

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 2013.

## 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 from 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, & 3)

### Outcome 1:

- The student designed and built DANDE satellite was launched and became the first Colorado Space Grant payload in Earth orbit.
- A student team at Colorado Mesa University participated in the semi-finals for the DARPA Challenge. The team was one of only 17 from around the world to

participate in the semi-finals, alongside entries from NASA's Jet Propulsion Laboratory and Johnson Space Flight Center.

- The student designed and built ALL-STAR 3U CubeSat was delivered and is pending launch at the writing of this report, through NASA's ELaNa 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.
  - **36%** of scholarships were awarded to women (Goal: 33.7%, p. 9)
  - **19%** 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 2013 funding directly to students in the form of scholarship awards. (Goal: 30%, p.10)
- **165** scholarships were awarded to COSGC undergraduate and graduate students in FY 2013. 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)
- **374** 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 2013 all COSGC institutions of higher education facilitated hands-on student projects that fall within the *Staged Hands-On Program* approach to student experiences outlined in the COSGC Strategic Plan: **17** facilitated at least one introductory (or "Walk") level student project (Goal: 17, p.16); **3** 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 **2** facilitated an advanced (or "Fly") level project.

#### **COSGC Goal 3 (Research Infrastructure)**

- **8** students participated in EduSourcing internships at Lockheed Martin, Black Sun Solar, and Digital Globe. (Goal 4, p.12)

#### **COSGC Goal 4 (Research Infrastructure)**

- **0** seed grants were awarded to junior faculty for research at Colorado State University (CSU). (Goal: 4, p.12) [CSU seed grant program was discontinued with the reorganization of CSU Space Grant programming.]
- **4** COSGC institutions facilitated research projects for students to work in collaboration with industry and/or academic mentors. (Goal: 4, p.12)
- **12** students participated in research projects for credit or as volunteers. (Goal: 10, p.12)

**NASA Outcome 2:** (Precollege)

- **24** teachers participated in **4** weeks of training at the Space Foundation’s summer Space Across the Curriculum courses. (Goal: 170 teachers; 7 weeks, p.17) This year, The Space Foundation focused partially on “training-the-trainers” with their Space Grant support. Space Foundation educators participated in professional development workshops with educators and industry representatives to make their workshops more innovative and in-line with new education guidelines.
- **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 (Adams State College). The new AD changed the program accordingly, including shifting focus to undergraduate STEM students, not pre-service educators. This was detailed in the 2011 Statement of Work accompanying the budget update that year.

**NASA Outcome 3:** (Informal Education)

- Students at Fort Lewis College are contributing expertise and participating in general public “star parties” at the Fort Lewis Observatory, engaging with **~50** citizens; Adams State University students and faculty host STEM Saturdays and engaged **37** citizens of all ages in STEM explorations; Colorado Mesa University students facilitate the Math Extravaganza each year for over **100** citizens of all ages (Goal: 1 activity with 30 participants, p.18).
- **80+** COSGC undergraduate students facilitated **42** K-12 hands-on science and engineering activities, engaging **700+** 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 K-12 participants, p.18)

**PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES**

- **Student Data and Longitudinal Tracking:** Total FY 2013 awards = 165, all of which are categorized as Fellowship/Scholarship awards.
  - 31 awarded to minority students underrepresented in STEM fields
  - 60 awarded to women
    - 142 students are still enrolled in their degree programs
    - 5 students are pursuing graduate studies
    - 2 are employed by NASA
    - 1 is employed in the aerospace industry

