Aerospace Vehicle Flight Test Laboratory Operations for Workforce Development

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Through the proposed Aerospace Vehicle Flight Test Laboratory Operations for Workforce Development program, California State Polytechnic University Pomona (Cal Poly Pomona, or CPP) proposes to continue and extend its current laboratory programs in order to expand our workforce development programs involving education, research, hands-on training and outreach activities. This program will be conducted in CPP facilities on campus, except for some student-run flight-testing operations that will occur at suitable off-site locations. The program will benefit engineering students at CPP and eventually regional K-12 schools. We request engineering project funding to support student interns in developing flight testing capabilities and peer advising, as well as continuing to adapt our existing laboratory operations in order to support these workforce development activities. In addition to its current Uninhabited Aerial Vehicle Laboratory (UAV Lab), Cal Poly Pomona has recently established a second “flight” laboratory called the Space and Launch Vehicle Laboratory (SLV Lab). The initiation of this second lab is intended to support the “space” activities and curriculum of our students, just as the UAV Lab supports “air” activities. In 2009-2010, activities in both of these labs were supported by funding from a NASA Aerospace Workforce Development Grant, as well as funding from external industries such as the Jet Propulsion Laboratory, Northrop-Grumman Corp., the San Gabriel Valley section of the American Institute of Aeronautics and Astronautics (AIAA), and members of the local industry who provided material and fabrication support to our students. We hope to continue such relationships and initiate new ones with funding requested in this proposal.
California Space Grant Consortium Workforce Development Programs
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Undergraduate Programs in the Astronautical Engineering Department at USC
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This proposal seeks financial support for undergraduate space technology programs of the Astronautical Engineering Department (ASTE) at the University of Southern California. The support is requested to fund five fellowships for undergraduate students in the programs that have been supported by the CaSGC for several years, and have been quite successful in reaching the educational goals set by the Consortium. This can be seen in the facts that a number of students who were participating in the programs were accepted as PhD students at prestigious institutions (e.g. Caltech, MIT), obtained internships from leading space corporations (e.g. Boeing, Northrop Grumman), and have been employed by top NASA organizations (e.g. Jet Propulsion Laboratory, Johnson Space Center). The space technology undergraduate programs were selected last year as one of the best undergraduate programs at USC, and praised by USC Administrators, the University Board of Trustees members and a number of world-class space technology experts, and covered by several major media organizations.

