UNIVERSITY OF MINNESOTA

AN ANALYSIS OF THE IMPACT OF THE FEDERAL BUDGETARY CYCLE UPON THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MANNED SPACECRAFT CENTER RESEARCH AND DEVELOPMENT BUDGET FORMULATION PROCESS

BY

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The subsequent views expressed in this paper are those of the author and in no way should be construed as representing the position of the National Aeronautics and Space Administration or any of its officials and employees. This dynamic agency provided the necessary data for the author's research and value judgements or decisions reached thereafter were formulated independently by the writer.

CONTENTS

TABLES

FIGURES

PART I

AN INTRODUCTION AND BACKGROUND TO THE PHENOMENA UNDER STUDY

CHAPTER 1

An Introduction

The subsequent dissertation represents an analysis of the impact of the Federal Budgetary Cycle upon the National Aeronautics and Space Administration (NASA) Manned Spacecraft Center (MSC) Research and Development (R&D) budget formulation process. The author's objectives may therefore be seen as the following: (1) to analyze the Federal Budgetary Cycle; (2) to analyze MSC R&D estimates and growth trends in relation to their implications on the Federal Cycle; (3) to identify relevant problems; and, (4) to recommend solutions which display promise and feasibility.

Any research involving the Federal Budgetary Cycle can well be characterized as of almost infinite scope and enormous complexity. For such reasons one must meticulously delineate all operational parameters and thereafore maintain their integrity. To do otherwise is to invite intellectual dilution and hazard a paltry effort.

Quite naturally then, the reader must understand various relationships which generate implications regarding the basic substance and scope of this study, before full appreciation for the dynamics of such an esoteric system can be realized. To facilitate such discernment the ensuing must be discussed as they ultimately relate to MSC: first, NASA's organizational evolution, structure, and corresponding program responsibilities; second, the gender of the appropriation under investigation compared with other NASA functional appropriations; and, third, the explicit phases of the Federal Budgetary Cycle coming under scrutiny. The remainder of this introductory chapter will be devoted to a treatment of these three areas in an admittedly cursory fashion. The author's objective is to provide the reader with the familiarity necessary to comprehend the parameters defining the scope of this treatise. Yet, overall coverage is not intended in any manner.

A Beginning

Ironically, the United States has frequently initiated steps toward establishing eminence in a given endeavor only after her stature in the field has been admonished through world vicissitudes. With the outbreak of World War I, the principal participating European nations by necessity advanced their aeronautical expertise to a level of undeniable superiority over that of America in a relatively short period.

Due recognition of this fact lead to the establishment of the National Advisory Committee for Aeronautics (NACA) on March 3, 1915. NACA was charged with the supervision and direction of scientific studies concerned with the practical solution of the problems of flight.[1]

Over the year's NACA's activities covered the spectrum of aeronautics research and in its latter years of space research too. NACA's membership base of individuals who served without compensation was drawn from "the military and air services, the Weather Bureau, the Smithsonian Institution, and the scientific community."[2]

Basically, the work of NACA centered around task orientated research and the establishment of policy in the realm of aeronautical and space research.

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[1]NASA Historical Staff, Historical Sketch of NASA, (Washington, D.C., 1965), p. 10.

[2]*Ibid.*, p. 10.

Its contribution to America domination in the aircraft industry and our national defense cannot be underestimated.[3]

The primary theme being advanced here is that NACA represented an organization which over its 43 year history was continually undergoing a positive evolutionary process and thereby developed considerable maturity. By 1958 NACA was truly a dynamic, capable cadre of advisors, administrators, scientists, and engineers who had achieved proficiency not only in their specific functional areas, but also in effecting a rational integration of their individual efforts and relationships at the national level.

National Aeronautics and Space Act of 1958 and NASA Organization

The advent of Sputnik I brought a dramatic review and alteration of American policy relating to aeronautics and space. The impressive Russian feat was without question the primary stimulus in generating the National Aeronautics and Space Act of 1958. The language of this act called for the creation of the National Aeronautics and Space Administration whose paramount objectives were to be:

(1) Developing aeronautical and space vehicles;
(2) Studying the space environment by scientific instruments of many types;
(3) Beginning the exploration of space and the solar system by man himself;
(4) Applying space science and technology to the development of earth satellites for peaceful purposes to promote human welfare; and,
(5) Applying space science and technology in support of military purposes of national defense and welfare.[4]

On October 1, 1958, the date NASA became officially operational, approximately 8000 NACA personnel and their research facilities were transferred to

[3] Ibid., p. 10.

[4] "NASA's Basic Management Structure and Concepts," Headquarters Management Seminar, Unit 1, (Washington, D.C., September 1965), p. 4.

NASA. However, the provisions set forth in the Space Act obviously demanded a substantially increased role of government in aeronautical and space programs. The magnitude and rate of NASA's total program growth may emphatically be shown from inspection of tables 1.1, 1.2, and 1.3. Special note should be made of the "rates of growth" between civilian personnel and appropriations (table 1.3) over the years. This reveals one of the basic concepts of the NASA program – namely, its mounting dependence on American private industry to contract for and produce space program hardware (over 90 percent of NASA's annual budget is now accounted for in this way).

Table 1.1

PERSONNEL GROWTH

	1959	1960	1961	1962	1963	1964	1965	Est. 1966
Scientists and Engineers	3,194	3,515	5,767	8,161	10,978	12,427	13,304	17,050*
Administrative (Professional)	550	700	943	1,834	2,811	3,421	3,783	3,410*
Technicians, Clerical and Wage Board	5,491	6,017	10,763	13,691	16,145	16,651	16,657	13,640*
Total Civilian	9,235	10,232	17,471	23,686	29,934	32,499	33,744	34,100
Military	58	64	89	139	210	250	252	250*
GRAND TOTAL	9,293	10,296	17,560	23,825	30,144	32,749	33,994	34,350

*Assumes same ratio among civilian and same number of military as in 1965 merely to arrive at an order of magnitude estimate in table 1.1.

Table 1.2

INCREASES IN APPROPRIATIONS, OBLIGATIONS AND DISBURSEMENTS**

Fiscal Year
(Millions of dollars)

	1959	1960	1961	1962	1963	1964	1965	Est. 1966
Appropriations	$331	$524	$964	$1,825	$3,674	$5,100	$5,250*	$5,175
Obligations	299	494	923	1,692	3,448	4,865	5,500	5,100
Disbursements	145	401	744	1,257	2,552	4,171	5,100	5,600

*Includes supplemental appropriation of $72.5 applied to fiscal year 1964 authorization.

**Explicit meaning of these terms explained later in this chapter.

Table 1.3

RATES OF GROWTH

IN PERSONNEL AND APPROPRIATIONS
(FY 1959 = 100)

	1960	1961	1962	1963	1964	1965	Est. 1966
Civilian Personnel	111	189	256	324	352	365	369
Appropriations	158	291	551	1,110	1,541	1,586	1,568

Yet, one must be cognizant of more than simply the gross impact this act had on NASA's growth in terms of personnel and monies. Generally speaking the Space Act established the overall NASA program framework while expressing essential authorities and responsibilities the agency holds. Fortunately, it did leave the arena of exact program content, formulation, and execution up to the discretion of NASA management.[5]

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[5] "The Planning and Approval Process," Headquarters Management Seminar, Unit 2, (Washington, D.C., December 1965), p. 4.

Obviously, in any organization which has experienced the tremendous growth rate characteristic of NASA since 1958, frequent organizational changes are not unusual, but rather, often essential if the organizations rapidly expanding programs are to be managed well. While such a phenomenon has occurred within NASA, the author will discuss only the existing organizational structure germane to the topic under study.

Figure 1.1 depicts NASA's total organizational structure. The rationale behind this method of organization is inherently related to the basic concepts NASA management advocates for efficiently achieving its primary objectives. More specifically, NASA is structured so that the following management concepts can be practiced: (1) maximum decentralization; (2) free flow of information; (3) minimum approval and review; and, (4) maximum local option in selecting administrative procedures and methods.[6]

As shown in figure 1.1, NASA's ultimate managers are the Administrator, the Deputy Administrator, and the Associate Deputy Administrator, respectively. The Administrator may be epitomized as a source of policy formulation at the agency and national levels. Moreover, he devotes his attention to external relationships of critical importance to NASA such as those with the President, Budget Bureau, Congress, and the public. The Deputy Administrator carries out identical functions, particularly so in the Administrator's absence, and extends special attention to agency policy as affected by its technical and scientific interests. Neither of these individuals will typically be concerned with NASA's daily operations, as this responsibility is under the Associate Deputy Administrator's bailiwick. He may be looked upon as the

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[6]"NASA's Basic Management Structure and Concepts," op. cit., pp. 35-36.

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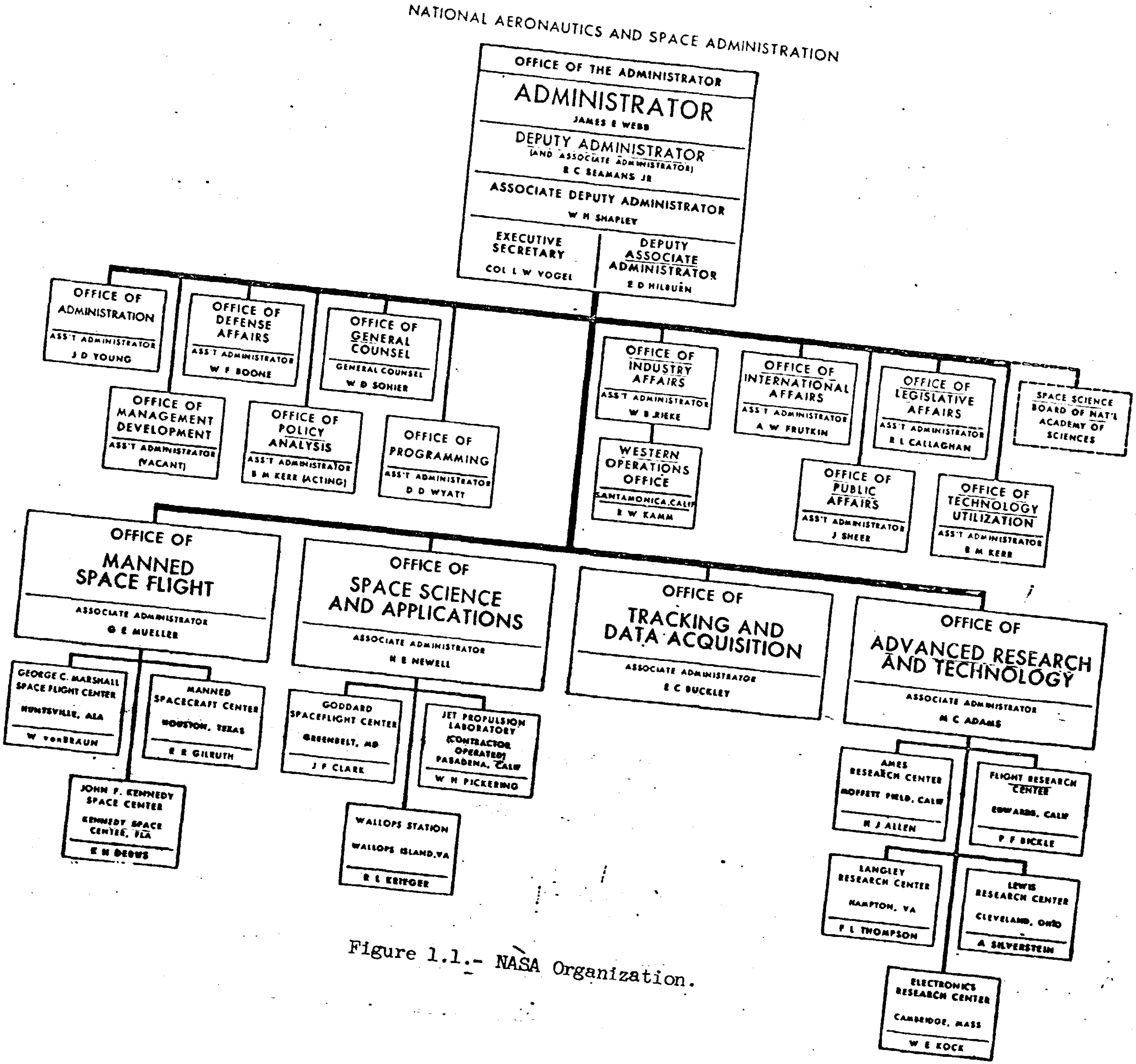

Figure 1.1.- NASA Organization.

"general manager" of the agency and is thereby responsible for the maintenance of agency-wide program integration, balance, and flexibility.[7]

Directly under the Associate Deputy Administrator are: (1) Office of Manned Space Flight (OMSF); (2) Office of Space Science and Applications (OSSA); and, (3) Office of Advanced Research and Technology (OART) - each is under the guidance of an Associate Administrator. These offices are responsible for principal areas of NASA's total program and each major field installation reports to one of these three offices. Each office assumes both program and institutional management over the installations within their jurisdiction. This alignment is advantageous in that it relieves the Associate Deputy Administrator (general manager) of numerous everyday tasks so that he has the freedom to examine policy and overall management matters.[8]

The institutional focal point of this analysis, the Manned Spacecraft Center (MSC), lies within OMSF as portrayed in figure 1.2. The major program responsibilities of OMSF specifically relate to manned spaceflight and currently consist of three programs: (1) Gemini; (2) Apollo; and (3) Advanced Missions. Under the fiscal year 1966 appropriations bill the former were only three of the twenty-three R&D programs receiving appropriated monies within NASA, however they accounted for approximately 71 percent of NASA's R&D total appropriation.

MSC holds assignments in all three of the manned space flight programs, although by far (in terms of dollars and manpower) Apollo is the largest with Gemini second and Advanced Missions a distant third. Figure 1.2 indicates that

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[7] Ibid., p. 11.

[8] Ibid., p. 11.

regardless of the program at hand, MSC is charged with three primary responsibilities: (1) the development of spacecraft and related equipment for manned spaceflight programs; (2) the selection and training of flight crews; and, (3) the conduct of manned flight operations.[9] MSC's R&D budget in fiscal year (FY) 1966 will be around 45 percent of the OMSF R&D budget and 32 percent of the complete NASA R&D budget. Therefore, it seems rather self-evident that MSC has been delegated the responsiblity for momentous inputs into the NASA R&D effort. Assuming there has been sufficient assimilation by the reader of MSC's organizational position, role, and the magnitude of its gross R&D efforts, the author will now discuss additional parameters which must be elucidated before the fundamental analysis may begin.

Appropriations Classification

The basic thrust of this paper extends toward an analysis of phenomena inherently caused by, derivable from, or attributable to the budget formulation of MSC Research and Development programs. However, while R&D receives singular examination, one should realize that this appropriation does not denote the MSC budget in its entirety. The total MSC budget is derived only after the inclusion of the Administrative Operations (AO) and the Construction of Facilities (C of F) appropriations with that of the R&D function.

Research and Development appropriations are used in functional activities implied by their name, and in FY 1966 represented 87.5 percent of NASA funds appropriated. These funds are structured on a Program/Project basis and may be used to incur obligations until totally obligated and are thereby termed

[9]"Manned Spacecraft Center," Budget Estimates: Fiscal Year 1966 - Manned Space Flight Programs, Volume V, (Washington, D.C., October 1965), p. A01-13.

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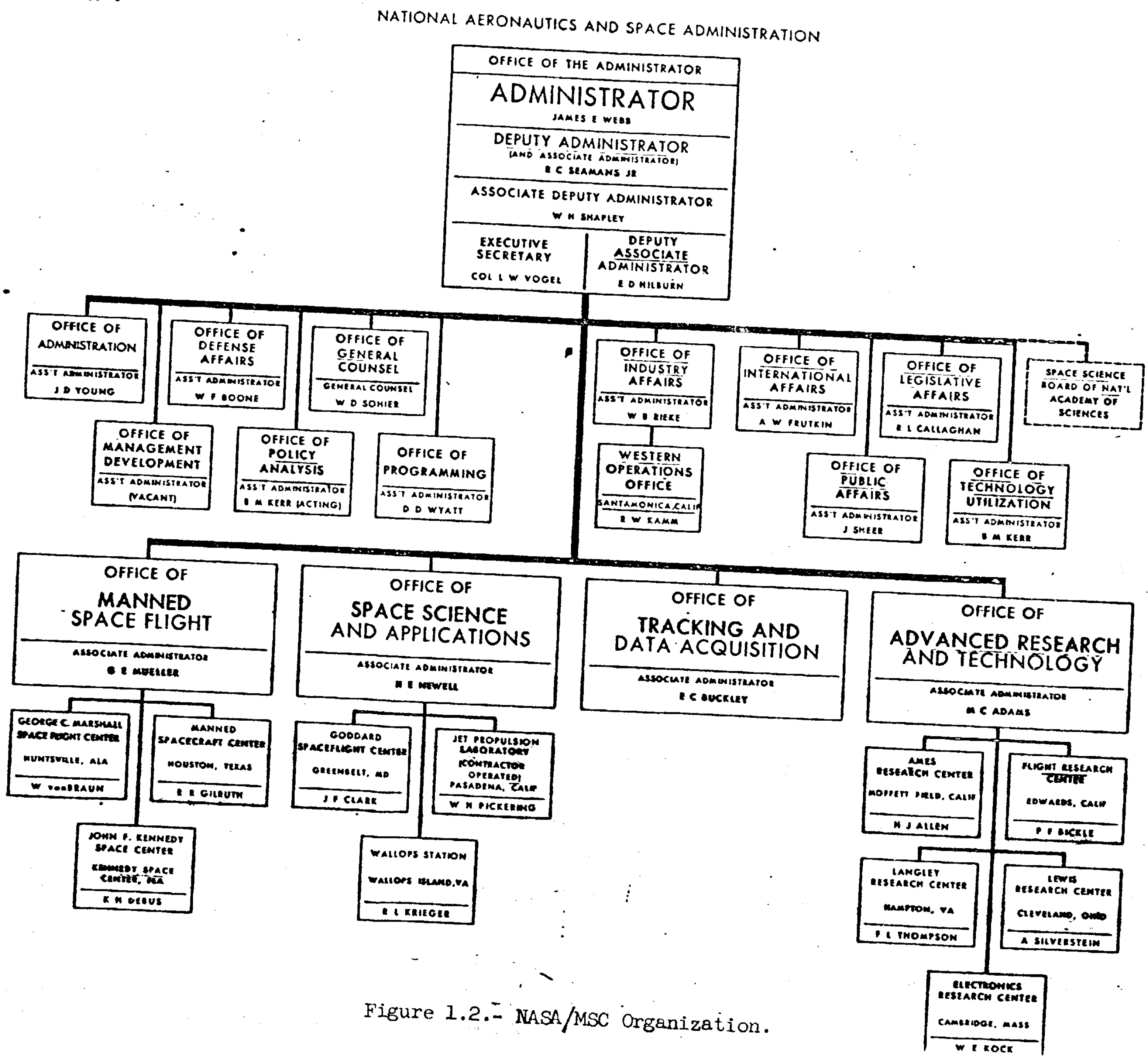

Figure 1.2.- NASA/MSC Organization.

"no year" money. Apportionment by the Budget Bureau is on a "bulk" basis with a reserve retained by BOB. Funding to MSC from NASA Headquarters is by allotment on an incremental basis.

Similar to R&D appropriations, are those for Construction of Facilities which fund major construction and/or modification, minor construction, and design engineering. These appropriations are structured on a location/project basis and are included under the "continuing activity" class which enables MSC to carry them from one year to the next until these funds are totally obligated. The Budget Bureau also apportions C of F monies of a "bulk with reserve" basis, however MSC receives authority to obligate them in a single allotment.

Congress displays a vital interest in this class of appropriations as they approve all specific projects individually and thereby remove most of the flexibility these programs might have. Traditionally C of F appropriations have possessed less lee-way than any other type. Thusly, long range programming is of the utmost importance in this function.

The final appropriation class found in NASA's budget is that for Administrative Operations. The pay of personnel, travel and transportation of persons, and all other administrative operations are funded from AO. This appropriation differs from R&D and C of F appropriations in that it is annual - therefore any funds not obligated by the end of the FY for which they were appropriated are wholly lost. AO funds are of the center/object class structure and are apportioned by the Budget Bureau on a quarterly basis. In turn, NASA Headquarters allots these funds according to the "level-of-effort" being partaken at MSC.

