undergraduate students at Adams State College are facilitating a Robot Society for peers and the general public as they learn more advanced robotics concepts.
- In collaboration with mentors from Lockheed Martin, students at the Colorado School of Mines researched and evaluated the possibility of landing on Near Earth Objects as part of a sampling mission, with a focus on landing systems and probes.
- Undergraduate student teams at the Colorado School of Mines engaged in research projects about Habitation Strategies. Projects included 1) Development of a game to raise public awareness of NASA's mission; 2) A counter weight gravity system and safe room for solar radiation protection for Mars habitation; and 3) Long-term underground construction for mining, radiation protection, and nuclear power.

- Lockheed Martin supported one undergraduate at Colorado School of Mines to examine impact cratering and the excavation process. Research included accessing NASA's Planetary Data System (PDS) and various software tools.
- Colorado School of Mines students participated in the NASA Moonbuggy competition at Marshal Space Center.
- Students at the University of Colorado, Colorado Springs (UCCS) continued research on a space tether sling system.
- UCCS students began a new project focusing on biomechanics. They are working to optimize locomotion in a low-gravity environment.
- University of Northern Colorado students continue to develop a robotics platform that can be used remotely by students across the country.
- Students at Colorado State University are developing a laser sensor for sensitive measurements of carbon dioxide and its isotopes. Students are collaborating closely with a mentor at the NASA Langley Research Center.
- Students at Pueblo Community College are providing machining support to robotics and satellite projects at various COSGC affiliate institutions.
- Students at Colorado State University – Pueblo (CSU-Pueblo) completed their work with faculty on a zero-gravity bone density research project.
- CSU-Pueblo students continue to work closely with faculty on the Mars return fuel research project. A paper was presented at the Mars Society Convention.
- Students at Western State College are engaged in an observatory research project collaborating with faculty to obtain light curves associated with exoplanet transits.
- Students at the University of Colorado at Boulder (CU) started a new long-duration high altitude balloon mission in collaboration with the Center for Astrophysics and Space Astronomy that will launch in September 2012.
- CU students have begun a new sounding rocket payload mission that will launch in June 2012.
- Staff and students at CU coordinated and facilitated the 2011 RockOn! Workshop in collaboration with NASA Wallops Flight Facility (Wallops) and Virginia Space Grant Consortium. The team continues work on the 2012 RockOn! Workshop scheduled for June 2012.
- CU students and staff manage the RockSat-C and –X launch programs in close collaboration with Wallops working with 13 universities across the nation.
- Students at CU continue working on the DANDE satellite mission, working toward a late 2012/early 2013 launch.
- Two students at Fort Lewis College are involved in observatory research projects.

b. <u>Engage middle school teachers</u>

- Summer Space Across the Curriculum courses were held in Colorado Springs and Pueblo, Colorado. A portfolio of 5 courses focusing on science technology, engineering and math are offered as graduate courses for teachers seeking a graduate degree or continuing professional development through university partners that included University of Colorado – Colorado Springs, Regis University, and Colorado State University - Pueblo. **54** teachers participated in the 2011 courses.

c. Summer opportunities for secondary students on college campuses

None in base.

d. Continued relationships with community colleges

- All COSGC community college affiliates have unique programs:
    - Students at **Pikes Peak Community College** are engaged in a follow-on balloon payload mission following a successful inaugural flight in 2010.
    - Students at **Pueblo Community College** (PCC) are collaborating with peers in COSGC institutions across the state by machining parts for robotics projects, sounding rocket payloads and satellite missions as part of their coursework and utilizing the state-of-the-art equipment on campus. Previously, PCC students learned to use the advanced technology in labs by creating "widgets" – items that had no practical purpose.
    - **Community College of Denver** had their first successful balloon payload mission in 2011. The project paved the foundation for follow-on missions in the coming years.
    - **Trinidad State Junior College** (TSJC) continues a successful robotics program that includes **3** courses and an extra-curricular club. TSJC programs engage both secondary and post-secondary students (all receiving college credit for coursework).
    - **Community College of Aurora** students were selected to develop and fly an experiment on a microgravity flight. In addition, these motivated students completed and launched a long-duration balloon payload.

