California Space Grant Consortium
Lead Institution: University of California, San Diego
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Telephone Number: (858) 822-1597
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Lines of Business (LOBs): NASA Internships, Fellowships, and Scholarships; Stem Engagement; Institutional Engagement; Educator Professional Development

A. 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 California Space Grant Consortium is a Designated Consortium funded at a level of $760,000 for fiscal year 2018.

B. PROGRAM GOALS

1. Promote diversity and inclusion in all programs and activities by encouraging participation by underrepresented minority and female students and faculty. *1A*: Each academic year, provide a percentage of awards to underrepresented minority and female students that is consistent with diversity targets established by NASA. The diversity targets for the state of California are currently 49.27% for awards to minority students and 40% for awards to female students. *1B*: Undertake at least three collaborative programs with a non-member Minority Serving Institution (MSI) each year. *1C*: Each academic year, conduct at least one outreach event in partnership with a non-member MSI to promote programs and opportunities to students and faculty.

2. Conduct quality internship, scholarship and fellowship programs including STEM (Science, Technology, Engineering, and Math) research awards for community college, undergraduate and graduate students to broaden and deepen students' knowledge and prepare them for advanced STEM degrees or STEM employment. *2A*: Each academic year, award undergraduate, graduate, and community college students with internships, scholarships and fellowships. Students will be competitively selected by a review panel. *2B*: Award at least the minimum funding amount required by NASA (currently $150,000) to at least 50 students each academic year. *2C*: Each academic year, provide a percentage of fellowship/ scholarship awards to underrepresented minority and female students that is consistent with diversity

targets established by NASA. The diversity targets for the state of California are currently 42% for awards to minority students and 40% for awards to female students. *2D*: Longitudinally track 100% of all students receiving significant awards to identify their next step in academia or the workforce. Significant awards are those equal to or greater than $5,000 or 160 contact hours, cumulatively, or a combination of both. *2E*: At least 90% of students completing their education and receiving significant awards will be employed by NASA, an aerospace contractor, higher education or other educational institutions. *2F*: At least 50% of undergraduate students receiving significant support from CaSGC will move on to advanced education in NASA-related disciplines.

3. Undertake programs that foster research capabilities at our affiliate institutions and serve as a catalyst for linking university researchers to NASA and other opportunities. *3A*: Each academic year, support at least three interdisciplinary student research infrastructure projects in partnership with CaSGC affiliate institutions. *3B*: Each academic year, involve at least 10 students in research infrastructure projects in partnership with CaSGC affiliate institutions. *3C*: Each academic year, provide a percentage of research infrastructure awards to underrepresented minority and female students that is consistent with diversity targets established by NASA. The diversity targets for the state of California are currently 49.27% for awards to minority students and 40% for awards to female students.

4. Offer quality interdisciplinary hands-on higher education programs in partnership with our affiliate institutions to prepare students for STEM employment. *4A*: Each academic year, provide paid internships for at least five students at California NASA Centers and at least one student at an industry partner. *4B*: Each academic year, conduct at least five hands-on interdisciplinary higher education projects in partnership with CaSGC affiliate institutions. *4C*: Each academic year, involve at least 50 students in hands-on interdisciplinary higher education projects in partnership with CaSGC affiliate institutions. *4D*: Each academic year, involve students from underrepresented backgrounds in hands-on higher education projects at a level consistent with diversity targets established by NASA. The diversity targets for the state of California are currently 49.27% for awards to minority students and 40% for awards to female students. *4E*: Each academic year, at least 70% of MSI affiliates will be involved in our higher education programs. Currently there are 8 MSI affiliates. *4F*: Each academic year, at least two new or revised courses targeted at the STEM skills needed by NASA will be developed with CaSGC support.

