



Mechanical and Aeronautical Engineering Department
University of California Davis
Davis, California 95616-5294
mae.ucdavis.edu/SpaceED

2002-2003 Monthly Seminar Series on Space Research

3rd Thursday 4:00-5:00 pm

Miniature Launch Vehicles for Mars Sample Return

Dr. John C. Whitehead

Lawrence Livermore National Laboratory

Date: 16 January 2003_Thursday Time: 4:10-5:00 pm Location: 1065 Engineering II
Refreshments will be provided at 4:00 p.m.

ABSTRACT

Returning rocks and soil from Mars to earth has been a planetary science goal for decades, but the rocket engineering challenge remains unsolved. Ascending to Mars orbit requires a 4 km/s velocity change in 5 minutes. Existing launch vehicle stages can accomplish this, but a Mars ascent vehicle (MAV) must weigh only hundreds of kilograms to be affordably sent there at costs typically approaching \$1M/kg. Propellant fractions and thrust/weight ratios which determine rocket maneuvering capability are not necessarily limited by scaling down, so it should be possible to build an appropriate MAV. However, available small-scale rocket technology is tailored to the relatively modest maneuvering needs of conventional satellites and spacecraft. Liquid launch vehicles use low-pressure tanks and high-pressure engines to maximize both propellant capacity and thrust relative to hardware mass. Unfortunately, their turbine-driven centrifugal pumps are not readily scaled down. Solid propellant rockets offer an alternative, but they have their own unique issues. For example, small ones burn quickly with higher acceleration than necessary, which requires high flight control forces and more precise pointing.

The suggested solution is to miniaturize liquid launch vehicle technology using reciprocating displacement pumps. The speaker and industrial collaborators have developed and tested appropriate fluid systems and components. Miniature piston pumps can deliver their own mass in propellant each second at 1000 psi if powered directly by high-pressure gas without rotating machinery. This is expected to enable a 100 kg MAV which is over 80 percent propellant, and delivers thrust exceeding twice its launch weight on Mars.

ABOUT THE SPEAKER

John Whitehead earned his PhD at UC Davis in 1987 following undergraduate degrees from Caltech. His graduate work in Mechanical Engineering focused on road vehicle steering dynamics. Since 1988, he has been doing rocket propulsion development at the Lawrence Livermore National Laboratory. He has authored numerous technical papers and has 9 patents.

***For more information about SpaceED program or the seminars please contact
Professor Nesrin Sarigul-Klijn at (530)-752-0682 or nsarigulklijn@ucdavis.edu***

Members of the campus community and visitors from the region are welcome to attend the seminar series. Sign-in is required at the event. SpaceED seminar will replace MAE297 seminar on 3rd Thursdays.

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