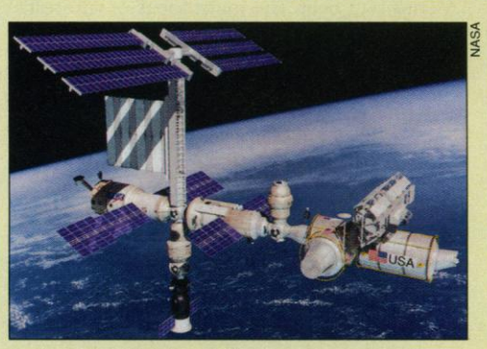
problems," says Johnstone. Launching two spacecraft also reduces the impact if one craft should fail, but money is the inevitable problem. "It would be better to have two, but it would be more expensive," says Moroz.

Despite the disappointment, Mars 94 has provided valuable lessons for both IKI and its Western partners in the art of collaboration. Wes Huntress, head of space science at NASA, says scientific exchanges between the two sides have been very beneficial, "but culturally they have a different way of doing missions, and that has sometimes been difficult." Russian work plans have softer milestones, he says. "Sometimes it is hard to understand what their schedule is." And their documentation is not as thorough as that demanded of NASA projects. "But then maybe we have too much," Huntress admits.

The experience gained in collaborating on Mars 94 has certainly helped keep IKI's main planned astrophysics mission, Spectrum-X-Gamma, on track. This project, which is due for launch in the fall of 1995, has required even closer cooperation between Russian and Western groups. Technically, the mission is going relatively smoothly. Engineering tests are now underway at IKI on models of many of its 28 instruments and its two huge telescopes. Because the West has a lead in high-technology sensors, IKI was keen to bring in foreign help with the mission. And the sheer size of the two telescopes has forced Russian and Western groups to collaborate in their construction—a departure from previous collaborations, where Western groups have simply supplied smaller packages of instrumentation to be bolted onto the spacecraft.

Space Station: A Marriage of Convenience

When the Russian and U.S. space programs tied the knot last September to work together on an international space station, it was not quite a match made in heaven, but the union does have major benefits for both sides. The U.S. National Aeronautics and Space Administration (NASA) gets a chance to learn from Russia's wealth of experience in running a space station—the current Mir station has been in orbit since 1986—and to tap into Russia's relatively inexpensive aerospace industry for cheap parts for the future station. For Russia, the union gives an international stamp to its crewed space program, a move that may help secure its future just as it is helping other space-science missions (see main text). But it is destined to be a difficult marriage.



NASA

Orbiting hybrid. Latest design incorporates Russian modules, but its future is up in the air.

The details of the deal were still being hammered out as *Science* went to press, but the outline is clear. NASA will pay $400 million over 4 years to the Russian Space Agency (RSA) to provide key hardware for the station. NASA sources say they currently expect to receive equipment known as the "Salyut tug" for guidance, navigation, and control of the station; three research modules; and an "enhanced" version of Mir's living module that will be the core of the new station.

Part of the agreement will also involve hands-on work for U.S. astronauts aboard Mir. Beginning next October, U.S. shuttles will dock nine times in 2 years with Mir so that NASA scientists can try out two new research modules—called Priroda and Spektr—that will be hooked onto Mir next year. Research aboard the two modules will give NASA officials a sense of what can be accomplished on the future station's Russian modules, says Frank Sulzman, head of research programs at NASA's Office of Life and Microgravity Sciences and Applications.

Priroda and Spektr have been in the planning stages in Russia for years. They will be uncrewed except when astronauts periodically take measurements and retrieve samples, and will be packed with 1.5 tons of scientific equipment. Priroda is Russia's answer to NASA's planned Earth Observing System satellites and will carry a battery of sensors provided by France, Germany, Britain, Russia, and the United States—including high-resolution cameras, laser radars, and spectrometers—to study environmental processes in the atmosphere and on the Earth's surface. RSA originally planned Spektr as a chemistry/physics lab to study the upper atmosphere, but the latest plan includes biomedical equipment, mostly supplied by NASA, including freezers, an echocardiograph, radiation dosimeters, and a rotating chair for studying balance in microgravity.

So far, the deal seems to have something for everyone, but many space scientists and space policy analysts still feel uneasy about Russia's shaky political climate. Particularly unnerving, say some policy analysts, is that NASA proposes to rely on an advanced version—not yet designed—of a Russian spacecraft for an occasional boost to keep the finished space station in orbit. This will mean relying on the Russians for the station's entire lifetime, says Marcia Smith, an aerospace policy analyst at the Congressional Research Service. Some members of Congress would prefer that Russia "enhance" the station rather than provide critical hardware.

Another wild card is the participation of the other partners in the space station project—the European Space Agency (ESA), Canada, and Japan—who have watched from the sidelines as their roles in the space station have been made to fit around the Russians. Earlier this year Canada, citing economic constraints, threatened to pull out; last month, however, NASA and the Canadian Space Agency agreed to reduce Canada's station costs to salvage its participation. Officials at the Japanese and European space agencies have publicly supported Russia's involvement; however, one ESA official told *Science* that Europe still has strong concerns about the station's fate if Russia were unable to deliver the goods. NASA says it's working on "contingency plans" for the station if the Russians were to pull out, maintaining to a skeptical Congress that it will still be a going concern.

The Russians may, however, have greater cause for concern about fickle U.S. politics: Support for the station in Congress this year looks weak. If Congress were to send the station the way of the Superconducting Super Collider, the Russians say they would still try to build an advanced version of Mir even if the Americans were to quit. They would probably still need foreign help, however, possibly from Germany. Such a deal would make sense because Germany and Russia have in the past collaborated on several space projects, says space policy analyst John Pike of the Federation of American Scientists.

Even though both sides say they would soldier on after a divorce, it is not clear that either partner could live without the other. A marital breakup would probably leave researchers without a permanent home in space.

–Richard Stone