The astronautical engineering program we are seeking funds for in this proposal consists of three continuing projects (Lunar Lander Laboratory, Microsatellite Laboratory, and Rocket Laboratory) where students from Astronautical, Aerospace, Mechanical, Computer, Electrical Engineering and Physics Departments design, build, test and launch various spacecrafts. This program has been in operation for five years now and continuously supported by CaSGC. The fraction of under-represented minority students and female students participating in the projects every year has been above the national average in the schools of engineering. The program is well organized and effectively managed. The program has led to development of two new undergraduate class-based courses (one 200-level and the other 400-level) which have become a part of the undergraduate curriculum of the Astronautical Engineering at USC. The hands-on projects effectively prepare engineering students for a faster transition to the space industry. (New employees in the industry and in the U.S. Government space organizations usually have no hands-on experience with real space systems.) They produce graduates with skills that are sought by the space industry and the government. The hands-on projects are highly multi-disciplinary tasks dealing with spacecraft systems, including structure, propulsion, thermal, electrical control system, guidance algorithms, and other aspects. The projects emphasize integration and test, require students to work individually as well as a team, and develop communication skills, documentation skills, and hands on training in actual hardware development and test environment. The training requires students to learn and understand not only engineering and managerial aspects of the problems put also science needed to solve related problems.
Lightweight Deployable and Adaptive Systems for Space Applications
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We propose a multi-disciplinary approach with students from the Physics and Engineering Departments at UCSB from the Physics Dept at Cal State San Luis Obispo (Cal Poly) and Santa Barbara City College (SBCC) to develop an actively adaptable and deployable Carbon Fiber Reinforced Plastic (CFRP) systems using servodriven actuators with a laser interferometer feedback system. The Las Cumbres Observatory has donated significant amounts of machining time in a 4 and 5 axis CNC and ATK in Santa Barbara and San Diego is working with us on interferometer based metrology systems. Students from Mechanical Engineering and Physics at UCSB will work with Engineering and Physics students from our local community college (SBCC) as well as Physics students from Cal Poly. We have excellent contacts in each of these schools and have a long track record of working with students and faculty from both schools. Our ME department students are using this as their Capstone project for this school year. Each year we take on ME students to work on space related projects and combining these students with UCSB Physics and SBCC Engineering and Physics and Cal Poly Physics (possibly ME). Students will work as a team on this program which will involve the design and finite element analysis of very lightweight actively stabilized systems that will focus on both optical systems that are launchable (a 10 meter telescope to start) and deployable using ALGOR and COSMOS FEA packages, learn 3D CAD design using Solidworks and AutoCAD, learn 3-5 axis CNC machining design using MasterCAM, learn on the UCSB student CNC machines and then with the CNC operators at LCO, learn servo system design and electronic servo amplifier design and implement a closed loop servo software loop with a laser interferometer and phase modulation as the feedback. We have spoken to ATK in Goleta that makes most of the deployable solar panels for the US space program as well as designing space deployables for some upcoming satellite program and they are very interested in working together on this. ATK Goleta (formerly Abell Engineering) is one of the leaders in space deployable in the country. They are located one mile from campus and take in local UCSB and SBCC students as part of their workforce internships. As part of the UCSB Mechanical Engineering senior design program there is a team of 4 seniors working with us on this project. These students work for 9 months on a program known as the Capstone program. We tried this approach last year and it worked extremely well. Students meet weekly in formal sessions and have two critical design reviews and one final review, a final full day presentation and poster competition. By combining students at UCSB, Cal Poly and SBCC we will forge new alliances that will encourage cross fertilization of ideas and personnel. By combining with professional industry in town we will give students access to potential future jobs and professional experience.
Ample evidence demonstrates that undergraduate research opportunities are a valuable tool for recruiting young people to science, technology, engineering, and mathematics (STEM) fields, for retaining them through the bachelor’s degree, and for advancing them to graduate studies. The University of California, Riverside, operates a number of programs to provide undergraduates with research experiences during the academic year and particularly during the summer. We request support from the California Space Science Grant Consortium workforce development program to expand the number of undergraduates served by two in the summer of 2011.

