be used beneficially to enhance our security and to improve the quality and tranquility of our society.

Let me first make a specific proposal prompted by the current Sentinel debate. In considering the strategic options available to us in the years ahead, it seems essential that we plan not by single systems, such as the Sentinel, one at a time, but for the strategic system as a whole. This and other considerations lead me to suggest that an *ad hoc* commission or task force be appointed to make an independent, comprehensive study in depth of our weapons technology and of the factors which bear upon the decisions the nation must make regarding ongoing strategic forces and policies.

For several months I have become increasingly convinced that such a task force is now urgently needed. The commission that I have in mind should be made up of members who would devote full time over a period of several months to the study. The task force should be independent of the Department of Defense and other government agencies. . . .

I do not propose that the findings of such a commission should necessarily carry more weight than studies conducted within the government. I have great respect for the thoroughness and rigor which the government can bring to the formulation of policy decisions. Independent studies, such as I suggest, might well serve to sharpen the government's own analyses. The task force's recommendations should be critically examined by the normal procedures of the government and considered in relation to proposals which have come from the Department of Defense. Their special value would be that they would be independent conclusions reached by a group of competent citizens who were free of organizational loyalties and who could, therefore, formulate their evaluations and recommendations without being constrained by any departmental commitments or biases. So often the roles and missions interests of the Armed Services influence defense decisions more than they should, and the task force I suggest could transcend these service interests. By virtue of its freedom from any vested interests, such a commission could also provide some reassurance to the growing number of citizens who are concerned about the "military industrial complex" and its alleged influence on our strategic policies and programs. . . . ■

Lunar Science Institute: Link between NASA and Academe

Houston, Texas. The manned space program has been viewed by many scientists as a circus run by the Barnum and Baileys of modern engineering—a technological conceit which, by its vast expense, diverts funds that might otherwise go to science. The $24-billion Project Apollo will, however, produce some scientific by-products, most notably the priceless rock samples which astronauts will bring back from the moon.

These samples clearly would call for special handling even if there were not the remote possibility of their containing dangerous extraterrestrial pathogens. Looking to the return of such samples, the National Aeronautics and Space Administration has laid elaborate plans.

First, the moon rocks will be put under quarantine (as will the astronauts themselves) and will undergo preliminary and "time-critical" analyses at the Manned Spacecraft Center's $8-million Lunar Receiving Laboratory (*Science*, 3 February 1967); then, most of the specimens will be distributed to carefully selected investigators at universities and laboratories in the United States and abroad. Now, in addition, NASA is furnishing funds for a "Lunar Science Institute" (LSI), being set up by the National Academy of Sciences under a consortium of universities. The institute will provide a base for outside scientists, encouraging them to visit the Manned Spacecraft Center (MSC) and use its laboratories, lunar photographs, and (ultimately) its rock samples. LSI is viewed as a major potential stimulus to lunar science at MSC and elsewhere.

The return of rock samples from the first manned lunar landing, now set for July, will be a great scientific event. These specimens, together with those gathered on later missions, may provide clues for understanding the origin of the moon, the earth, and the solar system itself. The National Academy of Science's Space Science Board believes the moon will reveal a decipherable historical record of a kind that cannot be found on the earth.

Active mountain building, erosion, and sedimentation have obliterated most if not all remnants of the primordial earth, with the result that little is known of the early period of the earth's history. By contrast, the geological processes that change the lunar surface are believed to work much more slowly. Analysis of the chemical and isotopic composition of lunar samples may yield major new insights. It may, for example, help settle the arguments as to the moon's origin—whether the moon was a body "captured" by the earth's gravitational field, or one formed by fission from the earth or by independent condensation from a proto-earth nebular mass.

The Lunar Receiving Laboratory (LRL) contains special facilities necessary for handling, analyzing, and storing lunar samples. For instance, there is the ultra-clean-vacuum laboratory system which will allow examination of samples without exposing them to terrestrial contamination. Other LRL facilities include biological test laboratories and various physical-chemical facilities, including a below-ground gamma ray counter which has the lowest background radiation of any radiation-counting laboratory in the world.

