A DISCUSSION OF SPACE PROGRAM COSTS

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The subject I have been asked to speak on today is the "real" costs of the national space program. Ordinarily when a person says he is going to talk about the real costs of something, there is an implication that an expose is in the offing, that the real costs are different in some important way from the advertised costs. But it will hardly come as a revelation to anyone here that space program costs have been much higher in most cases than originally estimated. The Mercury program, for example, cost $384 million, almost twice the original estimate. Current development on the various Saturn engines and stages is costing more than anticipated. Several space programs exceeded original estimates to such an extent that they have had to be dispatched by the budgeteer's axe.

Thus I cannot presume to talk about real costs except in retrospect. In looking toward the future, any projection of space program costs is inherently unreliable. New scientific discoveries, unexpected technological roadblocks, changes in the domestic and world political situation--all these things force program revisions from year to year and sometimes from month to month. We can predict with some certainty the direction

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in which costs will change--it always seems to be upwards--but the extent varies. Increases of 100 per cent are not uncommon. Increases of 200 per cent are not unknown. Recently, it was called to my attention that present estimates of the cost of a new rocket engine are up by a factor of four over what they were a few years ago. You will understand why it is with something less than total confidence that I present any estimates of space program costs, and whether these costs are real or not is a question only time can answer.

The national space program today is comprised of the efforts of five government agencies: NASA, DOD, AEC, Weather Bureau, and NSF. In the current year NASA's share of the space budget amounts to about 75 per cent, DOD has about 23 per cent and the other three agencies divide what little remains. I propose to discuss only the NASA portion today because (1) it is the most important in terms of dollars, (2) it is much better defined than the military space program, and (3) security classification might inhibit discussion of military space projects in an open meeting of this kind.

By far the most important space program today by almost any conceivable criterion is the manned lunar landing and return, and by no means its least interesting aspect is its cost. Few programs have borne as many price tags as this one. Originally listed at $7 billion by President Kennedy, it went shortly thereafter to $20 billion, then $35 billion, and a number of skeptics thought, and still think, in terms of $40 or $50 billion. It has also been advertised in the public press as a $2 billion dollar program. As of last August, however, when Mr. Webb was testifying before the House Appropriation Committee, the official number was still $20 billion. It turns out under examination that when these first three numbers--seven, twenty and thirty-five billion--are placed in their intended contexts they are mutually consistent.

Originally, NASA had a 10-year plan roughly estimated at $28 billion which provided for booster development, the space sciences and applications programs, and some manned spaceflight but did not include a manned lunar landing. President Kennedy's figure of $7 billion was incremental to that $28 billion, and was described as the amount required to accelerate the program sufficiently to achieve manned exploration of the moon before the end of the present decade. This made the total cost $35 billion, of which some $20 billion could be considered in direct support of the lunar landing.

The source of the $40 billion figure is apparent to anyone who has been involved with advanced weapon system development--it is simply $20 billion multiplied by two to allow for the unforeseen contingencies that historically seem always to have occurred. The $2 billion estimate covers only those costs associated with the lunar landing itself (the lunar excursion module and associated hardware); manned space flight and development using large boosters and maneuverable space craft would be undertaken at an estimated cost of $18 billion even if the moon itself were not there. It seems clear that the problem of determining the cost of the moon program is closely associated with the problem of defining it. As the mix of activities included under the headings "manned spaceflight," "Apollo," and "manned lunar landing" changes, the cost must change as well. This problem of classification, partially due to realignments of the NASA budget structure, has been intensified by statements by public figures and by a tendency to classify as much of the space program as possible under the budget currently felt to be most popular with Congress.

I am sure that my definition of the lunar landing project would be no more acceptable or appropriate than some of the others, and rather than attempt a sterile exercise in taxonomy it seems preferable to avoid the problem altogether--since the decisions are basically political, not economic--by looking simply at NASA budget categories, the funds allocated to each, and the goods and services being procured. Figure 1 shows a 10-year projection of NASA funds based on rigorous adherence to a $35 billion total. I want to make it clear from the outset that these projections are not the result of a detailed analysis. Starting with the bottom area--Administration--we have simply assumed that administrative operations, for which $640 million is requested in FY 65, will remain at about its present level throughout this period.

Similarly, it is assumed that Applications, Space Sciences, and Advanced Research and Technology will maintain their 1964-65 levels. These categories include, to mention only a few of the many projects underway, meteorological and communication satellites, orbiting astronomical observatories, unmanned lunar and planetary exploration and nuclear rockets. Projects of this type are perhaps less dramatic than manned space flight but are just as important, and it seems reasonable to expect funding to continue about as at present.