5. Pre-service and in-service educators and student-focused programs for students throughout the precollege pipeline. *5A*: Each year, provide professional development in STEM using NASA resources to at least 30 pre-service and/or in-service teachers. *5B*: Each year, reach over 150 precollege students by conducting student-focused programs and activities promoting participation in STEM and related careers. *5C*: At least 75% of precollege educators participating in two or more days of professional development will use NASA resources in their classroom following the workshop. *5D*: At least 60% of precollege educators receiving NASA resources or participating in CaSGC-led short duration activities will use NASA resources in their classroom. *5E*: At least 50% of all precollege students participating in CaSGC-sponsored programs will express an interest in STEM careers.

6. Conduct Informal Science Education programs in partnership with formal and informal education members and partners. *6A*: Each academic year, utilize material developed in CaSGC's other program elements to inspire and engage the general public in at least 4 science-related events and university open houses. *6B*: Sponsor at least one program each year with the Reuben H. Fleet Science Center, the San Diego Air & Space Museum, and/or the California Science Center. *6C*: Consider other appropriate informal science education opportunities as funding and partnerships permit with the goal of at least one other activity per year.

C. PROGRAM/PROJECT BENEFITS TO PROGRAM AREAS

1. The success of CA Space Grant is measurable through the accomplishments of the students who have been funded. One such Space Grant student is Dr. Jessica Watkins. Earning her Bachelors from Stanford University and her Doctorate at UC Los Angeles (UCLA) where she was a Space Grant fellowship recipient at UCLA's Earth, Planetary, and Space Sciences (EPSS) Department, Jessica was selected as a NASA astronaut candidate for the class of 2017. Prior, Jessica had a stellar career at Ames Research Center and Jet Propulsion Laboratory in Pasadena where she was a collaborator on the Mars rover Curiosity.

2. Multi-disciplined collaboration continues to be fostered within California. At the UC Santa Barbara (UCSB), students and researchers are pursuing a multi-disciplinary program of developing directed energy for space applications and related topics of optical SETI (searching for DE signals from possible extraterrestrial civilizations), and Astrobiology (safe transport of micro-animals to out of Earth orbit, and to interstellar space, a precursor to understanding how to send humans on such a journey). These topics have recently become top priorities for NASA's Mission Directorates of Space Technology and Human Exploration and Operations. 35 students participated this past summer (2018) and came from three colleges at UCSB (Letters and Sciences, Engineering, and the College of Creative Studies) from the departments of Physics, Mechanical, Electrical, Chemical, and Computer Engineering, Molecular and Cellular Developmental Biology (MCDB), and Mathematics as well as students from Santa Barbara City College, other colleges around the country, and several high schools from Santa Barbara to the Los Angeles area. In the 2017 Congressional Appropriations Bill, there is a specific directive for NASA to assess TRLs, risks, milestones, and funding requirements to launch an interstellar mission to Alpha Centauri at a minimum velocity of 0.1c by 2069, on the 100th anniversary of the Apollo 11 Moon landing, and in the same year, the President signed into law the Space Policy Directive One, charging NASA to develop an innovative and sustainable program of space exploration. Immersive, hands-on research experience for undergraduates and high school students in UCSB labs have directly supported these goals of NASA, Congress, and the President.

3. With the sponsorship from the CA Space Grant and NASA's participation, California State University, Sacramento (CSUS), has been able to develop a unique expertise in computer modeling and simulation of space vehicles and in the analysis of Mechatronics and control systems. Both of these technologies were used in the successful development of computer simulation models of the International Space Station which influenced the curriculum in their Mechanical & Aerospace Engineering Department and now such technology is being applied to other NASA projects and to ground vehicles. This research collaboration has now expanded

to the California Highway Patrol who is interested in the computer simulation technology developed as a result of NASA projects for space vehicles, technology which is now being used in projects to model ground autonomous vehicles. As a result of this joint collaboration, a research paper, "Vehicle Modeling and Simulation for determination of Drag Factor in Accident Reconstruction" by CSUS student Felipe Valdez was published and presented at the 13th International Conference on Bond Graph Modeling and Simulation (ICBGM'2018) in Bordeaux, France. July 2018.