Terminology – Concepts

The discussion advanced thus far has touched upon numerous facts and terms. Undoubtedly, many of these will become clearer and hold more meaning for the reader as the paper progresses. A much more explicit understanding of the R&D function should develop and hopefully the "big picture" will appear.

However, it is essential that several key terms and concepts be unequivocally differentiated before continuing on. This may be viewed as a further refinement of the parameters setting the context of this work and should therefore not be taken too lightly. The terms to be discussed are by no means comprehensive in their coverage of the topic under examination, but rather are representative of crucial concepts associated with the primary elements of this study and will be considered in the chronological order they assume in a typical budgetary cycle.

Before any of the appropriations formerly mentioned can ever be considered by Congress, there must be a bill providing for the authorization of the given appropriation. Congressional authorization bills generate the legal authority for the appropriations committees to appropriate monies up to, but never over, a specifically stated ceiling. Quite often the actual amount appropriated is less than what was authorized to be appropriated.

An appropriation bill, once signed into law by the President, represents the quantity of new obligational authority (NOA) assigned to a given agency for the relevant FY. In other words, this amount represents to what degree the agency may incur new obligations over and above what it previously had the authority to incur. Moreover, it is a legal guarantee that these additional obligations will be honored by the U.S. Treasury through payment. One should recognize that NOA may not uniformly be equated in any given FY with an agencies' total obligations incurred or dispersements made, especially when their programs include substantial R&D or construction efforts as in the case with NASA. This point will be reinterated later in the chapter and schematically depicted.

However, even after the President signs NASA's appropriation bill, there remains one more step which must be met before NASA receives its duly processed NOA - namely, apportionment by the Bureau of the Budget. Functionally, the apportionment process represents a transfer or release of NOA to NASA by the President. As mentioned earlier, this can take on several forms depending upon the class of the appropriation.

Following the apportionment process, NASA Headquarters will allot monies or NOA to field installations pursuant to their Program Operating Plans (POP).[10] The allotment process is simply another of the several major institutional control mechanisms employed to distribute NOA. Without legimate allotments, new programs cannot be initiated or existing programs maintained. As related previously, the procedural mechanics of this process vary according to the nature of the appropriation.

Upon receiving an allotment for NOA, MSC can then legally incur obligations - bilateral, legally binding commitments between MSC and various contractors - within the designated ceiling figure of the Headquarters allotment. In doing so, MSC will usually contract industry to provide hardware, services, or other entities at a specified future date which are necessary in accomplishing MSC's ultimate program objectives.

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[10] See chapter 4.

For obvious reasons, MSC deems it advisable to check, measure, and analyze the progress of these contracts which their obligated monies are to fund. One of the principal means for doing so is the use of accrued cost. This concept represents the technique in which for a given contract the "use, application or consumption of human and material resources expressed in dollars terms, (is) reported in the period of time when occurring (rather than when the item is delivered or billed)."[11]

Finally, when MSC is billed for commodities provided in full accordance with the stipulations of a given contract, it must honor its contractural obligations and thusly incur disbursements. With the exception of post-audit and other reviewing processes, one may visualize disbursements as marking the end of the budget cycle.

Frequently, the general public is confused by the relationships of the latter three budget terms under discussion: obligations; accrued cost; and, disbursements – particularly as they concern agency or government budgeting. Figure 1.3 characterizes this interaction as it typically would be for one of MSC's major R&D programs. This diagram should by no means be construed as relating explicit phenomena for differing classes of appropriations or for dissimilar agencies (although approximations and likenesses definitely exist).

Figure 1.3 shows NOA appropriated for a hypothetical FY which by T_9 will equate obligations (OB), accrued cost (AC), and disbursements (D) to the cumulative dollar total of CD_5. While the author's concern in this paper is with the phenomena governing R&D budget formulation of NOA for a given year, it will be advantageous for the reader to understand how accrued cost and disbursements of appropriated NOA relate to the incurrence of obligations. The

[11]"Budget Formulation and Execution," Headquarters Management Seminar, Unit 3, (Washington, D.C., September 1965), p. 6b.

graph does not portray the incurrence of OB, AC, or D from NOA appropriations gained in years prior to or after the hypothetical FY under examination. Under this case the author is assuming that Congress has enacted, the President approved, the Budget Bureau apportioned, and NASA Headquarters alloted the NOA under scrutiny.

First consider point CD_0 which represents the initial realization of either OB, AC, or D. We see that at CD_0, $T_0 < T_1 < T_2$, or at CD_1, $T_3 < T_4 < T_5$, which simply means for a finite cumulative dollar level AC lags OB and D lags AC in the time dimension. Thusly at a discrete time, such as T_6, one sees $D_6 = CD_2 < AC_6 = CD_3 < OB_6 = CD_4$.

Another factor worthy of mention is that not all R&D NOA is fully incurred in a single FY for either OB, AC, or D, but that it may be carried on into the ensuing FY – this does occur infrequently though. For example, at T_6 (which we shall consider the end of our hypothetical FY) one sees the following remainders: $OB_6 = CD_5 - CD_4$; $AC_6 = CD_5 - CD_3$; and, $D_6 = CD_5 - CD_2$. These amounts must be incurred before being equal to NOA appropriated for the hypothetical FY.

At T_8 we find $CD_5 = OB_8 = AC_8 > D_8$ as the contractors have now libeled themselves for an amount equal to what NASA is legally obligated. Finally at T_9 one discovers $CD_5 = OB_9 = AC_9 = D_9$ and the monies appropriated have been obligated by NASA, associated cost accrued by the contractor, and the subsequent disbursements effected in full.

<u>The Federal Budgetary Cycle – An Admonition</u>

As the reader will learn in more detail later, there are four phases to the Federal Budgetary Cycle: (1) Executive Preparations and Submission;

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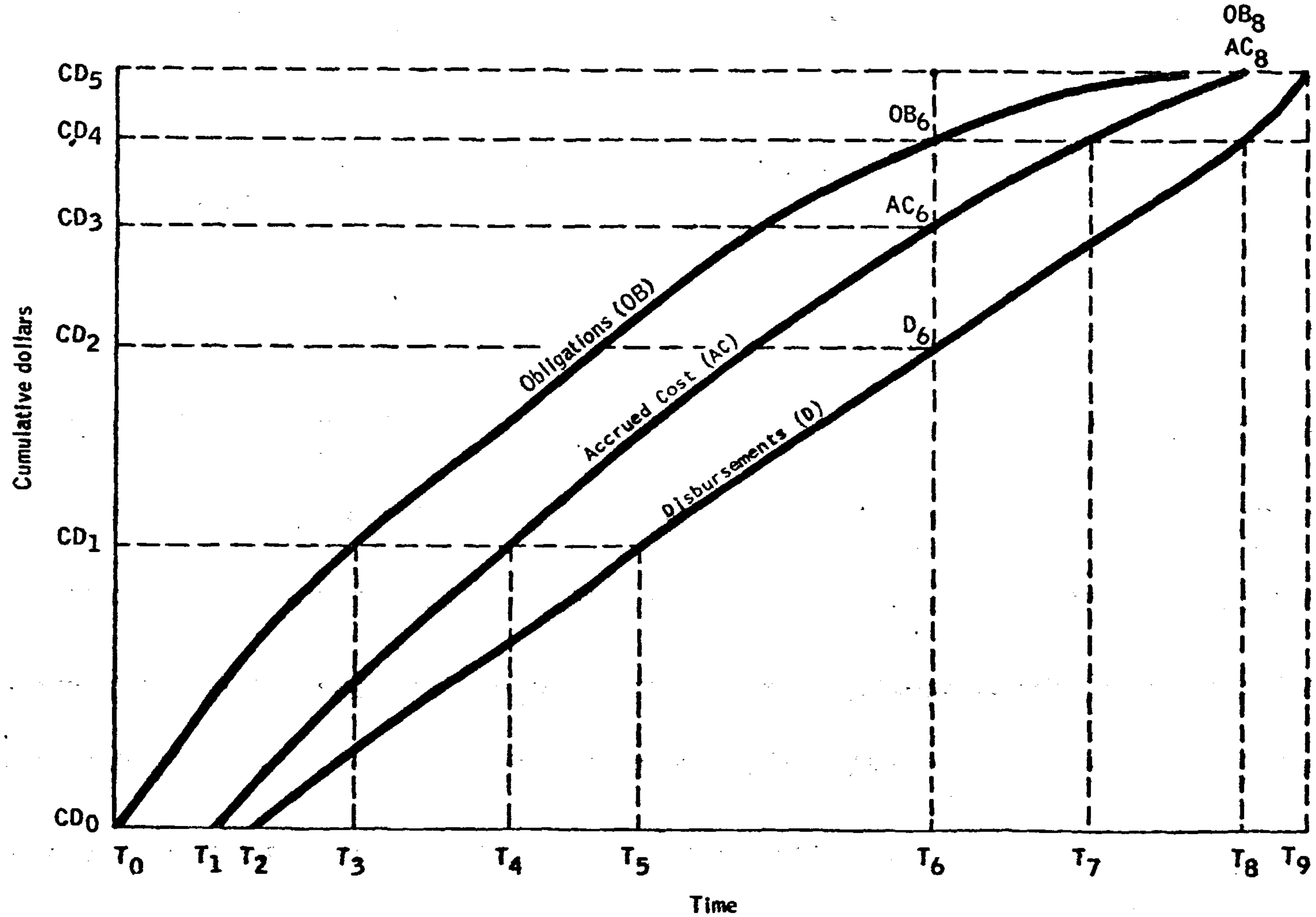

Figure 1.3. - Schematical representatio̶n of the relationships between new obligational authority for a given FY and oblig̶ations, accrued cost and DISBURSEMENTS.

(2) Congressional Authorization and Appropriation; (3) Execution; and, (4) Audit. While elementary coverage will be afforded all of them, the author's principal concern gravitates to the initial two phases.

Furthermore, these two phases will be delved into in depth only in matters of major significance to the R&D budget formulation process. It is hoped that such a methodology will enable a sufficiently penetrating analysis of the problems at hand.

CHAPTER 2

Background of the Problem

The chapter will attempt to portray in a realistic, operational context, the background central to the problem under analysis in this dissertation. Therefore, the author will initially provide a description of the Federal Budgetary Cycle and subsequently scrutinize the problems unique to the R&D programs. The inclusion of the Federal Budgetary Cycle at this point has been effected to better facilitate the reader's understanding of how this Cycle imposes substantive constraints upon the R&D programs at the Manned Spacecraft Center. However, the treatment in this chapter directed at the Cycle will be decidedly cursory, as a substantially more penetrating examination thereof will be provided in chapter 3.

The Federal Budgetary Cycle

Since the formulation of the Constitution of the United States in 1787, the Congress of the United States has held the due authority to authorize and appropriate monies of the United States Treasury. The procedural mechanics governing this process and their underlying rationale have been slowly evolving since the inception of the process to accommodate the demands of our dynamic, kaleidoscopic democracy.

While the United States is admittedly the richest, most powerful country in the history of civilization, it also possesses a limited amount of resources, or dollars if you will, with which it can strive to satiate its desires, wants, and needs. This applies to all entities; rich and poor, large or small – including the Government of the United States of America. Accordingly, since the days of the Articles of Confederation, the United States Government has ascertained the necessity of employing its resources in a prudent fashion. This is made more lucid upon examining the words of Professor Jesse Burkhead:

> Government budgeting is one of the major processes by which the use of public resources is planned and controlled;[1] and a budget system is synonymous with a clarification of responsibility in government, whether the range of governmental programs is broad or narrow.[2]

Thus, one sees a process pursuant to allocating all resources controlled by the Federal Government in as efficient a manner as possible. The process to which reference has been made is, namely, the Federal Budgetary Cycle. It may be deemed one of the primary causal factors from which many of the NASA/MSC budget formulation problems are derived.

This chapter will yield a brief description of the Federal Budgetary Cycle as it passes through its four principal phases: (1) Executive Preparation and Submission; (2) Legislative Authorization and Appropriation; (3) Execution; and, (4) Audit. Specifically, the Cycle will be traced from inception to completion using MSC as the focal point.

Several words of caution are due at this stage. For the purpose of chapter 2 is essentially to provide an overall view of the Cycle and some of its inherent characteristics so that correlations between it and R&D problems can be inductively realized by the reader after his completion of Part I. This background is imperative if the chapters of Parts II and III are to achieve their full impact. The author also believes it would be gainful for the reader to keep these and the introductory remarks advanced by the author

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[1] Jesse Burkhead, Government Budgeting, (New York, 1956), p. vii.

[2] Ibid., p. 29.

in mind as the subsequent chapters unfold. Such an approach will undoubtedly aid the reader in perceiving explicitly the scopt of the study and its intrinsic objectives.

The time required for the completion of all activities for a given fiscal year (FY) in the Federal Budgetary Cycle may well approach three years or more if advanced agency planning and external audit functions are considered. However, the Cycle is usually characterized as requiring approximately 30 months for completion. Therefore, it is not uncommon to discover agencies substantially involved in various phases of the Cycle for three different fiscal years at any one given time.

Figure 2.1 represents schematically how the Federal Budgetary Cycle operates to provide the resources essential in accomplishing the ultimate program objectives of MSC. It is vital that the reader understand this overall process – especially the time and schedule relationships which will portend crucial phenomena throughout this paper.

The Federal Budgetary Cycle is formally activated in March or approximately 16 months before the commencement of the budget year as the Bureau of the Budget (BOB) issues a call for preliminary estimates (Step 1). Correspondingly, MSC would receive the same call as it is transmitted (Step 2) down from NASA Headquarters (NASA/HQ). MSC management has been generating preliminary budget data since early January, and it then submits its preliminary estimates to NASA/HQ for review and consolidation into the overall agency preliminary estimates which are then forwarded to BOB (Step 3a). Generally speaking, the preliminary estimates pertain to broad programs and lack much detail.

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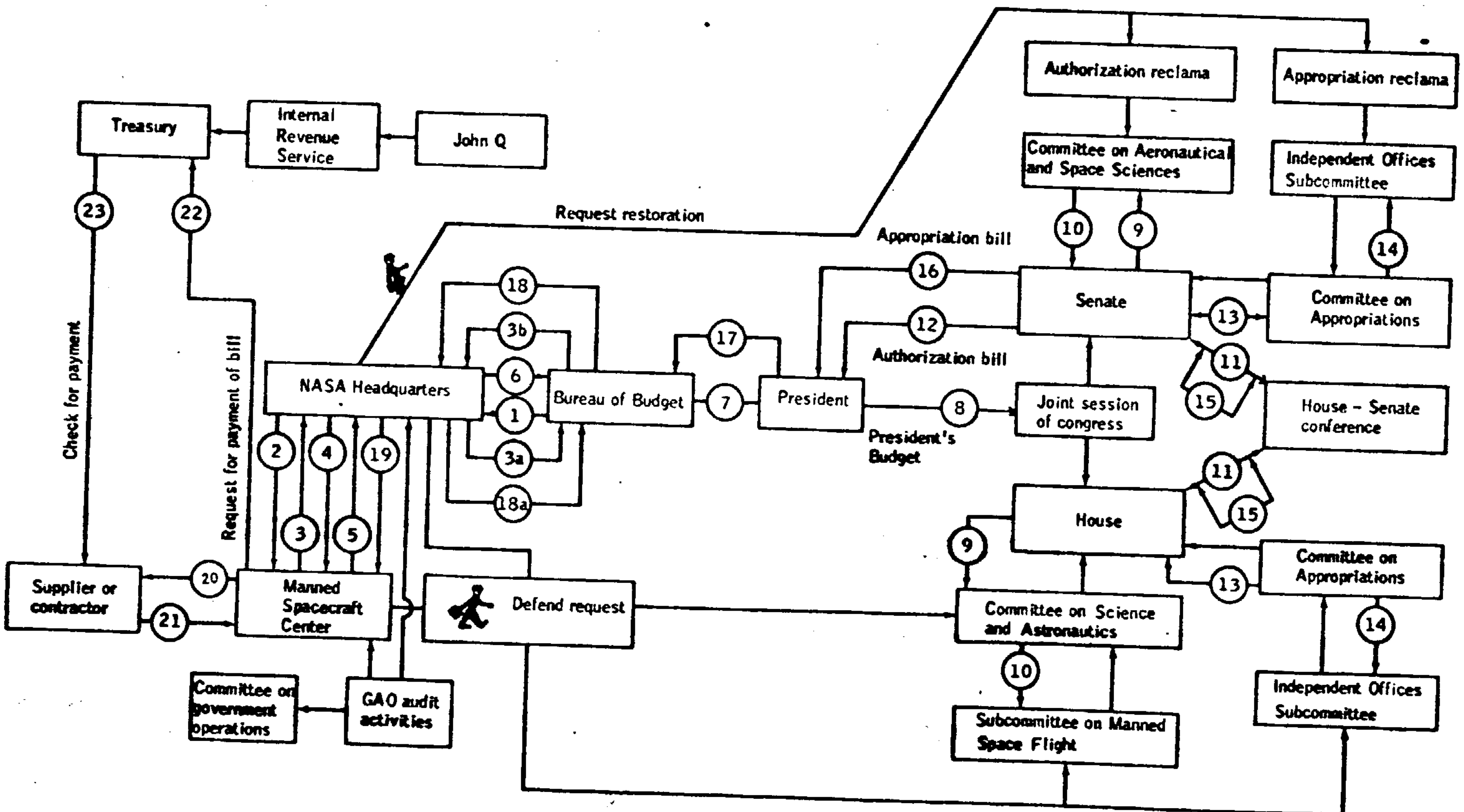

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	MAY	Jun	Month
		1-2	3	3a		3b	4-5	6		7		8	9-17					18a - 23 on a recurring basis												Step in schematic
18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Budget Year												Lead time to budget year in months

Figure 2.1. - NASA/MSC Federal Budgetary Cycle.

Following analysis at the Presidential level of the Administration, BOB will direct to NASA/HQ (usually in July or 11 months in advance of the budget year) a policy letter delineating format, scope, and guidelines to be adhered to while computing the substantively more determinate final budget estimates (Step 3b). NASA/HQ then relays this information along with its own qualifying and restricting budget criteria to MSC (Step 4). Once again, MSC supplies the requested budget data to NASA/HQ (Step 5), although considerably more justification and backup data (down to the systems level — see chapter 4) are incorporated into this submission. The final agency estimates are then presented to BOB in the end of September (Step 6: 9 months before the budget year begins), after a relentless review, consolidation, adjustment, and analysis process on the part of NASA/HQ management to ensure the achievement of program balance and integrity.

Subsequently in October, BOB holds hearings and other review actions on the final NASA budget estimates, consolidates and incorporates them along with estimates from most other government agencies into the President's budget, and finally transmits the complete budget package with specific recommendations to the President (Step 7). Throughout this period, BOB informs agencies of alterations in their finals estimates and transmits appeals regarding such changes to the President. After these proceedings are finalized, BOB will be responsible for drafting the Presidents budget message in November, December, and early January.

Typically, the President will present his budget to a joint session of Congress in the latter half of January (Step 8). All actions involved up to this point represent the first phase of the Federal Budgetary Cycle, namely, that of the Executive Preparation and Submission.

The Cycle's next sequential event occurs when the NASA authorization bill comes before the House Committee on Science and Astronautics for action in February. Subsequently the Senate Committee on Aeronautical and Space Sciences will initiate proceedings for the NASA authorization bill and following passage in both Houses of Congress the Conference Committee will meet to resolve any existing differences in the two bills (Steps 9 through 11). Having done this under the approval of both the House and Senate, the bill will go to the President for signature into law – this will often occur as late as May (Step 12).

The last major effort in this phase of the cycle is the appropriation of funds. The procedure adhered to is much the same as in the authorization process (Steps 13 through 15) with the exception that the bills are taken up in the Independent Offices Subcommittee under the Committee on Appropriations. The exact nature of this process will be given considerably more detail in chapter 3. The approporation phase will ideally occur in May and June.

Hopefully, the NASA appropriation bill has been passed in the House and Senate and expeditiously signed by the President before July 1st (Step 16). However, the interaction of myriad societal, political, and strategic vicissitudes will frequently overload Congress to the extent where some appropriation bills are not resolved by the beginning of the budget year (July 1).

