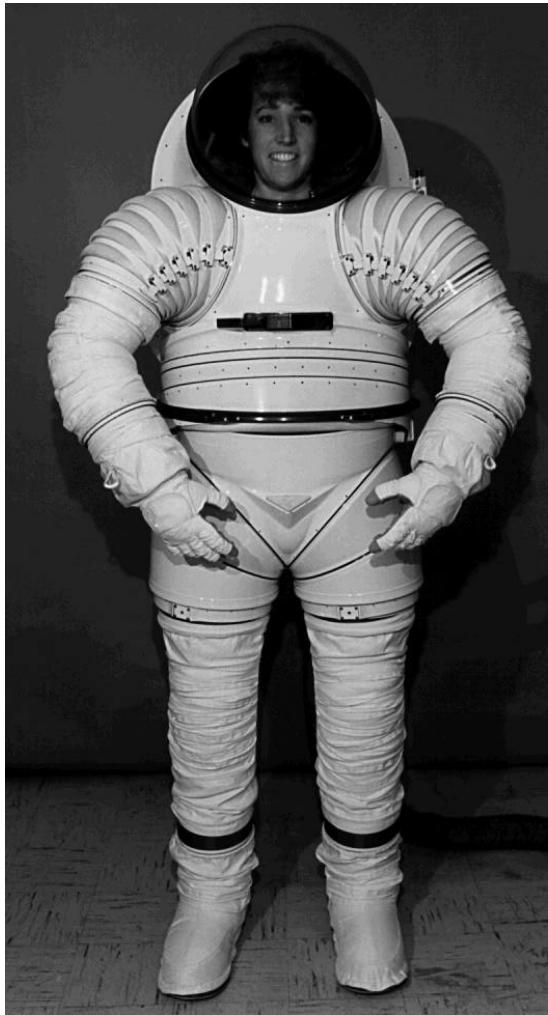


Future Space Suits

The current Extravehicular Mobility Unit (EMU) and all its associated EVA systems are the result of many years of research and development. They now comprise a powerful tool for orbital operations, but they are not end-of-the-line equipment. Many improvements are possible; the spacesuit of the future may look dramatically different from the Space Shuttle EMU.

Advanced versions of the EMU are being studied, including spacesuits that operate at higher pressures than the current EMU. The advantage of higher operating pressures is that virtually no time will be lost to prebreathing in preparation for EVA.

To build an operational high-pressure suit requires improved joint technology and integration of those joints into the suit. Under consideration are fabric and metal suits and suits with a hard external shell. Most of the technology needed for these suits has already been tested. One of the biggest challenges is to make a highly mobile glove. At higher operating pressures, fingers of older-style spacesuit gloves become so increasingly stiff that finger dexterity is severely reduced. Research to address this problem has led to the development of high-pressure gloves made with metal bands for knuckle and palm joints. These gloves show potential for use with future suits as well as with current suits, but there is still more work to be done. One line of



The Mark III Hard Suit is modeled by a spacesuit engineer.





A prototype of a next-generation spacesuit is tested.

research has explored incorporating robotic aids into the glove such as motor and cable systems to provide grasping force at higher pressures. So far, such systems have not been successful because of the extra bulk added to the hands and arms of the suit and because of the "what if" problem of a system failing while the hand is clamped onto an object. That could make it very difficult to release the object.

Another improvement in suit design will permit servicing and resizing suits in orbit. This improvement has already been tested on the STS-82 mission to service the Hubble Space Telescope. The original design of the Space Shuttle EMU required the removal or the addition of sizing inserts to lengthen or shorten legs and arms. This



Spacesuit technicians test the mobility of a proposed hybrid suit design.