D. PROGRAM ACCOMPLISHMENTS

- NASA Internships, Fellowships, and Scholarships (NIFS): Three CA Space Grant awards at $6,000 each (two at Ames and one at Armstrong) were awarded for the 2018 NASA Summer Internships to undergraduate students from California attending a California university or college. For 2019, six CA Space Grant awards at $7,300 each (three at JPL, two at Ames, and one at Armstrong) will be awarded at the beginning of summer (SMART Objective 4A).

- Higher Education (HE) projects: In 2018, ten CA Community Colleges participated in the fourth year of the Community College partnership program - Butte College in Oroville, CA, Cerritos College in Norwalk, CA, Citrus College in Glendora, CA, College of the Desert in Palm Desert, CA, Irvine Valley College in Irvine, CA, Los Angeles City College in Los Angeles, CA, Mendocino College in Ukiah, CA, Rio Hondo College in Whittier, CA, Southwestern College in Chula Vista, CA, and Victor Valley College in Victorville, CA. Approximately 100 students (ten from each of the 10 colleges) were be funded with scholarships and individual Arduino kits. These community college students presented their summer projects at poster symposiums and were given a field trip tour at one of the following – Space Systems Loral in Mountain View, CA, Armstrong Flight Research Center in Palmdale, CA, or University of Southern California (USC) and California Science Center in Los Angeles, CA.

  Our HE projects from our UC affiliates include UC Berkeley's (UCB) Cal Space Technologies And Rocketry (CalSTAR) rocketry projects, UC Irvine (UCI) faculty-mentored Earth System Science research projects, UC Los Angeles's (UCLA) electronics laboratory mentorship program, UC Santa Barbara's (UCSB) Directed Energy for Space Applications Program, UC Santa Cruz's (UCSC) Lamat Program and Undergraduate High-Performance Supercomputer Training, and UC San Diego's (UCSD) Summer Engineering Institute and UCSD School of Medicine's Space Biology of Human Space Exploration project. (SMART Objective 4B, 4C)

  CaSGC led the development of a hands-on two-course aerospace structural capstone design sequence at UCSD. Senior teams design, analyze, fabricate, and test full-scale advance composite aerospace structures. Major progress steps require presentations to outside review teams (Northrop, General Atomics, Space-X, NavAir).

  Other HE projects in the form of Workforce Development programs include Azusa Pacific University (APU) faculty-mentored research projects in Biological Sciences supporting ten students, Cal Poly Pomona's (CPP) Aerospace Vehicle Laboratory Operations & Field Testing in its fourth year, CSU Fresno (CSUF) Unmanned Aerial Systems program, Sonoma State

University (SSU) CubeSat and rocketry projects, CSU Sacramento (CSUS) faculty-mentored projects in space exploration, aeronautics and vehicle dynamics, Santa Clara University's (SCU) development of a UAV field operations program for education and research, and Mills College faculty- mentored research projects for four students in Chemistry and Physics. (SMART Objective 4B, 4C)

Support was provided to nine (9) student clubs throughout California in rocketry competitions (NASA's NSL, Intercollegiate Rocket Engineering Competition, and First Nations Launch), Micro-g NExT Challenge, AIAA Design Build Fly UAV competition, and iGEM (competition in synthetic biology). Two Stanford University teams, one team from San Jose State University (SJSU), three UCLA teams, one CSU Long Beach (CSULB) rocketry team, one CPP rocketry team, and one Citrus College rocketry team were supported in these national STEM related competitions and challenges as HE activities.

- Research Infrastructure projects: Two major research projects were conducted by UCSB on directed energy for interstellar exploration and planetary defense and SCU for the development of a mission operations systems/equipment and on-board components for the EdgeCube satellite project in cooperation with Sonoma State University.