Participation in research helps students attain a higher level of competence in the majors, understand the methods and processes of research, make informed judgments about technical matters, and communicate and work in teams to solve complex problems. Students rate undergraduate research experiences as very influential in their career choices. Several studies have examined the impact of undergraduate research experience on advancement to graduate study (Zydney et al., 2002; May and Chubin, 2003; George, 1996). These agree in general that student research experience was both beneficial and a contributing factor in the decisions to attend graduate school.
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Development of Satellite Formation Flying Technology and a Neutral Buoyancy Testbed
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Santa Clara University’s Robotic Systems Lab proposes to extend its existing multi-robot formation control technique, known as Cluster Space Control, for clusters of small spacecraft. This technique, which has previously been tested with land/sea/air robots, will be adapted to 6 degree-of-freedom vehicles, verified via simulation, and integrated into a new ground-based “neutral buoyancy” 4 DOF testbed that capitalizes on the program’s expertise in underwater robots. This work will prepare the research team for an ultimate demonstration of the formation control technique on the SPHERES satellite formation flying testbed, housed on the International Space Station. The proposed program is an outstanding example of a new initiative to be seeded by California Space Grant, that leverages significant matching funds, that spans disciplines, that combines both undergraduates and graduate students in a unified research and design team, and which builds strong ties with NASA Ames Research Center.
The development of the X-51 has surged the development of scramjet technology at NASA and DoD. Fuel injectors play a decisive role in scramjets and have been subject to significant efforts at NASA Centers and AFRL. The design of fuel injectors determines the fuel-air mixing which has a significant impact on the quality of combustion. Poor combustion can lead to flame instability, acoustic instability, and increased emission of pollutants among others and degrades the overall combustor performance. In scramjets used in hypersonic air-launched vehicles, fuel injectors typically inject gaseous or liquid hydrocarbon fuels in a supersonic cross-stream. Challenges in the design of these injectors include ignition, a stable flame-holding, a drag overhead and the deep penetration of the fuel into the flow. Many of these challenges are directly related to the complex flow structures and consequent mixing levels close to the injector. Based on recent breakthrough Lagrangian theories developed at SDSU in collaboration with MIT and using our high-fidelity in-house Direct Navier-Stokes and LES solvers, we aim to identify distinct Lagrangian flow structures upstream of the fuel injectors and develop a new theory that enables the quantitative analysis of the dynamic mass and fuel flows into the flame zones. We further seek to control these flow structures by local plasma heating to obtain desired fuel-air mixing levels and ignition temperatures.
California State University, Sacramento promotes mentored projects with faculty guidance and student participation at the undergraduate and graduate level. These projects have a positive impact on students and faculty. The mentored engineering projects are a tool to motivate, keep and retain students by keeping them engaged in Space-related projects of practical importance. The objective of this proposal is to perform engineering projects, which will assist students in becoming the workforce of the future for NASA and their contractors in the Aerospace Industry. In particular, it is of interest to investigate the factors that contribute to the low numbers of Hispanic students in aerospace academic programs and in the aerospace industry. The current projects are in two areas, the aerospace related senior projects and graduate students thesis. We want to continue to collect data and research an answer to improve the number of minority students in Engineering and Computer Science. This year we also would like to support the LUNABOTICS project for which CSUS has been invited to participate in partnership with Modesto Junior College.
California Launch Vehicle Education Initiative Support
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California State University, Long Beach (CSULB), in partnership with Garvey Spacecraft Corporation (GSC), has been leading the California Launch Vehicle Education Initiative (CALVEIN). This program aims at providing students of all levels, from freshman to graduate, with an opportunity to enhance their educational experiences through flight projects mentored by industry experts. Over the years, the program has engaged the participation of other universities within California such as Stanford and Cal Poly, SLO, and also beyond our state with other Space Grant funded institutions, such as Kentucky Space, Montana State, and more recently University of Maine through their Space Grant Consortium. The various projects contribute to the development of new technologies for future low cost launch vehicles and small satellites. Examples include the development of aerospike engine technologies funded by the Missile Defense Agency and the demonstration of wireless technologies for low cost launch vehicles and small satellites with funding via an SBIR from NASA Ames to Garvey Spacecraft Corporation. CSULB proposes to have the California Space Grant Consortium (CaSGC) fund student projects complementing these activities and which would contribute to enhancing the impact of its ongoing externally funded programs. More specifically, the funds would be used to support students developing the Prospector-18, a vehicle designed to flight test CubeSat avionics for rocket command, data handling and telemetry purposes. This program integrates technology development and demonstration of interest to NASA along with aerospace workforce mentoring in a flight program.
Workforce Development in Mechatronics
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The Lyles College of Engineering (LCOE) at California State University, Fresno (Fresno State) is requesting support from the California Space Grant Consortium (CASGC) to support two multi-disciplinary workforce development projects in mechatronics currently in progress:

--Project 1: Phase 3 of the Unmanned Aerial Vehicle Project (UAV)

--Project 2: Year 2 of the The Lowell Neighborhood Project

The UAV project’s phase 3 goals are: Integration of auto-pilot into existing flight systems to allow way point flight and autonomous take-off and landing, Video image processing and shape recognition, design of a Carbon fiber Faraday cage and structural airframe parts, and competing in the national Student Unmanned Air System Competition. The Lowell Neighborhood Project’s goals are for LCOE Honors Students to mentor the 16 fifth grade students that were introduced to Lego Robotics during Year 1 of the project so that these students will gain competence in robot construction, programming, communications, team work and research skills, and compete in the 2011 regional competition. The funds requested will support students and faculty associated with these two projects. These projects have been partially funded previously by CaSGC and significant progress has been made as a result of the funding. This proposal aims at extending the progress.
Advanced Fuel Grain Design for Hybrid Rocket Motors
Profs. William R. Murray, Joseph D. Mello, and Patrick Lemieux
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This request seeks support for advanced fuel grain design and testing, which is the next step in the process of having Cal Poly students design, build, test, and launch rockets powered by hybrid rocket motors with advanced nozzles. We propose to develop advanced fuel grain geometries that are made as a composite material composed of HTPB1 and carbon fiber. Using carbon fiber reinforcement for HTPB fuel grains has the potential to yield multi-port grains that display very low residual mass fraction with little to no HTPB chunking. Under the supervision of Profs. Murray, Mello, and Lemieux, this design, build, and test project will be accomplished by a graduate student, for whom fuel grain design studies will be thesis research, and by a team of undergraduate research students who will assist in the design and manufacturing of these fuel grains.