e. Aeronautics Research directly addressing the fundamental research needs of the Next Generation Air Transportation System

None.

f. Environmental Science and Global Climate Change

- Students at the University of Colorado at Boulder continue work on the Drag and Atmospheric Neutral Density Explorer (DANDE) mission toward a late 2012/early 2013 launch. DANDE is a low-cost density, wind, and composition-measuring satellite that will provide data for the calibration and validation of operational models and improve our understanding of the thermosphere.
- A new program began as senior design project fall 2011. The project is a CubeSat mission designed to study polar ice. The project has continued past the senior design phase as a collaboration between COSGC and the National Snow and Ice Data Center. The project has also garnered the interest of NASA's Earth Science Technology Office.

g. Diversity of institutions, faculty, and student participants

- COSGC includes:
    - 4 Minority Serving Institutions
    - 5 two-year colleges
    - 3 four-year baccalaureate colleges
    - 3 four-year baccalaureate through masters institutions
    - 5 universities through PhD

    - 1 non-profit organization
  - 26% of 156 scholarships were awarded to women
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h. <u>Enhance the capacity of institutions to support innovative research for early career faculty.</u>

- Colorado State University awarded two seed grants to junior faculty to support research and student engagement. The program has been successful in generating future external funding. In 2011 faculty in Electrical and Computer Engineering and Biomedical /Mechanical Engineering received awards.

IMPROVEMENTS MADE IN THE PAST YEAR

- Extended the statewide DemoSat (balloon payload) program to include Community College of Denver (CCD).
- COSGC Advisory Board membership revised and more effective sub-committees in place to engage members in more focused actions in support of Consortium efforts.
- Students and faculty from affiliate institutions participated in hands-on workshops focusing on balloon payloads and robotics projects. These workshops were not available in previous years.
- Revamping of affiliate institution reporting process in order to 1) make report more streamlined with new NASA requirements, and 2) gather data more efficiently – with less faculty time necessary.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

<u>COSGC MEMBER INSTITUTIONS:</u>

- **Adams State College** (4-year, Baccalaureate & Graduate): Minority Serving Institution; Facilitates students programs that contribute to Outcomes 1 & 3.
- **Colorado School of Mines** (University through PhD): Facilitates student programs that contribute to Outcome 1.
- **Colorado State University** (University through PhD): Facilitates student programs that contribute to Outcome 1.
- **Colorado State University – Pueblo** (4-year Baccalaureate & Graduate): Facilitates student programs that contribute to Outcome 1

- **Community College of Aurora** (2-year college) Facilitates student programs that contribute to Outcome 1.
- **Community College of Denver** (2-year college) Minority Service Institution. Facilitates student programs that contribute to Outcome 1.
- **Fort Lewis College** (4-year Baccalaureate) Facilitates student programs that contribute to Outcome 1.
- **Mesa State College** (4-year Baccalaureate & Graduate) Facilitates student programs that contribute to Outcome 1.
- **Metropolitan State College of Denver** (4-year Baccalaureate) Facilitates student programs that contribute to Outcome 1.
- **Pikes Peak Community College** (2-year college) Facilitates student programs that contribute to Outcome 1.
- **Pueblo Community College** (2-year college) Minority Serving Institution. Facilitates student programs that contribute to Outcome 1.
- **The Space Foundation** A non-profit organization supporting space activities, space professionals and education. Facilitates student programs that contribute to Outcome 2.
- **Trinidad State Junior College** (2-year college) Minority Serving Institution. Facilitates student programs that contribute to Outcome 1.
- **University of Colorado at Boulder** (University through PhD) Facilitates student programs that contribute to Outcomes 1 and 3.
- **University of Colorado at Colorado Springs** (University through PhD) Facilitates student programs that contribute to Outcome 1.
- **University of Northern Colorado** (University through PhD) Facilitates student programs that contribute to Outcome 1.
- **Western State College** (4-year Baccalaureate) Facilitates student programs that contribute to Outcomes 1.

