Apr 26th, 2:00 PM - 5:00 PM

Paper Session II-C - Redesigning the 2nd Stage Lunar Exploration/ Settlement Team

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REDESIGNING THE 2ND STAGE LUNAR EXPLORATION/SETTLEMENT TEAM

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Background

What will it take to not only get back on track with human exploration of space, but with its settlement as well? Is this a goal which can be accomplished to any significant extent during our own lifetimes? This paper makes specific recommendations about the possibility of such an accomplishment, re-considers the conventional recommendations for an infrastructure to support lunar exploration, and argues for several changes in the program as it is generally proposed.

Even with the great new information coming in from the Clementine mission, we have scarcely begun to develop a *real* program which will actually allow us to develop a permanently inhabited facility. A whole collection of U.S. and Soviet unmanned explorers, mappers, and probes, supplemented by the Apollo program, have provided us with literal tons of information. We have an ever-growing collection of information about lunar geology (selenology), terrain, radiation exposure and other environmental issues. We have concepts and, in some cases, plans, for habitats on lunar orbit and on and within the Moon itself. In various nations around the world, there exist detailed studies of construction techniques adapted to 1/6G, factory concepts and plans, mining recommendations for the collection of Helium 3 and endless amounts of speculation about everything from the possibility of diamonds to evidence of former habitation on the moon. Despite all that, there are *no* funded programs for the return of human beings and the establishment of a permanent facility on the Moon.

Re-Thinking the Program Stages

The Apollo program, those unmanned explorers, mappers, and probes provided a great deal of preliminary information. On the assumption that everything which has come thus far is clearly preliminary, Phase I of the actual permanent human presence on/in Luna can be expected to relate closely to recommendations such as those in the Ride Report. Some changes in those recommendations, now eight years old, are made below. Phase II will begin with the presence of a permanent, albeit extremely primitive, facility on Luna, staffed by a mix of permanent "loonies" and temporary "ground hogs" -- those who return to Terra. At that time, the sense of permanence, of people no longer confined to the home planet, will be inarguable. Among other things, this paper recommends telescoping Phase I so that we can move more quickly and efficiently into Phase II. To do that requires re-considering both the history and the future of the plan for a permanent lunar facility.

In re-reading the mission information from the sixties, one cannot help but think that there were actually two lunar programs all along. The first one, developed by scientists, engineers and academicians began with the unmanned exploration of the moon and the preparatory missions of Gemini, thundered directly into Apollo's original 20-mission schedule, and was expected to segue directly into longer and longer missions on and below the surface of the moon. The second was clearly driven by a separate political agenda? Actually, there were several: the President's need for

something big and attractive enough to overcome the Bay of Pigs fiasco; then there was the drive to "beat them Russians" which pervaded the U.S. during the late 50s and beyond. When it became easy to shut down the program, the politicians terminated the scientific missions and did so. Since that time, any substantial return of human beings to space in any real quantity and for any truly long-term missions has suffered from endless ennui. How to break that grip, and get back on track -- immediately -- with or without a manned lunar program on the books?

Regaining the Inertia

If we are ever to reach Stage II, it is imperative that we stop thinking (and planning missions) in a strictly linear fashion. We *must* begin to think in terms of mission concurrency instead of continuing the pretense that a permanent human presence in space is somehow isolated from space activities which are more politically acceptable. The key is in using missions which *are* funded, whatever they may be, to accomplish the maximum number of tasks. One currently developing unmanned mission provides an excellent example: Lunar Discovery Orbiter.

Assuming, of course, that the U.S. space program and the Lunar Discovery Orbiter program itself survive the current American anti-intellectual and anti-technology blitz, the mission objective for that program is to provide "the first high-resolution global survey" regarding lunar composition, gravity and topography, and imagery". This program was developed as a part of the NASA Discovery Program, eacb concept developed by some of the best minds in the world to make available the most science "bang for the buck". That is politically and economically sound and, if the technology is well done, scientifically effective as well. But an effective return to the moon can be developed far more quickly if we can just manage to provide program planners with a sound rationale for using high-return, comparatively low-cost missions for secondary purposes. It does not hurt any that the second goal of the program is to "Pursue innovative ways of doing business".[1] So how can missions be re-arranged to do "double duty" and what can be accomplished in that almost incidental fashion which will forward the Lunar program?

