C - 7.7

Mars Tumbleweed: a New Way to Explore Mars

H.C. Hanrahan [(1)], *D.A. Minton, F.R. DeJarnette*[(2)], *I.A. Camelier*[(3)], *M.H. Fleming*[(2)]

(1) Fred J. Carnage Middle School, Raleigh, NC, USA
(2) NC State University, Raleigh, NC, USA
(3) Universidade da Beira Interior, Portugal

email: hhanrahan@wcpss.net

The planet Mars is currently the focus of a great deal of attention and enthusiasm. Much of what is known about the surface environment of Mars comes from the three successful landers that have visited the Red Planet, Viking I and Viking II in 1976, and Mars Pathfinder in 1997. Orbiting spacecraft provide good global coverage, but are limited to remote sensing. Rovers provide direct in-situ data collection, but currently cannot safely travel in many scientifically interesting but hazardous locales, and they have very limited ranges on the order of a few kilometers. One solution is to carry payloads aloft on balloons and periodically land to collect direct surface measurements. Deployment, power, and guidance problems are difficult to overcome with either Mars balloons or a Mars Airplane.

A novel solution to the problem of global, in-situ data collection, is to design a robot with the capabilities of a rover, but without much of its complexity, and with the range on the order of that of a balloon, but without the associated severe buoyancy and materials limitations. This type of robot would collect atmospheric and geological data at multiple locations on Mars, be powered by the wind, able to travel long distances over very rough terrain, and require very little power to operate. The concept is known as the Mars Tumbleweed. Large surface areas of Mars could be covered using multiple Mars Tumbleweed vehicles.

The results of the North Carolina State University, NCSU, Mars Tumbleweed two- semester design project are presented. In order to cover larger areas of Mars, the design should have a high drag and low mass. The project was broken down into four major phases: Preliminary Design, Downselect, Primary Design, and Manufacturing. During Primary Design, four Mars Tumbleweed designs were considered and analyzed. Those four Tumbleweed vehicle concepts were developed at the NASA Langley Research Center's Spacecraft and Sensors Branch. During the Downselect Phase, one concept, known as Box-kite, consisting of a sphere and three mutually orthogonal disks, was chosen based on a number of Figures of Merit, including drag, mass, and number of parts needed for manufacture. During the Primary Design Phase, the Box-kite concept was developed into a demonstration Mars Tumbleweed vehicle called TED, the Tumbleweed Earth Demonstrator. The vehicle will demonstrate the capability of the Mars Tumbleweed concept to deploy from the air, operate on the surface, and collect and transmit science data. During the Manufacturing phase, the TED vehicle was built. Its major structural components were fabricated out of a lightweight carbon fiber/Kevlar® composite material. An instrument core was designed in the UnigraphicsTM CAD software, and built using stereolithography techniques by Fineline Prototyping, Inc. The TED instrumentation includes a GPS receiver, accelerometers, pressure transducers, temperature sensors, and a camera, and transmits data to a remote ground station. Vehicle dynamics were determined using empirical testing techniques, including wind tunnel testing and rolling tests.

At the time of the development of the project, 6th grade students from Fred J. Carnage Middle School, Raleigh, NC, collaborated with NASA and NCSU to create prototypes for possible development for unmanned space launches to Mars. Students ran several trials during this semester-long project, putting their tumbleweeds through what might be normal paces in atmospheric conditions simulating the planet's surface.

Not only did students have to do in-depth research on the planet as well as principles of design, they worked collaboratively on design teams to select the best materials and shape for such a device.