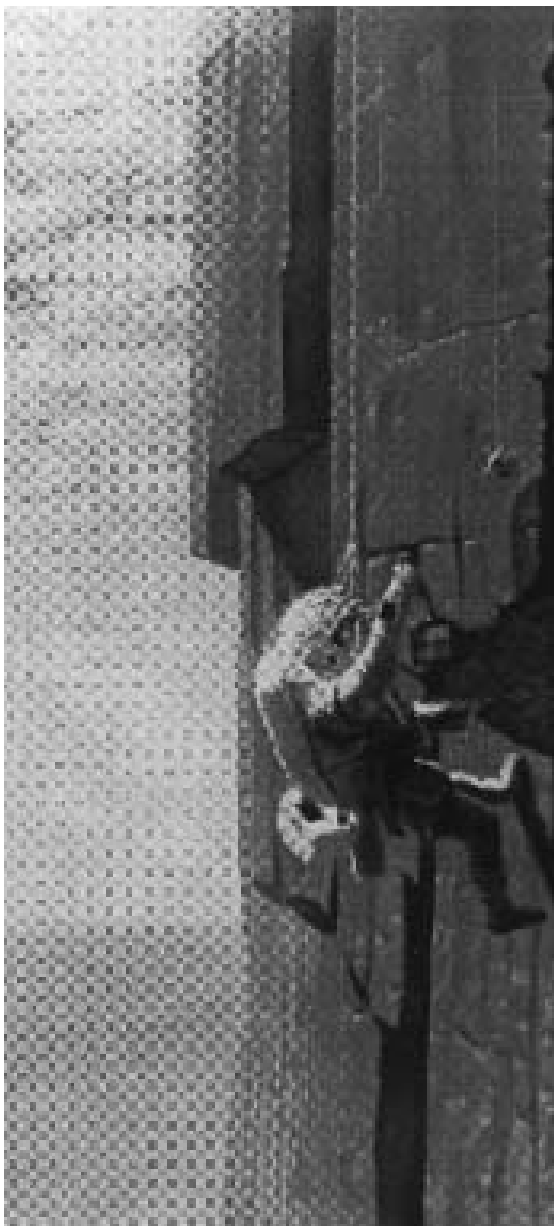
was a lengthy process because it involved lacing pieces together. Quick disconnect sizing inserts have been designed that greatly speed up and simplify the process. The new system involves threaded quick disconnects, aluminum sizing rings, and adjustable restraint lines. The capability of servicing and resizing suits in space is vital for operations on the International Space Station. There, crew members will remain in space for months at a time, and EVAs will be routine events. With this and other improvements in design, spacesuits will be able to be used 25 times on the International Space Station over a period of 180 days before they have to be returned to Earth for major reservicing.

Another suit improvement is an electronic version of the checklist worn on the arm. The new system, similar to a pocket electronic organizer, will enable the spacewalker to run through complex sequences at the touch of a button. The checklist can be easily reprogrammed for new tasks. It may also have the capability of displaying television pictures from external cameras.



Other Worlds

For the most part, the design of a spacesuit is based on the environment in which it operates. Space Shuttle spacesuits for use in Earth orbit are designed to operate in a vacuum and microgravity. A spacesuit for use on the surface of the Moon or Mars will require a different design. On the Moon,



A future Martian explorer takes rock samples dangling off the escarpment of the Olympus Mons volcano. Pat Rawlings, SAIC.

a Space Shuttle style spacesuit would weigh about 19 kilograms. The suit will operate in an environment in which there is an up and a down direction. Circulatory pumps in the suit will face increased loads. Temperature extremes on the Moon will be about the same as in orbit about Earth when in direct sunlight and in shade. However, when the astronaut walks on the Moon, heat will be conducted into or out of the suit via the feet. On Mars, a Space Shuttle style spacesuit would weigh about 43 kilograms, exhausting the astronaut who has to wear it for long periods of exploration. Consequently, lighter EMU structures will be needed to lessen the load a future Martian explorer will carry. In addition, the thin Martian atmosphere may provide too much pressure for a cooling sublimator to work. Some other cooling strategy will have to be devised. Still another concern is to provide protection from dust that is carried by Martian winds and will be kicked up by the explorers. On the Moon, lunar sediment is very angular and abrasive but there is no atmosphere to stir it up. Until samples of the Martian sediment are returned to Earth, we won't know how abrasive it will be. These and other properties of the Moon and Martian environment provide interesting and exciting challenges to spacesuit designers and builders.

EVA

Starting with Edward White II's spacewalk in 1965, American astronauts have logged many hundreds of hours of extravehicular activity in space. Mission planners correctly foresaw the role EVA would play in future space missions. The early Gemini experience was primarily experimental. During the Apollo and Skylab programs, EVA was critical to success. With the Space Shuttle and the International Space Station, it is even more critical. By donning the EMU, an astronaut becomes a small, short-term spacecraft. Space-suited crew members can manipulate payloads, make adjustments, repair broken parts, join pieces together,





Future spacewalkers will roam the surface of the Moon and Mars. This picture, painted by artist Pat Rawlings of SAIC, shows the first humans to explore the surface of Mars. The explorers, wearing spacesuits specially-designed for the Martian environment, are scouring the surface looking for clues to the planet's history and evidence for signs of life.

and handle a host of other activities. Most important, they bring with them the human ability to cope with unexpected or unusual situations that

occur in the hard and unforgiving environment of outer space.

