AVIATION WEEK'S
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In Space To Stay By 20??

BY HARRISON SCHMITT

Twenty-five years from now there should be a permanent settlement on the Moon with commercial operations producing helium-3 for a growing terrestrial fusion electrical power industry. Hydrogen, oxygen, water and food also would be produced for a second-generation, permanent International Space Station, operated largely by NASA, or a replacement agency, as a research facility for the National Institutes of Health, National Institute for Science and Technology and other world-class research entities. The ISS would be a tourist destination of major interest.

By 2029, the U.S. should be in its fifth year of Mars exploration. Activities related to Mars would rest on the relatively low-cost foundation of heavy-lift rockets, fusion propulsion, and long-term habitats and consumables available as a consequence of lunar resource development. Further, with the availability of permanent production lines for heavy-lift rockets, fusion propulsion systems and interplanetary spacecraft, the Earth should have had 10-15 years of on-call protection from asteroid and comet impactors. These capabilities also should have provided 10-15 years of advanced national security options.

In December 1972, Harrison Schmitt (below) and Gene Cernan became the last two astronauts to land on the Moon as part of the Apollo 17 mission.

To change the words "should" and "would" to "shall" and "will" requires a sustained commitment of funding as well as competent and disciplined management comparable to Apollo. If government were to lead the return to deep space, the NASA of today is probably not the agency to undertake the program. NASA lacks the critical mass of youthful energy and imagination required for work in deep space. It also has become too bureaucratic and risk-averse. Either a new agency to implement such a program, or a total restructuring of NASA would be needed. In either case, using the lessons of what has and has not worked for 45 years would be critical. Of particular importance would be:

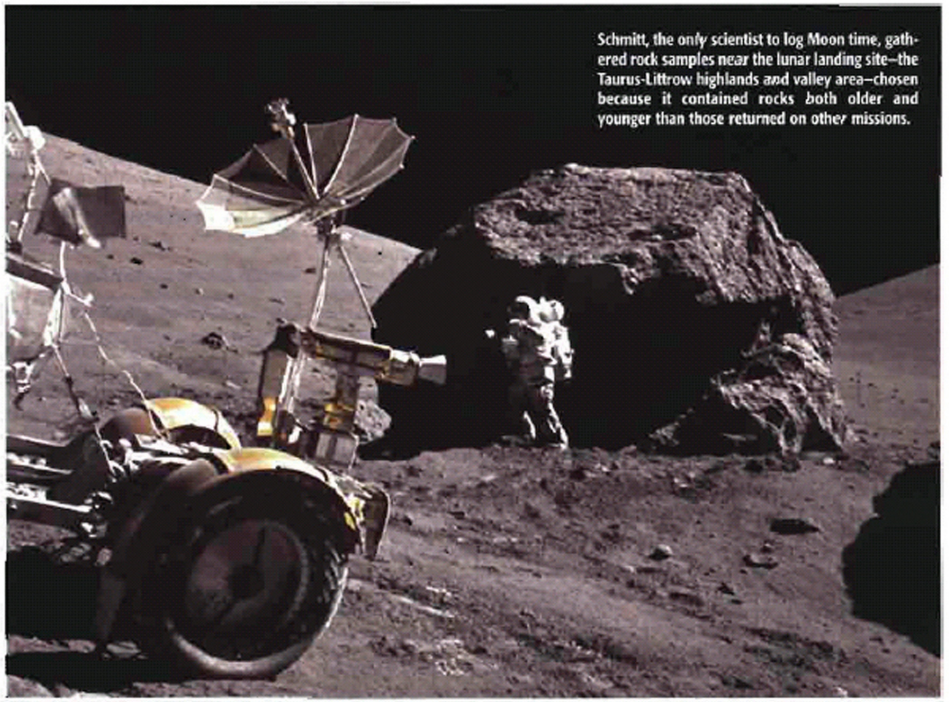
- A space agency comprising engineers and technicians in their 20s and managers in their 30s.
- Reinstituting internal design engineering activities in parallel with those of contractors.
- Streamlining and delegation of management responsibility.

The revitalized space agency also would need to undergo a major rebuilding of program, risk and financial management structures. A total overhaul is necessary to recreate the competence and discipline necessary to operate in the much higher risk and more complex deep-space environment relative to near-Earth orbit.

Again, most importantly for a revised NASA would be the guarantee of a sustained political (financial) commitment to see the job through. There can be no turning back when a deep-space operational capability exists once again or when accidents occur. Such a commitment must include adequate funding; underfinancing remains a huge problem for the space shuttle, ISS and other post-Apollo programs. At this point, sadly, we cannot count on the government for such a sustained commitment.

The U.S. has three basic options for both assuring results from and continuation of a "sustained commitment" to deep-space exploration and settlement. First, it could find a means to restructure and revitalize NASA and guarantee it continued funding sufficient to do the job. A tough order. Second, the administration and the Congress could create an agency with the same guarantee. Also, a tough order. Third, the country's entrepreneurial sector could persuade investors to make sustaining commitments. Not easy, but at least predictable. The options of rebuilding NASA or creating another agency are highly unpredictable and would depend on a set of world circumstances comparable to those facing the Congress and Presidents Eisenhower, Kennedy and Johnson in the late 1950s-60s. Arguably, those circumstances exist today, but there is clearly no consensus on this point as there was in 1961.

