able the wearer to act intuitively in controlling the exoskeleton. The software in the microprocessor would (1) take account of all sensor signals to infer the motion of, and the forces and torques exerted by and on, the wearer and (2) generate commands to assist or resist the wearer's motion as needed. The sensor and control design would be characterized by redundancy and robustness.

This work was done by Yoseph Bar-Cohen, Constantinos Mavrodis, Juan Melli-Huber, and Avi (Alan) Fisch of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1). NPO-30558*

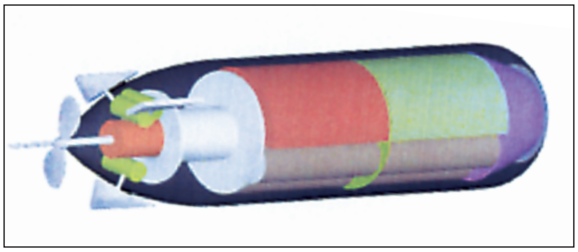
Miniature Robotic Submarine for Exploring Harsh Environments

Extreme miniaturization would enable exploration of previously inaccessible regions.

NASA's Jet Propulsion Laboratory, Pasadena, California

The miniature autonomous submersible explorer (MASE) has been proposed as a means of scientific exploration — especially, looking for signs of life — in harsh, relatively inaccessible underwater environments. Basically, the MASE would be a small instrumented robotic submarine (see figure) that could launch itself or could be launched from another vehicle. Examples of environments that might be explored by use of the MASE include subglacial lakes, deep-ocean hydrothermal vents, acidic or alkaline lakes, brine lenses in permafrost, and ocean regions under Antarctic ice shelves.

The instrumentation carried aboard the MASE would include one or more high-resolution video camera(s), circuitry for capturing image data from the cameras, and microelectromechanical-systems-based (MEMS-based) sensors designed to gather scientific data under the extreme conditions (e.g., high pressure, high or low temperature, acidity or alkalinity) of the aqueous environment to be explored. The instrumentation would be contained in easily interchangeable modules. The MASE would be equipped for autonomous control, real-time processing of scientific data, and high-speed, full-duplex communication with a monitoring station via a fiber-optic tether.



The **MASE** would be 20 cm long and 5 cm in diameter — small enough to be carried aboard another vehicle prior and to explore confined spaces inaccessible to larger exploratory vehicles.

The basic MASE concept allows for variations for different applications. In most applications now envisioned, the MASE would be designed as a disposable system to be used once.

This work was done by Alberto Behar, Fredrik Bruhn, and Frank Carsey of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1). NPO-40501*