In the advent of such an occurance, Congress allows the affected agency to operate under a condition of "Continuing Resolution" which essentially represents the transmittal to said agency of program and obligational authority <u>in established programs</u> at a rate commensurate to the prior year's appropriation level. This interim act constitutes a portion of the authorization and appropriation phase of the Federal Budgetary Cycle whenever it is implemented.

The Execution process represents the next phase of the Cycle. Initial action here begins with NASA/HQ requesting apportionment of their appropriated funds from BOB after top NASA management has reviewed budget needs in light of the NASA appropriations warrant which is generated by the Treasury Department. Step 18a relates this deed which must be accomplished by May 21 or within 15 days from the approval of the NASA appropriations act, whichever is later. Similarly, BOB must apportion these funds and thereby advance new obligational authority (Step 18) to NASA by June 10 or 30 days after approval of the appropriations act, whichever is later.

Upon gaining apportioned funds, NASA/HQ then allots to MSC obligational authority in line with programmed levels for the fiscal year (Step 19). This, together with the program authority HQ has given MSC, allows the Center to embark on explicit program orientated actions necessary to realize the MSC inputs into NASA's integrated, overall effort.

Thusly, the NASA/MSC Federal Budgetary Cycle schematic shows activities such as ordering goods and services (Step 20), receipt of bills from the suppliers and contractors providing such commodities (Step 21), MSC requesting for the payment of these bills by the Treasury Department (Step 22), and finally the treasury's payment of the relevant bills (Step 23).

The last stage in the Cycle concerns audit supervision. This duty is the responsibility of the General Accounting Office which reports to the Committees on Government Operations in the House and Senate. Although being characterized as the last phase, audit operations can and do occur throughout any given fiscal year and may be either comprehensive or general in nature when applied to MSC.

These proceedings are primarily conducted to check and ensure the integrity of MSC reporting, accounting, and other operating procedures. If GAO discovers incorrect or illegal use of agency funds and/or other resources, remedial measures will be sought in addition to a possible report to Congress if the offense is serious enough.

What then are a few of the major characteristics displayed by the Federal Budgetary Cycle? What are the principal constraints the reader might well remember while pursuing chapter 3 and building knowledgeably a firm base upon which a thorough understanding of the problems at hand can be analyzed rationally?

First, the Cycle is a formalistic-legalistic mechanism which has come to rely heavily upon a traditional and uniform methodology that is often subservient to the political environment. Mind you! – this does not necessarily imply damning evil and moreover the need for the Cycle's elimination, but rather that it can readily impose inhibitive effects upon government agencies whose mission involves substantial advanced R&D efforts.

Secondly, the Cycle demands the ability (of agencies) to schedule and predict with reasonable accuracy the total amount of resources needed to meet (agency) ultimate goals and objectives for a given fiscal year long before they are to be needed. This as we shall see, can prove to be a most difficult task.

These two phenomena will be developed extensively in later chapters. It will suffice for now to say that they are crucial factors to which some type of resolution is necessary.

Problems in Research and Development

Generally speaking most Research and Development activities have been universally characterized as unpredictable and complex. However, this statement is a wholly inadequate description of the R&D function – particularly so, when one restricts his attention to the major R&D programs being administered by agencies such as the Atomic Energy Commission, the Department of Defense, and the National Aeronautics and Space Administration.

Before a genuine appreciation for the problem under attack can be developed, one must realize explicitly the mundane problems epitomizing the R&D efforts. Therefore, the author will use the remainder of this chapter as a vehicle for investigating the dilemma unique to aerospace programs in general and to NASA's Manned Spacecraft Center in particular.

National Priority

It is, perhaps, amazing to discover that most R&D program difficulties under study in this paper originate because of the relatively lofty priority they have been assigned by most U.S. citizens, the Federal Government, and many citizens and countries of the Free World for that matter. Logically then one might ask, "How is it that the space effort has come to enjoy the unyielding commitment and support of the United States of America?" Upon establishing cognizance regarding NASA's high priority, one is better able to comprehend the dynamic processes involved and the volatile milieu within which they function.

On October 4, 1957, the U.S.S.R. launched an earth satellite approximating four tons which remained in orbit around 90 days. In doing so, the Soviets spectacularly usurped the United States into a space race which exhibits prospects of continuing on for years, if not for decades and centuries to come. In the words of Eugene Emme, a NASA historian, this feat:

"...greatly prodded man's scientific conquest of space and animated a chain reaction of subsequent events which has not yet expired. One of the immediate consequences was the creation of the National Aeronautics and Space Administration by October 1958."[3]

Any objective analysis of the high priority NASA possesses along with a rationalization of that organizations near astronomical R&D fund growth must consider five factors in the following order of importance: (1) military supremacy; (2) the pledge of two Presidents; (3) man's insatiable propensity to conquer the unknown; (4) propaganda opportunities; and (5) technological spillover. All of these are fundamental requisites for the strategic well-being of the United States and naturally assist in determining societal priorities.

First, there is a convincing nexus between the goals and objectives of NASA and the military supremacy of the United States. Admittedly, when President Eisenhower signed the act creating the National Aeronautics and Space Administration on July 29, 1958, the language therein stated expressedly:

that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind.[4]

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[3]Eugene M. Emme, Aeronautics and Astronautics: An American Chronology of Science and Technology in the Exploration of Space 1915 – 1960, (Washington, D.C., 1961), p. 89.

[4]Ibid., p. 100.

Yet, in a speech on future security in 1957, President Eisenhower had expounded candidly:

> If the project is designed solely for scientific purposes, its size and cost must be tailored to the scientific job it is going to do. If the project has some ultimate defense value, its urgency for this purpose is to be judged in comparison with the probable value of competing defence projects.[5]

The key word in this quote is "urgency," for irregardless of when man ultimately lands on the moon the cost will be substantial. Few will repudiate the fact that the American space program reflects a note of urgency, and accordingly rates a high national priority.

The simple facts are that the United States is pursuing a peaceful exploration of outer space on the whole. However, once we realize the capability to effectively attain, live, and work in such a hostile environment, it will be relatively facile to engineer military applications to our peacefully begotten knowledge and swiftly achieve tremendous strategic military eminence. The author finds it most difficult to argue that our present involvement in space would assume its existing scope if derivative military applications were not feasible.

Second, the pledge to land a man on the moon and bring him back to earth safely within this decade has been resoundingly expressed by two Presidents. This national goal was originally enunciated by President Kennedy in the summer of 1962.[6] It has been similarly recognized, advocated, and justified by

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[5] *Ibid.*, p. 92.

[6] James M. Grimwood, *Project Mercury: A Chronology*, (Washington, D.C., 1963), p. 141.

President Johnson as shown in the following quotation:

> This Nation has embarked on a bold program of space exploration and research which holds promise of rich rewards in many fields of American life. Our boldness is clearly indicated by the broad scope of our program and by our intent to send men to the moon within this decade.[7]

Third, man's insatiable propensity to conquer the unknown which has existed since time immemorial affixes additional thrust and contributes noticeably in raising and maintaining the high priority of the space program. To ascent to meer technological plateaus will not suffice - it is the summit to which mankind aspires, albeit knowing its ultimate attainment is not within the confines of any mortal being's genius.

Without question, to assume any other behavior would eventually signify stagnation of the mind and the probable decline of all that which civilized man holds dear. For ours in a world in which one cannot afford the luxury of resting on one's laurels.

History has ever-so lucidly related how countries who continually and relentlessly strive for excellence in the technological arena frequently reap benefits previously believed impossible. Dr. Hugh L. Dryden eloquently related this in the following statement concerning the space effort:

> Free peoples everywhere must retain a reliable perspective from which to discern better the future scientific, social, economic, political, and strategic consequences of dynamic advances now underway.[8]

Fourth, the "space race" if you will, extends to the United States invaluable, positive propaganda opportunities. Contrarily, any laxity on its

[7] "The Budget", U.S. Code Congressional and Administrative News: 39th Congress - First Session, (St. Paul, 1965), p. 56.

[8] Emme, op. cit., p. iv.

part could unfortunately inflict a diametrical effect upon our world stature.

The accomplishments of both the United States and the Soviet Union in space have made and will continue to make strong impressions upon the countries and peoples of the world. This is true whether they be "advanced" or "emerging" — rich or poor.

That the Soviets have exploited their space feats to a maximum is self evident. That the United States has done so even more advantageously and openly (thusly creating more of a chance for adverse contingencies) is also self-evident.

In other words, the world community — particularly the "emerging" countries whose systems of government and political idealogies are markedly insecure — has been given a front row seat to observe a most crucial contest. The tenor typifying this "face-off" is conspicuously unique for one sees the world's two most powerful nations vying to become the first to land men on the moon and return them to earth unharmed. Yet, this contest in entirety is being conducted under the superficial veil of good-natured, peaceful competition.

These "emerging" nations may well recognize a different perspective though. For to them, this race is not necessarily a match between two nations, but rather one between two opposing systems of government — Democracy vis-a-vis Communism. This exposition provides them with an excellent chance to compare the expertise, resources, and efficiency generated by these systems in their parallel conquest of the moon and cosmic space.

Many of these small "emerging" nations really do not know or care who started first in this endeavor, but they will be immensely impressed by who gets to the moon and back first. While the United States may not relish such state of affairs, the facts are that either it beats the Soviets or it will suffer the international political consequences!

Finally, the author believes the potentiality of substantive "technological spillover" stands as yet another reason for the high priority assigned to the space program. Even today examples of "technological spillover" are present. Although some of these may be considered a direct result of our space program, they do provide advances for the industries concerned which can be classed as "spillover".

Just to list a few of these "spillovers," one may first look to the communications industry and the pronounced effect the Early Bird Satellite has made. Or, one could cite how weather forecasting has been improved through the Tiros Meteorological Satellite. Finally, one must credit the continuous breakthroughs which have emerged from micro-miniaturization in the electronics industry – these advances are assisting American industry's push to dominate the international computer market.

However the fundamental element demanding recognition here is the fact that our expenditures of money and intellect will undoubtedly be gainful in the years to come. This is shown in marvelous fashion by an experience Michael Faraday had over one-hundred years ago:

> Michael Faraday was demonstrating his electromagnetic equipment to a British government committee in the hope of obtaining government support. One member admitted he was fascinated, but asked Faraday, "What practical benefits can we expect?" "I can't answer that question," Faraday replied, "but I can tell you than one-hundred years from now you will be taxing something like this."[9]

"Technological spillover" may also be looked at in a slightly different manner. For NASA, like her predecessor NACA, has assumed the role of the

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[9] Eberhardt Rechtin, "Why the [illegible] Race?", IRE Student Quarterly, Vol. 7, No. 4, (May 1961), p. 46.

guardian for America's supremacy in aeronautical and space technology. This does not simply imply the transfer of lucrative technological "windfalls" enjoyed from task orientated aerospace programs, but rather a continuing effort to maintain our aerospace technological eminence. Quite simply, this means NASA must support numerous programs in pure research.

Briefly then, the urgency and high national priority of America's space program has been discussed. The five underlying reasons for this priority have also been related, although numerous other considerations of less significance may enter the picture.

It is the author's hope that this coverage of national priority will enable the reader to establish an adequate perspective in which full knowledge of the problems unique to R&D may be attained. For while the primary phenomena has yet to be analyzed, and appropriate background will prove to be most valuable.

Many of the problems inherent to advanced aerospace Research and Development (R&D) projects are decidedly unique. The author will survey these in the remainder of the chapter by first affording the reader with a discussion of the factors critical to aerospace R&D work and then through touching on three broad problems in the subsequent order: state-of-the-art advances; changing requirements and definition; and, lack of cost data.

Before continuing on, it might be wise to engage in one slight diversion which will give the [illegible] into the unbelievable complexity overshadowing the space program. In doing so the author will not submit the reader to an extended technical discussion, but rather provide a sparkling statement made by Dr. Shea, Manager of the Apollo Spacecraft Program Office, before the Subcommittee on Manned Spaceflight in 1963:

> I think somebody noted at one time that for Apollo itself we will probably generate sufficient paper that if we piled it up it would get to the moon before the Apollo spacecraft did and we are on our way – as you can see.[10]

Performance – Schedule – Cost

Obviously, the space program's high priority requires the realization of adequate performance and a realistic schedule while observing cost constraints which delineate the extent of its effort as provided under law by Congress. As will be shown, the frequent interdependency of these variables proves to be not only perplexing, but moreover the causal factor in many of the unique R&D problems under study in this paper.

The American pledge to the world is not only the landing of men on the moon, but also their safe return before 1970. Both of these fantastically complicated exercises call for the near errorless performance of literally millions of functioning mechanisms and parts which will be contributing inputs over a period of several weeks.

R&D projects of this type are therefore characterized by "the ever-present feedbacks among action, results, information, and new action"[11] that must ultimately be assured through reliability criteria:

> ...in Project Apollo, in all of our manned space flight projects for that matter, the key to the success of the mission will be

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[10] U.S. Congress, House, Subcommittee on Manned Space Flight, 1964 NASA Authorization, Hearings, 88th Congress, 1st Session, May 8, 1963, Part 2b, (Washington, 1963), pp. 1082-1083.

[11] Edward B. Roberts, The Dynamics of Research and Development, (New York, 1964), p. xix.

> the reliability of all the systems, of all the components, of everything that goes to make the spacecraft.[12]

Performance usually must take first place over either schedule or cost in importance, if for instance tradeoffs[13] are to be made pitting one against the other. Much of the problem as we will learn in more detail later, arises when performance criteria are altered for one reason or another thereby affecting the other variables adversely.

Dr. Gilruth exemplified this spiraling cause and effect process in a statement before the Subcommittee on Manned Spaceflight in which he cited the failure of the Atlas carrying the first production-Mercury capsule:

> It occurred in 1960. It was the first real setback we had in the program. We had a structural failure at maximum dynamic pressure in the interface area between the capsule and the Atlas forward tank. I guess it cost us about four months.[14]

Very evidently then, R&D difficulties relating to performance can impose without warning schedule slippage. And yet, did or was anyone able to forecast this turn of fortune — no! However, is not a reliable schedule an integral part of our total space commitment — yes, definitely so!

The damning aspect of schedule slippage is that it can raise its ugly head in such a variety of ways and be created as a derivative of the myriad other actions involving the eventual culmination of a given program. One might well

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[12] U.S. Congress, House, Subcommittee on Manned Space Flight, 1963 NASA Authorization, Hearings, 87th Congress, 2nd Session, April 5, 1962, Part 2, (Washington, 1962), p. 901.

[13] A tradeoff occurs when a sacrifice in one variable such as cost (i.e. higher cost) is made to accomodate or maintain the value of other variables such as performance or schedule.

[14] U.S. Congress, House, Subcommittee on Manned Space Flight, 19[illegible] NASA Authorization, Hearings, [illegible] Congress, 1st Session, (Houston, Texas, [illegible], [illegible]), edited version, p. [illegible]-4.

liken this phenomena to a vast, interwoven configuration of standing dominoes – if only one of the pieces in the entire system should happen to fall, they will all fall backward.

This does not necessarily imply that if one of the entities comprising a part of the Lunar Excursion Module (LEM), for example, fails to meet a scheduled completion date then virtually all other work on the LEM must be frozen. However, in more cases than not, this could happen in the subsystems of the LEM, thusly causing the probable delay of the overall program if it is not solved expediently.

Furthermore, schedule as well as performance criteria forge a strong bond with cost. The author will go into more detail concerning this relationship later in the chapter. However, one fact should be emphasized immediately. This is the grim reality that program lags and schedule overruns, regardless of cause, will almost universally generate an upward projection of the total program cost. This fact may be used in partial rebuttal to those critics who sit on the fence's edge – those who would rather we deliberately structure a reduced program level into the manned spaceflight segment of our space program and thereby extend the moon landing date back as far as 1973.

There have been instances in which Congress delved on this very same question, and in one case it was asked of Dr. Shea. On this occasion he provided an answer which quantitatively exemplifies why our efforts in the space program cannot rationally be lowered and thereby stretched out over a longer period of time:

> The Rand people, even without looking at the details of Apollo, have said, "Gee, the cheapest program is almost the quickest program." As long as you are doing it in a sound, rational way, and you are not

> crush, and Apollo is not a crush program even though some people have accused it of that, if you do it in a sound rational way the cheapest program is the quickest program, because things just tend to drag on and keep running up your costs.[15]

The volatile character of performance, schedule, and cost combine to synthesize a foreboding atmosphere of uncertainty in aerospace R&D programs. Peck and Scherer have devoted considerable time to the uncertainty factor in aerospace R&D programs and have constructed a graphic representation of this in their "Isoquality Plane Under Uncertainty" in which for a given quality level (of performance) the corresponding time and cost levels are relatively undefined.[16]

Figure 2.2 portrays the variance one might expect in schedule (time) and cost variables when one holds the quality or performance of a given product constant. Therefore these variables could realize final values anywhere within the lined area denoted as Q_x.

While investigating uncertainty it is also advantageous to recognize the phases required for advanced R&D programs as this bears a pronounced effect on the problems at hand. Figure 2.3 depicts the four principal phases needed for these complicated programs. The completion of all four phases for any given contract may easily require 5 years or more which gives an idea of the significant lead times one must contend with in the space program. In addition, the schematic extends an uncertainty projection and a relative cost projection plotted over the phase continuum. This graph should give the reader an appreciation for how unforeseen circumstances may inflict strong pressure upon

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[15] U.S. Congress, House, Subcommittee on Manned Space Flight, 1965 NASA Authorization, Hearings, 88th Congress, 2nd Session, February 19, 1964, Part 2. (Washington, 1964), pp. 1020-1021.

[16] Merton Peck and Frederic Scherer, The Weapons Acquisition Process: An Economic Analysis, (Boston, 1962), v.d. ch. 11.

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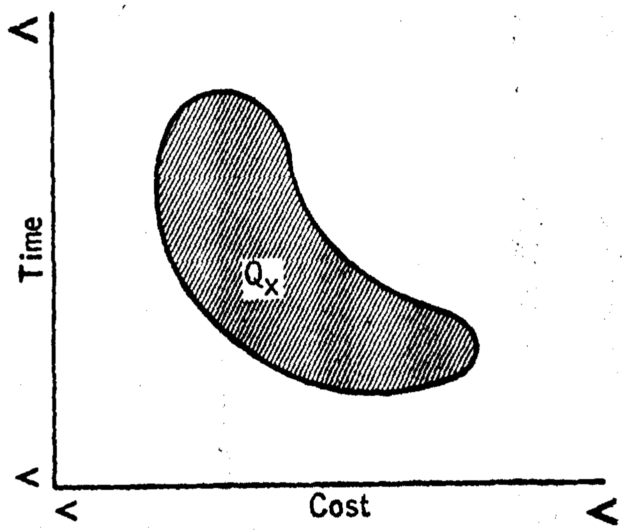

Figure 2.2.[17] - Isoquality plane under uncertainty.

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[17] Ibid., p. 310.

