many papers presented supporting the Fleischmann-Pons results and many presenting both negative results and the theoretical impossibility of cold fusion. A subsequent panel set up by the DoE advised that cold fusion merited further study, but established a go-slow policy, in part dictated by the fears of the conventional fusion researchers that their funding would be cut.

But as much as the naysayers escalated their disparaging reports that cold fusion was a mistake, reports of successful and innovative cold fusion experiments—producing excess heat, neutron bursts, and tritium—continued. As one Texas A&M scientist put it, it was in the "Third World" universities—including in the U.S.—that researchers were able to replicate Fleischmann and Pons's experiments, and they would have to work twice as hard to prove to the Ivy League establishment scientists that they were right. The situation became so sharply polarized, however, that many successful experiments were not discussed publicly, for fear that the researchers and institutions would come under attack from the press and the scientific establishment! In some cases, the particulars of the research were being kept under wraps at the advice of the patent lawyers.

With a $5 million budget allocated by the state, the National Cold Fusion Institute opened at the University of Utah in August and began a series of experiments, pulling in researchers from around the country. By late summer, both India and Japan had teams of researchers experimenting with varieties of cold fusion, and India had announced its intention to push for commercializing the technology, because the early results indicated that the process could be scaled up to produce electricity at competitive rates.

A closed Washington, D.C. meeting sponsored by the National Science Foundation and the Electric Power Research Institute Oct. 16-18 and attended by 50 scientists, including Edward Teller and Paul Chu (the discoverer of high-temperature superconductivity), put forward a more positive "consensus" statement on the state of the research. The meeting established that, while the process was not understood, the fact that *something* was happening to produce excess heat, neutrons, and tritium was indisputable.

What will the future bring?

The researchers who have successfully produced results with a Fleischmann-Pons type of apparatus are convinced that cold fusion will fulfill its promise—if they have adequate funding to continue their research. Hal Fox of the Fusion Information Center, a private corporation established to promote cold fusion development, is organizing private investment now to develop cold fusion applications in the near future. As Fox pointed out (*EIR*, Dec. 1, 1989), the Japanese have perfected this kind of rapid technology transfer, and now the United States should learn from their success.

The latest cold fusion presentations at the annual meeting of the American Society of Mechanical Engineers in San Francisco Dec. 12 were positive enough to cause any respectable naysayer to start eating his hat. A team from Oak Ridge National Laboratory reported its success and noted, "Cold fusion is a fact; there is no way to deny it."

Also impressive were the results announced by Stanford's Robert Huggins. Huggins, who founded the solid-state ionics laboratory at Stanford, specializes in the motion of species in metal lattices. He reported on results from a second round of experiments, where a closed cell is producing net power on the order of 36 megajoules over a period of two weeks. In an interview to be published in *21st Century* magazine, Huggins stated that by spring 1990, there would be enough of the experimental details published from his and other experiments in technical papers so that any laboratory should be able to set up an experiment to produce net energy from cold fusion.

New starts for space science

by Marsha Freeman

On July 20, 1989 President George Bush announced that his administration would set the United States back on the path to frontier manned exploration in space. The detailed plans to accomplish the colonization of the Moon and Mars at the beginning of the 21st century are currently being formulated. Their implementation will revitalize the U.S. technology base and restore a sorely needed spirit of adventure and optimism.

The year also saw the end of an era in space exploration and the start of a new one. After a 12-year journey, the Voyager II spacecraft made its final planetary encounter at Neptune, and the Space Shuttle deployed the Magellan and Galileo spacecraft to Venus and Jupiter. These will be the first applications of 1980s technology to the mysteries of the Earth's neighbors in the solar system, and will provide us with a greatly enhanced look at the planets.

The Soviet space program suffered one of its most embarrassing and disappointing failures this year, with the loss of *both* of its Phobos spacecraft on their way to Mars. In addition, manned flights to the Mir space station were suspended as the Soviets surprised the international space community by announcing that budget constraints would not allow the station to be manned on a continuous basis. Enthusiasm for international space cooperation with the Russians was dampened somewhat by these failures and difficulties.

Completing the mission of Apollo

In early November, the National Aeronautics and Space Administration (NASA) submitted a study to the National

Space Council headed by Vice President Dan Quayle, for the human exploration of the Moon and Mars. The reference approach outlined puts man back on the Moon in the year 2001, and on Mars in 2016.

In the 15 years between the two milestones, the technology to live, work, and experiment outside the Earth would be developed, tested, and refined. Man would learn to create and sustain a life-supporting biosphere on the Moon, grow his food, protect himself from deadly radiation, develop and use nuclear power for life support and industrial production, and establish scientific observatories.

