Astronomy

Space station: Merger with the Russians

NASA's decade-long struggle to build a space station has taken a new international twist.

President Clinton announced on Nov. 29 his support for building a space station jointly with the Russians. Some components of the proposed station, scheduled for completion in 2001, would come from parts originally meant for MIR-2, the planned second generation of the Russian space station now in orbit. The U.S.-Russian collaboration was one of several proposals suggested by NASA earlier this year after the White House ordered the agency to come up with a less costly design (SN: 6/19/93, p.389).

The call for Russian participation has political overtones. The United States wanted to reward its former Cold War enemy for promising to back out of selling missile technology to India. Nonetheless, the White House's approval of the joint venture is "a fundamental decision in the history of space policy," says John M. Logsdon, a space policy analyst at George Washington University in Washington, D.C.

Marcia Smith, an analyst with the Congressional Research Service in Washington, D.C., sees things differently. She says the proposal "may be good for U.S. foreign policy; I'm skeptical that it's going to be good for space policy."

The first phase of the plan would give NASA access to the existing MIR space station, allowing scientists to test equipment designed for the new space station. Between 1995 and 1997, the United States would launch 10 shuttle missions to dock with MIR; U.S. astronauts would spend three to six months aboard the craft. Some shuttle missions would repair and refuel MIR, ensuring that it remains in orbit through 1997.

In mid-1997, U.S. and Russian crews would begin the second phase, assembling in space the nucleus of the new space station. In the final phase, astronauts would construct the truss that will hold the station's solar arrays and laboratory modules built by Japan and several European countries. Complete assembly will require an estimated 31 flights, 19 by NASA and 12 by the Russians. Robert Clarke, an international relations specialist at NASA headquarters, estimates the Russian involvement would save the United States between $2 billion and $4 billion and make possible the station's completion two years earlier than planned.

It's unclear how many U.S. jobs might vanish because of the use of Russian equipment. Clarke contends that the biggest impact on jobs has already occurred — when the White House directed NASA to design a cheaper space station. Smith notes that unlike the arrangement with other foreign contributors, who are providing equipment for the space station without charge, the United States would lease or purchase some components from the Russians. In addition, Smith and congressional aides express concern that the extra cost of launching U.S. shuttles into the orbit preferred by the Russians might exceed an annual $2.1 billion budget cap previously requested by the administration.

Other concerns, says Smith, include reports of physical deterioration at Russia's launch site, the Baikonur Cosmodrome in the former Soviet republic of Kazakhstan. She notes that the site must remain in good condition for at least a decade to ensure the success of a U.S.-Russian space station. Maintaining Baikonur will require continued good relations between Russia and Kazakhstan, Smith adds. She also worries that if U.S.-Russian relations sour, the White House might cut Russia out of the loop, leaving the space station in limbo.

"From my perspective, there's lots of really nifty things we could do jointly with the Russians in space, but they've chosen the one particular program that is the most troubled at NASA," says Smith. "Loading all these policy issues on the shoulders of an already troubled program is going to make it less likely to succeed."

Materials Science

Richard Lipkin reports from Boston at a meeting of the Materials Research Society

Getting a leg up on artificial bones

In the ongoing quest to create artificial materials that can be used to repair or replace bone, Samuel I. Stupp, a materials scientist at the University of Illinois at Urbana-Champaign, reports the development of new types of "organoapatites" that integrate successfully into the bone tissue of living animals.

These materials, which consist primarily of mineral networks, mesh well with existing bone, Stupp contends. Testing implants in the leg bones of adult dogs for periods of 12 to 35 weeks, he found evidence of both growth and repair of bone. What's more, he says, "bone cells can erode organoapatites and induce the regeneration of natural bone, which intermeshes with the artificial bone in excellent contact."

Electron microscopic images "reveal similar crystalline textures in both the natural and artificial sides of the interface," adds Stupp.

These new organoapatite compounds, according to Stupp, derive from hydroxyapatite, a naturally occurring crystal that gives bones and teeth their rigidity. Stupp's research aims to mimic the ways in which the body glues hydroxyapatite crystals into matrices, embedding them in organic materials. "We have taken advantage of the complex interactions between hydroxyapatite and organic substances to invent a new concept in the preparation of artificial bone materials that can be used to repair the human skeleton [damaged] as a result of accidents, disease, or congenital defects," he explains.

The new materials can be prepared in a variety of shapes and compositions, says Stupp. For instance, surgeons can preform the organoapatites as rigid implants, insert a soft paste — which then hardens — into a damaged area, or coat the metal surface of a skeletal implant to increase the body's ability to accept and integrate it.

Another advantage of these organoapatite mixtures is their ability to blend with other useful substances, such as antibiotics, anti-inflammatory and chemotherapeutic agents, or growth factors, which stimulate healing and tissue repair.

The skinny on thin-film batteries

Batteries as small as shirt buttons, as thin as plastic wrap, and capable of sitting on and powering individual computer chips may soon make a commercial debut.

John B. Bates, a chemist in the solid state division of the Oak Ridge (Tenn.) National Laboratory, reports the fabrication of a new electrolyte that may make rechargeable thin-film lithium microbatteries feasible. "The idea of a thin-film solid-state battery has been around for a decade," Bates notes, "but its development went nowhere, mainly because the electrolytes weren't stable and the protective coatings were poor. We've now solved both those problems."

The electrolyte can withstand high cell voltages, shows decent conductivity, and doesn't react with lithium, all important features, Bates says. Developing a protective coating that completely seals the battery was also essential to prevent corrosion and leakage, he adds.

Thin-film batteries could potentially power miniature sensors, micromotors, memory devices, and individual computer chips, with applications ranging from lap-top computers and cellular telephones to equipment for space exploration. Measuring as little as 1 square centimeter in area and only 6 micrometers thick, the cells have generated electric potentials ranging from 2.5 to 4.4 volts.

What makes these cells so "robust," says Bates, is their ability to recharge several thousand times, thanks to the new amorphous electrolyte, called lithium phosphorus oxynitride. An additional plus: The batteries can be fashioned in virtually any size or shape. And because they are all solid-state, the tiny powerhouses generate no hazardous gases or heat.