This exceptional complex of sophisticated equipment for the handling of specimens from another world will be operated by a staff of NASA scientists and technicians assembled by Wilmot N. Hess. Hess, a physicist formerly at Goddard Space Flight Center, came to MSC about 2 years ago to head its new directorate of science and applications. Taking part alongside the LRL staff in the work of the laboratory will be a number of non-NASA scientists, mostly from universities, serving on two groups which Hess chairs. One is a team which, working inside LRL's biological barrier, will make the preliminary examination of lunar samples. The other group will work outside the the barrier, advising NASA on LRL operations and determining, from data reported by the preliminary examination team, which samples go to which principal investigators.

(These investigators, or "P.I.'s," now number more than 135, about a fourth of them foreign scientists. According to Hess, NASA's choice of investi-

gators, who were selected following study of their proposals by the agency's peer-group review panels, appears entirely acceptable to the scientific community. Yet to be given a lunar sample is to be awarded a prestigious and coveted prize. Scientists in Europe, Hess says, have noted favorably, and with some surprise, that the Europeans among the selected P.I.'s are mostly younger scientists who are active in research, rather than the "Herr doktor, institute-director type of guy.")

All samples, except those necessarily destroyed in the course of analysis, are to be returned to the LRL for reuse by other scientists. These latter investigators, unless they have research contracts or other understandings with NASA, normally will look to the LSI to arrange for use of samples and laboratory facilities. This use must not interfere with NASA missions.

Establishing LSI as a kind of academic way station between the LRL and the universities is a significant step in keeping with a government policy of making federal laboratories—especially those which are costly and unique—more accessible to academic scientists. First set forth in a document issued in March 1968 by the Federal Council for Science and Technology, this policy was recently reiterated by President Nixon, who instructed his science adviser, Lee A. DuBridge, to monitor its execution.

The institute can be viewed also as a means by which MSC—heretofore essentially an engineering organization faced with the task of sending astronauts on a safe journey to the moon—hopes to add to its strength scientifically and, at the same time, build a sizable constituency in the academic community. This, if it can be accomplished, will be timely, for NASA soon may have to assert a stronger scientific rationale for its manned flight program. In the past, NASA officials have offered a variety of arguments for manned space flight, calling it a source of scientific return, technological progress, and international prestige and a safeguard of national security. But, with the first successful lunar landing, much of the prestige will have been attained and an already impressive technology will have been delivered.

And if a manned lunar station holds promise of serving the national defense, as some Pentagon dreamers undoubtedly think, the Air Force—long jealous of NASA's preeminent role in space flight—almost certainly will claim a right to the mission. Thus, to improve its chances of winning executive and congressional approval for a program of extensive manned lunar exploration in the post-Apollo period, NASA may have to justify that program in the name of science.

To be effective as a bridge between MSC and the academic community, LSI must have the leadership and atmosphere necessary to attract top-flight scientists to MSC for seminars, symposia, lectures, and research. Accordingly, Frederick Seitz, president of the National Academy of Sciences, last fall appointed one of science's respected elder statesmen, William W. Rubey, professor of geology and geophysics at the University of California, Los Angeles, as LSI's first director. Rubey, an Academy member, was awarded the National Medal of Science by President Johnson in 1965. He will keep his professorship and divide his time between UCLA and LSI.

A Mansion for LSI

In choosing facilities for LSI, the Academy seems to have been guided by a sense of the amenities. The institute will be housed in a two-story mansion of Italian Renaissance style, built 40 years ago by an oil millionnaire who had a taste for elegance. Situated on a site adjacent to MSC, the mansion overlooks Clear Lake, a tidal basin connected to Galveston Bay, and is surrounded by oaks handsomely draped with Spanish moss. Some years ago the mansion was acquired by Humble Oil and later given to Rice University, which had no immediate use for it. Although the mansion fell into disrepair and suffered the depredations of vandals, a $580,000 renovation project is now under way and by late summer the building will be ready for LSI's occupancy, under lease from Rice. It will have offices for about 15 visiting scientists, administrative space, two libraries (including one for lunar photographs), conference rooms, and the like. Except for a caretaker's house that is being converted into several apartments, no living accommodations will be available on the institute grounds, but there will be quarters for lease nearby.

