



TRAJECTORIES, LAUNCH DATES and flight times for proposed Venus and Mars fly-bys are shown in diagrams.

## Manned Venus-Mars Fly-by in 1970 Studied

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Interplanetary "grand tour" flights in which three-man spacecraft would fly by both Venus and Mars on missions launched in 1970 or 1972 have been suggested by specialists who conducted extensive studies on the problems and requirements of manned interplanetary flight.

Possible grand tour missions were outlined by R. W. Gillespie, R. V. Ragsac and Stanley Ross of the Lockheed Missiles and Space Co. at the recent annual meeting of the Institute of Aerospace Sciences in New York.

Trip times would vary from about 460 days to about 680 days if launched during opportunities in the 1970-1972 period.

The first 1970 mission, a three-planet fly-by, would be launched Sept. 6, 1970, pass Venus the first time on Nov. 20, 1970, fly by Mars on May 9, 1971, encounter Venus the second time on Mar. 4, 1972, and return to earth July 22, 1972.

The second of the 1970 opportunities would be Dec. 25, 1970. The spacecraft would make its closest approach to Mars on Nov. 10, 1971 and fly by Venus on June 7, 1972. The spacecraft would return to earth on Aug. 21, 1972.

### Mars Fly-by

Grand tour flight, said the authors, could be made within the requirements for a single Mars fly-by. They added: "... the amount of information obtainable per trip is greatly increased, and little or no penalty is incurred in launch weight. Guidance problems associated with these journeys do not appear to be insuperable, although a major disadvantage ... stems from their restricted launch windows and long

repetition cycle. If they are not performed at the time indicated, the next opportunities for such easy missions will not present themselves for an additional 13 years."

Launch vehicle and spacecraft systems for grand tour and other Mars and Venus missions suggested by the authors would be based on "a level of technological accomplishment of the advanced Apollo period." This means use of an Advanced Saturn-type, possibly with an early nuclear upper stage. Use of the Advanced Saturn-type launch vehicle is predicated on assembly of spacecraft modules in earth orbit.

### Re-entry Techniques

Re-entry would be made "either by solid-propellant retro propulsion down to parabolic speed, or by an advanced atmospheric braking technique, which, in addition, employs a small auxiliary rocket to provide negative lift for the maintenance of proper entry corridor height. Advanced ablator designs are also under study, but it is unlikely they will result in major weight revisions, even if they do prove ... preferable to the other two re-entry concepts. Planetary escape, during the capture missions, has been calculated for a storable chemical rocket of moderate impulse ratings."

Spacecraft would consist of a 20,000-lb. mission module and a 9,000-lb. modified Apollo command module, which also would serve as a re-entry vehicle. Flight plan would include release of one or more probes during planetary contact.

All of the proposed missions would bring the spacecraft within one planetary radius in so-called "grazing passages." According to the Lockheed study, the two-planet fly-by would bring

the spacecraft close to the illuminated side of Mars only 98 days after opposition and by Venus' illuminated side only 11 days before conjunction.

The three-planet fly-by would bring human observers close to Venus for two observations, near the time of inferior conjunction, and by Mars near opposition.

Manned planetary missions will require a new kind of life support system. In the current manned flight programs—Mercury, Gemini and Apollo—life support systems depend on the spacecraft's storage capacity. In the missions proposed in the Lockheed study, a semi-closed ecology system, in which liquid but not solid metabolic wastes would be recycled, would be used.

Variable life support allotment of 22.7 lb. per day, plus a 3,500-lb. fixed weight has been adopted for the three-man crew. Radiation shielding equivalent to 50 to 55 grams per square centimeter is recommended, assuming a very low probability for solar flares intense enough to result in absorption of more than 200 rads by the blood-forming organs.

### Other Problems

The study did not examine many other important problems associated with very long space flights. These include prolonged weightlessness, confinement in a small space and psychological effects of stress and distance travel from the home planet.

National Aeronautics and Space Administration is studying manned planetary missions as possible follow-ons to Project Apollo, the manned lunar landing program in which flights are scheduled to be made around and to the moon by 1968.