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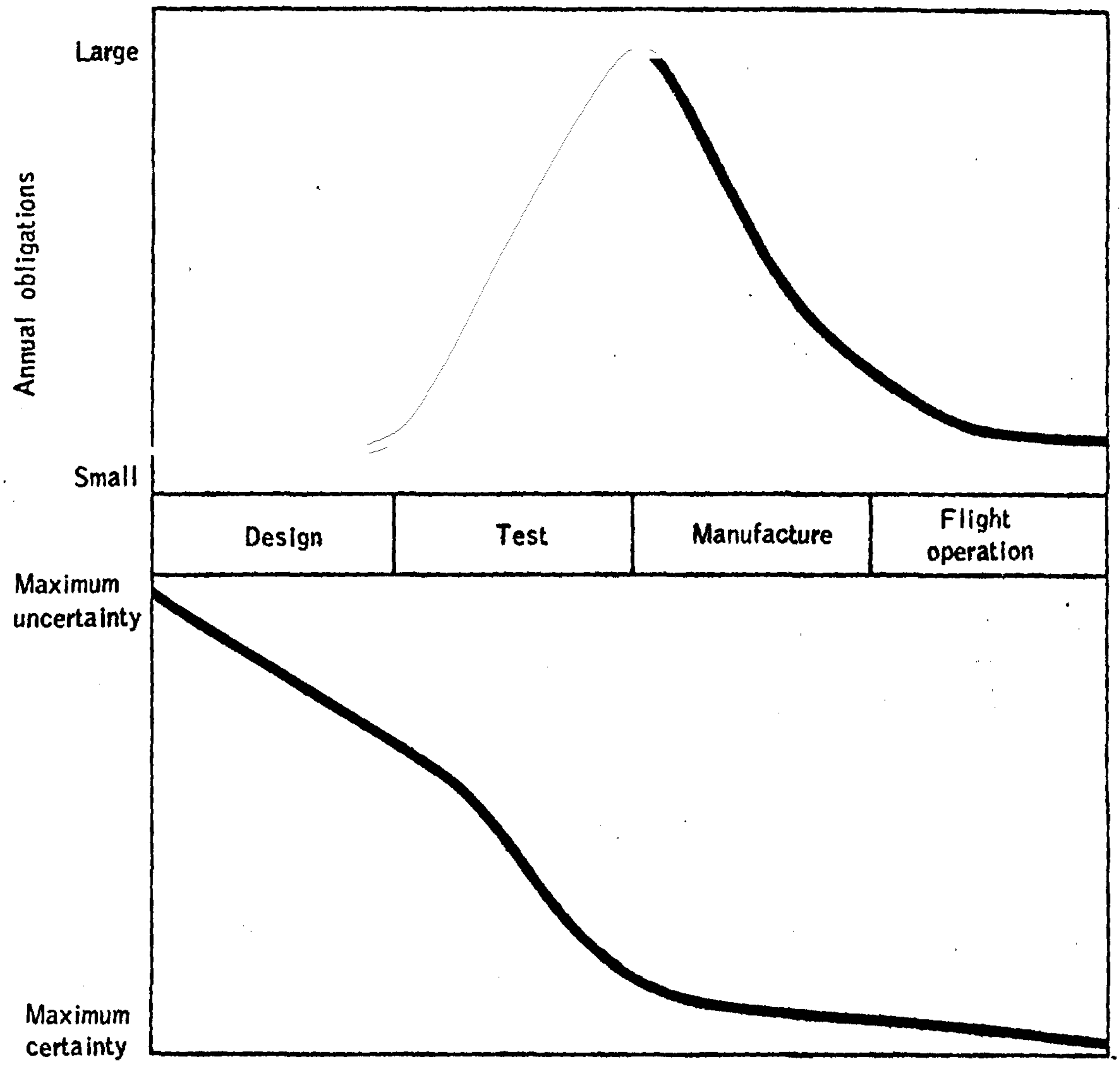

Figure 2.3. - Annual obligational- relative certainty relationships R & D project development four phase continuum.

performance, cost, and schedule criteria — particularly in the design and test phases of the R&D activity.

Before yielding close scrutiny to the three broad problems associated with R&D, a brief word on the "nature of the aerospace market" is in order. For the market serving NASA's R&D programs is unique.

The majority of NASA/MSC's R&D work is accomplished through contractors and subcontractors. MSC enters the picture primarily in establishing specifications for the various contracts to be let. In utilizing this procedure, NASA/MSC controls the technical guidance and policy aspects of its programs while allowing free enterprise to assume its traditional role in the American system.

The nature of the contractural work emanating from MSC is such that fixed price contracts are rarely used due to the virtual impossibility of predicting final cost. At best, incentive contracts may be employed, although this is not practicable until the contract has progressed well along in the test phase so that both MSC and the contracting party can reach agreement on the cost-to-completion — most variables are within well defined parameters at this point.

Unfortunately, when contracts are originally awarded, they are not sufficiently well defined to meet requirements necessary under the incentive basis. In fact, numerous contracts are let on the evaluation of performance proposals submitted by competitors — such contracts will not even contain hardware specifications initially. This phenomenon of ambiguous and frequently changing program definition is a serious problem in aerospace R&D contracting. More on this matter will be said later.

Thusly, MSC can only advance estimates regarding the ultimate cost of a given contract. Unlike many other government agencies, NASA/MSC usually cannot hold a contractor to a finite dollar amount for various goods and services rendered.

SOTA – Changing Definitions and Requirements – Poor Cost Data

For the remainder of this chapter the author will consider the problems of state-of-the-art advances, changing requirements and definitions, and the lack of cost data. These areas will be discussed for their individual peculiarities and then integrated with the material covered heretofore.

The state-of-the-art represents "the level to which technology and science have at any designated cutoff time been developed in a given industry."[18] Essentially it defines the terminal zone beyond which man cannot pass in the technological development of hardware without first achieving basic theoretical and design advances that are applicable to the task at hand.

State-of-the-art problems superficially at least are probably the most obvious to the average person. For the notion of space travel (not to mention landing, living, and working on the moon for a short duration, and returning to earth) has prodded man's imagination for centuries. Yet we as terrestrial beings have only recently moved toward realizing the capability of accomplishing these dreams, and no doubt many people question our ability to do so before 1970 – with good reason. Such pessimism, although certainly not universal, is frequently derived from statements released by prominent technical researchers which while not necessarily reflecting pessimism, do relate concisely the nature of various obstacles ahead in the space program:

> It is an understatement to say that gaps exist today in the basic technical knowledge needed to assure a successful manned moon shot.

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[18]Martin Caidin, The Man-In-Space Dictionary, (New York, 1963), p. 196.

In fact, much applied research will be necessary to support this advanced development program.[19]

The state-of-the-art (SOTA) problems confronting NASA/MSC may be characterized as inculcating program uncertainty upon management. This is true in any advanced R&D program which demands substantial improvements in SOTA. Especially in the design and test phases of R&D, the degree of uncertainty can be tremendous, due to two related factors.

For one thing, there is not always complete accord on the best method or technique to accomplish the various parts of a mission. "Missiles and Rockets" reported in 1962:

> There is considerable debate by those participating in the Apollo Program as to the best route for landing an American expedition on the moon. Should it be by direct ascent? By use of Earth and lunar rendezvous techniques? By means of a lunar "bug" which would ferry a team down to the lunar surface from an orbiting spacecraft?
>
> Until the decision is made, much of the technical effort on the program cannot go ahead. Until it is determined whether that module actually will land on the moon or remain in orbit, work cannot begin on hardware.[20]

If a delay in program decisions such as this occurs, the effect on SOTA advances can be decidedly adverse because any delay will likely impose schedule and cost problems. The intrinsic nature of advanced SOTA R&D work is such that breakthroughs are not subservient to man-made schedules – rather, the converse is true.

At times attempts to resolve this problem are made through the use of parallel R&D efforts. However, this usually proves to be prohibitively expensive:

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[19] W. L. Davidson, "The Case for Advanced Technical Programs," Achieving Full Value From R&D Dollars, (New York, 1962), p. 23.

[20] William J. Coughlin, Missiles and Rockets, (Washington, D.C., May 21, 1962), p. 15.

> The large cost of an individual program makes hedging against technical difficulties through the use of duplicate or parallel projects extremely expensive.[21]

Moreover, the extreme integration of most aspects comprising the space program will frequently generate paradoxical problems. For R&D technical groups traditionally strive to produce as sophisticated and reliable a product as is possible.[22] Frequently their efforts will create advanced techniques or designs which exhibit superiority over existing hardware. Naturally, when these SOTA advances arise, those responsible for the program's success have them incorporated and integrated with the existing systems even though higher cost and extended schedules are likely to result. When queried on this practice Mr. Holmes replied as follows:

> We found as we developed the subsystem of Gemini that it was much easier to incorporate technology known today, not something that was early developmental technology of the past.
>
> In developing the Gemini subsystems, we find that they are better and more sophisticated than initially conceived, and that the spacecraft is much more sophisticated than anticipated. Therefore the costs tend to be higher and the time scales longer.[23]

Thusly one may see SOTA as causing programmed requirements to change: first, due to unforeseen R&D problems; and, ironically, second, because of unexpected breakthroughs which are then incorporated into a given project. However, changing requirements are not solely attributable to SOTA, for frequently a lack of initial definition and subsequent redefinition is also a major source of changing requirements.

The successful completion of the lunar program demands the integration of numerous complex subsystems which are highly dependent upon one another. If

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[21]Peck and Scherer, op. cit., p. 53.

[22]Ibid., p. 80.

[23]1963 NASA Authorization, op. cit., p. 874.

not dependent in a functional manner, they are dependent from the standpoint of meeting specific physical design specifications such as configuration and weight if unitary spacecraft requirements are to be met in the final assembly process.

For example, take the case of two hypothetical subsystems A and B, both of which are essential to the operation of the Lunar Excursion Module. Subsystem A is well defined while the concepts and necessary data governing the development of subsystem B remain nebulous. Then, even though subsystem A may be produced with the near perfect assurance it is acceptable, subsystem B does not provide equal confidence. However, design and test proceedings on B will be effected using whatever limited knowledge may be available to produce a functionally capable and reliable piece of hardware.

But, as often is the case, new data obtained midway through the program can alter the performance requirements and therefore the design specifications of subsystem B. This contingency very possibly will necessitate a major redesign of the hardware.

Furthermore, there is a strong probability that these mid-program alterations in subsystem B will mean the previously acceptable subsystem A must be modified. Presentation data used in the 1965 BOB Hearings elucidates such subsystem integration problems (changing definition and requirements) incisively:

> Weight growth is still a major problem and is receiving continued management attention. As spacecraft subsystem development progresses, the weights become both more precisely known and more difficult to reduce. The impact of design on the Program may be severe in terms of both dollars and time. Weight control has been extended to the subsystem level and a comprehensive weight control program has been established.
>
> Since our presentation a year ago, the LEM weight has increased about 10 percent, increased the landing problem considerably. As

a result the landing gear design was changed from a 160 inch radius contilevered gear to a 167 inch radius contilevered gear.

The problem is not solved, however. Improved landing dynamics analysis have shown landing stability problems which we didn't have the necessary sophistication a year ago to recognize.

The most significant lack of information lies in the soil mechanics area. We do not know the soil mechanics of the lunar surface (though we hope to obtain useful data from the Surveyor Program), but are studying the effect of earth soil mechanics on landing stability of the LEM vehicle in an effort to better understand the dynamics.

Any major change in the spacecraft design concept (as is conceivable for LEM weight reduction) could have a significant effect on micrometeroid protection.[24]

The fusion of adversities generated from state-of-the-art advances, changing requirements, and changing definition, formulate a milieu which exerts formidable pressure upon cost. This leads to the last general problem typically unique to R&D - lack of cost data.

Meager cost data may be visualized in several contrasting lights. First, and highly correlated to all causal factors discussed here, is simply the singularity of this immense undertaking. The affinity for cost projections to display considerable positive variance in a program of this type seems unusually high and therefore accurate calculations of cost are not readily construed.

The two general problems examined previously are responsible for much of the cost projection difficulties typical to R&D. For anytime a project's performance and schedule parameters are by necessity adjusted to reconcile changes in SOTA or program definition, costs will be affected. In rare instances the effect will be downward, however usually the converse is true.

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[24] Quote extracted from unassembled data used in NASA/MSC FY 1967 Hearings before the Budget Bureau in October 1965, Houston, Texas.

Another contributing factor to the lack of cost data is the enthusiastic optimism on the part of contractors. This dubious behavior is usually rewarded through the means of contract awards and insignificant penalties when the contractor's original estimates are far off target.

Related to this fact is the problem of technical people also displaying optimism in controlling cost. Their downfall can usually be traced to an over-concern for technical facets of an R&D operation while diverting too little attention to schedule and cost.

D. Brainerd Holmes tied much of this together while postulating on cost overruns in the space program:

> ...firms may tend to be overly optimistic in their original estimates.
>
> Industry misunderstanding of technical requirements and NASA's penchant for changing its mind on specifications are other pertinent reasons for the higher costs.[25]

However, the exact point or factor of causation in cost overruns cannot reasonably be attributed to any single entity. Instead, it is more logical to rationalize these overruns as a hybrid effect which unfortunately can approach substantial proportions. For as Marshall and Meckling report:

> Cost increases on the order of 200 percent to 300 percent and extensions of development time by a third to a half are not the exception, but the rule.[26]

Also not to be forgotten are the conditions governing and setting the pace of the American economy. These may inflict pronounced effects upon the space program due to the considerable research and development lead times many

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[25] Charles O. LaFord, "Apollo Guidance Costs Under Control," Missiles and Rockets, (Washington, D.C., October 22, 1962), p. 12.

[26] Marshall and Meckling, op. cit., pp. 21-22.

contracts in R&D cover. Various key economic variables such as wages, the unemployment rate, percent of industrial operating capacity, prices, and the full employment surplus to mention a few, may over time alter cost projections.

Summarily, the author would like to mention the key points advanced in this chapter. For the preceding discussion had dealt with a combination of unstable variables whose interaction can have a very confusing effect upon the long range forecasting of plans, schedules and cost in space programs. Figure 2.4 should facilitate gaining the proper overview of the phenomena under study.

This paradigm represents the movement of our entire space program from the planning, operating, and evaluation functions. Starting with requisites established through the Federal Budgetary Cycle and national priority, specific goal orientated tasks or programs are instituted.

Next, one enters into the area of operational catastrophe in which nearly anything can occur. For it is here that one sees the interaction of three crucial variables: performance; schedule; and, cost. Each of these variables is capable of affecting the other two through its own variance.

To further complicate the picture, each of these primary variables is dependent upon three additional factors which have been treated as general problems in this chapter: state-of-the-art advances; changing requirements and definition; and, the lack of cost data.

All of these entities react over time to yield a means for evaluating program accomplishment and formulating estimates for future programming. BY now, the heart of the problem central to this paper should be emerging in crystal clear fashion. For as we shall see in the subsequent chapters, the phenomena described herein are anything but in consonance. This is the real dilemma!

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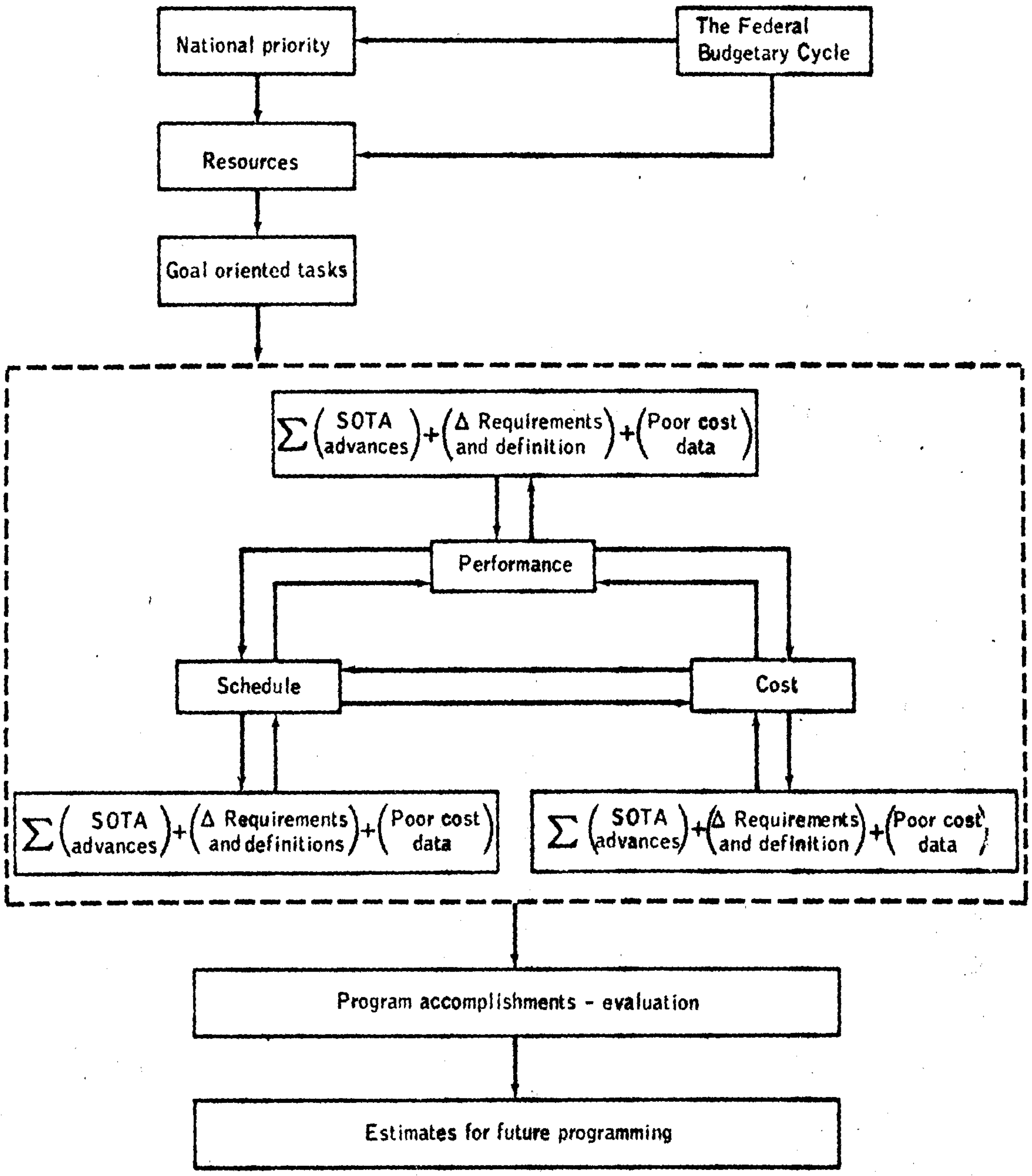

Figure 2.4. - The R&D program paradigm.

PART II

ANALYSIS OF THE PROBLEM

Part I of this treatise should be seen as primarily a mode for the introduction, delineation, and exemplification of the phenomena under study. Now that the reader has been given a sketch of the objectives and parameters guiding the author's efforts along with a background treatment on the major problems underlying the elements of this study, a transition to a more penetrating examination and evaluation of the topic will be effected in Part II.

CHAPTER 3

An Analysis of the Federal Budgetary Cycle: Phases One and Two

This chapter will focus once again upon a segment of the Federal Budgetary Cycle: first, upon Executive Preparation and Submission; and, second, on Congressional Authorization and Appropriation. In so doing, other integral issues such as budgetary theory will be scrutinized.

Whereas chapter 2 dealt in part with the four phases of the cycle and stressed schedule and flow phenomena, this chapter will show a much greater concern for establishing a "feel" for the more subtle, tacit relationships necessary to realize the appropriate "overview" of this system. The author will investigate not only questions of "when" and "where," but also those concerning "how," "why," "what," and "to what degree." Of course, all of these queries will be related to the ultimate factor of schedule in budgeting for the R&D function.

Yet another objective is to acquire in no undertain terms knowledge of the countless interfaces and levels of perspective influencing the R&D budgetary process. While a perfunctory analysis may yield no discernable consequences of importance in this area, the reader will learn in the following pages that nothing could be further from the truth. For as related by Berkley's Aron Wildavsky:

> Presidents, political parties, administrators, Congressmen, interest groups, and interested citizens vie with one another to have their preferences recorded in the budget. The victories and defeats, the compromises and the bargains, the realms of agreement and the spheres of conflict in regard to the role of national government in our society all appear in the budget. In the most integral sense the budget lies at the heart of the political process.[1]

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[1] Aron Wildavsky, The Politics of the Budgetary Process, (Boston, 1964), p.5.

The explicit role MSC plays in R&D budget formulation and submission will receive individual attention in chapter 4. Therefore, the author will speak of MSC inputs in this chapter only where they are specifically identifiable. The coverage to be given here will concern an analysis at the National level and thusly gravitate around budget proceedings in Washington, D.C.

Budgetary Theory

Before any further examination and evaluation of the Federal Budgetary Cycle (FBC) is attempted, the reader should understand the reasons, both implicit and explicit, why government must rely so heavily on the FBC. In fact, while pondering over this point in issue, one might even more rationally increase the scope of the question and look at the necessity for all people or organizations to budget their resources.

