ENAE 484 - Spring 2004
Project Statement

Space Systems Laboratory

University of Maryland

MORPHLAB:

MOdular Roving Planetary Habitat, Laboratory, And Base

After Scott and Admundsen raced to be first to the South Pole, forty years passed until another human traveled to the interior of the Antarctic continent. Only after technology advanced did permanent scientific habitation of the South Pole become practical.

On January 14, 2004, thirty-three years after the last human walked on the moon, the President of the United States laid down the challenge of a permanent return to human lunar exploration in the next decade, laying the groundwork for an eventual human mission to Mars. Like the South Pole, the moon is envisioned to become a scientific outpost for the advancement of knowledge.

Unlike the South Pole, however, which is a distinct and specific location, the moon encompasses almost 38 million square kilometers of land area, which has been visited to date at six small sites, all on the near face and close to the equator. While a permanent lunar base offers the opportunity to develop extensive infrastructure, a traditional approach would require the selection of a single location for development. On a purely geometric basis, the likelihood of any given lunar feature being investigated would drop as the inverse square of distance from the chosen base location.

This year's University of Maryland ENAE 484 space design project will investigate the concept of the MORPHLAB: a Modular Reconfigurable Planetary Habitat, Laboratory, and Base. A set of

modular base components will be independently landed in a localized area, and will have the robotic capability to maneuver and self-assemble into a complete habitat and laboratory complex. This will be the base for an extended human exploration mission, lasting several lunar day-night cycles. With the completion of the first human phase, the MORPHLAB modules will disassemble and proceed overland as a group to a designated location for the next human mission. During the transit, the modules will have the capability to perform scientific data collection throughout the trip. At the new site, they will again self-assemble into a waiting base for human exploration.

This approach, building on and extending the HABOT concepts of John Mankins and Neville Marzwell at NASA (PDF; 4.1 Mb, 11 pgs), seems to offer a number of advantages for the next phase of human lunar exploration. Each extended mission will go to a new target location, rather than revisiting an already explored site. The modular approach will allow the evolutionary development of greater base capabilities, spreading the costs out over the life of the program rather than "front-end loading" all the base development costs at the beginning. If one module is lost during the transit time, the system should be designed to accommodate that loss, allowing the next exploration mission to proceed on schedule while replacement components are fabricated and launched.

This year's class will perform the detailed design and operations analysis for the MORPHLAB concept. This will include the definition of the ideal modules, concepts for robotic assembly and maintenance, surface mobility systems, and all transfer and landing vehicles beyond low earth orbit. The design process will also include detailed cost modeling, and the overall science design for a multi-year program of human and robotic MORPHLAB operating intervals. It is expected that this effort will include not only analysis and computer design, but also the construction of mockups for visualization and human factors testing.