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 $845,000 for fiscal year 2010.

## 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:

- Former University of Northern Colorado student, Adam Wilson (graduated May 2010) was featured on the cover of the October issue of *Entrepreneur* magazine. His company builds "Robot Balls" that can be controlled by a smartphone. (http://www.entrepreneur.com/article/217321)

- Sabrina Eggleston and Puja Kapoor from new consortium affiliate community colleges (Pueblo and Arvada respectively) participated in summer internships at the Jet Propulsion Laboratory.
- David Ceniceros from new consortium affiliate, Denver Community College, participated in a summer internship with the Hermes Satellite Mission at the University of Colorado in Boulder.
- A three-student team from a new consortium affiliate community college (Aurora) built and tested a biological payload to fly on the 2010 HASP launch.
- Colorado State University students participated in the RocketSat program for the first time. Their work has been remarkable. Their development of a fuel gauge has created collaboration with engineers at Marshall Space Flight Center (MSFC). Students wrote a paper that has been accepted in a peer reviewed journal – Journal of Spacecraft and Rockets and they presented their research at the AIAA Joint Propulsion Conference. They are continuing research with partners at MSFC. The implementation of the RocketSat program has provided a staged-hands-on program for CSU students who can work on Robotics, then balloon payloads and faculty research projects and finish their undergraduate experience working on a sounding rocket payload.
- Shane Chatfield, David Miller, and Mackenzie Schmalz (students at Mesa State College) were asked to present research results on the "Distribution of a Weighted Chi-squared Sum" to the United Space Alliance and NASA engineers at the Johnson Space Center in May of 2010. Under the supervision of Dr. Rick Ott these students presented their findings through close follow of the protocols of a paper by H. Solomon and M. Stephens (1977). The invitation to present came at the request of Joe Frisbee, Collision Probability Analyst with the United Space Alliance Space Shuttle Program.

## Outcome 2:

- The Space Foundation Discovery Institute serves teachers along the Colorado front range as well as across the nation through the Teacher Liaison program. A total of **423** teachers nationwide are provided access to lesson banks, NASA resources, and Space Education Specialists employed by the Space Foundation. Monthly conference calls, e-mail communication, and Liaison Briefs are some of the benefits Space Foundation Teacher Liaison's enjoy in addition to programs and courses offered for their exclusive benefit at the National Space Symposium.

- Former University of Northern Colorado student, Sage Andorka (graduated May 2010) is now an advanced physics teacher at the Air Academy High School.

## Outcome 3:

- The Space Foundation Discovery Institute, located on the campus of the Jack Swigert Aerospace Academy, experienced its first full year of operation. A full service conference center was added in 2010 and the Mars Yard, an interactive robotic experience on a simulated Martian terrain is currently under construction.

## PROGRAM ACCOMPLISHMENTS

## NASA Outcome 1:

### COSGC Goal 1

- All COSGC students who received scholarships participated in hands-on, space hardware programs at their respective institutions.
    - **24%** of scholarships were awarded to women
    - **15%** of scholarships were awarded to minority students underrepresented in STEM disciplines.
- The Journey to Space Course that was detailed in the FY 2010 proposal did not come to fruition. The Director, Associate Director and Research Coordinator completed numerous brainstorm sessions and planning meetings with faculty and staff in the BOLD (Broadening Opportunity through Leadership and Diversity) Center. Funds designated for this diversity effort will carryover into FY 2011 and be used on continued diversity efforts. A small step has been made toward a more regular collaboration with the BOLD Center and its diverse population of students. COSGC is participating in the inaugural year of BOLD's *You're @ CU* program. Beginning in January 2011, **1** BOLD student joined the ALL-STAR mission at CU working with a graduate student mentor.