As stated earlier, most people, organizations, governments, and entities thereof, possess limited resources which they can employ for accomplishing and meeting their various desires, objectives, goals, and aspirations. Because these resources are limited in quantity, they are termed "scarce" by means of definition and must be allocated amongst competing projects accordingly. This action will necessitate the use of a budget whose function may be likened to the discipline of economics – namely, to discern:

> ...how men and society choose, with or without the use of money, to employ scarce productive resources to produce various commodities over time and distribute them for consumption, now and in the future, among various people and groups in society.[2]

Basically then, a budget may be characterized as an evaluation (usually in dollar terms) of a given entities capacity to purchase the resources to be

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[2] Paul A. Samuelson, Economics – An Introductory Analysis, 6th edition, (New York, 1964), p. 5.

used in achieving its goals. Becoming more specific, we see that to meet its overall purpose a budget must weigh and relate four factors: (1) the objectives and goals desires; (2) the methods or work plans through which the expressed objectives and goals are to be attained; (3) the resources necessary to implement the work plans at the rate programmed for in the budget; and, (4) a finite expression of these resources in dollars. This does not necessarily imply that all budgets advance singular proposals, but rather they may be either singular or pluralistic in terms of being vehicles for deciding the way to derive maximal gain from a given amount of resources through the use of alternative plans of action.

However, before getting into the mundane use of budgets in the FBC, the author would like to delve on one more general aspect of budgeting – the planning function. For essentially the FBC and budgeting are nothing more than highly sophisticated inventions which enable one to plan more effectively while adhering to the constraints of our democratic system. Few scholars or practitioners of management will refute the hypothesis that planning is one of the most important functions in an organization. For without planning one could not rationally derive the four primary factors comprising a budget (mentioned above). Although planning, per se, easily warrents a study in itself, just a few characteristics of this activity particularly relevant to R&D will be touched upon immediately – others will appear as the chapter progresses.

Planning is an activity whereby one attempts to accurately define various parameters through the use of historical, present, and future analyses concerning a program and thusly reduce the variance in its crucial elements to a minimum. However, the most carefully laid plans can prove to be embarrassingly erroneous for factors which may or may not be charged to the planner. For example, a good plan must rest upon the solid foundation of perceptive assumptions relating the plan to its milieu candidly. They also depend upon a stable political setting which will ascribe consistency of purpose to a plan's objectives. If either of these factors changes, which well may be the case in R&D plans containing prolonged lead times, one's plans can quickly become poor projections. Unfortunately budgeting in government is hard-pressed to facilitate the demands of such occurrences:

> It is axiomatic that government budget-making should be flexible and capable of adaptation to changes in governmental responsibilities. But in many government the procedures – the phases of the budget cycle – are so rigid and so time-consuming that adaptation is difficult.[3]

The main point to be remembered is that formal plans afford an agency a means by which it may more rationally make a decision that would otherwise be the case. In addition, well documented plans provide the means for program implementation and can be used whenever so desired in appraising the degree to which objectives and goals are being achieved.

Before scrutinizing specific actions in the preparation and submission of a budget, the author will make one more general observation. This is simply that budgets are continually being generated in two constrasting fashions, and the final formulation of a budget in the FBC necessarily represents a fusion of these two methods.

First, one sees the birth of budget estimates at the "grass roots" level of an organization. Subsequently these estimates filter up through the vertical

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[3]Jesse Burkhead, Government budgeting, (New York, 1956), p. 269.

levels of the agency and other government institutions to be incorporated into Executive Budget and acted upon by Congress. Frequently this procedure is referred to as "budgeting from the bottom up."

Understandably though, if there was sole reliance upon this type of budget formulation, our nation would not be able to produce all the resources under demand. The demand schedule would simply overpower the supply available.

The technique used in eliminating such faults adopts the opposite philosophy of "budgeting from the top down." Under this procedure those individuals and institutions situated at the apex of the bureaucracy make an analysis of existing conditions and probable future needs as they relate to a given budget. This calculus includes myriad factors as diverse as the political environment, "acts of God," the state of the economy, and many others. These are integrated and evaluated according to their various resources demand as priorities are established. Then guidelines are delivered to relevant subservient bureaucratic units from which they can in turn use to allocate resources within their organization.

In reality neither method of budgeting is completely dominant over the other, and one is usually being played off the other throughout the budget process. While this may seem somewhat paradoxical and contradictory now, the ensuing chapter should assist in clarifying this phenomenon. These two elements of vertical budgeting are in flux throughout all phases of the FBC and not just the two phases understudy in this chapter.

The remainder of this chapter will be directed at the initial two phases of the FBC. To facilitate the description of schedule relationships the author will speak of the typical budget proceedings to be taken for FY 1968. Also, this will enable a treatment of the Budget Bureau's new Planning-Programming-Budgeting System which is being used to formulate the budgets of most cabinet level agencies or others of substantial size including NASA.[4]

Executive Preparation and Submission

Budget Preview

As early as January, 1966, the "Quadriad," consisting of the Budget Bureau, Federal Reserve Board, Treasury, and Council of Economic Advisers, will meet to discuss, analyze, evaluate, and forecast the range of critical economic parameters which will dictate the probable state of the economy in FY 1968. Quite evidently, this must be done before valid projections expressing government revenues for FY 1968 can be made which will in turn largely delineate the tenor of government policy and the substance of its programs for that year.

Once this "embryonic" evaluation has been reached, the President will discuss the broad policy positions which may be pursued with the Director of Budget Bureau and a decision on the overall expenditure level for FY 1968 is originally cast. However, this "expenditure level" is much more realistically characterized as an "expenditure range" which because of numerous contingencies may be either an understatement or an overstatement of government activity in FY 1968. Nevertheless, a basal point must be derived in early 1966 from which the Administration can institute its first evaluation of the foreseeable program scope in FY 1968 — then it can expand and refine upon them as the previously projected variables become more accurate and reliable. This evaluation

[4] Bureau of the Budget, Planning-Programming-Budgeting, Bulletin No. 66-3, (Washington, October 12, 1965), quod vide, pp. 1 through 11.

process involving the President and the "Quadriad" will essentially continue right up to the time of the FY 1968 budget's Presidential submission to Congress in January, 1967, and then on into the given FY. To do otherwise, would be inconsistent with the most elementary principles of sound planning and budgeting (not to mention politics).

Yet projections of expected resource levels are of no value unless correlated to the need for the given resources. Only after appraising the fragmentary requests and their summation effect on total predicted resources can rational policy and program decisions even hope to be made. Therefore, in March, 1966, the Budget Bureau will issue a "Call" for the FY 1968 preview budget submissions (preliminary estimates) from agencies in the Executive Branch. This "Call" will relate the Administration's board policy position , which will be of concern to the specific agencies.

The Budget Bureau is unquestionably a dynamic, highly competent (although understaffed) organization whose allegiance is singularly directed toward the President, and rightly so, due to his near plenary reliance upon them in budgetary affairs. BOB has since its creation under the Budget and Accounting Act of 1921 held massive responsibilities in assisting the President arrive at a credent budget, however, this is becoming an increasingly difficult task as government's burgeoning role assumes greater diversity and complexity. It is Aaron Wildavsky's belief that:

> Aside from the complexity of individual budgetary programs, there remains the imposing problem of making comparisons among different programs that have different values for different people. No matter how hard they try, therefore, officials in places like the Bureau of the Budget discover that they cannot find any objective method of judging priorities among problems.[5]

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[5]Bureau of the Budget, Planning-Programming-Budgeting, Bulletin No. 66-3, (Washington, October 12, 1965), quod vide, pp. 1 through 11.

While the question of exactly how much analytical objectivity BOB is capable of rendering programs under the National budget remains open, the Budget Bureau is effecting a new Planning-Programming-Budgeting System this year at the request of the President which will lend more objectivity to the NBC. A discussion of pure program budgeting is not intended here, but specific provisions of this new system will be mentioned, particularly when relevant to schedule aspects of the Cycle.

Approximately at the same time (March, 1966) BOB issues its preview "Call," NASA Headquarters is engaged in preparing a "tentative preview" for FY 1968 from data generated in the 66-1 POP.[6] As we shall learn in more detail in chapter 4, the MSC input for this preview estimate constitutes the budget information supplied by this Center exclusively through the 66-1 POP.

Once NASA Headquarters has all the necessary inputs from the field, they will integrate this data and make an analysis considering past accomplishments, existing commitments and obligations, and future needs of both established programs and proposed ones. Then decisions regarding NASA policy must be effected regarding the Agencies' preview request for FY 1968 resources. This data is subsequently translated into NASA Program Memoranda and is transmitted to the Budget Bureau by May 1, 1966. Also, throughout March and April, BOB receives Special Studies from NASA which "may involve intensive examination of a narrow subject or broad review of a wide field."[7] The preview estimates are primarily used to resolve broad policy issues and afford them with an associated gross dollar figure.

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[6] The POP refers to the Program Operating Plan and essentially represents a summation of NASA's financial plan. This agency wide document is formulated at field installations and adjusted at Headquarters. Chapter 4 will cover it extensively.

[7] Bureau of the Budget, op. cit., p. 7.

Following receipt of the NASA preview estimate for FY 1968 and its review, the Director of the Budget Bureau will meet with NASA's Administrator to discuss the Agencies' request in light of the Administration's overview on the scope and content of government programs in FY 1968.[8] Nominally this will occur around June 1, 1966, and at this time the Administrator will provide the BOB Director with up-dated budget data generated through the 66-2 PCP.[9]

This session extends to the Administrator an opportunity to personally convey his Agencies' plans, aspirations, and resource needs for the given year. Conversely, the Director is afforded a chance to play his role as the President's "right hand man" in budget matters and accordingly stress the degree to which NASA's programmed activity levels may be met in view of the Administration's total projected commitments. Of course, the Director's position relates the latest feedback from the "Quadriad," of which he is a member, and the most recent policy decisions derived from the continuing analysis of the "big pictures" by the Administration.

By the end of June, the first part of the Executive Preparation and Submission phase is complete. This represents the initial battle in the long range confrontation to strategically plan for, request, and wind appropriated new obligational authority. Before continuing the analysis of the FPC, the author will advance a few comments and observations concerning the interactions of this preview period which are pertinent to NASA/MSC's R&D budget formulation process.

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[8] Donald Bowman – interview on 3/2/66.

[9] See chapter 4.

Preview Period Observations

One of the most self-evident and significant expositions emerging from this initial period is the united attempt to create congruence between the governments program base and the spectacle of the FY 1968 expenditure base. Inclusive in this action are the techniques of budgeting from the "bottom up" and the "top down" along with a broad projection of futuristic parameters of critical importance to the economy. Thusly, agency heads, the Budget Bureau Director, and other members of the Administration are making the first-run evaluations of our nations domestic, international, and defense positions for FY 1968 and then trying to inculcate consonance between them and the multitude of discrete resource demands deluging their jurisdictions from subordinate units.

Yet, interest here is not directed toward the idealistic value of the present system or Cycle, if you will. Rather the author's foremost purpose is to analyze the FBC in relation to the R&D budget function at NASA/MSC. Pursuant to this inquiry, one hypothesis will be stated now and reinforced in this treatise's ensuing pages and chapters.

Specifically, the nature of the R&D function does not permit a rational econometric analysis and projection of need, per se, that will develop in a FY beginning 12 months after the cessation of the preview period. The R&D activity is without question a volatile entity which displays negligible affinity towards progostic efforts. There are those who maintain the difficulties in the R&D arena may be attributed to a lack of analytical sophistication and expertise on the part of operating organizations. However, while there is an element of truth to this philosophy, the author unequivocally believes that the intrinsic nature of the R&D endeavor as professed in [illegible]ter 3 should be the target for indictment regarding positive spiraling cost estimates.

This should be lucid if one simply integrates the facts of chapter 3 and the lead time implications derived from the preview estimate concept practiced in Federal budgeting. For the bulk of the data incorporated in NASA's preview figure are generated at the "grass roots" (i.e. the Centers) in January – 18 months in advance of the FY 1968 budgets operational inception and a minimum of 30 months before its consummation. This data is augmented by new budget facts available in April, 1966 – 15 months before the first dollar may be obligated. While such budget lead times may be acceptable to the more static agencies of government charged with traditional and well understood programs displaying extablished historical patterns, they usurp NASA R&D programs into a position of added hazard and uncertainty while simultaneously extracting the flexibility so vital in such a discipline.

At this point the reader may justifiably ask, "Why is there such consternation over policy and budget plans if the estimate is only a preview and thereby at best an approximation of the ultimate Executive decision concerning an agencies' program scope and substance?" Admittedly, if the preview estimate were just a vague approach to reality, budget and other agency officials would breathe somewhat easier in assembling and submitting these estimates.

However, with growing consistency, the preview estimate is becoming the "ceiling figure" over which agencies (including NASA) may not cross in formulating their budgets for a given fiscal year." In other words, the likelihood is great that NASA's preview budget estimate generated in March, 196[illegible], will represent the maximum dollar figure for which the Agency may be appropriated NOA. This by no means implies government agencies will receive NOA equal to this preview figure! In fact, the preview budget figure is characterized as a "summit" by many Washington budget professionals. Over the course of an Administration's pre-operational budget evolution, most agencies (including NASA) run the risk of having their "summit" incrementally shrunk by finite bits and pieces, although the degree an agency is affected varies according to their function and the overall state of affairs existing throughout the relevant period. This is because after the period in which the preview estimates are prepared, the FBC enters a phase in which BOB is concerned primarily with cutting priorities and eliminating what are considered to be "marginal" programs. One finds that it is only the projects of the highest priority which can gain entrance into an agencies' program once the Cycle has passed the preview period.[12] The "contracting summit" phenomenon is one of the principal reasons why budget officials demand their preview compilations epitomized a relentless effort of unquestionable integrity.

The tremendous impact an agencies' preview estimate may exert on the final amount of NOA it receives will necessitate the adoption of numerous intricate procedures, especially in external relationships with other government institutions holding substantial power and responsibility in the budget process. The cruciality of these interfaces means that policy inputs must be refined and implemented in as sophisticated a manner as possible so that an agency can be victorious in the competitive battle for appropriations. This is accomplished through close alliances with top management, the prudent reading of and living with political undercurrents, and the development of a sound strategy.

In formulating a strategy of optimal value for advocating its programs, an agency will essentially be involved with the Budget Bureau throughout this

[12] J. Dawson – interview on 8/23/65.

preview period. While other institutions enter the picture before the Cycle is complete, concern throughout the Executive Preparation and Execution phase is again primarily with BOB.

Therefore, the strategy employed in exchanges with BOB is of expressed significance not only in the preview period, but also throughout the year and during any phase of a budget's development. Naturally an agency will attempt to request and obtain the maximum number of dollars they think their programs can justify. Yet to continually submit estimates substantially higher than the NOA received will mark an agency as irresponsible and consequently their proposed budget will likely be subjected to mechanical cuts irregardless of merit. Or conversely, such agencies will discover their budget submissions coming under scrutiny in an excruciating fashion. Neither of these situations is thought to be beneficial in the opinion of an agency.

Quite naturally then, there will be a concerted effort on the part of an agency to establish, nurture, and sustain effective rapport with the Budget Bureau. Most agencies believe this is imperative even though the real authority to appropriate monies lies with the Congress. For the "budgeting game" is at best an esoteric process in which life can be much more bearable if mutual respect and fluid communications exist amongst the principal participants.

Hereagain, the reader should intuitively recognize potential problem areas. NASA must be reasonable knowledgeable on the status in its programs in FY 1968 before it can rationally develop the strategy to use in pursuing monies for that FY. As previously shown, the inherent nature of the R&D function makes this an arduous task. Nevertheless, NASA <u>must</u> assume a position from which it can substantiate its budget and accordingly the Agency constructs a preview estimate for its FY 1968 activities. While accuracy historically has left much to be desired in these estimates, at least the initial actions are taken and the Agency passes from the period of the preview to that of the final estimates which are incorporated into the President's budget.

Final Budget Estimates

The interactions, assumptions and phenomena governing the preview period are also very conspicuous over the duration of the final budget estimate period. For the entire FBC is directed at a singular objective — the development of a sound National budget. Changes realized over this period are more of degree than substance as the Administration is afforded an increasingly clear portrayal of the parameters (economic and political) which will ultimately delineate the new obligational authority level for FY 1968.

By July, 1966, the President has received all agency preview estimates and the "Quadriad" has finished a complete re-evaluation regarding the revenue-expenditure projection for FY 1968 which is subsequently incorporated into his Administration's plans on the budget. Another factor which must be schrewdly analyzed is the Congressional climate and particularly the fate of legislation coming before the authorization and appropriation committees in 1966.

All of these data will be integrated and a resultant "overview" will emerge sometime in July. Then the President resolves the issues concerning FY 1968 program and fiscal guidelines, and transmits this information to the Budget Bureau Director who subsequently disperses a "Call" for final budget estimates. In compliance to the President's direction, the agency "Calls" relate guidelines, format, and other pertinent information which must be observed and included within the agencies' final budget submission. The "Call" could occur anytime from late July up through August in 1966.

Upon receipt of the BOB "Call," NASA Headquarters will initiate steps toward generating the stipulated information. The primary input relied upon will be the 66-3 POP which is consolidated and adjusted at Headquarters by the middle of August, 1966. The procedures and techniques instituted are almost identical as in the preview period with the exception that all facets of the estimates require noticeably more detail and justification.

Also, NASA will likely deem it advisable to engineer a slightly different strategy in its final budget request from the Budget Bureau for several good reasons. First, the Agency will have been assigned an explicit guideline whereas the preview estimates were cast under no such constraint, but rather under the broad direction of elementary policy decisions advanced by the Administration at that time. Second, NASA will possess a more comprehensive and reliable projection of its FY 1968 resource needs by September, 1966, as this is significantly nearer that year's program inception than would the preview estimates were calculated. By no means does this necessarily imply that the final estimate lead time is acceptable in R&D budgeting. Contrarily, the author simply ranks it as the lesser of two evils. Finally, one must recognize the germane fact that there are no provisions for FY 1968 program alterations after these final estimates are cast and concrete. For once any agency has its budget put before Congress, they theoretically must be as adamant in its support as is the President. Occassionally though, agency heads will overtly show dismay over their final budget as derived through the Executive Preparation and Submission process.

Thusly, one can visualize two possible strategies. One would be to "come in" with a final budget estimate over the BOB guidelines while the other would be to "come in" at the Administration's figure. In either case one is not sure of the final outcome.

The maneuver of submitting estimates above the guidline position might be practiced under several conditions. For example, recent positive economic indicators could be the deciding factor in advocating such an attack. Or, strategic contingencies of salient scope directly associated with our space or military stature may drastically and swiftly occur thereby justifying an immediate policy redefinition in NASA's programs and accordingly in their total dollar budget. When submitting estimates which breach guidelines, one must be thorough, rational and protect one's flanks at the same time. In so doing, all estimates must be extrapolated for FY 1968 in detail, and what are termed "marginal" programs must be projected in depth and ranked too.[12a] (These "marginal" programs if eliminated completely would force the overall budget under the BOB guideline.) Yet under the conditions described above the agency would believe there is adequate political pressure to warrant a budget over the guideline figure.

The other strategy is to "come in" exactly on the guideline. The rationale behind this approach is essentially that of playing the cooperative role and hopefully enhance your likelihood of receiving a equitable piece of the pie from the Budget Bureau. For in either of these strategies there is an excellent possibility if not a certainty that an agency estimate will be cut when

[12a] One note of clarification is called for here. What the author refers to as "marginal" programs are often considered absolutely vital by numerable NASA advocates — yet "marginal" as used by the author denoted programs not essential to effect a manned lunar landing and safe return of astronauts within this decade. Admittedly such a definition surports negative implications for our integrated evolving space effort, however the author believed it is a candid evaluation as will be further related in chapter 5.

the Budget Bureau makes its recommendations ("mark up") to the President. However, here again, NASA will submit estimates of their hard-core programs and also relate which programs are "marginal." These will be assigned priorities so that if cuts are instituted the Budget Bureau knows which programs they are extirpating.