- 3 are employed in non-aerospace STEM fields
  - 12 are employed in K-12 academic field in STEM disciplines
- **Diversity:**
  - COSGC includes:
    - 4 Minority Serving Institutions (MSI)
    - 5 two-year colleges
    - 3 four-year baccalaureate colleges
    - 3 four-year baccalaureate through masters institutions
    - 5 universities through PhD
    - 1 non-profit organization
  - 36% of 165 scholarships were awarded to women
  - 19% of 165 scholarships were awarded to minority students underrepresented in STEM disciplines.
  - 91% of 165 scholarships were awarded to undergraduate students
  - Of the 374 students participating in Higher Education projects, who did not receive fellowship/scholarship awards:
    - 28% were women
    - 31% were students from populations underrepresented in STEM disciplines
  - Of 80 faculty involved:
    - 28% were women
    - 7% were underrepresented
  - **Minority-Serving Institution Collaborations:** COSGC had 4 MSIs engaged as active members of the consortium:
    - Adams State University (ASU): Students teams participated in the Colorado Robotics Challenge, robotics workshops, and the Robotics Society. Provided content for summer high school robotics course.
    - Community College of Denver (CCD): Student teams participated in the DemoSat balloon payload project including 3 launches throughout the year.
    - Pueblo Community College (PCC): Student teams working on space-hardware projects (balloon and robotics); Student teams participated in the Colorado Robotics Challenge and robotics workshops.
    - Trinidad State Junior College (TSJC): Student teams participated in the Colorado Robotics Challenge and the DemoSat balloon payload launches. TSJC also hosted the 2013 annual meeting.
    - All institutions participated in the 2013 annual meeting and contributed to the strategic plan process. In addition, all MSI institutions are collaborating with the consortium statewide on the new Colorado Undergraduate Retention in Science and Engineering (COURSE) community college transfer initiative.
- **NASA Education Priorities:**
  - a. **Authentic hands-on student experiences in science and engineering.**
    - STATEWIDE EFFORTS:
      - Student teams from **10** COSGC campuses participated in the Colorado Robotics Challenge by designing and building autonomous robots.
      - Student teams from **11** COSGC campuses participated in the statewide DemoSat program – building **36** short-duration balloon payloads that launched on **3** flights in August, November, and April.

- Students from **9** COSGC campuses participated in robotics and balloon payload workshops facilitated by the COSGC Lead Institution in fall 2013 at Western State Colorado University in Gunnison and in spring 2014 at University of Colorado at Boulder.
- Students from **10** COSGC campuses participated in the annual Colorado Space Grant Undergraduate Space Research Symposium. Students (either in teams or individually) submit research papers that are reviewed by judges from industry. Students then present their research. Students also participated by completing posters and/or hardware demonstrations for industry judges the day-of the Symposium.
- WESTERN STATE COLORADO UNIVERSITY (FORMALLY WESTERN STATE COLLEGE):
  - One of WSCU's main goals was to more successfully integrate students historically underrepresented in STEM into WSCU Space Grant programs. This has been highly successful. One thing that worked well was engaging WSCU Space Grant in the COSGC Robotics Challenge effort. This year's team is improving upon the design from 2013.
  - DemoSat has proven to be a good way to engage women students. WSCU was able to support a DemoSat team comprised of all women. So far, the team is doing well, leading up to launch in April 2014.
- UNIVERSITY OF NORTHERN COLORADO:
  - One student team is working on a cosmic ray payload to launch with the summer 2014 DemoSat effort.
  - Students are working on multiple robotics projects. These include general sensor development, use of 3D printing for creating robot structures, investigation into the process of balance, preparation for participation in the 2014 Colorado Robotics Challenge, and the design and assembly of a quadcopter.
- UNIVERSITY OF COLORADO AT COLORADO SPRINGS:
  - UCCS Space Grant students continue work on the kinetic motion research project with faculty mentors. This year students completed inverse dynamics calculations necessary to compute internal forces and torques for any motion. The team has also improved the video capture system software.
- UNIVERSITY OF COLORADO AT BOULDER:
  - Students designed, built, and launched (September 2013) a long-term, high-altitude balloon payload (called HELIOS II) in collaboration with the Center for Astrophysics and Space Astronomy as part of the LASPACE HASP program.
  - A team of students began work on the CU HELIOS III payload in November 2013, which is scheduled to launch September 2014, as a follow-on to the HELIOS II mission.
  - CU students and staff manage the RockSat-C and RockSat-X launch programs in close collaboration with NASA Wallops Flight Facility (Wallops) working with universities across the nation; 17 in 2013 and 13 in 2014.
  - CU students launched two payloads on the August 2013 RockSat-X launch at Wallops Flight Facility. Another student team began work on a RockSat-X payload in January 2014. This payload is scheduled for launch in August 2014.
  - Staff and students at CU coordinated and facilitated the 2013 RockOn! Workshop in collaboration with Wallops and Virginia Space Grant Consortium with 48

