MANNED PLANETARY FLIGHT

WHERE ARE WE TODAY?

H. H. Koelle
Director, Future Projects Office
George C. Marshall Space Flight Center

The MARINER flyby past Venus in 1962 opened up planetary space to mankind by being the first messenger of manned flights. Many more unmanned flights will follow before man himself will undertake his first journey.

We are now in the early planning stage of manned planetary flight. No firm objective or time period has been established by the government, but a statement by the Vice-President of the United States that manned planetary flight is a firm objective of the national space flight program has been made. It is our task now to prepare attractive alternative mission profiles and objectives, and balance those with the resources expected to be available. This process of program optimization is very complex and will take considerable time. Many organizational elements of NASA, with support of industrial contractors, take part in these preliminary investigations.

We have learned to understand quite a number of the system parameters of manned planetary flight but are far from being "on top of the problem." We have, however, identified many problem areas and the most sensitive system parameters. We have to assure that the mission objectives and probability of success are balanced with the resource requirements. Unless we find a mission profile which appears to be a logical step towards the long range objective and at the same time appears to be a "bargain," it will be difficult to secure a firm decision and national commitment. We have to realize that the country is firmly committed to the APOLLO Manned Lunar Program, which will have priority and will require most of the available resources in the next few years. It will probably not be earlier than FY 1967 that resources become available to start one or two new major space programs. The manned planetary program is only one of the applicants for these resources.

The other limiting factor is the "state of the art." Even though it is possible that chemical propellant propulsion systems could make marginal and modest manned interplanetary scouting flights possible, they will definitely not be good enough for extended manned planetary flights including planetary landings. At this time, it is generally concluded that nuclear or nuclear-electric propulsion systems are mandatory for any manned flight of significance. Thus, it appears that we will have to wait for firm commitments for major manned planetary missions until the development of a nuclear propulsion system has progressed to a point that the timely availability of an operational nuclear propulsion system is virtually assured. It is too early today to predict when this will be.

This situation is complicated by the fact that Mars seems to be a logical goal for the first manned landing, and that the velocity requirements for fast missions will increase rapidly in the later-1970's. This makes such an expedition not only more costly but also technically more difficult to achieve. If we also consider the lead-time required to prepare for such a mission, we are tempted to doubt whether a manned Mars landing for 1975 is an attractive or even feasible program. If it should turn out not to be desirable, an alternative might be to attempt the same mission in the mid-1980's. At that time, however, technology should offer new propulsion systems such as nuclear-electric or even nuclear-pulse systems, which probably would permit more ambitious mission objectives for about the same expenditures. We must also not forget the fact that the manned planetary program is only one part of the national space flight program and, therefore, must be integrated with all other space transportation systems and approved or anticipated projects.

All these ramifications make it difficult to arrive at a decision for a definitive manned planetary space flight program; thus, the need for more mission analysis is clearly evident. NASA has embarked on an integrated matrix of such studies with an expenditure of several million dollars per year. It is hoped that clear alternatives for a manned planetary flight program will be developed during the next few years with one goal in mind: To enable the country to make a firm commitment for a manned planetary program at the appropriate time.

It appears appropriate at this time to attempt to summarize, in general terms, what we do know about manned planetary flight and what we do not know:

WE DO KNOW THAT:

1. Available resources will determine - more than anything else - when a major effort for the manned planetary program can begin. It is unlikely that this can be done before FY 1967.

2. Venus flyby's are the easiest and fastest manned planetary missions.

3. Mars landings are the easiest of all planetary landing missions.

4. It is mandatory that the properties of the Martian atmosphere be determined early by unmanned probes in order to be able to design Martian landing and launch vehicles with any degree of confidence.

5. Chemical propulsion systems will permit only the most modest manned planetary missions.

6. Chemical propulsion systems alone will certainly not be adequate to provide economical transportation for manned round trips to the planets.

7. Manned planetary flyby missions might fit into the manned planetary flight program. They are nice-to-have, but they are definitely not the final objective of manned planetary flight.

8. The mission velocity requirement for fast Mars round trips during the 1975-1984 period result in greater technical and economic demands.

9. Solid core nuclear propulsion systems will make fast exploration trips to Mars possible, when the expedition is limited to a few people.

10. Only high thrust (larger than 1/3 g) and high performance (larger than 1, 200 sec specific impulse) propulsion systems and/or extraterrestrial propellant production will result in the desired short travel times (round trip below one year) and acceptable economics for manned planetary transportation systems. All other propulsion systems will limit us to a few modest space exploration trips.

11. The economy of manned planetary flight is decisively influenced (for any system) by the economy of the Earth launch vehicle; this is a very good place to start early development work with the goal of a major step improvement in cost effectiveness.

12. The manned planetary flight program can be considered only as a subprogram of the total national space flight program and not as an entity in itself.

13. Other programs such as new large launch vehicles, Earth-orbital space stations, a lunar base, and possibly military space programs will compete for the same national resources at the time a decision is to be made.

14. We have to conduct a great number of detailed system studies and subsystem testing and evaluation before we can offer attractive alternatives to satisfy the manned planetary flight mission objectives. We still have much homework to do and a long way to go before a firm decision can be made with confidence.

WE DO NOT KNOW:

1. Whether artificial gravity is needed throughout most of the mission profile of a manned planetary flight.

2. Whether direct hyperbolic entry into the planetary atmosphere on a fast mission profile is an attractive and desirable solution to the braking problem, both for the target planet and for Earth.

3. The metoroid and radiation distribution in space as a function of time accurately enough to make a detailed space vehicle design without great penalties.

4. Whether graphite or fast spectrum metal reactors are the preferred choice for thermal heat exchanger nuclear propulsion systems required for fast planetary missions; however, the graphite reactor presently has a lead of several years.

5. Whether thermal heat exchanger nuclear propulsion systems or nuclear-electric low acceleration propulsion systems will be superior for manned planetary missions in the time period of interest. Also, hybrid systems of these two propulsion concepts might be competitive alternatives.

6. Whether the SATURN V launch vehicle capabilities will be sufficient to accomplish a desirable early mission profile for manned planetary flights.

7. Whether a NOVA size launch vehicle development program must be charged completely to the manned planetary flight program.

8. What, if any, role a lunar base might assume in the planetary program.

9. What detailed methods and functions have to be developed for orbital operations in support of manned planetary flight.

10. What detailed methods and requirements regarding environmental protection systems are needed.

While this list is not complete, it is indicative of what we know and what we don't know. This is where we are today! In summary then, a well-coordinated and vigorous study program is underway at present. It can be hoped that in a few years information will be available on which a reasonable decision can be based: The decision as to what constitutes the best manned interplanetary exploration program as an integrated part of our overall national space flight program.