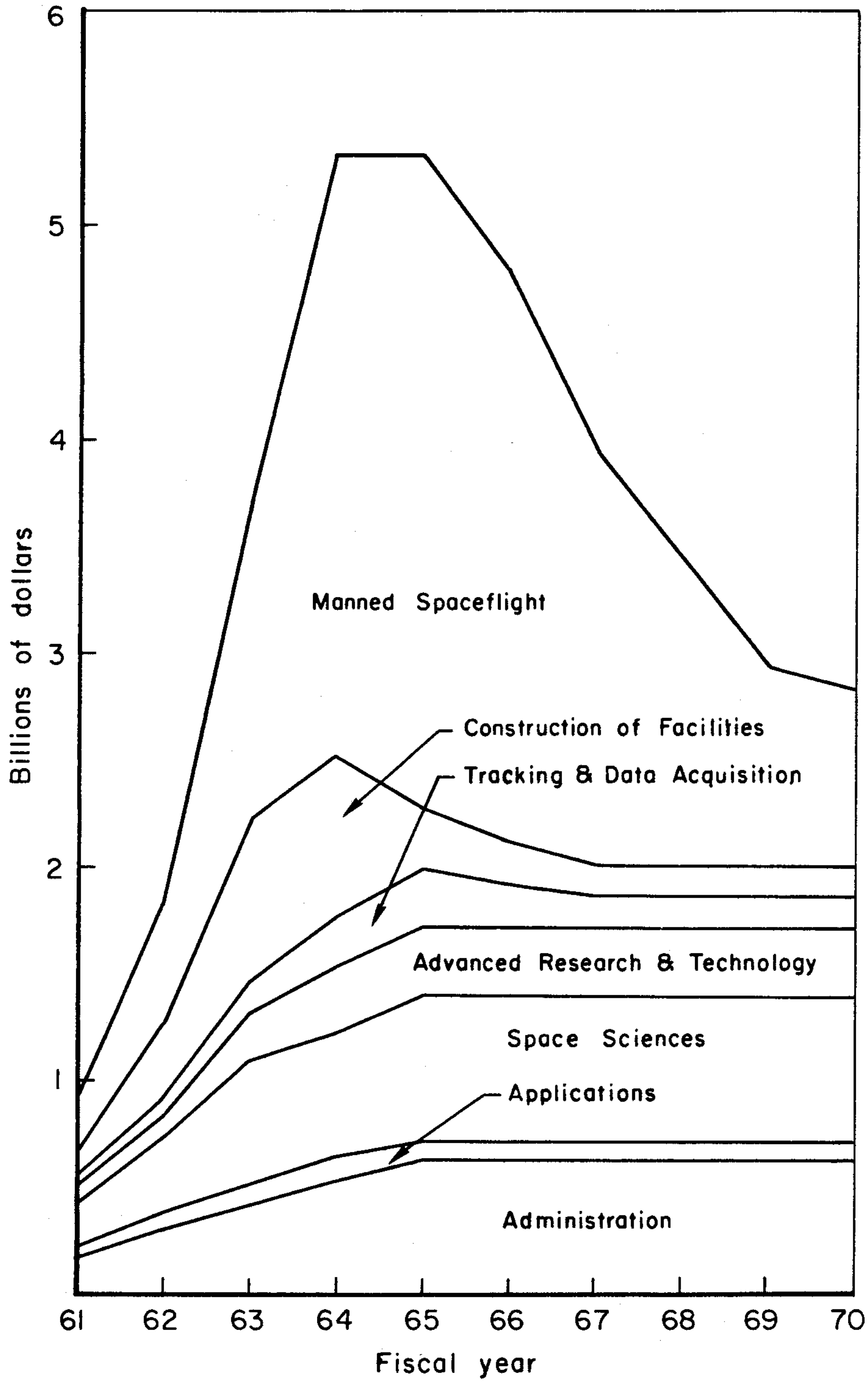

Fig. 1 — Projection of NASA funding

Tracking and Data Acquisition increased sharply in 1964 and will continue to be high for about two more years as the operational ground instrumentation, communications, and data processing equipment is procured for the NASA worldwide network of tracking and data acquisition stations. Network operating costs amount to about $100 million per year, and with supporting research and some replacement of equipment each year an annual sustaining cost of at least $150 million can be anticipated. That is the level shown on Fig. 1. Construction of Facilities is at its peak in FY 64--about $674 million, almost half of which is for Merritt Island launch operation facilities. The other two major items included are test and production facilities for the Saturn boosters and tracking and data handling installations. The amount is expected to decrease to below $300 million in FY 65, and then level out at some lower number.