We in the aerospace industry have become tightly focused, our professional survival within the extremely fragile space program so dependent on meeting *only* the mandates placed upon us that any alternative is considered intrusive at best and, at worst, program threatening. Yet we can move noticeably, significantly closer to Stage 2 activities and, in the process, shorten Stage 1, if we can only force ourselves to set aside tunnel vision during the earliest mission planning stages.

Are there 35 or 40 cubic centimeters of space here and there in the Lunar Discovery orbiter -- or can such small increments of space be *put* there by slightly altering its design? The STS may seem an odd analogy, but its GAS-can program provides the seed of an excellent idea. The GAS program was developed as a way of carrying additional small experiments in the cargo bay of the STS by supplying small containers in areas which would otherwise be wasted. In the instance of the STS, those little bits of space are filled with experiments. But it need not be experiments which are crammed into tiny corners of the Lunar mission hardware. Tools, sensors, and other long-life devices could be attached to or stored in the hardware for any mission which is going to remain in lunar orbit for an extended period and/or remain on the moon. Sufficient mass/weight to anchor them in position is negligible -- even a package of a few ounces will remain where it is

[1] "The Discovery Program Concept"; NASA WWW; downloaded January 5, 1995; most recent update logged as 20 Dec. 1994.

dropped, ready to be picked up and utilized when we finally do send people back. And if the craft is actually going to be left on the Lunar surface at the end of its mission, then so much the better "Extra" items can be stocked in every possible square inch to the maximum extent possible without jeopardizing the stability or mass of the hardware.

This concept can be significantly enhanced if mission planning can be altered in one other extremely significant fashion. If it is in any way possible, mission design should be reconsidered to explore ways in which the hardware can, at the end of its other mission activities, be programmed to "park" in a specific place. A related effort might be based on the fact that there are insufficient experiments cleared in time for any given shuttle flight to ensure that GAS cans are all filled. It may be time to reconsider the possibility of filling some of that space with payloads which can be launched from shuttle and then boosted toward lunar orbit. On a somewhat grander scale, it may now be the time to pull old studies off the shelf, dust them off, and seriously re-consider the Hitchhiker program, which was designed to permit the shuttle orbiter to carry small loads intended for deep space. While the program was once deemed unfeasible for both technical and economic reasons, technology has changed radically and the program may now be feasible.

Regardless of the method by which small supply loads are launched, the time it will take them to arrive and land remains irrelevant as long as we have no manned program anyway. The primary design constraints would be the ability of the container to survive the trip to lunar orbit, sufficient power to ensure that it can be boosted gently toward the Moon, and that it carry sufficient telemetry to direct to and through Lunar orbit.

There is one more hardware option which *must* also be considered, and that is the recent activity in single-stage-to-orbit technology. If we are serious about a permanent facility on the moon, the development of such launchers as the Delta Clipper, X-33 and/or the X-34 is imperative. None of that should be deemed a reason to delay the early stages of a lunar program, however. During the development stages of American launch capability, it appears entirely feasible to use internationally available heavy lifters to begin boosting equipment toward the Lunar surface.

Site Selection

Assuming that small payloads are actually sent to the lunar surface, where should all these items be allowed to drop? Numerous studies have recommended specific sites for the development of the first permanent Lunar facility. They have been analyzed for scientific potential, general location, and curiosity value. With so many potential sites available, and so few already explored, it may seem appropriate to commission another study. However, doing so will *not* shorten Phase I or advance the start of Phase II lunar exploration and settlement. At this point, it seems appropriate to simply say, "Just pick one site and do it!" Contrary to some mission planning traditions, when it comes to the Moon almost *any* site is legitimate. My personal preference is Mare Fecunditatis, but it doesn't really matter. If we can convince ourselves to select one site and start dropping off supplies there, then, when the day comes that we finally develop the collective will to get off our backsides and take people back there, the site with supplies already stocked up will make itself the logical base camp.

