

DP(AH:ad.)
24 Aug 1959

MEMORANDUM for Dr. Silverstein

Subj: Comments on a number of relationships between Saturn and Nova vehicles

1. Mr. Ed Kortright requested the comments of this office on a number of problems relating to the Saturn and Nova vehicles. It appears to me that the two vehicles may be discussed in terms of four broad areas of relationships. These are:

- (1) Engineering Approach
- (2) Need for a vehicle of the particular performance - what is planned employment of vehicles.
- (3) Timing - is there an urgency associated with the employment of a vehicle.
- (4) Cost.

2. In discussing the first item, it is my judgment that if a first stage Saturn were designed around the million and one-half pound thrust single chamber engine it would probably have a slight performance advantage over the clustered set of engines. Off-setting this probable advantage is the reliability that the individual H-1 engines have now achieved. Also, the vehicle is being designed to be capable of performing the mission if one of the eight engines goes out. Calculations show that this concept offers a marked improvement in reliability over the no engine out case. An overall view point is that the present first stage Saturn booster is soundly conceived and based on sound engineering principles with only a small penalty in performance when compared to a single barrel engine.

3. The proposal that the present or modified design of the first stage of the Saturn be used for a second stage of the Nova vehicle is not concurred in. For this purpose the engines would have to be modified to a higher expansion ratio and altitude restart capability. The tanks will have to be modified and strengthened. The added dimensions with the expanded engines might preclude its employment in itself. It should be recalled that the F-1 engine now has an expansion ratio of 14:1 which is reasonably efficient for a second stage.

4. The contention that, by making the first stage Saturn a second stage for the Nova, some \$300 million might be saved is not concurred in. I doubt that we would save anything. If, however, the Saturn development were discontinued at this time and the Nova second stage substituted for it, then a significant savings in overall cost might result. The penalty for this procedure would be a loss of approximately three years in time of availability.

5. Another important aspect of the relationship between Saturn and Nova vehicles is their planned employment. The Administrator has indicated that in addition to scientific explorations adjacent to the earth, the principle effort should be directed toward exploration of the Moon. I believe that this effort should be divided into two principle parts; the first part should consist of a series of probes, impacts, and landings with vehicles of no greater capability than the present Vega and Centaur. These explorations by remote instrumentation would provide sufficient background for the second part which would be manned exploration. At first these would consist of orbiting the Moon and later Moon landings. It is argued that an intermediate phase of soft landings on the Moon, with remote advanced vehicles for a close-up exploration of the Moon's surface, may be eliminated if funds or other factors do not permit a simultaneous prosecution of all three phases of Moon exploration. If the intermediate phase is eliminated and the prime objective becomes manned exploration of the Moon then it is further argued that rendezvous techniques be employed in its attainment. Therefore, a Saturn vehicle with high energy (H_2O_2) upper stages becomes adequate to carry out manned explorations of the Moon.

6. The Nova vehicle should be carried on at a lower priority than the Saturn vehicle. It is believed that the Nova vehicle will, in time, have a considerable number of uses. The large engine itself might be used to replace four of the present eight engines thereby providing a vehicle of intermediate thrust between the Saturn and the Nova. A complete Nova vehicle may, in time, be required for placing very large loads into orbit above the earth. Finally, it might be thought of as a back-up for manned Moon exploration if the rendezvous techniques proves undesirable.

7. In summary, it is believed that:

(1) The Saturn project should be supported at a rate of development to permit the first launching of the three stage vehicle to occur in late CY 62 or early CY 63.

(2) The Saturn vehicle should not be used as a second stage for the Nova.

(3) If the rate of planned exploration of the Moon is decreased so that an additional three or more years is allowed to accomplish this purpose, then the present Saturn could be eliminated and a single engine version be substituted for the first stage.
(Not Recommended)

(4) The present plans for the Nova vehicle should remain in effect but a decision on when to undertake additional hardware development should be delayed for one year.

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