The months of October and November (1966) will then serve as the span over which the Budget Bureau exercises its comprehensive examination of NASA's budget. To facilitate the mechanics of this process hearings are held, informal contracts are made, and an analysis is ultimately finalized. The individual assuming the primary responsibility in this scrutinization is the NASA Examiner. He will continuously keep pace with the Agency and throughout the year maintain liaison with Headquarters and the Centers in an effort to remain as knowledgeable as possible in this area. Probably in late November 1966, the Examiner will extend his recommendations on the NASA FY 1968 budget to a Review Board and they will in turn make recommendations to the Director of the Budget Bureau for incorporation into the Administration's FY 1968 budget. Typically this assessment and recommendation is termed a "mark up." As stated earlier, the "mark-up" frequently is lower than an agencies' guideline:

> The Budget Bureau is expected to cut partly because it has an interest in protecting the President's program and partly because it believes that the agency is likely to pad.[13]

Top NASA management is notified of said action and afforded an opportunity to make a "reclama" or an appeal, if you will, on the BOB "mark up." Those issues which cannot be resolved through NASA-BOB consultation will be forwarded to the President for a final (Executive) decision.

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[13] Wildavsky, op. cit., p. 23.

By the middle of December 1966, all agency budgets have been determined with the possible exception of the Defense Department. The President will once again pay heed to the "Quadriad's" predictions for FY 1968, re-examine the integrated National budget, and institute any modifications he deems advisable in the light of this latest analysis.

Simultaneously NASA and other agencies will compute fiscal and program schedule data pursuant to the President's summation budget pronouncement. These will ideally be submitted for inclusion in the President's Budget Document and Appendix by late December. Finally the phase of Executive Preparation and Submission for the FY 1968 budget will be consummated when the President submits his budget to Congress in January 1967.

Final Budget Estimation - Observations

The general characteristics marking the generation of final budget estimates are much the same as those inherent in the preview period. The obvious difference is seen in the more explicit parameters governing the process and the transition from ambiguous to specific actions. Budget refinement of this nature carries with it both positive and negative implications for the R&D function.

On the positive side of the picture NASA is obviously extrapolating under a less ominous lead time and therefore the uncertainly factor is diminished - this is an improvement, but only that over the lead time found in the preview period. Consequently, decisions made concerning program content and magnitude can be expected to be a better approximation of what NASA will in reality need in FY 1968. Moreover, the Agency will learn over this period precisely its fate as the Administration chooses to cast it.

Paradoxically, this firming up phenomenon creates a serious problem in the NASA R&D budgeting function. For with each succeeding day the budget becomes more finite, more easily identifiable, and accordingly the ability to vanquish sudden program adversity is impaired. Yet the reader may assume such an argument is superfluous and unwarranted in view of the fact the FY 1968 NASA budget still must pass through the most crucial phase of them all — Congressional Authorization and Appropriation. The author suggests two factors in refuting such an argument.

First, the Administration view with contentiousness any agency which attempts to bolster its budget after it has gone to Congress. There would have to be a major failure in one of NASA's first-line programs which could be recouped only through a strong influx of additional monies before the Administration would even consider backing such an addition to the budget.

Basically, what this means is that failures of less importance affecting programmed FY 1968 work will be circumvented at the expense of "marginal" programs. This may be necessary if NASA's lunar landing-safe return objective is to be effected as planned, but such actions portend negative connotations for the long duration capabilities in space endeavors of the agency, not to mention the United States. Unfortunately the next phase to be studied is unable to sufficiently cope with this situation as we shall see.

Second, even if the Administration believes more monies should be extended to NASA, for example, the cyclical aspects of the FBC may make this politically impossible. Particularly so in years when the projected revenue base may shrink from where it was earlier forecast. A lower revenue base together with the fact that other agencies cannot be feasibly cut back by the President all added to a substantial increase in the NASA budget would suggest a deficiency which will be politically more serious than the slippage in the space program. Therefore, the funds will not be advocated by the President although Congress may come to the rescue.

Once again, we have seen the curse of uncertainty associated with long lead times as the basic problem. It is an entity which represents the primary derivative of most R&D budget difficulties, and yet something that under our present FBC must be lived with.

Congressional Authorization and Appropriation

The budget year is now approximately 5 months away as it is late January, 1967. The Executive Branch has been engaged in planning-programming-budgeting activities for over 12 months, yet the authority and appropriations so fundamental to its agencies' programs has not even been considered by Congress. However, this is without question the most important phase of the FBC as one can readily imply from Article I Section 1 of the United States Constitution:

> All legislative Powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives.

Although either House in the Congress may initiate action on appropriation bills, the House has traditionally assumed the role of taking first action. Approproation bills required no fiscal authorization in Congress until 1337 at which time the authorization provision was adopted. Therefore the NASA FY 1968 budget will come initially before the House Committee on Science and Astronautics in February 1966 for the purpose of authorization. The full Committee will hold hearings over this period and subsequently divide into Subcommittees which will meet until the middle part of April 1967.

The Manned Spacecraft Center has special interest in the proceedings undertaken by the Subcommittee on Manned Space Flight. This is not surprising considering MSC's primary programs are in the manned space flight (MSF) arena, and MSC will prepare presentations, fiscal and program data, and other information for these hearings as requested – it is not unusual for this Subcommittee to hold some of its sessions at the three principal MSF Centers including MSC.

After hearing literally hundreds of pages of testimony, countless questions and answers, and making a genuine attempt to execute a persevering, in depth analysis of the MSF programs, the Subcommittee on MSF will transmit its findings and recommendations to the Committee on Science and Astronautics. The full Committee will then consolidate and integrate these subcommitee data into a bill which is reported to the House. Traditionally, the House accepts the recommendations of its subcommittees who are much more relatively knowledgeable in their given assigned areas than are other members and hold the real power. The House authorization bill should be resolved and passed by the end of April 1967.

Following passage of the NASA authorization bill for FY 1968 in the House, the Senate Committee on Aeronautical and Space Sciences will initiate hearings on the same bill. However, the role played by the Senate is markedly different from that of the House in both the authorization and the appropriation concerns. One finds that:

> ...Senators value their ability to disagree on items in dispute as a means of maintaining their influence in crucial areas while putting the least possible strain on their time and energy.[14]

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[14] Ibid., p. 52.

The Committee will accordingly examine carefully any "reclama" NASA submits on the House bill for FY 1968. The hearings will attempt to scrutinize these differences and finally the Committee will report its findings along with a recommended bill to the Senate floor where it is usually accepted by the other members. This action will not be completed before mid-May and frequently much later.

If any variance exists between the Senate and House versions of the NASA authorization bill which is more often than not the case, the Conference Committee composed of members from the two substantive committees mentioned herein will meet to resolve the differences. Their report must receive approval in both the Senate and the House. Assuming this is achieved the President will sign the NASA FY 1968 authorization Act in May or early June, 1967.

There is one very important fact the reader should learn about the explicit structure of NASA's authorization bill which extends constraints on the reprogramming of money. The authorization bill lists by program the finite amount of dollars that may be appropriated. The act for FY 1968, if similar to the one for FY 1966, will go on to state that:

> ...no amount appropriated pursuant to this act may be used for any program in excess of the amount actually authorized for that particular program...
>
> unless (A) a period of thirty days has passed after the receipt by each committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.[15]

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[15]"NASA Authorization, 1966," U.S. Code: Congressional and Administrative News, No. 7, (St. Paul, Minnesota, July 20, 1965), pp. 1232 through 1934.

The connotations advanced in this section of the act will be investigated later.

The authorization process is usually thought to be more involved than the subsequent appropriation period. For many of the programs are given the most substantive inquiry when before the authorizations committees.

Pursuant to Article I Section 9.7 of the United States Constitution "no Money shall be drawn from the Treasury, but in Consequence of Appropriations made by Law..." Accordingly even before the NASA Authorization Act of 1968 is passed in the Senate and signed by the President, the House Committee on Appropriations will consider the NASA request for monies beginning in March 1966. The specific NASA bill is then transmitted to the Independent Offices Subcommittee which holds the primary responsibilities and power for appropriating NOA to NASA. The Subcommittee will send an approved bill to the Full Committee whereupon conculsory approval is reached before the bill is recommended and submitted to the House. After the NASA Authorization Act of 1968 has been signed by the President, the House will take final action on its appropriation bill – hopefully by mid-May, 1967.

The Senate Committee on Appropriations commences work on the appropriations bill in May by submitting the legislation to the Independent Offices Subcommittee in the Senate. Once again, NASA will advance a "reclama" to the House bill when it feels justified in doing so. This reaffirms the Senate's basic role mentioned beforehand and is exemplified candidly by Senator Thomas:

> It has been the policy of our (appropriations) committee, to consider items that are in controversy. When the House has included an item, and no questions has been raised about it, the Senate Committee passes it over on the theory that it is satisfactory...[16]

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[16] Wildavsky, op. cit., p. 16.

Sanguinely by mid-June the Subcommittee will have extended to the Full Committee its recommendations and the subsequent transmission to the Senate will be effected by mid-June. Floor approval in the Senate, followed by the Senate-House Conference to resolve existing differences would occur, and the bill would be sent to the President for signature into law.

The President will route the proposed legislation to the Budget Bureau and they will afford the agencies affected therein (Independent Offices Appropriation Act, 1968) an occasion to seek Presidential veto or public recognition of the bill's deficiencies as they see them. By June 30, 1967, the President will sign the act into law – hereagain, the reader should realize this is an idealistic depiction of the Congressional Authorization and Appropriation phase's schedule and frequently agencies including NASA must operate under a "Continuing Resolution" until late July, August, or even later. The Congress is an independent institution in the most literal sense and does not function under a superimposed schedule such as the Executive Branch must.

Before discussing the characteristics of this phase, one general provision structured under NASA's section of the Independent Office's Appropriation Act, 1966 bears mention. The Act stipulates that:

> Not to exceed 5 per centum of any appropriation made available to the National Aeronautics and Space Administration by this Act may be transferred to any other such appropriation.[17]

This means that NASA may transfer up to 5 percent of appropriated funds from R&D, AO, and C of F to one another. Thusly under conditions where money is available in the AO and C of F appropriations, NASA can transfer these

[17]"Independent Offices Appropriation Act, 1966," U.S. Code: Congressional and Administrative News, No. 10, (St. Paul, Minnesota, September 5, 1965), p. 2436.

funds to R&D programs. Of course, in programs where these additional increments would create program levels over what is authorized, Congress must be notified as related in an earlier quotation.

In addition, there are two other external controls imposed upon the FBC system which are not specifically elucidated in either the authorization or appropriation acts. Revised Statute 3678 makes the condition that:

> Except as otherwise provided by law, sums appropriated for the various branches of expenditure in the public service shall be applied solely to the objects for which they are respectively made, and for no others.[18]

This promulgation is of course to be associated with the language of the authorization act concerning reporgramming and should be analyzed in that light.

Furthermore, Revised Statute 3679 explicitly states that:

> (a) No officer or employee of the United States shall make or authorize an expenditure from or create or authorize an obligation under any appropriation or fund in excess of the amount available therein; nor shall any such officer or employee involve the Government in any contract or other obligation, for the payment of money for any purpose, in advance of appropriations made for such purpose, unless such contract or obligation is authorized by law.
>
> In addition to any penalty or liability under other law, any officer or employee of the United States who shall violate subsections (a), (b), or (h) of this section shall be subjected to appropriate administrative discipline, including, when circumstances warrant, suspension from duty without pay or removal from office; and any officer or employee of the United States who shall knowingly and willingly violate subsections (a), (b), or (h) of this section shall, upon conviction, be fined not more than $5,000 or imprisoned for not more than two years, or both.[19]

The implications of this statute do not warrent pointed reiteration, although chapter 6 will regress to consider these provisions which are known as the Anti-Deficiency Act.

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[18]"Money and Finance," United States Code: Annotated, Title 31, (St. Paul, Minnesota, 1954), 31:628, p. 496.

[19]*Ibid.*, 31:665, pp. 513 through 517.

Congressional Authorization and Appropriation - Observations

The author will initially yield a survey of the FBC's second phase before generalizing on the aspects in the Cycle pertinent to R&D activities (exclusive of the execution and audit functions). Heretofore, the author's description of phase two has not been substantially expanded upon from chapter 2, for as stated in the introduction the interest is not so much in flow mechanics, but rather the more subtle, yet crucial interactions of relevance to the R&D budget formulation process. The ensuing discussion will extend some insight to the crux of the problem at hand.

Several factors regarding Congress and its members must be grasped before the correct overview may be assimilated by the reader. First, anyone who has even the slightest knowledge of the philosophy underwriting our democratic system is cognizant that Congress is an independent body which by and large owes its primary allegiance to the multitude of singular constitutents who in reality determine the composition of that assemblage. Second, and equally significant, Congress is an institution with an unimpeachable genesis which reveres its traditions, mores, and methodologies that have become so deeply ingrained with the passage of time.

One more fact before succumbing to specifies - the increasing complexity of the world today. While this is an obvious development, the author wonders if we appreciate the far reaching connotations this extends towards the many facets of everyday life. Specifically that which technology advances, population grows, international relationships near incomprehensibility, and the National Budget expands at will, the United States Congress embraces its ancient methods as staunchly as ever.

For example, in FY 1926 (just 40 years ago), the Administrative budget[20] was 2.9 billions which is a mere 55 percent of NASA's total appropriated NOA in FY 1966. Over this 40 year span the Administrative Budget has burgeoned astronomically to the extent of realizing an approximate 3787 percent increase. Over an identical period Congress has seen the House increase by zero members and the Senate by 4. This represents augmentations of 0 percent and 4.1 percent respectively – Congressional Committee Staff remains rather small. These data manifestly portray the fact that while budget responsibilities have aggrandized in near geometric proportions, the corresponding manpower affected has achieved what amounts to microscopic gains in relative terms – this is not to be construed as a flagrant indictment of Congressional capability, but rather a recognition of an area in which it may need assistance. For as Arthur Smithies states:

> Reform of procedures of Congress has lagged far behind reform on the Executive side, not because reform is less urgent, but because Congressional procedures seem more intractable and are deep-rooted in tradition.[21]

The enigmatic nature overshadowing numberous agency budgets to come before Congress is candidly recognized by many of its members:

> It is not surprising... that one runs across expressions of dismay at the difficulties of understanding technical subjects. Representative Jensen has a grand-daughter who is mentioned in hearings more often than most people, and who is reputed by him to have read "all the stuff she can get on nuclear science... and she will ask me questions and she just stumps me. I say, 'Jennifer, for heaven's sake. I can't answer that.' 'Well,' she says, 'You are on the Atomic Energy Commission Committee, Grandpa.' 'Yes,' he replies, 'But I an not schooled in the art.'" A cry goes up for simplification.[22]

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[20]The Administrative Budget is a measure of the United States Government's revenues and expenditures excluding trust fund transactions.

[21]Arthur Smithies, The Budgetary Process in the United States, (New York, 1955), p. 89.

[22]Wildavsky, op. cit., p. 9.

Compensation for such insecurity, espeically in R&D budgets, is attempted through several means.

One method is to interrogate the agencies' principal witnesses very intensely with little regard for the budget per se, but rather the witnesses' integrity. If the Congressmen can establish that the witness is an individual of substantial competence and remains "cool" while under fire, they are much more likely to have faith in the budget he is advocating – a budget which is virtually impossible for them to understand completely.

On the other hand, Congressmen may choose to investigate functional areas for which they are relatively knowledgeable in contrast to many of the highly technical areas of the budget. Here too the evidence of prudent, rational management in an isolated functional area will greatly enhance the legitimacy of an agencies' esoteric technical plans under proposal in the budget.

Or, a Congressman may approach being termed an "authority" in narrow segments of an agencies' technical programs. He may then direct questions of a markedly pedantic nature which frequently require advanced preparation to answer. If agency staff have been sufficiently perceptive or warned in advance, they will answer such questions with ease. However, if this isn't the case, their agencies' immage and its budget may suffer accordingly.

It would seem that the above techniques may leave something to be desired in a body whose paramount mission is to formulate policy. Admittedly, administrative review is also a Congressional function, but even here there appears to be little consonance between methodology and purpose.

The massive dimensions and dumfounding complexity of the National Budget has generated yet another phenomenon of interest. This is the increasing reliance on the part of Congress on incremental budgeting. Agency budgets are simply too large to analyze completely each year. Therefore a base of comparason is needed which has traditionally been historical budget data:

> Budgeting is incremental, not comprehensive...it is based on last year's budget with special attention given to a narrow range of increases or decreases. Thus the men who make the budgets are concerned with relatively small increments to an existing base.[23]

This incremental, historical approach purports several effects. For one thing, the inability to achieve an indepth coverage of the National budget has accounted for structural and procedural constraints as shown in the authorization and appropriation language as well as Revised Statute 3678. Congress also displays concern for variance between obligations and accrued cost in R&D programs, yet the intricacies guiding these programs are frequently not understood. Arthur Smithies strongly believes:

> The Congress has never made effective and systematic use of the review of actual operations as in instrument of control, in part because the Congress has been more anxious to control the Executive than to promote its efficiency.[24]

The implementation of the Planning-Programming-Budgeting System is another step forward in the Executive Branch, yet it will not accomplish its ultimate purpose until Congress discards its archaic functional exmainations and adopts a more realistic program orientation. Only if Congress can initiate actions guided at translating concern from its historical, fragmentary, and nonprogrammatic budget procedures toward a true program technique will there be any marked improvement in the FBC. For modernization of only the Executive Branch is of no value unless accompanied by similar efforts in the Legislative Branch.

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[23] Ibid, p. 15.

[24] Smithies, op. cit., p. 49.

To do otherwise may be likened to building the Empire State Building without structural steel and reinforced concrete – a virtual impossibility.

Yet, one must not become provincial in assessing the mechanics of the FBC. One of the foremost factors governing this system is the political environment. For the Cycle itself is essentially a procedural device engendered to express political decisions and realities.

Any agency which has demonstrated fair success in the budget process has undoubtedly been involved in prudent "political gamesmanship" – the following quote serves to elucidate this:

> "It's not what's in your estimates but how good a politician you are that matters."
>
> Being a good politician, (these) officials say, requires essentially three things: Cultivation of an active clientele, the development of confidence anong other government officials, and skill in following strategies that exploit one's apportunities to the maximum. Doing good work is viewed as part of being a good politician.[25]

Therefore, it is most important to present a dynamic program or the Congress may well designate another cut and thusly lower the agencies' budget "summit". There are many agencies advancing programs in this phase and invariably many of them will receive budget cuts – the principal desire is to avoid such cuts or keep them at a minimum. As W. A. Jump relates:

> ...unless departmental representatives proceed to present their viewpoint in a vigorous and tenacious manner, objectives which are essential...to the public welfare might, for the time being at least, be submerged by some purely budgetary objective, or by the budgetary power, rather than served thereby.[26]

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[25]Wildavsky, <u>op. cit</u>, pp. 64 through 65.

[26]W. A. Jump, "Budgeting and Financial Administration in an Operating Department of the Federal Government." Paper delivered at the Conference of the Governmental Research Association, Sept. 8, 1939, p. 5.

There is another factor extended by phase two that no doubt affects agencies responsible for substantial R&D programs more than any others. This is quite simply the schedule relationships Congress works under. The main problem is that verily no budget is assured of appropriations by the inception of a new FY. When new monies are not appropriated NASA must operate under a "Continuing Resolution" which tends to produce detrimental consequences upon both on-going and proposed programs.

Take for example a program where NASA is rising up the obligational curve towards its apex. This situation necessitates incremental obligations of progressively greater dollar magnitude. This is nothing unusual, but rather a simple fiscal reality – at given times more and more money is needed to achieve programmed objectives before decreasing costs occur. Any other method of funding breaks program momentum, increases overhead costs, generates secondary and tertiary derivative problems, and creates inefficiency and waste. Yet, this is what happens frequently in R&D program budgets as a result of "Continuing Resolution" funding.

The reason for this jamming-up of the schedule will be synthesized from a multitude of conditions ranging from filibustering in the Senate to the sheer and ever-increasing complexity in the budget itself. Regardless of causation though, the implications of such an occurance on an R&D program may be very serious indeed. It would seem Congress does not hold a full appreciation for the adversity such a schedule lag generates.

This difficulty also occurs when an R&D agency program developes a crises while the agency is under "Continuing Resolution" funding. Obviously flexibility and new funds are vitally needed under such a contingency if irreparable schedule, cost, or performance impairments are to be averted. However, once again, the damage will probably occur before funds are appropriated and apportioned.

The nature of the Congressional Authorization and Appropriation phase especially as it advances crucial connotations to the R&D function has been explored in the antecedent discussion. The succeeding relationships should be emphasized.

