Honors Research Project Proposal Form

Submission: An electronic copy of this form must be *emailed to honors@calpoly.edu* with a copy to salpteki@calpoly.edu by **5:00 PM** on **Monday, November 6, 2006.**

Project Title:	Hybrid Rocket Motor Development
Contact Info:	Name: William R. Murray Phone Number: 6-2414 Email Address: wrmurray@calpoly.edu
Department:	Mechanical Engineering
College:	Engineering
Description of the project:	In a recent project funded by the California Central Coast Research Partnership (C3RP), the hybrid rocket motor facility in the Mechanical Engineering Department was upgraded to state-of-the-art research standards. Unlike typical liquid rocket engines or solid rocket motors, hybrid rocket motors use a solid fuel and a liquid or gaseous oxidizer. The propellant combination chosen for this hybrid is identical to that used by Burt Rutan in SpaceShipOne: hydroxy-terminated polybutadiene (HTPB) as the fuel and liquid nitrous oxide (N_2O) as the oxidizer. Not only are these compounds inherently safe and inexpensive, they are relatively non-polluting: the combustion products are water vapor, carbon dioxide, hydrogen, nitrogen, and some carbon monoxide. For this hot flow environment, the rocket nozzles (aerospike nozzles and advanced bell-shaped nozzles) are being fabricated from solid carbon, carbon fiber, and/or ablative phenolics. With this new hybrid rocket motor facility now in place, we would like an Honors Program undergraduate to work with the MS student who is continuing to refine and optimize the design of our hybrid rocket motor. In conjunction with our MS student, and under the direct supervision of Profs. Thomas W. Carpenter and William R. Murray, the Honors Program student would design solid fuel geometries to optimize combustion performance in the rocket motor. This optimization process will require iterative cycles of design and testing. Geometric design of the fuel will involve computer-aided drafting and solid modeling. Testing will involve conducting static (ground-based) hot firings of the rocket motor and subsequent data analysis to determine fuel burn rate, oxidizer flow rate, fuel to oxidizer ratio, and resultant thrust. Not only will this testing lead to publishable results in the short term, this testing will play an important role in achieving the overall long-term goal of this project: to provide inexpensive access to low earth orbit with an environmentally acceptable, or relatively "green", rocket motor. Inexpensive access to low earth orbit would open the door for a new scientific revolution because many worthy experiments never reach space

	due to the currently prohibitive cost of launching satellites.
Description of the interdisciplinary nature of the project:	The science of rocket propulsion is inherently multidisciplinary. The core technologies of rocket propulsion are the thermochemistry of combustion, gas dynamics and compressible flow, design with temperature resistant materials, and real-time instrumentation for measuring temperature, mass flow, pressure, and force. In addition, our advanced rocket nozzles require computer controlled mechanisms that function in the hot-flow environment of the rocket motor. All of these technologies are used on a daily basis in our research on developing advanced rocket nozzles with thrust vectoring and throttling capabilities. At present, six MS students, three undergraduate students working on three separate senior projects, and three professors are actively involved in this overall project, which includes cold-flow nozzle studies, combustion chamber design, and hot-flow nozzle studies.
Number of Honors students needed, and their majors:	One (1) Honors Program student is currently needed, preferably a Mechanical Engineering student. If this proves successful, we may request more students in the future.
	Is there a url for the proposed project? No, not at this time.