### COSGC Goal 2

- COSGC maintained all four stages of the SHOP (Staged Hands-On Program) approach to student experiences within the COSGC academic network.
- All COSGC institutions awarded a minimum of **30%** of their FY 2010 funding directly to students in the form of scholarship awards.
- **172** scholarships were awarded to COSGC undergraduate and graduate students in FY 2010. 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.
- **130+** undergraduate and graduate students engaged in hands-on space focused projects as either credit students or volunteers.
- In FY 2010 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; **4** facilitated at least one beginning/intermediate (or "Run") level students project; **2** facilitated one intermediate/advanced (or "Jump") level project; and **1** facilitated an advanced (or "Jump") level project.
- **27** students attended launch and integration efforts for autonomous robot competitions, and HASP, RocketSat, and CubeSat payload missions.
- **80+** COSGC students facilitated **47** K-12 hands-on science and engineering activities, engaging **1,521** 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.

- **6** Supplemental Grants were awarded to COSGC institutions for extended FY 2010 student projects.
- **2** COSGC students participated in summer internships at NASA's Jet Propulsion Laboratory.

## COSGC Goal 3

- **3** students participated in EduSourcing internships at Lockheed Martin.
- **1** student participated in an aerospace internship at Textron Corporation.

## COSGC Goal 4

- **2** seed grants were awarded to junior faculty for research at Colorado State University.
- **21** students were engaged in the ALL-STAR satellite mission in FY 2010. **10** industry mentors were part of the project.
- **5** COSGC institutions facilitated research projects for students to work in collaboration with industry and/or academic mentors.
- **15+** students participated in research projects for credit or as volunteers.

## NASA Outcome 2:

- Course offerings in 2010 included a brand new course focusing on the Pre-K – 2nd grade. The course was developed after focus groups involving Space Foundation corporate partners indicated that focusing on early learning and identification of STEM inclined students was critical to student's success in those subjects. After two years of development, pilot programs and evaluation, the Pre-K – 2 grade teacher education course was offered at Colorado State University – Pueblo (CSU-Pueblo). CSU-Pueblo accredited the courses for graduate credit for attending teachers. Funding for the course came through a grant from CSU-Pueblo through the College of Education. A total of **23** teachers participated in the course at CSU-Pueblo and **50** teachers participated in **4** courses conducted at the Space Foundation Discovery Institute in Colorado Springs, Colorado.
- **74** teachers participated in the Space Foundation's summer Space Across the Curriculum courses.

## NASA Outcome 3:

- Adams State College (ASC) facilitated a San Luis Valley-wide Robotics Club. The **40** participants ranged from middle school through adult community members. ASC faculty provided content and expertise for the weekly club.
- Adams State College faculty provided content and expertise to the Zacheis Planetarium and Observatory in addition to facilitating Science Saturdays with ASC students engaging with approximately **300** young citizens from across the valley, into northern New Mexico.
- Pikes Peak Community College hosted a Star Party in collaboration with the Colorado Springs Astronomical Society. The event was open to students, friends, and the general public. Over **200** people attended.