Long-Term Objective: The overall objectives for the proposed project are twofold: 1) to foster and support significant project-based learning activities related to rocketry and propulsion in the College of Engineering at Cal Poly; and 2) to increase interaction between those students and faculty participating in these rocketry and propulsion projects at Cal Poly and the California companies involved in providing access to space.
Azusa 2010-2011 Aerospace Workforce Development Program
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The Center for Research in Science at Azusa Pacific University is pleased to submit this proposal requesting funds from the California Space Grant Consortium to assist in preparing Azusa Pacific University students majoring in Math or Science (Physics, Pre-Engineering, Biology, Chemistry, or Computer Science) to enter the workforce in aerospace or related fields. The specific elements of our proposed Aerospace Workforce Development Program are as follows:

1) Continue conducting an on-going series of evening seminars for students and faculty mentors geared toward the exploration of job search strategies, interviewing techniques, and career opportunities.

2) Upgrade and maintain both online and physical copies of a searchable database of “STEM” internship, scholarship, fellowship, and job opportunities with contacts at government agencies, public and private companies, schools, colleges and universities, specifically tailored to the aptitudes and abilities of our STEM students.

3) Encourage the participation of under-represented and disadvantaged individuals (including females and minorities) in our programs. We propose to visit at least two schools with underrepresented minorities within the next academic year to promote science and technology. We will expand on our track record of giving science lectures at local schools with large numbers of minority students (e.g., Ontario Center Elementary School in Rancho Cucamonga). With this additional funding we will be able to take some APU education students with us to other schools to train them in working with primary and secondary students. We also plan to invest a modest amount of funds to develop some science demonstrations on topics such as climate and weather.

4) With student involvement, design, develop and maintain a set of visually engaging (possibly interactive) science displays for our new science building to attract the interest of new students and visitors to the sciences.

5) Work with APU’s School of Education in developing partnerships to help train future science teachers and involve student teachers in our science training and research programs.

6) Fund student internships/scholarships to work with a mentor on any of several aerospace-related research projects.
Work Force Development at UCLA
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To successfully enter the workforce students need to obtain real-world experience in areas in which industry is seeking new talent. This is difficult to achieve within a classroom setting but in a research university real-world experience in the laboratory is possible if the students can be integrated into the existing projects being undertaken there. At UCLA we have had a succession of such work force projects as various space projects moved through our laboratories. These projects included the Polar mission, ST5, THEMIS and MMS. Currently work continues on MMS and has begun on LOMONOSOV, a mission to be launched in 2011 and supported at UCLA by NSF. We propose to use UCLA undergraduate students to assist with both MMS and LOMONOSOV development. The project will be managed by Prof. Wirz and Angelopoulos with some assistance from the office of the UCLA Branch CaSG director.
The Lamat Program
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The Lamat initiative is fundamentally an academic enhancement and enrichment program that has three components: an intensive summer internship; a mentoring program for students and their families; and a public outreach program. The core aspects of the program are to develop academic skills in space physics and to prepare students at the undergraduate level for careers in engineering and science.

The Lamat summer internship program offers an intensive eight-week introduction to astrophysical research methods and tools with an emphasis on computational astrophysics. Students are recruited each year from Hartnell Community College, where the principal selection criteria are outstanding academic accomplishments and promise of future achievement. The selected interns will work closely with UCSC’s space-science faculty and PhD students on a research project. For undergraduate students who are interested in a career in science, active participation in research as early as possible is extremely important. This gives the student the opportunity to put into practice the critical thinking skills and knowledge that they are developing in a real-world situation, and builds their excitement and love of space science. It shows them that what they are learning goes beyond the classroom experience and is an indispensable continuation of the educational process. Upon completion the participant will be required to give an oral presentation. The intern will be encouraged to submit an abstract to present their research in a student session at the SACNAS (Society for Advancement of Chicanos and Native Americans in Science) National Student Conference, as well as at other professional meetings. The intern will be also integrated into one of the many existing student support programs at UCSC, such as the California Alliance for Minority Participation (CAMP) program. This will provide the interns with a student community as well as the opportunity to develop additional skills to advance their education and career. The programs provide sessions on science communication, writing personal statements, preparing for graduate school and a range of other valuable topics. In addition, many of these students do valuable work and have made substantial contributions to the research they participate in.

This program is targeted at potential transfer students who are at the same time promising researchers at the beginning of their careers and also members of groups who are traditionally under-represented in the university.