- Precollege projects: The CaSGC conducted eight (8) activities in a progression of educational opportunities involving precollege students, pre-service teachers, and in-service teachers to engage and educate in the STEM disciplines (SMART Objective 5B). The CA Space Grant supported four California school teachers (K-12) to attend the Texas Space Grant Consortium Lift-Off, weeklong professional development training for teachers. This aerospace workshop, called LiftOff, emphasizes STEM learning experiences by incorporating a space science theme supported by NASA missions. At CPP, a CaSGC sponsored project titled, "Maximizing Engineering Potential: Preparing the Next Generation of Minority and Women Engineers" has created STEM-based teaching tools which introduce fundamental concepts in engineering and, at the same time, incorporate NASA content through creative activities using low-cost materials. These same teaching tools will be used for outreach which will integrate engineering material that conforms to K-12 standards. Another precollege activity at CPP was engaging 825 students in six elementary and secondary school events by performing presentations about the NASA Student Launch (NSL) project design phases and activities that ranged from various topics, such as programming, propulsion/drag, and the launch vehicle design and construction.

  At the UC System, three CaSGC Affiliates led precollege activities. With over 280 educators (and continually increasing every year) attending from 23 different district in both Riverside and San Bernardino Counties, UC Riverside (UCR) led the STEPCon Educator Conference in October 2019 at the Bourns Technology Center in Riverside, CA. STEP (Science, Technology, Education, Partnership) Conference is a full day conference focusing on training and empowering area teachers in STEM education through inspiring keynote addresses, informative workshops and practical resources that can readily be used in the classroom. In its second year, Educator STEP Con is part of a nearly weeklong conference that includes a two day K-8 student conference that reaches over 4,000 students. (SMART Objective 5A). Building a unique educational environment not found within the standard school curriculum, UCB hosted Splash! event in March 2018 which brought local high school students on campus for a day of unlimited student-led learning (SMART Objective 5B). At UCSD, a project is

being spearheaded to engage the homeless youth in STEM activities through the collaboration of Monarch School, a unique school in San Diego dedicated to helping homeless students break the cycle of poverty through education.

Other CaSGC sponsored precollege activities include the Student Spaceflight Experiments Program (SSEP) at (1) Fairmont Elementary School and Sanger High School and (2) Moreno Valley Unified School District. Local Flight Experiment Design Competitions were conducted for SSEP Mission 12 to the ISS and launched on the SpaceX Falcon-9 rocket from Cape Canaveral Air Force Station, FL, in late Spring 2018 where their student teams vie to fly an experiment in low Earth orbit in a real research mini-laboratory reserved just for their community (SMART Objective 5E). The SSEP program provided seamless integration across STEM disciplines through an authentic, high visibility research experience, an approach that embraces the Next Generation Science Standards. (SMART Objective 5B).

- Informal Education projects: The CaSGC has been very active in outreach and informal education activities throughout the year, participating in twelve (12) science and space related events (SMART Objective 6A). To reach out to the general public and attract students to science, UCLA held the annual Explore Your Universe (EYU) event hosted by the combined science departments engaged in Space, Astronomical, and Astrophysical investigations. The event drew up to 7,000 attendees to provide them a much deeper understanding of engineering and research programs in planetary, astronomical, astrophysical, solar, and earth sciences.