The highest line on Fig. 1 represents an arbitrary time-phasing of that portion of the original $35 billion remaining after all other allocations have been made. This amounts to almost $16 billion of which half can be accounted for fairly accurately since it falls in the fiscal years FY 61-65. This means, assuming our other allocations are not grossly in error, that about $8 billion remains, and an examination of funding patterns for other development programs suggests that funding half the money during the first half of the development period is close to the norm.

This top area--Manned Spaceflight--represents the costs of developing and procuring the engines and stages for the Saturn I, Saturn IB, and Saturn V launch vehicles to be used in the various phases of the lunar program. It also includes development of the Apollo command, service, and lunar excursion modules; development of the necessary guidance, navigation, instrumentation and scientific equipment; supporting development such as a backup propulsion system for the service module; and the Gemini program with its capsules and Titan II boosters. It is obvious that there is a great deal more here than just what is required to stake out a claim in the Mare Tranquillitatis. We are buying the capability of orbiting a quarter of a million pounds and of performing any variety of space explorations. Whatever we may choose to do in space, the current manned spaceflight program is providing a basic capability for many years to come.

At the risk of straying across the borderline into the area of what might be construed as payoffs rather than costs, I would like to suggest several important missions made possible by the Saturn V booster that the nation might wish to undertake. The first is an operational space station. It is true that small 4- to 6-man stations could be launched by boosters in the Saturn IB and Titan III-C class and would be of great value, but they should be considered as first-generation stations. For extensive operations heavier and better manned stations will be necessary. The Saturn V, which could place a research laboratory with 20 men into orbit, would probably be able to handle most space-station requirements. Experiments and investigations could be carried out in geophysics, meteorology, cosmic ray and particle physics, and astronomy, to mention only a few. In the area of astronomy there are many questions we can answer once we have large telescopes--perhaps as large as 200 inches--above the distorting layers of our own atmosphere. A whole new era will begin for celestial observations, and an essential feature of all such activities aboard a space station is the ability of man to observe the progress of each experiment, record the information, make decisions, and adjust or modify procedures or equipment accordingly.

A permanent manned lunar base could well be a follow-on to the Apollo program. The support of such a base would require delivery of large stores of supplies to the moon and relatively frequent transportation of personnel between the earth and the moon. The Saturn V can land about 25,000 lb of payload on the moon, which could be either a capsule of nine men or a shipload of equipment. Since each man would consume on the order of 20,000 lb of supplies each year, a larger payload would be desirable, and development of a nuclear third stage for the Saturn V would increase the soft-landed payload to about 40,000 lb.

As indicated by the table below, the Saturn V, augmented with chemically-fueled upper stages, would enable extensive unmanned space investigations even beyond the neighboring planets of Mars and Venus. Even manned exploration of Mars would be possible using this basic booster and nuclear or electrical propulsion for earth escape. With a capability for unmanned probes to Saturn and Uramus, and in fact throughout our entire solar system, there is a good chance we might never feel a need to look further.

Mission	Payload (lb)	Transit time (days)
Mars orbiter	30,000	270
Jupiter flyby	22,000	600
Jupiter orbiter	6,000	600
Saturn flyby	5,000	600
Saturn orbiter	2,000	700
Uranus flyby	3,000	1100

There are people, of course, who feel neither a compulsion nor a desire to look that far; they see space exploration only as a diversion of resources from more pressing terrestrial problems and a further spread of the common cold. It cannot be assumed, however, that the Apollo exploit will be the climax of our national space program and, returning to the subject of costs, it would be surprising if the funding projection shown earlier and repeated in Fig. 2 depicts the future with any accuracy. In projecting Air Force programs over the years we have discovered that funding requirements always appear to tail off in the future because people cannot predict what new programs will be started. But new programs are always started and the tail-off if it occurs is usually slight. A view common in the aerospace industry is that since NASA's budget now amounts to about one per cent of the Gross National Product it should continue to do so, and as GNP grows by 5 per cent per year or thereabouts, the money available for space activities should similarly increase. Under this assumption the space budget would amount to around $7 billion by 1970, as shown by Fig. 2, and the total for the decade would be over $50 billion.