Back on Earth and on Space Station Freedom, new propulsion technologies using nuclear fission would be under development. Though not included in the NASA plan, more advanced nuclear fusion should also be developed to take human crews to Mars in a matter of weeks, rather than months. NASA makes clear in its report that to meet the timetable in its reference approach, the schedule for completing Freedom would have to be accelerated. The Space Station would have to be fully operational by 1997, shaving two years off the current schedule. Severe budget cuts since the start of the project in 1984 have pushed the station nearly five years behind schedule, and have degraded the original design and capability of this crucial space infrastructure.

The development of a series of heavy-lift expendable launch vehicles, similar to the Soviet Energiya, is also a prerequisite for the Moon/Mars mission. The current fleet of Space Shuttle orbiters can carry only about 20 tons of cargo to Earth orbit on each mission. A first-generation heavy lift vehicle should have a 60-ton capability. Later designs would carry double that. NASA estimates that, to carry the spacecraft bound to the Moon filled with supplies and equipment to Space Station Freedom, will require a doubling of the tonnage of payload taken to orbit over what is now possible. The manned missions to Mars will double the payload delivery requirements once again.

By the turn of the century, a new fleet of reusable Space Shuttle-type passenger vehicles will have to be in the pipeline to go to the Space Station, as well as specialized spacecraft to ferry people to the Moon.

A series of robotic scientific precursor missions to both the Moon and Mars will be required before people can be sent to either place to live. In addition, the application of new 1980s technology in electronics, computer techniques, and remote sensing instrumentation to the unmanned exploration of planets where man can not easily go himself, will revolutionize our understanding of Earth's neighborhood.

This past year, Space Shuttle crews launched into Earth orbit the Magellan spacecraft to Venus, and Galileo to Jupiter, for the start of their journeys to these planets. Shrouded in clouds, Venus will be revealed anew by the advanced imaging radar system Magellan is carrying.

Galileo is the first in a series of spacecraft which will not simply fly by, but will orbit one of the giant planets, providing moving pictures rather than just snapshots of the atmopsheres, moons, and rings of these fantastic small solar systems.

The highlight of this past year's accomplishments in space was undoubtedly the unimagined beauty and complexity that Voyager revealed at Neptune. This giant planet, nearly 2 billion miles from the Sun, was thought to be a cold, bland, Uranus-type planet where little of interest would be going on. Instead, Voyager found that Neptune is a fast-changing planetary system, with the highest-speed jet stream winds in the solar system. Its Great Dark Spot and other violent storm systems are constantly changing, and the remarkable tilt of the axis of its magnetic field keeps particles swirling around its set of moons. Neptune has a series of tenuous rings, which were not fully imaged from Earth, and only a few small moons, which had not been seen before. But the largest moon, Triton, was found to be the second body in the solar system, outside the Earth, with erupting volcanoes. It appears that under the stress of cracks or fissures in its frozen nitrogen surface, liquid nitrogen geysers spew material from under its crust, kilometers above the surface. Voyager showed scientists black plumes rising from the moon's surface, trailing through an atmosphere containing methane.

Voyager, launched in 1977, provided such a bounty of detailed data on the outer planets, that it helped give birth to the new science of comparative planetology. The two sturdy Voyager spacecraft showed mankind a ring around Jupiter, its dozens of moons, and fantastic atmospheric storms; a set of seemingly infinite rings around Saturn, which twist, change, and contain structures within them; a quiet, interesting, Uranus, which lies on its side in relation to the plane of the ecliptic; and a furthest giant planet, Neptune, with dynamic systems which cannot be explained by the conventional theories of planetary atmospherics, or magnetics.

During the course of 1990, the Bush administration must make real the President's July initiative and present at least the outlines of how the Moon/Mars mission will be carried out. Although additional detailed technical studies should be done to ensure that the broadest technology base is considered, the most immediate requirement is to get started.

In 1989 the question was posed: If the nation is committed to sending people back to the Moon by 2001, the budget madness of these past nine Republican years will have to be bypassed, in order to build Space Station Freedom and new launch vehicles, and to do the prerequisite life sciences research and technology development.

To have a Moon/Mars mission, this government will have to start to put its money where its mouth is. In the closing days of this year, the additional cuts for FY90 as a result of the Gramm-Rudman law, sliced $155.2 million out of the NASA budget. Before then, $893 million had already been cut from the administration's request of $1.3 billion for fiscal year 1990.