IN CONTRAST, IT IS at least predictable that investors will stick with a project if it is presented with a credible business plan and a competitive rate-of-return commensurate with the risk-to-invested capital. A private sector initiative, however, would have its challenges as well. Attaining a level of investor-supported, sustaining operations for a core business in fusion power and lunar resources would appear to require about 10-15 years and an estimated total of $15 billion. This is comparable to the total investment required for the Trans-Alaskan Pipeline. The time needed from start-up to delivery of the first 100 kg. of helium-3 (3He) (about one year's supply) to the first operating 1,000-megawatt fusion power plant on Earth will be a function of the rate at which capital is available, but probably no less than 10 years. (Relative to today's crude oil, a metric tonne of 3He would be worth about $4 billion in energy-equivalent terms.) As investors expect ROI over a much shorter time span than 10-15 years, such an initiative also would depend on interim marketing and profitable sales by several bridging businesses connected to a variety of applied but related fusion technologies. These businesses will provide investors early returns, increased confidence in the overall enterprise, and retained earnings for continued advancements in fusion technology.



Schmitt, the only scientist to log Moon time, gathered rock samples near the lunar landing site–the Taurus-Littrow highlands and valley area–chosen because it contained rocks both older and younger than those returned on other missions.

The development schedule for a private initiative depends to some degree on the government being actively supportive in matters involving taxes, regulations and international law, but no more so than is expected for other commercial endeavors. If the government also provided an internal environment for research and development of important technologies, investors would be encouraged as well. In this context, NASA and its precursor, the National Advisory Committee on Aeronautics, provided similar assistance and antitrust protection to aeronautics research during most of the 20th century.

On the question of international law relative to outer space, specifically the Outer Space Treaty of 1967, that pact is permissive relative to properly licensed and regulated commercial endeavors. Under the treaty, lunar resources can be extracted and owned, but national sovereignty cannot be asserted over the mining area. If the Moon Agreement of 1979, however, is ever submitted to the Senate for ratification, it should be deep-sixed. The uncertainty that this agreement would create in terms of possible international management regimes would make it impossible to raise private capital for a return to the Moon for 3He. It also would seriously hamper, if not prevent, a government initiative.

A business and investor-based approach to Moon habitation represents a clear alternative to initiatives by the U.S. government or by a coalition of other countries. Past technical activities on Earth and in deep space provide a strong base for initiating this enterprise. Also, over the last decade, there has been historic progress in the use of 3He fuels. This has occurred through development of inertial electrostatic confinement (IEC) fusion at the University of Wisconsin-Madison. Progress there includes production of approximately 1 milliwatt of steady-state power from the fusion of 3He and deuterium. Steady progress in IEC research as well as basic physics argues strongly that the IEC approach to fusion power has commercial viability. IEC fusion can have inherently lower capital costs, higher energy conversion efficiency, a range of power from a few megawatts upward, and potentially no associated radioactivity or radioactive waste. Although not yet certain of success, a business-investor approach, supported by the potential of lunar 3He fusion power and derivative technologies and resources, offers the greatest likelihood of a predictable, sustained commitment to a return to deep space.

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The financial threshold for a private sector initiative is low: about $15 million. This investment would initiate the first IEC fusion-based bridging business, i.e., production of positron-emitting isotopes for point-of-use support of medical diagnostics using positron-emission tomography (PET). In contrast to this low initial business threshold, the funding threshold for the government would be significantly higher: probably an average annual addition to the space and energy budgets of about $3 billion. This estimate assumes an agency capable of using the money efficiently. The government, of course, would not benefit directly from retained earnings of the IEC fusion-based bridging businesses that are a natural consequence of the private sector approach.

Whenever and however it occurs, one thing is certain: a return to the Moon to stay will be historically comparable to the movement of our species out of the Serengeti Plains of Africa about 150,000 years ago. Further, if led by an entity representing the U.S., this bold return will be politically comparable to the first permanent European settlement in America. ❁

Harrison Schmitt has been a geologist, pilot, astronaut, administrator, businessman, writer and U.S. Senator (R-N.M.). Selected for the scientist-astronaut program in 1965, Schmitt organized the lunar science training for the Apollo astronauts, represented the crews during development of hardware and procedures for lunar surface exploration, and oversaw final preparation of the Apollo 11 Lunar Module Descent Stage. He was designated mission scientist in support of the Apollo 11 mission. After training as backup lunar module pilot for Apollo 15, Schmitt was the module pilot for Apollo 17–the last Apollo mission to the Moon. On Dec. 11, 1972, he landed in the Valley of Taurus-Littrow as the only scientist and the last of 12 men to step on the Moon. Schmitt was elected to the Senate in 1976. He served one six-year term during which he chaired the Commerce subcommittee on Science, Technology and Space. He now consults, speaks and writes on policy issues of the future, the science of the Moon and planets, and the American Southwest.