## NASA 2010 Education Priorities:

**A. Authentic hands-on student experiences in science and engineering.**

- Colorado School of Mines supported a Lunar Habitation Strategy exploration, where students designed rovers to extract an injured astronaut; in addition one students team designed a Balloon payload that sampled gas and particulate materials as a function of elevation.
- Colorado School of Mines implemented a new Summer Space Internship program on campus. The program engaged 4 undergraduate students in a full range of activities that included research, design, and engineering and focused on space and planetary related topics. Projects included explorations of March volcanism, detection of harmful microbes in stored and reclaimed water, regolith simulant, and autonomous operations of the rough cutting system used to produce thin sections of rock samples in a space environment.
- Colorado School of Mines also supported a student team that designed a rover to compete in the NASA Moonbuggy competition. The effort was supplemented with a grant from Lockheed Martin.
- Western State College (WSC) engaged one student in telescope observation projects. Working closely with WSC faculty, the student has become adept at operating the telescope, learned theory and techniques of data collection, and gained experience in analyzing astronomical data and reporting data by light curves. He presented his work at a local symposium as was well received.
- Adams State College expanded support for the Colorado Robot Challenge. Workshops were facilitated statewide and in Utah designed to give students skills and confidence to build a rover for the event in April 2011.
- Students at the Community College of Aurora (CCA) flew a balloon payload that successfully gathered particulates from the upper atmosphere.
- CCA students had their project accepted for flight on the micro-gravity flight at Johnson Space Center as a part of the Minority Serving Institutions and Community College flight opportunity. They are scheduled to fly in June 2011.
- Community College of Denver went through a director transition. A total of 40 students have attended preliminary interest gatherings in the 2010 fall semester. A robot workshop was held to prepare a student team for building an autonomous rover that will participate in the Colorado Robot Challenge.
- Colorado State University – Pueblo students are building a biological balloon payload that will launch with the spring statewide DemoSat launch in April 2011.
- Two teams of students at Colorado State University (CSU) build balloon payloads as part of the statewide DemoSat program. One team focused on use of alternative energies in space and the other built an autonomous rover that was designed to be deployed upon landing.
- One team of CSU students designed and built an autonomous rover for participation in the Colorado Robot Challenge in April 2011.
- A team of CSU students continues the development of a fiber-optic interferometer fuel gauge for operation in zero-mass conditions. This effort is in collaboration with NASA Marshall Space Flight Center, Dr. Polzin.

- Students at Mesa State College built a large robotic vehicle with a grasping arm, computer vision, and an autonomous computer. In addition, students built several small "walking" robots.
- Students at Pueblo Community College (PCC) designed and built a new base station that will be used at the 2011 Colorado Robot Challenge. It has been integral in successful testing and development leading up to the annual event.
- PCC students completed a robotics workshop and have been working on an autonomous robot for the 2011 Challenge.
- Students at Pikes Peak Community College (PPCC) are working with faculty and industry mentors to build the first PPCC balloon payload that will launch with the statewide DemoSat program in April 2011.
- Students at Trinidad State Junior College (TSJC) built a balloon payload to collect high-altitude extremophiles using an Aircore-like device. They launched the payload in November 2010 and were able to culture specimens. They will present their findings at the 2011 Colorado Undergraduate Research Symposium.
- A TSJC student team is building a robot that will be demonstrated at the 2011 Colorado Robot Challenge.
- Students at the University of Northern Colorado (UNC) built and flew a balloon payload as part of the statewide DemoSat program. A separate team is building a robot that will be demonstrated at the Colorado Robot Challenge in April 2011.
- In June 2010, the UNC student RocketSat team launched their payload designed to measure fuel slosh as part of the RockSat C program (collaboration with COSGC and NASA's Wallops Flight Facility).
- Freshman students at the University of Colorado at Boulder (CU) proposed and won a mission to develop a payload through the High Altitude Science Platform (HASP) program at Louisiana State University. Student took their payload through testing and integration in preparation for launch in September 2010. Following an accident of a similar NASA payload, launch was postponed until August 2011. Students continue to further develop the payload working toward the summer launch.
- Undergraduate students at CU successfully designed, built, tested, and integrated the RocketSat VI payload. Launch took place in June 2010. The RocketSat VII payload began at the end of 2010, following analysis of data from RocketSat VI. RocketSat VII is scheduled to launch in June 2011.
- The CU Hermes CubeSat mission progressed through final testing and integration. The payload launched as part of the Glory/ELaNa launch in March 2011. A student mission operations team was fully trained and in-place prior to launch. With the launch failure, students have been moved to support mission operations development for the DANDE and ALL-STAR missions.
- CU students and staff facilitated the third annual RockOn! Workshop in conjunction with NASA's Wallops Flight Facility (Wallops), NASA Education, and the Virginia Space Grant Consortium. The workshop took place June 19-24, 2010 for 21 faculty members and college students from across the country.
- CU student, Shawn Carroll (Aerospace Senior) managed the RockSat C program that launched 10 student payloads from across the country in conjunction with Wallops in June 2010. Emily Logan (CU Aerospace Junior) took over program

management and is managing launch for 10 students payloads.

