

Once the bottom sampling was complete, the PAARV would increase its buoyancy by displacing liquid from the buoyancy-control chambers and would reel the tether back in. An onboard guidance, navigation, and control system coupled with acoustic range sensors would enable the vehicle to move slowly

toward shore as it ascended. Upon contact with ascending slope, the crawler tracks would be rotated to the angle of the slope and the crawler tracks would be activated. Once out of the water, the PAARV would crawl to a location of interest designated by coordinates provided by cameras on the carrier vehicle

or an aircraft overhead. The sampling process would be repeated at the location of interest.

This work was done by Charles Bergh and Wayne Zimmerman of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1) NPO-40731

System Would Acquire Core and Powder Samples of Rocks

A sampling system would be built around an ultrasonic/sonic drill corer.

NASA's Jet Propulsion Laboratory, Pasadena, California

A system for automated sampling of rocks, ice, and similar hard materials at and immediately below the surface of the ground is undergoing development. The system, denoted a sample preparation, acquisition, handling, and delivery (SPAHD) device, would be mounted on a robotic exploratory vehicle that would traverse the terrain of interest on the Earth or on a remote planet. The SPAHD device would probe the ground to obtain data for optimization of sampling, prepare the surface, acquire samples in the form(s) of cores and/or powdered cuttings, and deliver the samples to a selected location for analysis and/or storage.

The SPAHD device would be built around an ultrasonic/sonic drill corer (USDC) — an apparatus that was reported in “Ultrasonic/Sonic Drill/Corers With Integrated Sensors” (NPO-20856), *NASA Tech Briefs*, Vol. 25, No. 1 (January 2001), page 38. To recapitulate: A USDC includes a hollow drill bit or corer, in which combinations of ultrasonic and sonic vibrations are excited by an electronically driven piezoelectric actuator. The corer can be instrumented with a variety of sensors (and/or the drill bit or corer can be used as an acoustic-impedance sensor) for both probing the drilled material and acquiring feedback for control of the excitation. The USDC advances into the material of interest by means of a hammering action and a resulting chiseling action at the tip of the corer. The hammering and chiseling actions are so effective that unlike in conventional twist drilling, a negligible amount of axial force is needed to make the USDC advance into the material. Also unlike a conventional twist drill, the USDC operates without need for torsional restraint, lubricant, or a sharp bit.

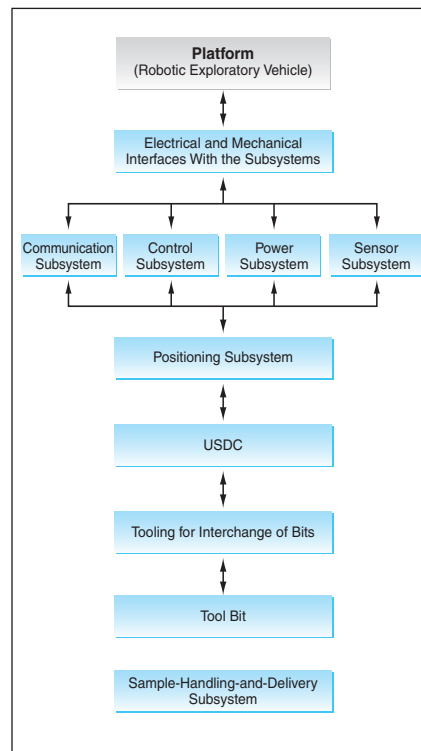


Figure 1. A SPAHD Device would be a highly integrated system containing specially designed mechanisms and electronic circuits working together to perform multiple functions, including probing, preparation of surfaces, acquisition of core and powder samples, and manipulation and delivery of the samples. The relative positions in this block diagram indicate approximate mechanical and electrical relationships among subsystems and components.

In addition to a USDC, the SPAHD device (see Figure 1) would include sensor, control, and communication subsystems; a subsystem for positioning the USDC at the desired position and orientation on the ground; a set of interchangeable USDC bits; a tool rack to store the bits; and mechanisms for manipulating and delivering samples. The

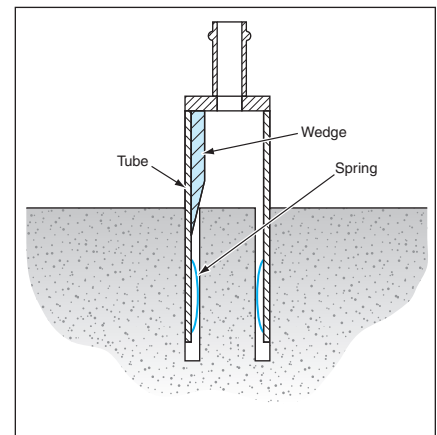


Figure 2. An Extraction Bit is one example of special-purpose bits that would be included in a SPAHD device. This bit would be inserted around a recently cut core. The wedge in the bit would introduce a transverse force that would cause the core to break off somewhere near its root. The springs in the bit would then retain the core so that the core could be lifted out of the hole.

bits would be attached to, and detached from, a resonator horn of the piezoelectric actuator by means of simple-to-operate snap-on/snap-off mechanisms. The set of bits would include a probing bit, bits for cutting cores and collecting powdered cuttings, bits for extracting the cores after they have been cut (see Figure 2), and an ultrasonic rock abrasion tool (URAT) bit [described in “Ultrasonically Actuated Tools for Abrading Rock Surfaces” (NPO-30403), *NASA Tech Briefs*, Vol. 30, No. 7 (July, 2006), page 58.

This work was done by Yoseph Bar-Cohen, James Randolph, Xiaqi Bao, Stewart Sherit, Chuck Ritz, and Greg Cook of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30640