The Moon is so close to the Earth, that running "home" in case of emergency is still possible. Not so for Mars. When humans go there, they will have to initially take with them all of the food, water, air, other consumables, and equipment they need. They will have to be able to perform surgery and take care of any other emergencies.

No one would think of sending the first Mars crew out with technologies they are trying for the first time, so the Commission report wisely recommends that, "many of the systems needed for reaching outward to the planet Mars will be proven in the course of work in the Earth-Moon region."

Before full-scale lunar development can begin, a Lunar Spaceport will be in orbit, to "handle incoming and departing transfer vehicles. . . . The Spaceport will become a hub of activity as tons of habitation modules, cranes, scientific devices, lunar rovers, and processing and manufacturing equipment descend upon the Moon's surface."

"Return traffic from the Moon will provide lunar soil for shielding and processing," at the Spaceport itself, "thus providing oxygen, lunar metals, and possibly hydrogen," the report states. Because lifting material from the Moon only requires 5% of the energy it takes to lift the same mass from the surface of the Earth, it will eventually be much cheaper to bring materials to the Earth space stations from the Moon, rather than from the nearer Earth.

Once lunar operations are in place, work to lay the basis for the Mars mission will include the development of self-sustaining biospheres, where virtually all waste is recycled and reused, and where food is grown for "local" consumption. Robotic industrial processing techniques, and automated factories that will be needed on Mars, will be "debugged" in orbital factories, and on the Moon. Full lunar industrialization—including mining, propellant production from the Moon's abundant oxygen, the processing of metals and other raw materials, and manufacturing and fabrication—will be the "growth industries" of the next century.

A laboratory to study effects of low gravity

As human beings move out to live in space stations, on the Moon, and then on Mars, they will be faced with the prospect of living in environments that have almost no gravity, or only some fraction of the one-g we experience on Earth. Scientists are still discovering what the long-term physiological effects are of leaving the one-g of our home planet.

The report of the National Commission on Space recommends establishing an Earth-orbital facility where the gravity can be varied, anywhere from near-zero to one-g. The laboratory would be rotated to simulate gravity through centrifugal force. The major question that scientists would seek to answer using the facility, is: "What gravity level is needed to prevent the deleterious effects of less than Earth gravity?"

"If one-sixth gravity is adequate, then long-term habitation on the Moon will be practicable; if one-third gravity is adequate, then humans can inhabit the surface of Mars," the report states. "What are the effects of return from low go to Earth gravity?" This is a crucial question to be answered, and "experiments to settle these questions will have to be carried out over long periods of time," the Commission cautions.

Space shuttle crews now spend up to 10 days in the microgravity of Earth orbit, without any noticeable long-term effect. But U.S. medical authorities have reported that Soviet cosmonauts who returned to Earth in 1984, after spending 237 days in orbit, emerged from the flight with symptoms that mimicked severe cerebellar disease, or cerebellar atrophy.

The cerebellum is the part of the brain that coordinates and smoothes out muscle movement, and the cosmonauts required about 45 days of normal Earth gravity before their muscle coordination allowed them to remaster simple children's games, such as playing catch, or tossing a ring at a vertical peg.

It has been observed for years, from both the U.S. Skylab program of the early 1970s, and the near-continuous use of Soviet space stations, that long-term space habitation produces problems of cardiovascular deconditioning, the demineralization of the skeleton, the loss of muscle mass and red blood cells, and impairment of the immune system.

The variable gravity research facility would be used for basic scientific studies of these questions. Eventually, it could be used to slowly accustom future space colonists to a lower-gravity planet, by having them live in progressively lower-gravity environments.

The laboratory would also be used for other scientific disciplines, in addition to biology. These would include physics and chemistry and also the long-term testing of synthetic biospheres that will support life during the voyages to Mars, as well as on the surfaces of the Moon and Mars.

It may well be the case, that humans who leave Earth to inhabit other worlds may find it difficult, if not impossible, to return to Earth, because while it is possible to rotate space stations to simulate gravity, the low gravity of the Moon and Mars themselves cannot be altered in that way.