Title of Project: ICEX - International Computer Engineering eXperience (focus on underwater science data acquisition and water and society web-based outreach project targets at middle school, high school, and university educators)

Faculty Advisors: Dr. Zoë Wood & Dr. Jane Lehr

Department: Computer Science & Ethnic Studies/Women’s & Gender Studies (respectively)

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Telephone: 756-5540 (Dr. Wood)

Anticipated Start Date: September 2012

Anticipated End Date: June 2013

Student Team Members & Departments:

Each year, we select a 5-10 student team for the International Computer Engineering eXperience (ICEX) program in September. We seek to integrate students from multiple engineering disciplines for the different components of the ICEX project (visualization, robotics, cultural learning). Participants have included students in computer engineering, computer science, mechatronics, Materials Engineering, Biomedical Engineering, and Aerospace Engineering. For the 2012-13 program, we are also committed to expanding participation to include students from the College of Liberal Arts in order to strengthen and expand opportunities for cultural and technical learning and leadership amongst project team members. Amongst the 2012-13 project team, we plan to invite 1-2 students from previous ICEX teams to participate again to establish leadership and mentoring relationships. From the 2011-12 ICEX team, likely mentors include Jeffery Forrester (CSC) and Erik Nelson (Mate).

Total Funds Requested ($): 5,000

Signature of Faculty Advisor: ____________________ Date: ____________________
1) A detailed statement of work with measurable objectives. Highlight the multidisciplinary nature of the project and how it will provide a contextual learning environment for the integration of STEM principles. Identify how innovation will play a key role in solving the problem.

We are submitting this proposal for funding to support the work conducted as a part of the International Computer Engineering eXperience (ICEX) program. The ICEX Program is a collaborative effort between California Polytechnic State University’s Engineering Programs and various international partners. ICEX is an opportunity for students to apply their technical knowledge in an international context, gain expertise on the relationships between culture and engineering work in order to prepare students to function as professional in global contexts, and to increase global citizenship across campus.

Each year 5-10 students from across the College of Engineering are selected for program participation via a process involving both applications and interviews. Students undergo both cultural and technical training, up until their departure for an expedition that takes place during the final weeks of spring quarter and spring break. One of the primary sites for ICEX expeditions (2009, 2011, 2012) has been Malta. During the Malta expeditions, Cal Poly students and faculty collaborate with marine archeologists and biologists from the Aurora Special Purpose Trust and the University of Malta to investigate previously unexplored underwater archaeological sites, including ancient water cisterns (underground water storage systems located beneath fortresses, private homes, and churches), marine caves, and coastal shipwrecks. During the 2012 expedition, in addition to traveling to Malta, the program also travelled to Sicily to map cisterns, wells and water galleries. The 2013 program will return to Malta and Sicily, for further mapping of water systems, with a focus on marine caves and the integration of increased biological data into the visualizations of these caves.

All work conducted as a part of ICEX is interdisciplinary, with the program focused on training global engineers who will be able to function in complex cultural and technical environments. In addition to technical training and development focused on robotics and visualization that occurs in the quarter immediately prior to the ICEX research expeditions, students also conduct independent historical and cultural research on the countries to which they are traveling (for example, Malta) as part of their participation in a new Ethnic Studies course on Global Engineering. This course is a comparative examination of historical and contemporary engineering institutions in different national contexts. It highlights the role of social, cultural, political, historical, and economic factors in determining what it means to be an engineer, do engineering work, and the structure of engineering education.

1 In the past and for the 2012-13 academic year, support has also been provided from the Cal Poly College of Liberal Arts via faculty course assignment (Jane Lehr) and, as indicated above, additional recruitment for the 2012-13 team will include a focus on students from this college.
An NSF IRES Grant has been awarded that pays the majority of travel funds (i.e. $50,000 for 1 month of travel for 8 students and 3 faculty members). We are seeking additional funds from CPConnect for $5,000 for items not admissible under the NSF budget, which is limited to travel expenses for Cal Poly participants only. Specifically we are requesting funds for two sub-projects of ICEX:

a) Equipment for acquisition of underwater science data in marine caves: We are requesting $2,400 in funds to rent a smart tether and to finalize development of a small science data sensor. This equipment, in conjunction with our current ROV, will allow us to explore marine caves and acquire scientific data such as water salinity and temperature. The smart tether is a cable that connects the ROV to the control box and has a series of sensors in place on the cable that together provide a means for estimating the position of the ROV in a global coordinate frame (i.e. it outputs latitude and longitude measurements in real time). Position estimation for previous missions was computed via the use of sonar, however, in caves with complex varying shape in three dimensions, the two dimensional sonar scan is not adequate for estimating position while mapping or collecting ocean data. In contrast, the smart tether is capable of providing meter level accuracy in position measurements. With the smart tether, we will be able to explore and measure data for under water marine caves, which marine biologists are actively studying. In addition, initial work and experimentation was conducted this year to build a small underwater sensor to gather science data. This sensor requires minor development to be finalized for test deployments this summer. Some of the funds requested will be used for equipment associated with this sensor (pams) for capturing science data. Students working on acquisition of underwater science data will need to develop innovative solutions to integrate the smart tether data with previous mapping algorithms to correspond the location of the ROV in a global coordinate frame and the acquired science data, such that the correct corresponding data can be visualized for study. Students will need to create novel software algorithms to acquire, correlate and visualize the science data and geometric models representing the global setting where the data was acquired.

b) Outreach & dissemination – The outreach and dissemination aspect of our project has multiple components and includes the development and management of a web database (Omeka) to provide access to:
   a. the scientific data and products produced as described above;
   b. original cultural research on and analysis of water and society relationships in Malta and Sicily – leading to the development of sample curricula on water and society relationships for educators and a searchable database of primary and secondary sources related to water and society. (For example, in 2012, students conducted interviews with water and society experts and laypeople as part of the research expedition in Malta and Sicily.)
We are requesting $2600 for the purchase of a dedicated server and software in order to host a new website and share this data in a stable consistent way via the Omeka database. This work is innovative for a number of reasons:

1. the scope of audience for outreach and dissemination is broadened from conference presentations and paper publications to include a broad audience that can access the materials via the web;
2. the integration of technical and cultural research provides a model what undergraduate education can look like at a 21st century polytechnic university that prizes “learn by doing” opportunities; and
3. the production of sample curricula and modules means that interdisciplinary research completed by Cal Poly undergraduates can directly enter the classrooms of middle schools, high schools, and colleges in order to facilitate increased exploration of water and society relationships.

In addition, the research conducted via the ICEX program has a range of potential broader impacts. According to Blouet (2007), these ancient water storage systems were of such importance that, during medieval times, residents were required by law to maintain access to three years of water supply. Today, Malta’s fresh water supplies are largely maintained through desalination by reverse osmosis -- up to 80% according to the Food and Agricultural Organization of the United Nations (2006). However, the “National Climate Change Adaptation Strategy” (2010) has called for the mainstreaming of grey-water systems and the enforcement of existing requirements regarding water catchment, namely that new buildings must have “a water cistern proportionate in volume to the roof area” (p. 54). By systematically surveying cisterns, investigators are better able to understand the development of Malta’s ancient water storage systems and subsequently inform current water management strategy and policy. The robotics and visualization technology developed will also be relevant to applications in oceanography, biology, homeland security, and defense.

As indicated above, we plan to return to Malta and Sicily for the 2013 ICEX program and the requested funds will help enhance our ability to acquire underwater science data and disseminate both science and cultural data from the trip. Both of these projects require innovative solutions to integrate the acquisition, processing and dissemination of both science and cultural data from the ICEX program.

2) Identification of a faculty advisor along with their contact information.

This project is co-advised by Dr. Zoë Wood in computer science and Dr. Jane Lehr from the departments of Ethnic Studies and Women’s & Gender Studies. Along with Dr. Chris Clark at
Harvey Mudd University, Dr. Wood and Dr. Lehr are advisors for the ICEX program and work together with students and one another on the ICEX program and research projects. Dr. Zoë Wood can be reached at zwood@calpoly.edu and Dr. Jane Lehr can be reached at jlehr@calpoly.edu.

3) Identification of a project team with student participation from multiple departments along with the skill sets required to complete the project.

There are currently several College of Engineering students working on ICEX related projects who potentially will continue that work into next year. Specifically, student ICEX team members in 2011-2012 are: Jeff Forrester (Junior, Computer Science), Sara Lillard (Sophomore, Aerospace Engineering), Bill McVicker (M.S. Student, Computer Science), Erik Nelson (Junior, Materials Engineering), Tim Peters (Senior, Computer Engineering), Tyler Vitti (Senior, Computer Engineering), and Brent Williams (Junior, Computer Science).