According to Rubey, LSI hopes to receive about $1 million annually from NASA once it is in full operation, though in its first year it will need less than that. The institute expects to have eventually as many as five or six staff scientists, serving on appointments of 1 or 2 years or perhaps longer. These scientists may include some senior people as well as a number of scientists at the assistant professor level.

In addition to carrying on their own research, staff scientists will have other duties, which will include leading symposia and seminars, giving lectures, or arranging for such activities by others. Persons applying to the institute as "visiting scientists"—that is, as scientists who seek to use the research facilities of LSI and MSC for periods of from a few weeks to a year—may request travel funds and stipends.

It is Rubey's responsibility to decide who is to be certified (and supported) as a visiting scientist and allowed access to the Lunar Receiving Laboratory and its rock samples. However, a national advisory committee, made up of people such as Wilmot Hess of NASA, Melvin Calvin of Berkeley, and Eugene M. Shoemaker of the U.S. Geological Survey, will advise him.

One of the institute's principal tasks, Rubey believes, is to encourage maximum interaction between MSC scientists, LSI's visiting and staff scientists, and scientists from Rice and the University of Houston. Efforts will be made to bring all these people together through frequent social occasions as well as through seminars and the like.

It will be many months before the first lunar samples are available for the use of visiting scientists, but, meanwhile, MSC facilities such as the Mapping Sciences Laboratory, with its large collection of lunar photographs, offer opportunities for research. And although its permanent quarters are not yet ready, the institute has a temporary office at MSC headquarters, and applications from prospective visiting scientists are beginning to come in. LSI's first major activity will start in August when about ten scientists meet for a 4-week symposium on the geophysical interpretation of the moon.

The institute's success in arranging for visiting scientists to use rock samples and LRL facilities will depend on the frequency with which lunar missions are conducted. The Laboratory will experience a crush of activity for a month or so before and after each mission. Though Rubey hopes that not more than one or two missions will be conducted each year, he fears that they will be more frequent. The question of mission scheduling has been under debate within NASA itself. For, while the launching of missions in rapid succession offers technical and cost ad-

vantages, such scheduling makes it more difficult to profit from experience in picking the most scientifically interesting landing sites, designing lunar-surface experiments, and collecting rock samples.

Yet, in Rubey's view, scientists will benefit from visits to LSI, even at times when rock samples and LRL facilities are not available to them. He believes, for instance, that, from their contact at LSI with MSC scientists and others in the field of lunar science, they will write better proposals to NASA and will be more likely to qualify as principal investigators.

The National Academy of Sciences will give up its responsibilities in regard to LSI once a university consortium has been formed, and, according to Seitz, this is likely to occur before summer. An organizing committee, made up of scientists from a dozen universities (such as Rice, Northwestern, Rutgers, Penn State, Washington University, and the University of Toronto), is reported to be well along in its work.

The idea for LSI emerged from discussions between the Academy and NASA following a proposal in 1966 by NASA's administrator, James E. Webb. Webb (who resigned last fall) wanted the Academy to operate the Lunar Receiving Laboratory. At the time, MSC lacked competence of the kind needed for managing such a facility. But, as the Center later began developing such competence, NASA found that what it really needed was an institution—a Lunar Science Institute—that would provide a liaison between LRL and the academic community. While Webb's initial proposal had conflicted with the Academy's general policy of avoiding large institutional management tasks, the Academy was quite willing to set up LSI under a university consortium.

The question of whether LSI emerges as a leading center for lunar and planetary studies is inseparable from the larger question of whether President Nixon and Congress will favor an ambitious post-Apollo program of lunar exploration. From the first moon landing the return of rock samples may be small, for, in this first venture in the hostile lunar environment, the astronauts will remain outside the lunar module (LM) at most no longer than 3 hours, and much of that time will be taken up with preparation for their departure.