- college faculty and students from 24 different college and universities. The team continues work on the 2014 RockOn! Workshop scheduled for June 2014.
- The DANDE satellite launched on September 29, 2013. Students have been involved in Mission Operations at the Mission Operations Control Center at the CU Space Grant facility on the CU main campus.
  - CU Space Grant facilitated the freshman level Gateway to Space course for 64 CU students. Students work in teams of 8 to develop a BalloonSat mission through proposal, build, test, launch, and data analysis.
  - A student team continues work on the PolarCube mission (CubeSat) through AFRL's University NanoSat-8 program.
  - The ALL-STAR student CubeSat mission continues toward a March 2014 launch in collaboration with Lockheed Martin and NASA's ELaNa program.
  - Two student teams are working on enabling mission operations through development and implementation of a ground station within the CU Space Grant facility and at a remote station near campus.
  - Several student teams presented a research papers and/or posters at the annual Colorado Undergraduate Space Research Symposium (judged by industry mentors).
  - CU Space Grant provided 6 weeks of hands-on workshops to the Society for Hispanic Professional Engineers/Mexican America Engineering Society and Society for Women Engineers. Workshops included soldering practice, use of an Arduino for various applications, and a basic Satellite Toolkit exploration.
  - TRINIDAD STATE JUNIOR COLLEGE:
    - One TSJC team is working on a robot leading up to the 2014 Colorado Robotics Challenge.
    - The TSJC Space Grant program obtained a 3D printer through a separate STEM grant. They are in the process of implementing a new project in addition to a 3D Printing and Design course.
    - One TSJC team launched a balloon payload in August 2013. The team explored the resistivity of air as a function of altitude.
  - PIKES PEAK COMMUNITY COLLEGE:
    - Students are working on a balloon payload scheduled to fly with the April 2014 DemoSat launch. Students are working with faculty to extend the reach of the PCC Space Grant program in a concerted effort to better engage students historically underrepresented in STEM fields.
  - PUEBLO COMMUNITY COLLEGE:
    - Students developed their own micro-processing board using a Microchip 250 32 bit processing chip. The board was designed for a versatile platform to be used in both PCC robotics and balloon payload projects.
    - A student team is building a balloon payload to demonstrate usage of the above board during flight. The payload will launch with DemoSat payloads in April 2014.
    - A PCC team is designing an autonomous robot to demonstrate at the 2014 Colorado Robotics Challenge.
  - COLORADO STATE UNIVERSITY – PUEBLO
    - Students continued work on an autonomous rover and lander design.

- A team of student developed a robotic hand and worked with faculty on the automation of the university observatory.
- Spring semester 2014, a team of students began working on a radio telescope project.
- COLORADO STATE UNIVERSITY - FORT COLLINS
  - CSU Space Grant provides robotics as an entry-level project that feeds into more complex projects. Three CSU teams are building autonomous robots to demonstrate at the Colorado Robotics Challenge. Robotics teams are supervised by graduate students.
  - A team of CSU students built a balloon payload that launched with the summer 2013 DemoSat flight in August. Following a partially successful flight in the summer, the student team continued the project into the fall as volunteers and re-launched the payload with the fall 2013 DemoSat flight.
  - CSU Space Grant supports one student as the project manager for the Space Grant program on the CSU campus. In addition, CSU Space Grant supported research of two graduate students (one female, one male). They are researching laser-based sensor use for air quality measurements and understanding plasma-material interactions within Hall thrusters.
- COLORADO SCHOOL OF MINES
  - Three teams designed and built balloon payloads as part of their freshman projects course. Two of the teams are working toward launch with the DemoSat effort in April 2014.
  - Two students were supported in summer research projects on the CSM campus, collaborating with faculty mentors.
- COLORADO MESA UNIVERSITY
  - The robotics program focused primarily on the DARPA Robotics challenge. This project engages students with cutting edge humanoid robot design. This ongoing project has inspired the university to create and support a MakerSpace at the Grand Junction business incubator center. Undergraduate students participating in robotics projects have developed a quad copter and are supporting FIRST Lego efforts as coaches.
  - The Space Science class is going well and has recruited more women than any other semester. Students are working on basic robotics projects with some autonomy.
  - The embedded systems lab continues to be heavily used by CMU Space Grant students, especially for DARPA projects.
  - A new effort has developed along with physics professor, Dr. Jared Workman. Dr. Workman with working with a CMU Space Grant students on cosmology modeling. This is in its early states, but so far the collaboration is working well.
- ADAMS STATE UNIVERSITY
  - ASU Space Grant continues to facilitate the Robotics Society. The Society is doing well, with increased exposure around campus. Students continue to develop robots that will be demonstrated at the 2014 Colorado Robotics Challenge.
  - A new class called Robotics Challenge was implemented and 8 students are enrolled. Students were recruited from the Introduction to Engineering course,