Recruitment for the 5-10 person student team for the 2012-13 International Computer Engineering eXperience (ICEX) program will begin in Sept 2012. Each year, as we select a student team, we seek to integrate students from multiple engineering disciplines with varying levels of expertise associated with the different components of the ICEX project (visualization, robotics, cultural learning) – creating the opportunity for all students to function as leaders and learners in a multidisciplinary setting. As in the past, special recruitment efforts in 2012-13 will focus on the Society of Women Engineers, the Society of Professional Hispanic Engineers, and the Society Black Engineers and Scientists. Participants typically include undergraduate and graduate students in computer engineering, computer science, and mechatronics, as well as students from other engineering disciplines such as Materials Engineering, Biomedical Engineering, and Aerospace Engineering.

For the 2012-13 academic year, we are also committed to expanding participation to include students from the College of Liberal Arts in addition to the College of Engineering in order to strengthen and expand opportunities for cultural and technical learning and leadership amongst project team members. Additional special recruitment efforts will occur, for example, in the Liberal Arts in Engineering Studies major, amongst CLA students with technical minors (for example, art majors with computer science minors), and within the department of Ethnic Studies, as these majors and minors have significant expertise in cultural analysis that can be directly applied in preparation for the international research opportunity.

Amongst the 2012-13 project team, we also plan to invite 1-2 students from previous ICEX teams to participate again in order to establishing leadership and mentoring relationships and allow these re-selected students to expand their research breadth and capabilities. For example, from the 2011-12 ICEX team, potential mentors include Jeffery Forrester (CSC) and Erik Nelson (Mate),
4) Identification of any potential industrial or non-profit partners.

This work is conducted with a casual industrial partner, VideoRay. In addition, to support provided for ROV repairs and support, VideoRay is particularly interested in the shared development of science data sensors and resulting visualizations. We are actively working with them on the development of the VideoRay Protocol Adapter Multiplexer (PAM) sensor for use in underwater data acquisition. In addition, this work is conducted with a partner archeologist from Malta who works for the Aurora Trust and marine biologists from the University of Malta.

Finally, these efforts are closely related to CENG and Lockheed Martin’s effort to support the development of an increased emphasis on preparing students to be global engineers. ICEX is one of the potential models for this effort as it showcases collaborations between the College of Engineering and the College of Liberal Arts.

5) Identify resources required to complete the project including facilities, equipment and lab space. Include a description of how your findings will be disseminated. Will any publications, presentation or participation in local or national competitions result from this project? Will the findings lead to the development of patentable intellectual property or other commercial opportunities?

The ICEX program has existing necessary resources to support these project goals (including an underwater VideoRay ROV). We are seeking support for equipment that will support new research initiatives, specifically underwater data localization via a smart tether and a web server to disseminate science and cultural data.

The ICEX program has successfully disseminated past findings via publication in peer reviewed papers. For example:


And two recent submissions are under review from the work from the 2011-2012 ICEX program. In addition, the global engineering educational aspects of the program will be presented at the PSW American Society for Engineering Education Annual Conference:

and was presented here:
Lehr, J.L. (moderator) (2010, Nov 12). Difficult Dialogues: Developing a reader in the
Intersection of Indigenous Feminism, Engineering and Feminist STS. National Women’s Studies
Association Annual Conference, Denver, CO.

We foresee that the work conducted in the 2013 ICEX project will result in further publications,
for example, one related to the underwater science data acquisition and visualization and one
focused on the development of an educational database for science and cultural data.

6) Provide a time-line for completion of the project along with major milestones.

Students and faculty from the 2012-12 ICEX team are currently working on software and
methodology related to many of the research goals for the 2012-13 ICEX Malta cistern and marine
cave project. This development and testing will continue in spring and summer, with current
faculty and students deploying and testing the smart tether and science data sensor in summer 2012
if resources are available. However, in general, in September 2012, we will begin recruiting for
the ICEX 2013 team and by late October will have officially selected the members of the 2012-
2013 team. From this team, key members will be identified to take on the specific duties relevant
for the underwater data visualization and water and society project. These students will be trained
casually in Fall 2012 and officially in ICEX related courses in January and February 2013 and then
the team will leave for Malta/Sicily in March 2013, where these projects will be actively pursued.
Upon the team’s return, we will process data and write-up results and publish data and educational
resources via the Omeka website through June 2013.

7) Include a budget and identify how the funds will be utilized to achieve the project objectives.

We are requesting $2400 to rent a smart-tether to work with our current Video Ray ROV for the
purpose of localization while gathering underwater science data ($400/week for 5 weeks, 4 weeks
abroad and 1 week in the summer for testing) and for minor equipment costs associated with
developing an underwater sensor for acquiring salinity and temperature ($400 total).

We are requesting $2600 to purchase a web server and associated software to share and
disseminate science and cultural data for the water and society project.