The collection of at least a "contingency sample" of 3 to 5 pounds of lunar material is given top priority, however. The first astronaut to set foot on the moon is to scoop up immediately a sample, seal it in a bag, and place the bag in his space suit. Later, a larger "bulk sample" will be scooped up and boxed; then, if time permits, a "documented sample" of selected rocks and of material obtained from just beneath the surface (and therefore not affected by the exhaust from the LM's descent stage) will be gathered.

In addition, pictures will be taken, and three rather simple scientific devices will be placed on the lunar surface: a solar-powered passive seismometer for the detection of tectonic activity, if any; a mirror to reflect a laser beam from the earth for more exact measurement of the distance between the earth and the moon; and an aluminum foil detector of solar-wind particles. On subsequent landings, astronauts are to emplace the Apollo Lunar Surface Experiments Package (ALSEP), containing a nuclear isotope power supply (good for 1 to 2 years' operation) and devices for investigating the moon's internal structure and energy budget and for detecting charged particles and magnetic fields. The goal is to establish an ALSEP network, with units placed at various points on the moon.

No Lack of Hardware

Following the circumlunar flight set for May and the initial lunar landing in July, NASA will have nine full sets of Apollo spacecraft and Saturn 5 rockets remaining. The agency ordered Apollo hardware in such quantity against the possibility of mission failures. Funds for four lunar landing missions (including July's) are in hand, but additional appropriations will be necessary if plans to use the rest of the Apollo equipment are to be carried out.

NASA officials announced last week that the agency is seeking about $100 million for next year to buy more ALSEP units and to extend the capabilities of Apollo hardware—for example, by giving the LM a longer "stay-time" on the moon's surface and by equipping the Command and Service Module with cameras and other remote sensors for use in lunar orbit. A full-scale program of lunar exploration could eventually require large appropriations for such things as vehicles for traversing the moon's surface and logistics support units delivered to the moon by automated landers. The ultimate step in lunar exploration would be to establish a manned station on the moon.

In their first four lunar landings, astronauts will visit, and collect samples from, sites in the moon's equatorial belt, the region deemed safest for early missions. Subsequent flights, however, will take them to sites outside this belt.

George E. Mueller, associate administrator for manned space flight, recently described NASA's strategy of lunar exploration:

> The first steps in exploring the moon will be landings which sample and observe the major classes of regions on the moon. A minimum of four landings is needed to establish these norms: the two types of lowlands or maria and the two major classes of highlands. The eastern and western maria appear distinctly different . . . the eastern maria have a barely reddish tinge, while the western maria are a bit bluish. The reddish areas are probably older. The two highland classes are debris sheets from giant impact basins and the more simple upland sites. But the exploration of these norms provides only a fraction of what we require to determine whether the moon is worth exploring. It is as if we explored North America by one-day visits to the East and West Coasts, the Gulf Coast and the Great Plains. The next step required is the sampling of each of the major classes of anomalies. . . . Accordingly, a second class of six possible landing sites has been identified, focusing on volcanic types, sinuous riverlike channelways, fracture zones and impact craters.

The long-term strategy of lunar exploration will be revised and refined in the light of experience from early missions. Clearly, LSI will have an influence on this strategy if it succeeds in bringing considerable numbers of first-rate lunar scientists as visitors to MSC. In fact, the establishment of LSI has been viewed uneasily by bodies, such as NASA's Lunar and Planetary Missions Board (LPMB), which have responsibility for advising the agency on scientific strategy.

Rubey says, however, that LSI will not try to preempt this advisory function. As he and NASA officials see the matter, the institute will conduct programs dealing with questions of mission planning and strategy, but ideas so generated will simply be passed along to the LPMB, the Space Science Board, and other appropriate groups. Yet LSI will be where the action is, and the scientists associated with it will be close to the ear of Wilmot Hess and other MSC officials who have a large say in lunar mission planning.

—LUTHER J. CARTER