Re-Thinking WHO Should Go

Off and on through the years, our space program policy makers have toyed with the idea of

allowing someone other than "traditional" astronauts into space. Of course, the concept of "civilians in space" is a whole separate issue. In a way, it has been addressed -- to a limited extent -- by the payload specialist program. However, rapid advancement to Phase II lunar exploration and settlement require much more attention to the idea of putting people on the moon who may or may not have strong public relations value, but whose sole purpose in going is to advance the development of the facility itself. Intellectually, many of us recognize that the time will come when we need to take someone other than (or, more precisely, in addition to) the NASA standard-issue astronaut on Luna. Though the analogy is somewhat simplistic, it is useful to think again of the days when sailing vessels carried settlers to the "New World". Comfort and ease of travel were not particularly relevant -- nor did the lack of those things prevent committed people from setting out on the journey.

Intellectually, we know that we must carry technicians, construction workers, and field engineers to the Lunar surface, but when the time comes for mission planning, that phase always seems to be "out there somewhere" -- after scientists have returned and finished their exploration, gathered more samples, photographed the dark side, measured the radiation hazard, planted seismometers, and the government has announced its blessing for the presence of "civilians". Moving as quickly as possible into Phase II requires that we face, directly and without flinching, the need to expand the types of people we will take into space.

The New Crew -- Recommendations for Lunar Exploration/Settlement Teams

Dr. Ride's report recommended an outpost of eight people, slowly growing to as many as fifty through a number of years. Stafford et al recommended a startup return group of six to 12 people with 45 days of life on the surface in some sort of habitat, with the emphasis on using a lunar rover to go further and further from the facility -- still a mission of preliminary exploration rather than permanence. To further complicate these issues, there is a large body of literature which discusses the isolation of small groups and the disastrous potential of placing eight people alone in an extreme environment. Almost inevitably, such groups polarize, jeopardizing not only the mission but, quite frequently, the lives of mission participants.

With those issues, and the goal of advancing Phase II level lunar activity as quickly as possible, the following crew recommendations are made: two career astronauts on the lunar surface (none on lunar orbit); one astronaut who is also a scientist on the surface; two tech people, construction workers, or others (e.g., Corps. of Engineers) as part of the landing party.

Age spread is probably one of the most critical crew criteria. There's something utterly depressing about the idea of a Lunar base without a Pete Conrad, a Storey Musgrave, or someone equally colorful. But there is a much more important reason for including experienced people in the crew. It takes only a few interviews with people who have spent extended periods confined in small quarters with others they might not even like to discover that the reason they were able to survive was because of the attributes which their age gave them. One survivor of an extended period in the Arctic recalled a 4-man team with an age spread of 27 to 52 sharing a single tent for months on end. "Tolerance was a critical issue," he said -- and also pointed out that, as time went on, the four men "developed more or less the same lifestyle."

Skills diversity may be as important as age. In addition to the obvious skills requirements -- being able to operate the hardware, run the scientific experiments, and collect exploratory data, the

crew of a serious Phase II effort must have other abilities. For instance, it is probably not necessary to take along a physician, but having more than one person on board who is highly trained as a paramedic and/or emergency medical technician not only seems logical, but imperative. Construction skills -- the ability read a blueprint, to blast basic shelter out of the lunar hardpan and to hook together functioning habitats or facilities from whatever is available at hand more closely resemble the description of an Englishman dropped off at the Australian penal colony than the picture of the classic American astronaut. Yet these are precisely the skills that will be needed in the early stages of Lunar development. Finally, if this crew is truly intended to be the forerunners of a permanent human presence, then a mix of genders and cultures must be introduced as early as possible -- preferably starting with the first mission.

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