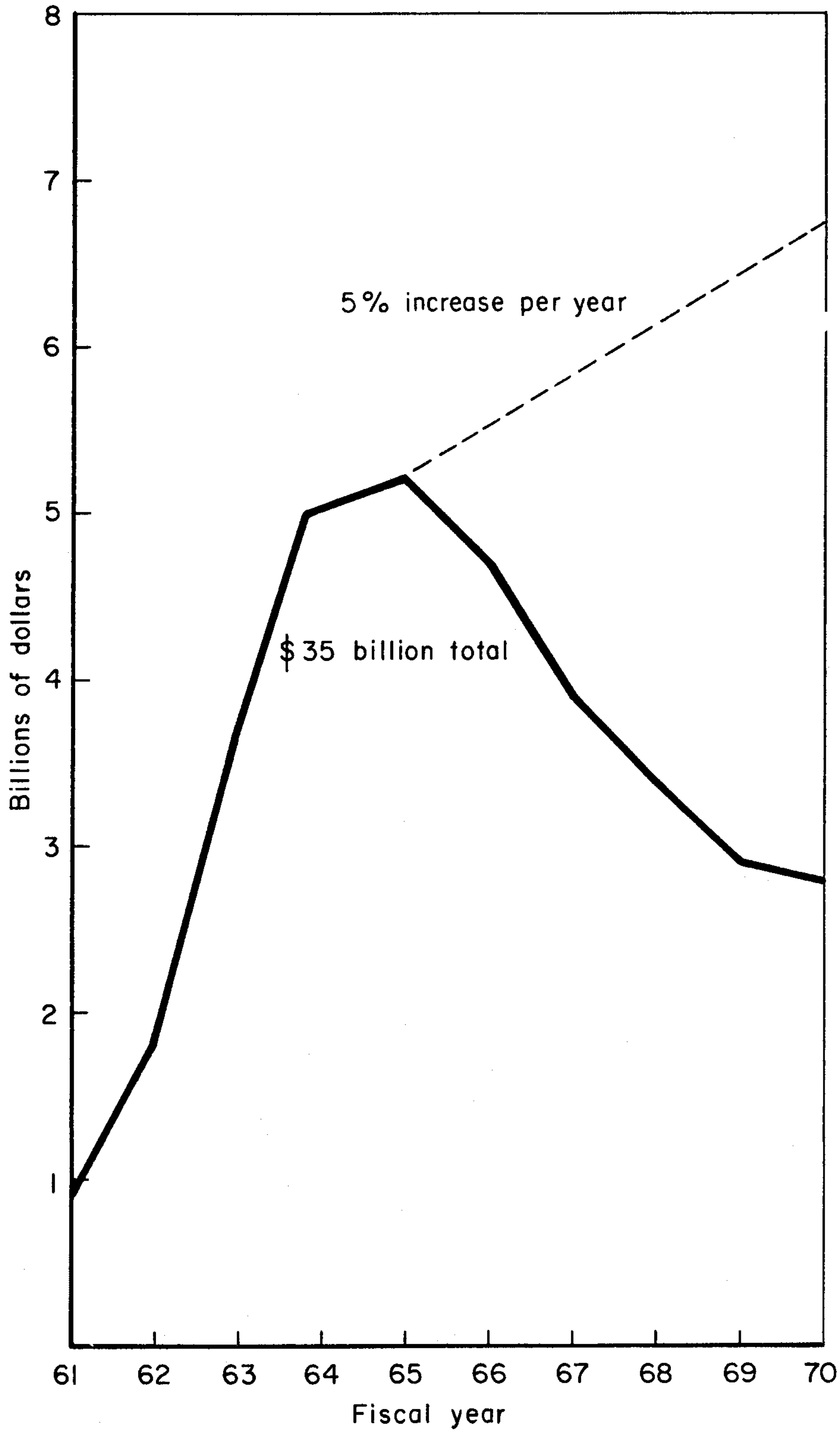

Fig. 2 — Two projections of NASA funding

As any Congressman can tell you, $50 billion is not the same as $35 billion, and I think it unlikely that the higher number will be realized. We could probably look at these two lines on Fig. 2 as upper and lower limits to NASA budget totals, and a bolder person might produce a line in between as the most likely level. Unfortunately, although I agree that, as in most such situations, the truth probably lies somewhere between the extremes, it is impossible to determine just where. Because of the investment in the moon program, however, and the heritage of capital assets it will leave the nation, it appears possible to continue an ambitious space program in the future without dramatically exceeding present budget levels.