others came from the Society and Computer Science. The course provides a basis for simple, autonomous robots. The hope is that students who take the class will continue their efforts in more complex robots next year as members of the Robotics Society and participants in the 2015 Colorado Robotics Challenge.

- METROPOLITAN STATE UNIVERSITY OF DENVER
  - Two teams are developing autonomous robots that will be demonstrated at the 2014 Colorado Robotics Challenge.
  - The electric car project continues to engage a large team of students.
  - The Intro to Space Course continues to focus on balloon payload projects and launches four team projects with the fall and spring DemoSat flights.
- COMMUNITY COLLEGE OF AURORA
  - The second iteration of the Experimental Design course is taking place spring semester 2014. 12 students are enrolled.
  - Two students from the 2013 Experimental Design course are working on a balloon payload that will fly with the spring 2014 DemoSat launch. The team is developing a reusable system that records UV and ionizing radiation during the flight.
- COMMUNITY COLLEGE OF DENVER
  - Students at CCD have worked on four balloon payloads over the past year. Students continue to refine their experiments each semester as they explore biological experiments, collect an air sample, record FM radio signals, and design robust systems to support the science. They are working on two payloads that will fly with the April 2014 DemoSat launch.
- FORT LEWIS COLLEGE
  - FLC students participated in the fall 2013 robotics workshop in Gunnison and have been developing autonomous robots that will be demonstrated at the 2014 Colorado Robotics Challenge.
  - Two physics students are finishing their senior research projects at the Fort Lewis Observatory.
  - Students flew a payload on the summer 2013 DemoSat flight and re-launched their design with improvements again in November 2013. Students continue to be challenged by data collection issues and are working through them to try again on the April 2014 DemoSat flight.

**b. Diversity of institutions, faculty, and student participants (gender, underrepresented, underserved).**

- 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
- 36% of 165 scholarships were awarded to women
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- 91% of 165 scholarships were awarded to undergraduate students
- Of the 374 students participating in Higher Education projects, who did not receive fellowship/scholarship awards:
  - 28% were women
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- Of 80 faculty involved:
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  - 7% were from populations underrepresented in STEM disciplines

**c. Engage middle school teachers**

- The Space Foundation's Summer Space Across the Curriculum courses were held in Colorado Springs, Colorado. **Two** 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. **24** teachers participated in the 2013 courses.
- COSGC Associate Director presented a workshop at the National Science Teacher's Associate conference in Denver, CO on rocketry for elementary and middle school teachers from Colorado in December 2013.

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

- University of Colorado at Boulder taught the Earth to Space course as part of the CU PreCollegiate Development Program (PCDP) for rising high school seniors June – July 2013.
- Adams State University facilitated a one-week STEM academy for high school students in July 2013.
- Students and faculty of the Space Grant program at Colorado Mesa University facilitated a robotics and engineering summer camp (ProtoCamp) on the Western Colorado Community College campus.
- 6 high school students participated in the RockOn 2013 workshop.