  Besides on-campus events, CaSGC Affiliates also participated in outside, organized, outreach events that have drawn thousands of families, K-12 students, pre-college educators and the public at large. SCU has served more than 500 K-12 students and 20 K-12 teachers by the implementation of a K-12 outreach program involving a mobile maker lab for school visits, a maker-oriented series of teacher training workshops, and a "remote fabrication" service in which students are advised online in their design tasks and then parts are fabricate for them in the mobile maker lab. The UCB CalSTAR's club participated in five outreach activities from October 2017 to April 2018 where UCB students presented on their competitions (NASA SLC, IREC, etc.), their research (e.g., custom rocket recovery, liquid bipropellant engines, rovers, and upright landers), and other related science and facts (e.g., Newton's laws, basic aerodynamics, etc.). The staff and students from UCSB participated in outreach events, reaching the public in Santa Barbara and Los Angeles. UCSB students and professors gave demonstrations and lectures at the (1) Santa Barbara Museum of Natural History's all-day event "Astrovaganza" in September 2017; (2) International Raw Science Film Festival, which was held at Santa Barbara's Lobero Theater and Museum of Natural History in January 2018; and (3) Yuri's Night, in Los Angeles in March 2018. At UCSD, Higher Education students from the UCSD Near Space Balloon/CubeSat Club conducted informal education activities related to the project in two venues, San Diego Science Festival EXPO Day (March 2018) and Space Day at the San Diego Air & Space Museum (May 2018). In each activity they had a booth with hands-on exhibits related to CubeSats and conducting a high altitude balloon launch (SMART Objective 6B).

E. PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE GOALS

- **Diversity**: Of the 216 directly funded participants: 103 (47.7%) are minority students underrepresented in STEM, 179 (36.6%) are female, seven (3.2%) are US Veterans, and eleven (5.0%) have a disability.

- **Minority Serving Institution Collaborations**: Our major collaboration with MSIs is through our Community College Partnership Program where most of the colleges are MSI or HSI categorized. This program competitively awarded ten (10) Community Colleges designed to enhance the college's STEM preparation and improve a bridge opportunity for students to either the UC or CSU system. The program involved student-team projects centered on the use of low-cost programmable microcomputers. These student teams would then work on these projects during the summer and present their projects at a poster symposium at one of the three CA NASA Centers (Ames, Armstrong, or JPL) or an Affiliate or industry partner where they would also receive a unique walking tour highlighting the current research challenges followed by a research seminar, and finally, meeting with scientists and engineers to discuss their research and get inspirational career counselling advice. To enhance the program, NASA webinars were broadcast from each of the CA NASA Center to the ten community colleges on research topics that highlight the unique work of each center and are of interest to the community college faculty and students. At the successful completion of their projects, the participating students also received a CA Space Grant scholarship.

- **Office of Education Annual Performance Indicators**:

    - API 3.3.3: STEM-18-1 __216____

    - API 3.3.5: STEM-18-5 _55_____

F. IMPROVEMENTS MADE IN THE PAST YEAR

- Our CaSGC Affiliates have reported an uptick in the diversity of students who have been working in their labs and conducting research. There has been a gradual rise in the percentage of minority students underrepresented in STEM, as directly funded participants, a 7% increase

from the previous year and a continually increase interest among all students to obtain STEM internships.

G. CURRENT AND PROJECTED CHALLENGES

- The biggest challenge to Space Grant is continual funding support for Space Grant on a national level. Because of current political climate, funding and administration of Space Grant through the NASA Office of Education continues to be in jeopardy as the CaSGC works with a funding profile disbursed as one-year extensions of the current 3-year bridge grant. This uncertainty has led to difficult in long-range planning and expansion and development of programs. The CaSGC Director along with other key directors have been advocating to Congress the significance of the Space Grant in workforce development and future space missions.

- Increasing Female Student Involvement: Nationwide, female student enrollment in all majors is (>50%), but within the STEM field female enrollment is closer to 10-15%. In a recent published study, three California universities ranked in the top five nationally for female STEM enrollment (UC San Diego 33%, UC Davis 24%, UC Berkeley 24%). Our greatest on-going challenge is meeting the 40% award target for high-quality female students. This year we are nearly 25 awards short of our goal. We are partnering with faculty mentors and student chapters of the Society of Women Engineers and other women resources groups to develop new programs at our university affiliates and community college partners.

H. PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

- Four-Year Public Institutions within the University of California System: *UC San Diego* (Lead Institution for CaSGC; fellowships/scholarships in Engineering, Near Space Balloon Team), *UC Berkeley* (fellowship/scholarship programs in Space Sciences), *UC Davis* (higher education and precollege programs in Environmental Sciences), *UC Irvine* (fellowships/scholarships in Earth System Science), *UC Los Angeles* (fellowships/scholarships in Geophysics, Space Sciences, and Aerospace Engineering), *UC Riverside*[1] (fellowships/scholarships in Engineering; precollege program with MESA), *UC Santa Barbara* (various experimental cosmology space-related instrumentation projects; works closely with Santa Barbara City College), *UC Santa Cruz*[1] (astrophysics programs with Hartnell and Cabrillo Colleges to develop students for careers in STEM research; serves on a CaSGC advisory board).

- Four-Year Public Institutions within the California State University System: *Cal Poly Pomona*[1] (UAV and CubeSat projects and K-12 outreach along with partnership with Citrus College), *Cal Poly San Luis Obispo* (CubeSats and rocket projects), *CSU Sacramento* (Mechanical Engineering projects in conjunction with NASA Johnson Space Center), *CSU San Bernardino*[1] (Astronomy projects with Mt. San Antonio College), *CSU Long Beach*[1] (rocket projects; serves on a CaSGC advisory board), *CSU Los Angeles*[1], *CSU Fresno*[1] (precollege

[1] Minority Serving Institution (MSI)

program for middle and high school students and workforce development in UAVs), *San Diego State University*[1] (runs the San Diego MESA Alliance Research Academy for community college students in hands-on university research as well as graduate student Aerospace Research), *San Jose State University*, *Sonoma State University*[1] (CubeSat research experiences including Napa Valley College & Santa Rosa Junior College).

- Four-Year Private Institutions: *Azusa Pacific University* (STEM outreach programs), *California Institute of Technology* (in a state of transition with CaSGC), *Pomona College*, *Santa Clara University* (robotics, CubeSats, and satellite operations in conjunction with NASA Ames Research Center), *Stanford University* (in a state of transition with CaSGC), *University of San Diego*, *University of Southern California* (Astronautical research).

- Other Educational Institutions: Astronomical Society of the Pacific

PARTNERS:

- California Community College District: Butte College, Cerritos College, College of the Desert, Irvine Valley College, Los Angeles City College, Rio Hondo College, Victor Valley College, Miramar College, Mendocino College, Woodland College, Citrus College, College of San Mateo, Hartnell College, Santa Monica City College, Mt. San Antonio College, Napa Valley College, Contra Costa College, Evergreen Valley College, Southwestern College, San Diego City College, Santa Barbara City College, Santa Rosa Junior College.

- Education: Center for Excellence in Education, Lincoln Middle School, Mathematics, Engineering, Science Achievement Program (MESA), National Center for Earth and Space Science Education, San Diego MESA Alliance, UCSD Jacobs School of Engineering, Texas Space Grant Consortium, Fairmont Elementary School, Sanger High School, and Moreno Valley Unified School District.

- Government: NASA Ames Research Center, NASA Armstrong Flight Research Center, NASA Dawn Project, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, NASA Johnson Space Center, NASA Marshall Space Flight Center, NASA Office of Education, National Renewable Energy Laboratory, National Science Foundation, and United States Geological Survey.

- Industry: ATK Aerospace Systems, Boeing, FLIR Systems, Inc., General Atomics, Intel Corporation, Lockheed-Martin, Microcosm, Inc., NanoRacks, Northrop Grumman, Pixar, Raytheon, SpaceX, Thermo Scientific, Blue Origin, Maxar Technologies

- Informal Education: Exploratorium, Reuben H. Fleet Science Center, San Diego Air & Space Museum, San Diego Science Festival.

- Societies & Organizations: American Institute of Aeronautics and Astronautics, AmericaView, Center for the Advancement of Science and Space, Keck Institute for Space Studies, National Council for Science and the Environment, Packard Foundation, American Indian Science and Engineering Society, National Society of Black Engineers, Society of Hispanic Professional Engineers, Society of Women Engineers.