



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

IN REPLY REFER TO:

M-FPO-69-64

July 23, 1963

Mr. Michael A. Minovich, Jr.
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California

Dear Mr. Minovich:

Thank you very much for the draft copy of your TR No. 32-464. We studied this interesting paper carefully, and here are two major comments:

1. If you will pardon my criticism, then let me say that I am very surprised by the lack of support you appear to be receiving in literature search. Your first paragraph on page 41 is greatly misleading. I shall name a few authors you might wish to check:

Crocco	-	I.A.C., Rome, 1956	(Earth-Planet-Planet-Earth type)
Gedeon	-	Northrop	(Earth-Planet-Earth, complete)
Ross	-	Lockheed	(Among other things, he proposed Venus encounter for a solar probe)
Lawden	-	Canterbury University	(Gravitational Maneuvering)
Ruppe	-	Handbook, McGraw- Hill	(Survey, Earth-Planet-Earth types)

Propulsion flyby's have been discussed already by Hohmann. I mentioned this class in above reference, and Gobetz (of U. A. Research Lab) developed an optimization procedure.

The out-of-ecliptic flight has been discussed frequently; most thoroughly, I think, by Breakwell of Lockheed.

Systems analysis of manned flyby's have been performed, see reference 10.10, 10.11, and 10.12 of the enclosure.

Mr. Michael A. Minovich, Jr.

July 23, 1963

The idea to utilize flyby's in connection with landing missions has been proposed originally in reference 10.1; then M. Faget of MSC rediscovered this possibility, and you propose a more elaborate version of this type - J. Smith of this office discussed the utility of manned flyby missions recently.

These references are not the result of any detailed search; I give them just as they came to mind.

2. Ad p. 111 & following:

In our EMPIRE contracts, we have studied the manned flyby's quite carefully. Your results are too optimistic for several reasons:

- a. $\frac{M_1}{M_2} = \text{Mass ratio} = \frac{\text{Mass prior to burning}}{\text{Mass after burning}}$
and not equal to $\frac{\text{initial mass}}{\text{payload mass}}$
- b. Your neglect losses (gravity, mixture ratio shift, reserves)
- c. Your neglect mid course propulsion requirements
- d. Some people feel that your entry speeds are too high for the APOLLO capsule.
- e. The derivation at the bottom of page 112 over estimates SATURN V capabilities.

As a result, in reality SATURN V is barely capable of a minimum Earth-Venus/Earth-flyby; for an Earth-Mars/Earth-flyby (of a type not listed in your report, about 650 days duration) we need (for chemical propulsion) at least four SATURN V vehicles. Your Earth-Venus/Mars-Earth trip will require about 250 tons in Earth orbit, or more than two of SATURN V vehicles, instead of one.

In spite of these critical remarks, I feel that you have performed a valuable trajectory study. Your work leads me to a better insight into the nature of multiplanet flyby's than I had before, and I think you created a valuable contribution to the astronomical literature.

Mr. Michael A. Minovich, Jr.

July 23, 1963

Again, thank you for sending the draft. I look forward to receiving a copy of the formal report, when it becomes available.

Very truly yours,

A handwritten signature in cursive script that reads "H. O. Ruppe".

H. O. Ruppe
Future Projects Office

1 Enc:
As stated