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

- COSGC proposed for and won funds to implement a new transfer student program to engage students in Space Grant programs at 4-year institutions as they transfer from Space Grant programs at 2-year institutions. All COSGC community colleges are actively recruiting students to participate in the effort and are providing mentorship as students complete the application process and move on to their new institutions.
- All COSGC community college affiliates have unique hands-on programs:

- **Pikes Peak Community College** is expanding its balloon payload program as more students are recruited to work on multiple payloads. Collaboration with faculty in other departments is strengthening this effort.
- Students at **Pueblo Community College (PCC)** – work in teams on autonomous robots and BalloonSat payloads. The program is also exploring an approach to reach students in the G.E.D. program in order to engage them with hands-on STEM projects, as they take coursework that points them towards transferring into a 4-year institution.
- **Community College of Denver (CCD)** has recently expanded their balloon payload program as they recruit more students. Participating students also work in teams to design activities and facilitate an all-day event to get younger students excited about STEM and into CCD.
- **Trinidad State Junior College (TSJC)** participates in the DemoSat program and is expanding their robust robotics program. The TSJC program has established a direct collaboration with Parallax Inc. that has provided innovative software and components for student use in robotics projects. TSJC Space Grant has established a new course to engage students in engineering design and included a 3D printer in the process.
- **Community College of Aurora (CCA)** has implemented a new course on the CCA campus: Engineering 151-Experiment Design. Students who complete the course are then recruited into a more complex space hardware project to continue their involvement in the program. CCA is hosted the 2013 Colorado Space Grant Undergraduate Space Research Symposium. Finally, CCA has implemented a transfer program in collaboration with Colorado School of Mines to engage graduating CCA students in CSM faculty research the summer prior to their enrollment as CSM undergraduate students in the fall semester.
- Students and faculty of the Space Grant program at Colorado Mesa University (CMU) facilitated a robotics and engineering summer camp on the **Western Colorado Community College** campus - informing students about the programs and opportunities available at CMU for an 4-year and/or advanced degree.
- Staff at the Lead Institution provide project mentorship for all community college student projects; teach sections in the CCA Engineering 151 course; facilitate robotics workshops for community college students; facilitate a transfer program to recruit graduating community college students into 4-yr institutions; provide testing facilities for student projects; host tours for community college student groups; and mentor community college affiliate directors through new projects and help make connections with NASA centers, government labs and industry.

f. **Aeronautics directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen).**

None.

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

- The Drag and Atmospheric Neutral Density Explorer (DANDE) satellite launched on September 29, 2013. DANDE is a student designed and built, low-cost, density, wind, and composition-measuring satellite designed to provide data for the calibration and validation of operational models and improve our understanding of the thermosphere.
- The PolarCube project is 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. PolarCube won an award in the Air Force Office of Scientific Research's University Nanosatellite 8 program. Collaborators for the PolarCube mission also include the Cooperative Institute for Research in Environmental Sciences and the Center for Environmental Technology.
- Several BalloonSat payloads have included missions to sample the atmosphere for heavy metals, pollution, and cosmic radiation.

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

None.

**IMPROVEMENTS MADE IN THE PAST YEAR**

- 1) COSGC won the COURSE award and has implemented the program to formalize the engagement of Space Grant community college students as they transfer into COSGC 4-year institutions.
- 2) COSGC membership officially accepted the 2013-2017 COSGC Strategic Plan at the September 2013 Annual Meeting.
- 3) Focus discussions about improving inclusivity for students underrepresented in STEM fields began at the 2013 Annual Meeting and have continued in regular telecons. Affiliate directors at all COSGC institutions are in the process of undertaking new efforts to more effectively engage underrepresented students on their campuses.
- 4) Redesign of the statewide robotics workshop - adding a balloon payload track to provide foundational resources to support both robotics and balloon payload projects at COSGC institutions across the state.

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

**COSGC MEMBER INSTITUTIONS:**

- **Adams State University** [formerly Adams State College] (4-year, Baccalaureate & Graduate): Minority Serving Institution; Facilitates student programs that contribute to Outcomes 1 & 3.
- **Colorado Mesa University** [formerly Mesa State College] (University through PhD) Facilitates student programs that contribute to Outcome 1.
- **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.
- **Metropolitan State University of Denver** [formerly Metropolitan State College of Denver] (4-year Baccalaureate and Graduate) Facilitates student programs that contribute to Outcome 1.
- **Pikes Peak Community College** (2-year college) Facilitates student programs that contribute to Outcome 1 and 3.
- **Pueblo Community College** (2-year college) Minority Serving Institution. Facilitates student programs that contribute to Outcome 1 and provides machining support for other COSGC student projects.
- **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 and fulfills duties as Lead Institution.
- **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 Colorado University** [formerly 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; academic departments, programs, and labs; NASA centers; and non-profit community organizations. These partners provide mentors, hardware donations, launch opportunities, funding, and/or testing facilities. The following is a list of partners that directly contributed to COSGC student projects this award period:

#### **INDUSTRY PARTNERS:**

- **Parallax Inc.** – provides software, training, hardware, and mentors for the Trinidad State Junior College (TSJC) Space Grant Robotics program.
- **High Country Technology Consultants** – provided mentors and training for the TSJC robotics program.
- **RoadNarrows Robotics** – provides mentors for the University of Northern Colorado (UNC) Robotics teams; also provides mentors for the development of a functional solar telescope on the UNC campus.
- **Raytheon** – provides mentor for UNC robotics projects.
- **Cascade Technologies** – Provides hardware and mentors for CSU graduate research.

- **Lockheed Martin** – Serves as Chair for the COSGC Advisory Board; Provides testing facilities and funding for student satellite missions at University of Colorado at Boulder (CU); and judges for the Colorado Undergraduate Space Research Symposium; provides mentors for Community College of Aurora Experimental Design teams and CU CubeSat missions.
- **Ball Aerospace** - Mentors for satellite missions at the University of Colorado at Boulder
- **Glenair** – Provided electrical components for the student RocketSat mission.
- **Howl Woodworks** – Mentoring and machining/construction support for Trinidad State Junior College robotics students
- **Analytical Graphics, Inc.** – Site licenses for Satellite Toolkit software used by students at University Colorado at Boulder (CU) for satellite missions; Provides free workshops for students; Speaker at CU course; and mentors for CU space hardware projects.
- **Composite Technology Development** – Serves on COSGC Advisory Board; Provide financial support and mentors for University of Colorado at Boulder student sounding rocket payload project.
- **Advanced Circuits** – Providing electronic components for the student ALL-STAR PropSat, and PolarCube CubeSat missions; HELIOS II and RocketSat missions.
- **SparkFun Electronics** – Support of statewide robotics endeavors including access to hardware and mentors for projects statewide.
- **Sierra Nevada Corporation** – Mentors for satellite missions at the University of Colorado at Boulder; provides test facilities for space hardware missions; donates hardware; and provides judges for the Colorado Undergraduate Space Hardware Symposium.
- **Northrup Grumman** – Provides mentors for satellite missions at the University of Colorado at Boulder; and provides judges and the keynote speaker for the Colorado Undergraduate Space Research Symposium.
- **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.
- **Xilinx** – Provides software donation for student satellite missions at University of Colorado at Boulder.
- **AeroFlex** – Provides hardware donations for student satellite missions at University of Colorado at Boulder.
- **Apex Software** – Provides software donations for student satellite missions at University of Colorado at Boulder.
- **Bro Software House** – Provides software donations for student satellite missions at University of Colorado at Boulder.
- **KRDO Channel 13** – provided a lecturer for the Space Across the Curriculum course at the Space Foundation.

- **Grand Junction Business Incubator Center** – hosted a space where Colorado Mesa University (CMU) was able to build and test a DARPA challenge robot; built and supporting a MakerSpace that will be used by CMU students.
- **All Metals Welding** – supports CMU robotics projects.
- **Autonomous Stuff** – supports CMU robotics projects.
- **Digital Globe** – Provides internships for COSGC students.
- **FirstRF** – Provides mentors for University of Colorado at Boulder (CU) satellite projects.
- **Hot Snapz** – Supported the RocketSat 9 mission at CU.
- **National Instruments** – Provided mentors for the RockSat X mission at CU.
- **SpaceX** – Provides mentors for CU student projects.