COSGC programs are only possible through collaborations with industry, government labs, and NASA centers. These partners provide mentors, hardware donations, launch opportunities, and/or testing facilities. The following is a list of partners that directly contributed to COSGC student projects this award period:

INDUSTRY PARTNERS:

- **Lockheed Martin:** Mentor research teams at Colorado School of Mines; Serves as Chair for the COSGC Advisory Board; Provides testing facilities for student satellite missions.
- **Ball Aerospace:** Mentors for student research at Colorado School of Mines and satellite missions at the University of Colorado at Boulder.
- **Miller Technology / Colorado Space Technology:** Financial support for the Colorado School of Mines balloon payload mission
- **Howl Woodworks** – Mentoring and machining/construction support for Trinidad State Junior College robotics students
- **First RF**: Provided hardware and mentors for University of Northern Colorado RockSat X mission.
- **Apogee Instruments**: Donated hardware for Pikes Peak Community College balloon payload team.

- **Analytical Graphics, Inc.** – Site licenses for Satellite Toolkit software used by students at University Colorado for satellite missions; Provides free workshops for students; Speaker at University of Colorado at Boulder course
- **Composite Technology Development** – Serves on COSGC Advisory Board; Provide financial support and mentors for University of Colorado at Boulder student sounding rocket payload project.
- **SparkFun Electronics** – Support of statewide robotics endeavors.
- **Sierra Nevada Corporation** – Mentors for satellite missions at the University of Colorado at Boulder; provides test facilities for space hardware missions; donates hardware.
- **Southwest Research Institute** – Mentors for long-duration high altitude balloon payloads at the University of Colorado at Boulder and provides internships for post-secondary students.
- **Northrup Grumman** – Provides mentors for satellite missions at the University of Colorado at Boulder.
- **Black Sun Solar** – Provides internship opportunities for post-secondary students.
- **Equinox Interscience** – Provides mentors for satellite missions at the University of Colorado at Boulder.
- **Instar Engineering** – Provides mentors for satellite missions at the University of Colorado at Boulder.

ACADEMIC PARTNERS:

- **Ortega Middle School,** Alamosa, CO – Science teacher: provided expertise to Robotics Society at Adams State College.
- **Mesa County Valley School District** – Provide facilities for robotics workshops facilitated by Colorado Mesa University
- **Metropolitan State College of Denver Biology Department** – Mentored students at Community College of Aurora in developing and analyzing data from long duration high altitude mission.
- **Michigan State University** – Provided mentors for student balloon payload team at Pikes Peak Community College specifically for nuclear emulsion technology.
- **Center for Astrophysics & Space Astronomy** – Mentors for long duration, high altitude balloon student project at University of Colorado at Boulder.
- **Montana Space Grant Consortium** – Serves on COSGC Advisory Board.
- **Virginia Space Grant Consortium** – Collaborates on RockOn! Workshop.
- **University of Colorado at Boulder Electrical, Computer, and Energy Engineering Department** – Provided senior design experience to develop the new PolarCube CubeSat mission.

GOVERNMENT PARTNERS:

- **NASA Langley Research Center** (Aerospace Technologist, Laser Remote Sensing Branch) – Mentoring student research team on Laser Sensor project at Colorado State University
- **NASA's Wallops Space Flight Center** – Provides launch support for RockOn! Workshop and RockSat-C and –X student payloads programs.
- **NASA's Earth Science Technology Office** – Provides mentors for the new PolarCube CubeSat mission.

- **NASA Jet Propulsion Laboratory** – Provide speakers in courses at University of Colorado at Boulder.
- **Air Force Office of Scientific Research** – Provides mentors for the DANDE satellite mission at University of Colorado at Boulder.
- **Air Force Space Command Space Analysis Center (A9A)** – Provides mentors for the DANDE satellite mission at the University of Colorado.
- **National Snow & Ice Data Center** – Providing mentors and mission development for CubeSat mission.

NON-PROFIT COMMUNITY PARTNERS:

- **Colorado Springs Astronomical Society** – Provide experts for star parties and advisors for observatory activities at Pikes Peak Community College.
- **Gunnison Valley Observatory**: Provides facilities for student/faculty research to Western State College.
- **John McConnell Math & Science Center** – Provide experience to students at Colorado Mesa University.
- **Edge of Space Sciences** – Provides balloon payload launches to statewide program.