- Shawn Carroll managed the first RockSat-X program that is preparing to launch 3 student payloads from Wallops in July 2011.
- The CU student team continued to build and test the DANDE spacecraft (low-Earth orbiting satellite) working toward a late 2011/early 2012 launch secured by a 1st place win of the AFOSR's University Nanosatellite Competition in 2009.
- CU students completed build and implementation of ground station capabilities in the Mission Operations Control Center on the CU campus and in an off-campus location, to support S-band communications for the Hermes mission and future Colorado Space Grant missions.
- Students at Colorado State University – Pueblo (CSU-Pueblo) continue working with faculty on zero-gravity bone density research. This year there were software related problems that proved challenging for the team, but have since been overcome and research continues.
- CSU-Pueblo students are also working closely with faculty on creating a Sabatier reaction system. The effort is going well and has proceeded with consultation with Dr. Zubrin and his staff at Pioneer Astronautics Corporation.
- CU students continued the ALL-STAR (Agile Low-cost Laboratory for Space Technology Acceleration and Research) satellite mission in collaboration with Lockheed Martin. The ALL-STAR team was awarded a flight on NASA's ELaNa 3 opportunity and is working toward a 2012 launch.
- Student at Fort Lewis College (FLC) participated in the statewide DemoSat program and built a payload that included a Geiger counter and photodiode detectors to measure radiation as a function of altitude.
- FLC students also engaged in observatory research. In addition to use of the observatory, students also helped with observatory projects that included the addition of an in-line adaptive optics component and additional camera cooling.
- Although not part of the FY 2010 plan, FLC students have become engaged with the Colorado Robot Challenge and are designing robots for the April 2, 2011 event.

**B. <u>Engage middle school teachers.</u>**

- Summer Space Across the Curriculum courses were held in Colorado Springs, Colorado and for the first time 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. **74** teachers participated in the 2010 courses.

**C. <u>Summer opportunities for secondary students on college campuses.</u>**

- CU Space Grant provided content for the University of Colorado Upward Bound Program (CUUB). CUUB hosts a 6-week, on campus program that recruits high school students from communities in and around Native American reservations across the U.S.. Students take a full load of classes while on campus. CU Space Grant teaches the required science class for 1st year students (upcoming

sophomores). The course is called Nanosatellites and includes lectures, homework, and exams. Students also work in teams to build and launch a balloon payload. In 2010, the course had 38 students. CUUB students are highly motivated, talented students who are recruited to top universities such as MIT, Stanford, and Harvard. The CUUB program tracks students through high school and into college.

**D. <u>New and continued relationships with community colleges.</u>**

- The four newest Colorado consortium affiliates, Community College of Aurora, Community College of Denver, Pueblo Community College, and Trinidad State Junior College, all completed their first full year as COSGC institutions. They joined COSGC in 2009 as part of a Minority Serving Institution Partnership Development grant. Students remain engaged on each campus and programs have expanded well past the short-duration balloon payload project (DemoSat) that initially engaged each campus. Students are now involved in autonomous robot programs, micro-gravity experiments, and long-duration high altitude missions in addition to the DemoSat program.
- COSGC continues a 15-year relationship with Pikes Peak Community College (PPCC). Faculty and students at PPCC continue to engage in observatory projects and laboratory exploration. In 2010, the first balloon payload team was organized and PPCC students will launch their payload on April 2, 2011. The payload development has created collaborations with local aerospace industry, in addition to building lab capabilities to do comic radiation research past the April 2011 launch.

**E. <u>Environmental Science/Global Climate Change research and activities.</u>**

- Students at the University of Colorado at Boulder continue work on the Drag and Atmospheric Neutral Density Explorer (DANDE) mission toward a late 2011/early 2012 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.

**F. <u>Diversity of institutions, faculty, and student participants</u>**

- 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
- 24% of scholarships were awarded to women
- 15% of scholarships were awarded to minority students underrepresented in STEM disciplines.
- 83% of scholarships were awarded to undergraduate students

**G. <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. One was to a faculty member in Mechanical Engineering and the other to a faculty member in Environmental and Radiological Health.