For one thing, the primary thrust governing this phase is political. This is not an attribute held in esteem by R&D planners. Alternations in the political environment, either domestic or international, may substantitively necessitate a readjustment of plans, objectives, and schedules as funding expectations evolve.

Recognition must also be accorded to the complexity of the National budget in general and the R&D budget in particular. Therefore, it is essentially impossible under existing analytical and methodological techniques used in the Congress to gain the necessary overview of the whole process or many individual agency budgets. The author believes decisions are frequently made in a void where all the facts have not been integrated and consolidated as extensively as they well could be with a few changes (see chapter 6) in our present system. Naturally, when decisions concerning NASA's R&D effort are being case before all their subtle implications are understood, various R&D programs will likely suffer.

This inability to evaluate all aspects of the advanced R&D programs is acknowledged by the Congress and rectified in their estimation through restrictive language in the authorization, appropriation, and Revised Statutes legislation. Yet, dynamic R&D programs in which flexibility is most vital are inhibited through such language moreso than need be.

Moreover, the mechanics and values dictating the tenor of committee hearings must in all sincerity be judged as in violation with the principles of merit. This fact may be especially crucial in advanced R&D work where "cost-benefit" and "cost-utility" are very difficult to apply objectively in the various projects.

Finally, the futile schedule fluxations inherent in Congressional Authorization and Appropriation is another major burden in the R&D budget formulation process. For example, NASA is not only frozen at or lowered from a given budget level, but is also forced to structure unnatural lags in its on-going and planned programs when Congress fails to appropriate NOA by July 1 in a given year. This phenomenon can reach critical proportions.

Many of the phenomena related herein by the author are lucidly summarized in the following quote by Jesse Burkhead:

> In every modern government there has been increased centralization of of executive budget authority and increased staffing for the central budget office, with frequent reorganizations of budgeting and financial procedures. No comparable centralization has occurred in legislatures; the trend here has been toward decentralization of budget-making authority.[27]

However before any postulations are advanced the author will explain the exact role MSC plays and how it is fulfilled in the NASA budget formulation process (chapter 4). In addition relevant budget data and a discussion thereof will follow so that the reader may see documented proof of the phenomena set forth in the preceding pages (chapter 5).

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[27] Jesse Burkhead, Government Budgeting, (New York, 1956), p. 315.

CHAPTER 4

The Program Operating Plan

The preceding chapter delt expressedly with the first two phases of the Federal Budgetary Cycle as it interacts at the NASA Headquarters and Washington level. The writer's interest will now transfer to the "grass roots" portion of this process and concentrate on the Manned Spacecraft Center's role in the FBC. In so doing, this chapter will center around the Research and Development – Manned Space Flight Programs – Program Operating Plan[1] (POP) generated at MSC and consolidated and revised into a unitary R&D MSF POP by the Office of Manned Space Flight at NASA Headquarters in Washington, D.C.[2]

Obviously, some type of fiscal plan must be formulated by MSC if the Center is to meet its charged duties and responsibilities in providing Headquarters with the data necessary in compiling the Agency budget. Since January 1964, NASA has relied upon the POP as its primary instrument in accomplishing this task. The ensuing discussion will examine the POP's purpose, format, and schedule aspects before yielding an evaluation on the document itself.

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[1]Hereinafter referred to as the "POP".

[2]MSC also submits POP's separately for Advanced Research and Technology and Space Sciences Programs. However, these are relatively insignificant at MSC and will not be scrutinized individually. These two submissions are identical in format, although scope and substance found in them differs from the R&D MSF POP.

Purpose

Basically the POP is nothing more than MSC's financial plan which portrays historical, present, and futuristic budget information. Since its creation in early 1964, the primary purpose of the POP has been to serve three functions.

First, the POP relates both preview and final budget estimates advanced by the Center to Headquarters each year. These are essential inputs into the Agencies' overall budget.

Second, this document operates as a plan which designates the probable rate of resources authorizations and allotments. Included in this plan are the typical recurring issurances, "Continuing Resolution" activity levels, and any year-end adjustments implemented to achieve the maximum utilization of Agency monies. One admonition is warranted here – namely, that the POP extends absolutely no authority in any sense to operating officials within NASA. As already stated, it is simply a plan of projected resource needs.

Third, the POP is instrumental in affording NASA a basis by which the status and performance of previously planned obligational activities may be thoroughly analyzed. This is a fundamental requisite of rational budgeting, as plans cannot be improved upon until detrimental phenomena identified through an historical evaluation are segrated out of the program or otherwise adjusted for.

Format

Quite naturally, a budget document such as NASA's POP must be structured and operationally implemented to furnish resources data which will be uniform in composition regardless of the generation point. The subsequent description should clearly delineate the format subscribed to by NASA/MSC and simultaneously set forth explicitly what the POP entails. The writer will use the 66-1[3] POP in the following discussion as an example – although POP formats vary over time, the primary concepts inspected hereinafter are well established.

The first concept relating to format coming under study will be the POP's substance. Hereinafter, all entities comprising the POP will be referred to as line items by the author.

Under this writer's definition, any given program such as Apollo constitutes a discrete line item. Yet the Apollo Program is divided into specific projects (in the MSC 66-1 POP) which are necessary for the ultimate attainment of that Program's objectives – namely: (1) Apollo Spacecraft; (2) Mission Control System; (3) Apollo Space Operations; and (4) System Engineering. Each of these projects represents a line item and upon summation they will equate the Apollo Program line item.

Furthermore, given projects of a program are each subdivided into units called systems. For example, the Apollo Spacecraft Project is formulated from systems such as the Command Service Module, Navigation and Guidance, and the Lunar Excursion Module to mention the three most prominent ones. The author also designates each of these as line items. However, for any given projects, one does not always find all of its specific systems included in a single POP.

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[3]This POP was generated at MSC in January 1966, and reviewed and adjusted by NASA Headquarters staff in February 1966. This code will be explained later in this chapter.

Finally, the POP has line items representing major and minor contracts. Major contracts are defined as 100 million dollar total value obligations while minor contracts must have a total obligational value of at least 100 thousand dollars in addition to being designated as a minor contract by Headquarters.

Thusly we see five distinct units qualifying as line items. In the 66-1 POP there were eighty-two line items listed in these classes. The data found in the POP's line items are summarized at the Program, Project, and selected systems level. This summary information is manually prepared while the aforementioned line items are a mechanized printout run from computer facilities.

Hopefully this treatment on line items has provided the reader with insight regarding the budget items covered in the POP. Now the author's treatment will gravitate to the specific financial management concepts related in a POP for each individual line item.

All line items scrutinized above are evaluated in the POP through the use of six information inputs. These are: (1) obligations; (2) accrued cost; (3) work days; (4) direct manpower; (5) unfilled orders and advanced funding; and, (6) accrued cost rate.[3a]

The strong reliance upon an obligational calculus in the POP is well based. This is self-evident if one recognizes that the Federal Budget is formulated primarily in the light of NOA to be alloted competing government programs. The entire process ranging from the preview estimate, budget estimate, authorization, appropriation, apportionment, and finally to the Agency allotments observes the budget from an obligational orientation.

[3a]Figure 4.0 constitutes a blank format used for a typical line item.

[redacted]

MSC --PROGRAM OPERATING PLAN--R AND D
ANALYSIS SCHEDULE -THOUSANDS OF DOLLARS-

FISCAL YEAR 1966		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
OBLIGATIONS	[LAST [DELTA [THIS												
COST	[LAST [DELTA [THIS												
RATE	[LAST [THIS												
WORK DAYS DIRECT MANPOWER	[LAST [THIS												

FISCAL YEAR 1967		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
OBLIGATIONS	[LAST [DELTA [THIS												
COST	[LAST [DELTA [THIS												
RATE	[LAST [THIS												
WORK DAYS DIRECT MANPOWER	[LAST [THIS												

ALL FISCAL YEARS		PRIOR	1965	1966	1967	1968	1969	COMPL	TOTAL	REMARKS-SYSTEM TOTAL
UNCOSTED										
OBLIGATIONS	[LAST [THIS									
	AFTER 12/31 [TOT AVAIL									MSC
COST	[LAST [THIS [533 REPORT									CONTRACTOR NAME- NOS-
YEAR END	[UNFILL ORD [ADV FUNDS [COST RATE									PROGRAM- PROJECT-
DIR MANYEARS[THIS										SYSTEM-

Figure 4.0.- Program operating plan format.

Thusly, one may view obligations in the following manner.[4] Each line item[5] will have its actual cumulative obligational status as of 12/31/65 and planned obligation (of money appropriated but not yet obligated) designated for two periods: (1) all FY's before FY 1965 as a discrete summation; and (2) FY 1965. As we reach the current FY (1966), cumulative obligational figures for each month are entered. FY 1967 is similarly related although programmed cumulative obligations by the quarter are relied upon here through the use of September, December, March, and June data. Finally, each line item will have yearly obligational levels (non-cumulative) posted for FY 1968 through FY 1970. The line item total obligational figure for all years is given as a gross summary of the above information.

A second essential financial management tool implemented in the POP is the notion of accrued cost. This affords MSC management a periodical gauge of future dollar disbursements levels in a given line item. For as explained in chapter 1, accrued cost enumerates in simple terms the dollar magnitude of work being done by contractor(s) on a specific line item, particularly in relation to the ensuing disbursement which will be incurred for the given workload If a line items accrued cost assumes unwarranted proportions, swift action must be taken to rectify the situation.

All actual accrued costs are lumped cumulatively for FY's before FY 1965 while data are entered singularly for FY 1965 and cumulatively by month for

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[4] 66-1 POP is used in this example concerning format.

[5] In the discussion on format, the writer assumes hypothetically that all line items considered herein had monies programmed for the times under discussion. However, this will not be the case 100 percent of the time.

FY 1966. The ensuing FY, 1967, relates cumulative accrued cost for the last two months of each quarter (i.e. February and March, etc.). FY 1968 through FY 1970 are recorded as yearly (planned and non-cumulative) accrued costs. The contractors 533 report[6] for accrued cost is also included. The last entry for accrued cost will be a summation for all the years in which the line item has programmed funds. Accrued cost and obligations are both entered as present quarter (66-1) and prior quarter (65-4) data along any existing difference. This is to facilitate quick comparisons between the projections of the two quarters.

The importance of accrued cost necessitates the employment of several indicators to assist in analyzing its frequently oscillating parameters. For if accrued cost fluxuates, NASA/MSC management deems it advisable to possess secondary indices substantiating or refuting the accrued cost input.

One technique implemented in the POP is an examination of the work days in each month under consideration. The 66-1 POP designates by month the work days in FY 1966 and those in the last month of each quarter for FY 1967 for selected line items. These facts are valuable in evaluating variance in accrued cost and determining whether it is reasonable or an anomaly.

Another utilitarian method for establishing the rationality of accrued cost is through an inspection of direct manpower. This is a finite disclosure of the man years input for selected line items in the 66-1 POP. As with the work days device, direct manpower facilitates understanding the degree of

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[6] This is the basic fiscal document generated by the contractor and used by MSC in compiling financial data on line items. It lists the contractors historical funding levels along with future programmed ones.

credence in a line items accured cost, for it should vary in approximate proportion with accrued cost.[7] Here again, inequalities implied through manpower – accured cost differentials would substantiate more exacting analytical efforts into the problem.

Accured cost rate is an additional POP input of central importance. This is simply the rate at which cost is accrued by contractor(s) on a given line item. The 66-1 POP depicts this on a monthly basis for FY's 1966 and 1967. FY's 1964, 1965, 1968, 1969, and 1970 have accrued cost rates set forth for the month of June only. These data are especially gainful to program management staff in judging current FY contractor rate curves, and to financial management staff in ensuring ample future funding on said line items.

The last major concept to be discussed is that of unfilled orders and advance funding (UOAF). UOAF makes reference to just what its name implies, specifically, orders which have not been filled or delivered and monies which have been advanced to the contractor(s) prior to identifiable cost accruals on his (their) part. The cruciality of UOAF is accounted for in that it together with accured cost for a given FY cannot equal more than the total obligational authority available to whatever line item is under consideration. This particular summation relates the finite level of funding necessary at a given time and is thereby a most important input to financial management as a line item developes. The 66-1 POP records UOAF amounts individually for FY 1964 and prior years as a summation, FY's 1965 through 1970, and the gross total for all FY's.

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[7] Direct manpower includes only that which is being applied to the prime contracts. This accounts for 50 percent of the total manpower working on a line item – the remainder come under the subcontractor and are not in the POP.

All of the line items alluded to in this chapter are given at least gross coverage in a manually prepared summary section of the POP. Also it should be noted that if contracts are not given singular recognition as line items in the mechanized schedule analysis, they are included in the same mechanized portion of the POP as part of a line item which summarizes all contracts not otherwise encompassed in the analysis schedule.

The numerical data extended in the summary section of the POP are augmented by specific assumptions and narrative statements around which the 66-1 POP, for example, was generated. All striking alterations realized since the last POP (65-4 in the writer's example) must be interpreted and justified – particularly those constituting a portion of the current year and the budget year (coming FY). Such explanations should account for reprogramming actions and in so doing delineate probable program tradeoffs, additions and deletions, and derivative schedule effects.

Before consummating this section on format, a few observations are called for. First, the preceding data, upon integration, yield a well documented financial plan which accommodates the implied requisites previously discussed under the POP purpose section of this chapter. Secondly, there is substantially more detail rendered the current year and slightly less for the budget year. And finally, this document serves a dual planning purpose; one essentially for programming staffs and one for primarily financial management staffs.

Now, the writer will elucidate further aspects of the POP by initiating an examination of schedule relationships inherent in the POP. These carry very profound connotations for the entire study and reinforce much of what has been related heretofore.

Schedule

No doubt the reader has implicitly assumed that the POP is a quarterly issuance — this is correct. The document is prepared at MSC during the first month of each quarter in the calendar year. Thusly, MSC POP complications are taking place in January, April, July, and October of every calendar year.

The reason for this schedule may be traced to several causal factors. One of these deals with NASA's internal generation capability in the planning and budgeting functions. A quarterly submission rate establishes consonance between the POP and such things as the contractor's 533 report along with internal up-dated obligational readings. Moreover, it is believed that quarterly compilations lend the agency data needed to meet specific external budget needs. In other words, the POP follows a logical sequence for yielding preview and final estimates, effecting "Continuing Resolution" operations as tranquilly as possible, and adjusting year-end monies.

The reader should now peruse figure 4.1 very carefully. This diagram outlines the principal phenomena under study. The author believes that if the reader realizes the implications advanced in this schematic his grasp of the intrinsic problems of R&D budgeting should be lucid.

Under the section entitled POP Submissions we see that each POP is codified by using three numerals. These numbers, termed the designator, are constructed in the following way. The first two digits represent the calendar year while the digit positioned after the dash signifies the quarter in which the POP was generated. Thusly, the 64-3 POP was produced in the third quarter of 1964 while the 66-1 POP, being exemplified herein, was formulated in the first quarter of 1966. Figure 4.1 relates the exact month each MSC POP was composed with a darkened block under the given month.

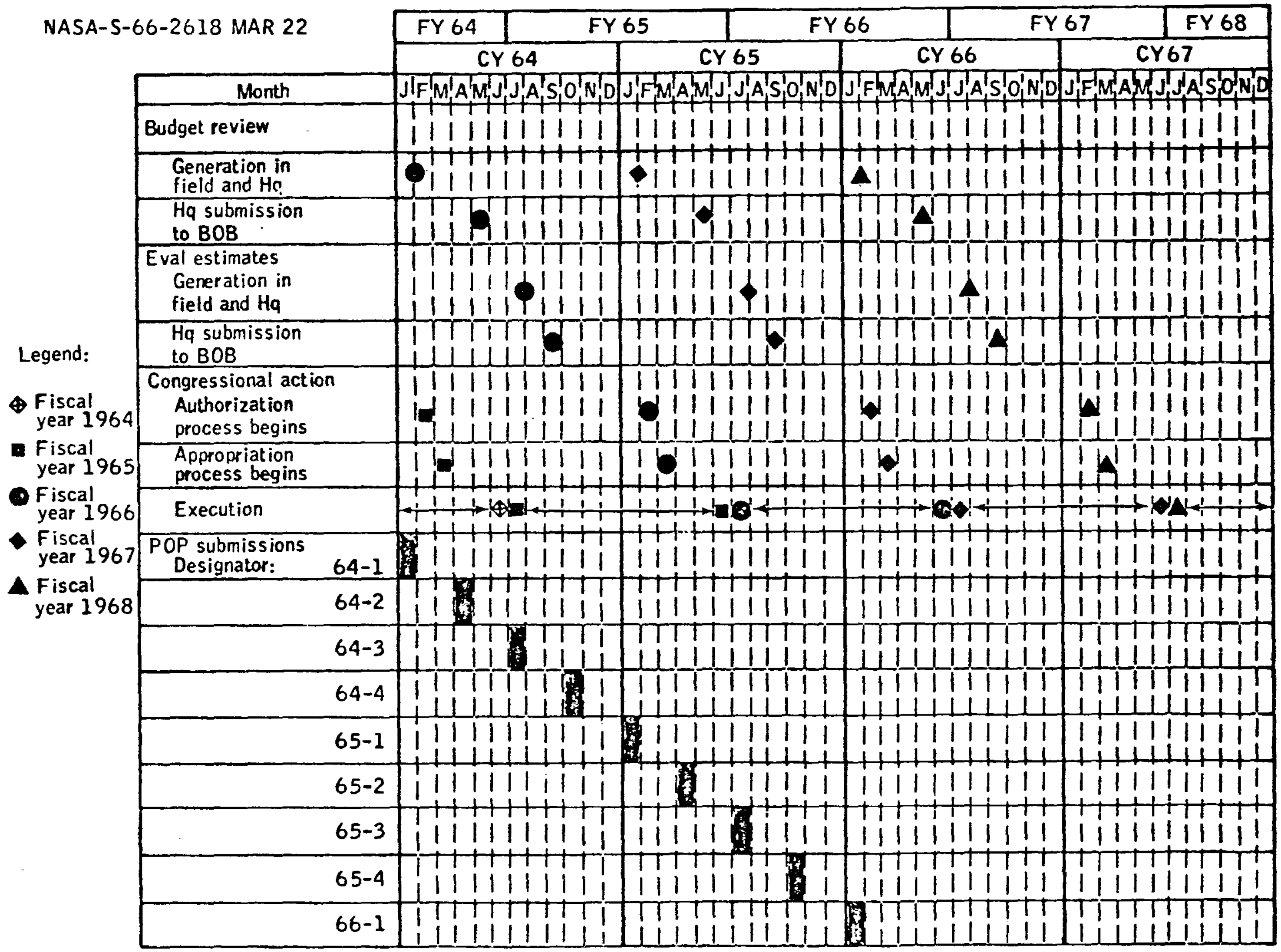

Figure 4.1. - Federal Budgetary Cycle - program operating plan relationships.

However, the POP must evolve through several successive phases before being finalized, and according the MSC POP generation period is followed by a review, analysis, adjustment, and consolidation period (second month of each quarter) at NASA Headquarters in the Office of Manned Space Flight. The decisive pronouncement regarding the financial data in a specific POP is termed the Headquarter's "mark-up" and constitutes the plan MSC must live within for the relevant quarter. This information will be forwarded to MSC in the "marked-up" OMSF MSF R&D POP which depicts the most recent quarter's officially approved plans for the Manned Spacecraft Center, the George C. Marshall Space Flight Center, and the John F. Kennedy Space Center.

This phenomenon explains why the POP Submission entails only one month in the schematic while the symbols signifying the generation of budget previews and final estimates covers two months. For any internal budget plan used for external purposes must receive full concurrence from Headquarters. Only then will the agency-wide budget display the consistency, rationality, and feasibility which are so vital. This also applies to XX-2 and XX-4 POP's which are more for internal planning purposes.

Figure 4.1 additionally demonstrates the relationships existing between the various POP's and other actions typical of the FBC. Inspection of the diagram shows that all XX-1 POP inputs are used as substance from which the preview estimates are created.[8] Moreover, the XX-3 POP's form the basic inputs necessary to cast the final estimates.