#### **ACADEMIC PARTNERS:**

- **Community College of Aurora (CCA) Biology and Chemistry Departments** – provides mentors for CCA Experimental Design teams.
- **Western State Colorado University (WSCU) Biology Department** – faculty serve as mentors for the WSCU DemoSat project. Also provides supplies for the team.
- **WSCU Computer Science Department** – Provides mentors for robotics projects.
- **University of Northern Colorado School of Sport and Exercise Sciences** – collaborating with UNC Space Grant physics students in a research project.
- **Laboratory for Atmospheric and Space Physics (LASP)** – provided mentors for the Trinidad State Junior College (TSJC) balloon payload mission; and boards and mentors for the CU ALL-STAR CubeSat mission.
- **Fort Lewis College (FLC) Physics & Engineering Departments** – provided mentors for FLC Space Grant student projects.
- **FLC Information Technology Department** – provided services for FLC student projects including configuring cameras and remote power switches at the observatory.
- **Pikes Peak Community College (PPCC) Science Laboratories** – provide assistance to PPCC Space Grant student for use of laboratory space and equipment.
- **PPCC Biology Department** – provided mentors to help with preparation of biological samples for PPCC balloon payload experiment.
- **PPCC Internal Review Board** – provided assistance with the process for students to gain approval to use human skin cells for balloon payload experiment.
- **Community College of Denver (CCD) Biology Department** – provides mentors for CCD Rocket Day and balloon payloads.
- **CCD Mathematics & Astronomy** – provides leadership for the CCD Space Grant program.
- **Center for Astrophysics & Space Astronomy** – Mentors and financial support for student long duration, high altitude balloon and sounding rocket missions 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 (CU) Electrical, Computer, and Energy Engineering Department** – Provided senior design experience to develop the new PolarCube CubeSat mission.

- **CU, Aerospace Engineering Department** – Provides mentors for CU student satellite missions.
- **CU, Mechanical Engineering Department** – Provided senior design experience to develop the propulsion system for the ALL-STAR mission.
- **CU, College of Engineering and Applied Science Dean’s Office** – Provided cost match dollars used to support travel, student projects, and general CU Space Grant operations.
- **Integrated Teaching and Learning Laboratory, University of Colorado at Boulder (CU)** – Provides machining, electronics, and software for CU student projects.
- **The Center for Environmental Technology** – Provides mentors for the PolarCube mission at University of Colorado at Boulder.
- **Cooperative Institute for Research in Environmental Sciences** – Provides financial support for student BalloonSat mission at University of Colorado at Boulder.
- **Colorado State University (CSU) Department of Environmental & Radiological Health Sciences** – provided mentors for the CSU balloon payload team.
- **CSU Mechanical Engineering Department** – provided mentors for the CSU balloon payload team and graduate research projects.
- **University of Michigan** – Provides co-researchers for CSU graduate research project.
- **Colorado Mesa University (CMU) Mechanical Engineering Department** – provides mentors for the CMU robotics program.
- **Adams State University (ASU) Communications Department** – provides website and Github management for ASU Space Grant students’ projects.
- **ASU Chemistry, Computer Science, and Mathematics Department** – provides mentors and general support for ASU robotics projects.
- **Colorado School of Mines Physics Department** – provides guest lecturer for the Community College of Aurora Experimental Design course; provides summer research experience for transferring CCA student.

**GOVERNMENT PARTNERS:**

- **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 and judges for the Colorado Undergraduate Space Research Symposium.
- **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 the PolarCube mission.

- **Air Force Research Laboratory** –Provides mentors and testing facilities for the University of Colorado at Boulder (CU) DANDE satellite mission and mentors for the CU PolarCube mission; provides mentors for Colorado State University (CSU) graduate research projects.
- **National Oceanic and Atmospheric Associate (NOAA)** – provided a lecturer and tour for the Space Across the Curriculum course at the Space Foundation.

**NON-PROFIT COMMUNITY PARTNERS:**

- **Edge of Space Sciences** – Provides balloon payload launches to statewide program.
- **Great Sand Dunes National Park** – Provides the venue for the annual Colorado Robotics Challenge and provides resources during planning of the event.
- **Colorado Space Business Roundtable** – Provides financial support for the Colorado Undergraduate Space Research Symposium.
- **Gunnison Valley Observatory** – offers facilities for student use
- **City of Colorado Springs** – provided a lecturer for the PreK-2 Early Childhood Space Exploration Space Across the Curriculum course.
- **Durango Nature Center** – hosted star parties attended by Fort Lewis College (FLC) Space Grant students.
- **Old Fort Lewis** – collaborated with FLC Space Grant in maintaining the road and lighting up to the FLC Observatory.
- **Western Slope Math & Science Center** – supported demonstrations by Colorado Mesa University (CMU) undergraduates.

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