## PROGRAM CONTRIBUTIONS TO PART MEASURES

- **Longitudinal Tracking:** Total FY 2010 awards = 172, all of which are categorized as Fellowship/Scholarship awards.
    - 25 awarded to minority students underrepresented in STEM fields
    - 42 awarded to women
    - 28 students are pursuing graduate studies
    - 8 are employed in the aerospace industry
    - 8 are employed in STEM positions (non-aerospace industries)
    - 1 is employed at NASA
    - 3 are employed in K-12 academic field in STEM disciplines
    - 2 are employed in non-STEM fields
    - 1 is unemployed looking for work in a STEM field
    - 116 students are still enrolled in their degree programs

- **Course Development:** Mesa State College developed curriculum for the Introduction to Space Course that had students developing a model for a solar-powered space elevator. Pikes Peak Community College developed a Seminar in Cosmic Radiation as required preparation for the first PPCC balloon payload.

- **Matching Funds:** 1:1 (Core & Augmentation - $845,000)

- **Minority-Serving Institutions (MSI):** 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 2010 funding to support hands-on programs on their campuses. All institutions participated in the 2010 COSGC Annual Meeting. In addition to 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 5$^{th}$ year in 2011.

## IMPROVEMENTS MADE IN THE PAST YEAR

- FY 2010 was the first full year for the four new consortium member institutions: all of which have grown their programs beyond the initial balloonsat payload projects in which they initially engaged with COSGC. In addition, student programs at several veteran COSGC institutions have expanded through FY09 and FY10. As affiliate programs have become more robust across the consortium,

affiliate institutions are finding even more ways to interact and provide lessons learned across programs. This interaction has directly led to an expansion of the Colorado Robot Challenge and continued success of the Colorado DemoSat (balloon payload) program. In addition, several consecutive stages of hands on programs are now established at several COSGC institutions (when they had previously been only at the lead institution).

- In FY 2010, COSGC experienced affiliate director changes at several institutions. New affiliate directors at Metro State College and Western State College have breathed new life into student programs that had been struggling for several years. In addition, new affiliate directors at Pueblo Community College and Community College of Denver took over programs that were in their infancy and have been successful at maintaining student engagement on their campuses. As a direct result of the efforts of both new and veteran affiliate directors, talented faculty and professionals at all 17 COSGC institutions are successfully engaging Colorado students or teachers in high quality, real-world projects.

## PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

- 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. The Foundation's education programs have touched teachers in all 50 U.S. states and Germany. 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, or testing facilities. The following is a list of partners that directly contributed to COSGC student projects this year:

- Advanced Solutions, Inc.
- Aerospace Corporation (STP)
- Air Force Office of Scientific Research
- Air Force Space Command: Space Analysis Center (A9A)
- AMSAT
- Analytical Graphics, Inc.
- Ball Aerospace
- Colorado Space Business Roundtable
- Broad Reach Engineering
- The Boeing Corporation
- Colorado Satellite Systems
- Colorado Space Coalition
- Columbia Scientific Ballooning Facility
- Composite Technologies Development
- CU College of Engineering and Applied Science
- CU Department of Aerospace Engineering Sciences
- Edge of Space Sciences
- Equinox Interscience
- First RF
- General Dynamics
- Goddard Space Flight Center
- Honeywell
- Instar Engineering
- Jet Propulsion Laboratory
- Kennedy Space Center
- CU Laboratory for Atmospheric and Space Physics
- Level 3 Communications
- Lockheed Martin
- Marshall Space Flight Center
- NASA Launch Services Program
- Naval Research Lab.
- National Oceanic and Atmospheric Administration, Boulder
- Northrop Grumman
- Orbital Sciences
- Planetary Systems, Inc.
- Sierra Nevada Corporation
- Southwest Research Institute
- SparkFun Electronics
- Spectrolab
- Starsys Research Corp.
- Virginia Space Grant Consortium
- Wallops Flight Facility