The entire movement of the Federal Budgetary Cycle (excluding post-audit) may be traced for FY 1966 and FY 1967 by following the respective symbols

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[8] As related in chapter 3, the XX-2 POP also enters the picture as it provides the Administrator with the most recent financial reading before his confrontation with the Budget Bureau Director.

provided in figure 4.1. Once again, the reader should recognize the substantial lead time associated with the preview estimate and the shorter, yet still negatively significant lead time inherent in the final budget estimates.

Conclusion

Summarily, one should cite the POP as a fundamental element ingrained in the FBC as practiced by NASA. Two principal missions which must be properly effected in the FBC are substantially aided through the POP as related below.

First, the POP is the sole recurring interface between NASA Headquarters and its many field centers. This is with respect to resource needs and program substance.

Second, it affords the Agency a means of assigning relative priorities among competing programs. This is very important, as distinct programs are planned and approved in a vacuum and therefore the total agency program effort must be integrated, evaluated, and adjusted to reconcile agency resource constraints along with other contingencies of significance.

Basically, the author believes these two tasks are accomplished in excellent fashion. The overall concept of the POP is very good, although some of the inputs comprising it could be refined. The authors main concern lies in the area of the POP's schedule structure and this will be taken up in chapter 6.

CHAPTER 5

Research and Development Budgetary Phenomena: A Documentation

The author has made statements concerning the R&D budget formulation process and how it relates to the FBC in the preceding chapters. However, there has been little quantitative backup substantiating these phenomena thus far, and yet this is a critical aspect which must be related if the author's allegations are to assume any credence. Therefore, the ensuing chapter will set forth to portray in a well documented fashion much of what has been asserted heretofore.

The writer's methodology will evolve in the subsequent manner. Initially, a treatment of the MSC Gemini, Mercury, and Apollo program budgets will be extended to yield cognizance of their relative program magnitudes. Next, each of these program's spacecraft budgets will be analyzed in two contrasting lights: (1) the project runout[1] obligational values over time; and, (2) for actual and projected yearly obligational levels. Following this, an evaluation of NASA's three most recent R&D budget submissions to the Congress will be made along with a similar coverage of MSC's Apollo Spacecraft budget development for that period.

One additional factor should be stressed before proceeding on with the analysis. The author will be interested in the graphical plots seen in figures 5.1 through 5.8 from the standpoint of program dynamics and therefore there will be no real concern for discrete fund values. The figures provided

[1]Runout as used in this chapter designates the total monies necessary to complete a given program and may be equated to obligational authority.

should prove to be perspicuous instruments in discerning the issues under investigation.

MSC – A Program Overview

The reader's attention should now be directed toward figure 5.1. This diagram extends an excellent perspective of MSC's proximal program scopes. The author believes that a perusal of these program profiles will create a genuine appreciation for the immensity of the program responsibilities MSC has been charged with and will continue to hold.

The Manned Spacecraft Center did not really become operational until FY 1962 – before this period it was designated the Space Task Group and was located at the Langley Research Center. Thus, we see from figure 5.1 that most of the Mercury budget was embodied in the Space Task Group and actually decreased when this cadre transferred to MSC as the Mercury program expanded into essentially a production and flight operations effort.

Probably the most rational way to relate the tremendous differences in these three program obligational levels is to examine the objectives thereof. This will provide the reader with the necessary insight and yet ignore a relentless fiscal analysis of the programs as this is not the purpose of this paper in the literal sense.

First, we see the Mercury Program as what may now appear to have been a rather facile undertaking, but what at the time was unquestionably an arduous and significant step forward in the conquest of space. Basically, the Mercury Program was designed to, and succeeded in, accomplishing three objectives: (1) the earth orbiting of a manned spacecraft; (2) elementary scrutinization of man's capability to perform and function while affected by a cosmic milieu;

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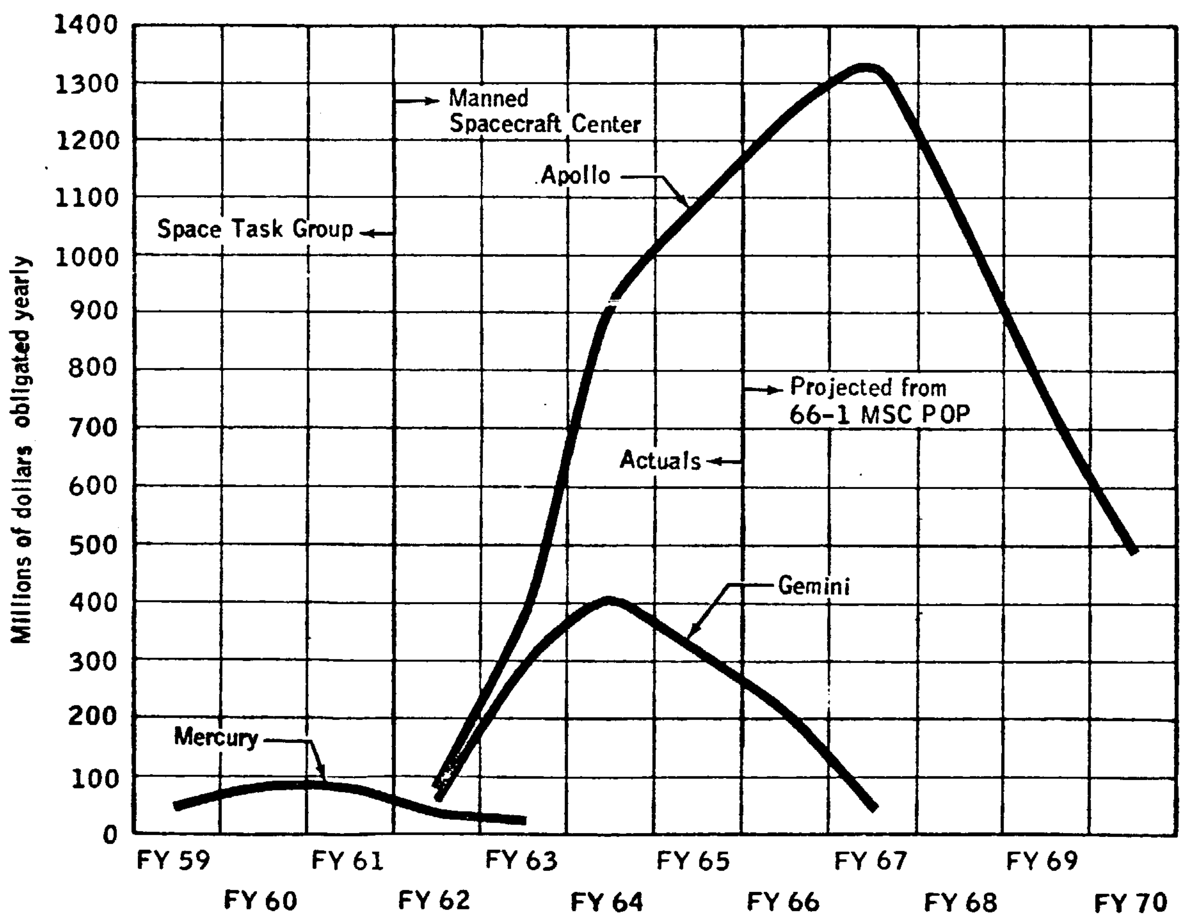

Figure 5.1. - Mercury, Gemini and Apollo programs yearly obligations - MSC and STG.

and logically, (3) successful recovery of the astronaut and his spaceship. The program from inception to completion spanned approximately four and one-half years.

Next, we recognize the more ambitious Gemini Program which may be characterized as a transitional program linking and integrating the evolving American space effort. This called for expanding the concepts and objectives of the Mercury Program in a highly complex and sophisticated manner. In other words, the capabilities realized in the Mercury Program were to be substantially refined in an operational context so that they could eventually supply vital inputs when desired in the Apollo Program. Therefore the prominent objectives of the Gemini program were (are): (1) fourteen day duration flights; (2) rendezvous; (3) docking; (4) extra-vehicular activity; (5) post-docking maneuvers; and (6) controlled reentry. The expected length of this program will be near six years.

Finally, comes the awe inspiring Apollo Program. This will encompass the transportation of three astronauts to the moon in a spacecraft displaying performance capabilities decidedly more advanced than those found in the Mercury or Gemini Programs. Subsequently two astronauts will be ferried to the moon's surface in a special spacecraft (the LEM) whereupon they will egress to explore the lunar terrain. Finally, the LEM will blastoff from the moon's surface, rendezvous with the lunar orbiting mother craft, and then the three astronauts will return to the planet earth. The overall time required to complete this program is nine years although the first lunar landing will be effected in eight years.

The objectives of the three programs discussed above should clearly assist the reader in understanding the relative magnitudes of the respective obligations curves[2] in figure 5.1. Yet, the preceding historical budget development as represented in this graph does not approach the problem under study. This information has been only extended for the reader's interest and also to sharpen his overall perspective of MSC's gross role.

The remainder of this chapter will investigate the principal phenomenon inherent in R&D budgeting – the constant upward fund requirements of given program elements. In so doing, the author will use the spacecraft budgets that have come under STG-MSC jurisdiction.

This approach was adopted for several reasons. First, it affords the use of a fairly unitary line item in each of the programs. Secondly, this technique furnishes the writer examples of typical MSC developmental responsibilities which are exemplary of the R&D function.

Mercury Spacecraft Budget

Figure 5.2 represents the Mercury Spacecraft runout budget as it was projected at discrete time intervals from FY 1960 to FY 1963. The reader should also study figure 5.3 which will be correlated to the runout diagram.

The most obvious phenomenon portrayed in figure 5.2 is the constantly increasing runout extrapolation for the Mercury Spacecraft until a plateau is reached in the latter half of FY 1962. This assumes even more significance if one analyzes the identical period on the yearly obligations schematic (fig. 5.3). For the plateau effect is achieved only at a point where MSC obligations are decreasing sharply. This occurrance signifies the Mercury Spacecraft was in the production and early flight phases discussed earlier in chapter 2. It is

[2]The obligational levels for the Mercury and Gemini Programs include booster procurement while that of Apollo does not.

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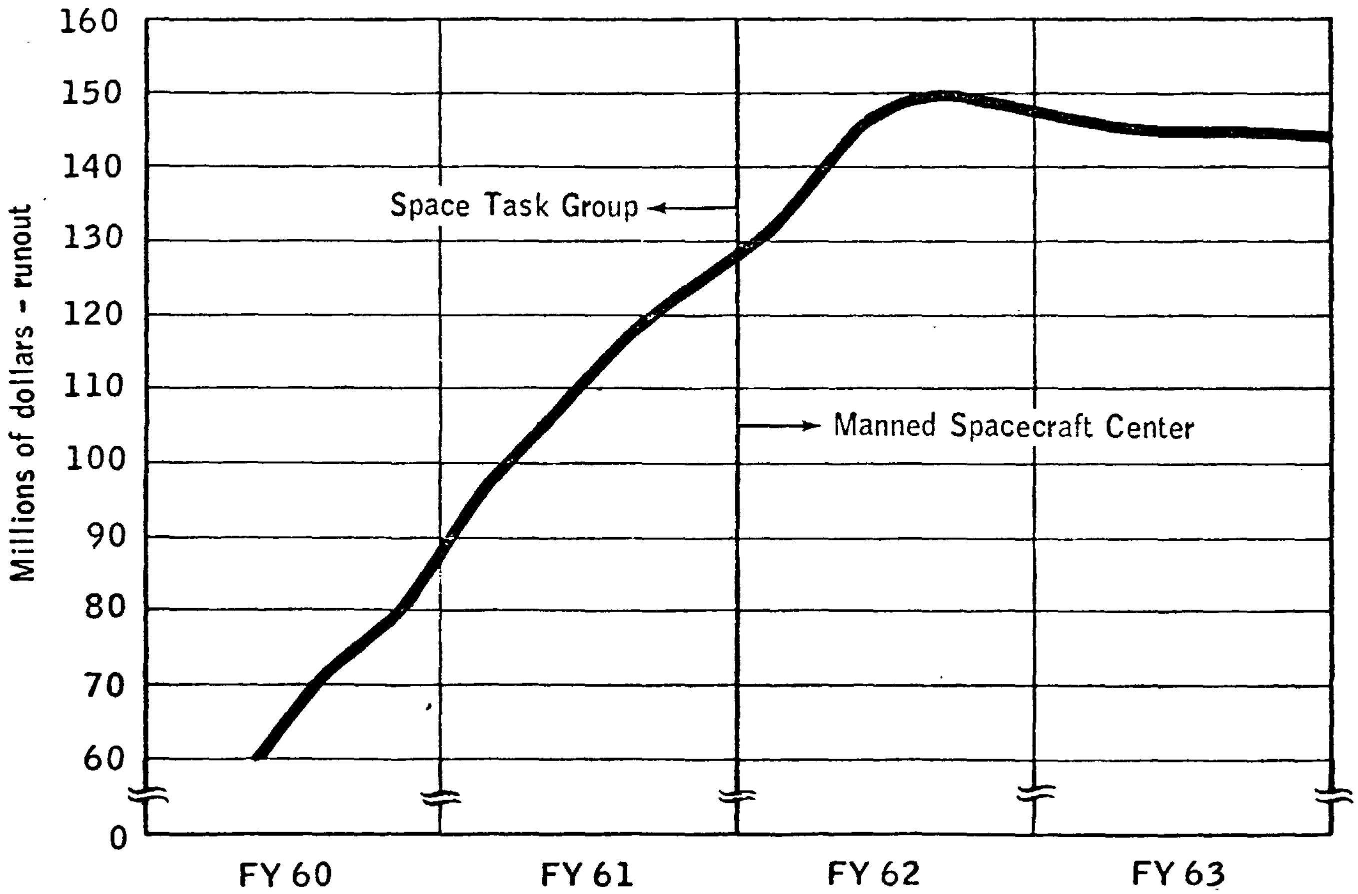

Figure 5.2. - Projected Mercury spacecraft runout obligations - MSC and STG.

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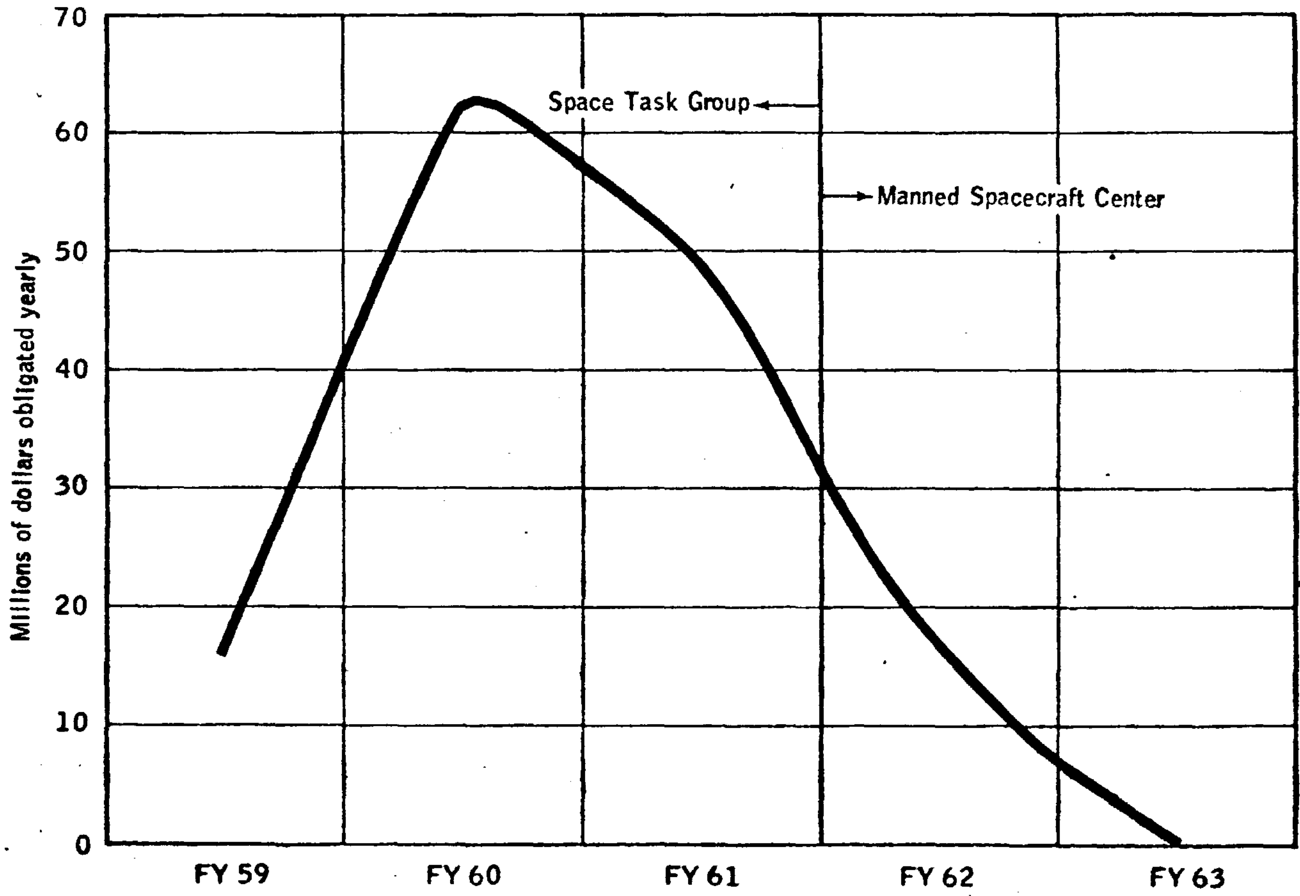

Figure 5.3. - Mercury spacecraft yearly obligations.

only at this time that major contingencies have been surmounted, program definition and scope finalized, and realistic funding needs calculated.

However, what are some of the fundamental reasons for this growth in runout value? Why did it temper off and stabilize so late in the spacecraft's development? Frankly, there are numerous reasons – the author will relate those which constitute substantial elements of this growth process.

The primary factor needing recognition here is the singularity characterizing this spacecraft's development. For until the terminal phases of the Mercury Program were approached, unique R&D contingencies dominated the program and thereby exerted unruly pressure upon performance and schedule parameters which invariably affected cost in an adverse sense.

Much of the trouble may be traced to early design and developmental problems along with predicaments encountered in qualifications tests. Following this phase of the Mercury Spacecraft's R&D evolution, the schedule was expanded further by the existing management philosophy of flying manned spacecraft only when the near perfection of its myriad systems could be guaranteed – therefore additional cost.

Another factor was the expanding scope and definition of the Mercury Spacecraft budget. For the original estimates of runout called for twelve spacecraft whereas twenty were ultimately procured. Moreover, four fiscal weighty entities were added to the McDonnell Mercury Spacecraft budget before the runout plateau was attained. These were: (1) a spare parts program; (2) ground support equipment; (3) trainers and associated equipment; and, (4) the launch support effort at Cape Kennedy. Quite naturally then, these factors accounted for some of the runout growth.

Finally there was work instituted in the program which had not originally been programmed. For example, plans fluctuated from engineering a spacecraft with a one day capability to a 3 orbit capability and back again to a one day capability. Moreover, there was a fair amount of effort expended toward realizing a three day capability which did not materialize.

The reader should remember several factors which will be reinterated, refined, and expatiated upon under the Gemini and Apollo spacecraft programs. One is the obvious hazard inherent in budget formulation when runout budgets possess the positive variance epitomized by the Mercury Spacecraft example. Secondly, flow of the yearly obligational curve should be recollected for comparison to the more complex spacecraft budgets coming under discussion. For an examination of these curves will relate phenomena of central interest.

Gemini Spacecraft Budget

The analysis now shifts to the Gemini Spacecraft budget depicted in figures 5.4 and 5.5 The configurations (not gross values) of these two schematics bear similarity to those of the Mercury Spacecraft. However, the substantive derivation of these profiles must be attributed to incidents somewhat different than those governing the Mercury effort.

Simple recall of the objectives delineated earlier for the Gemini Program will help establish the reader's perception regarding the unique R&D challenge in this undertaking over that experienced in the Mercury Spacecraft's development. This is due to the vastly increased versatility and sophistication of the Gemini Spacecraft which was achieved through incorporating the following revolutionary subsystems: (1) fuel cells; (2) rendezvous radar; (3) an inertial guidance system; (4) ejection seats; and, (5) onboard propulsion.

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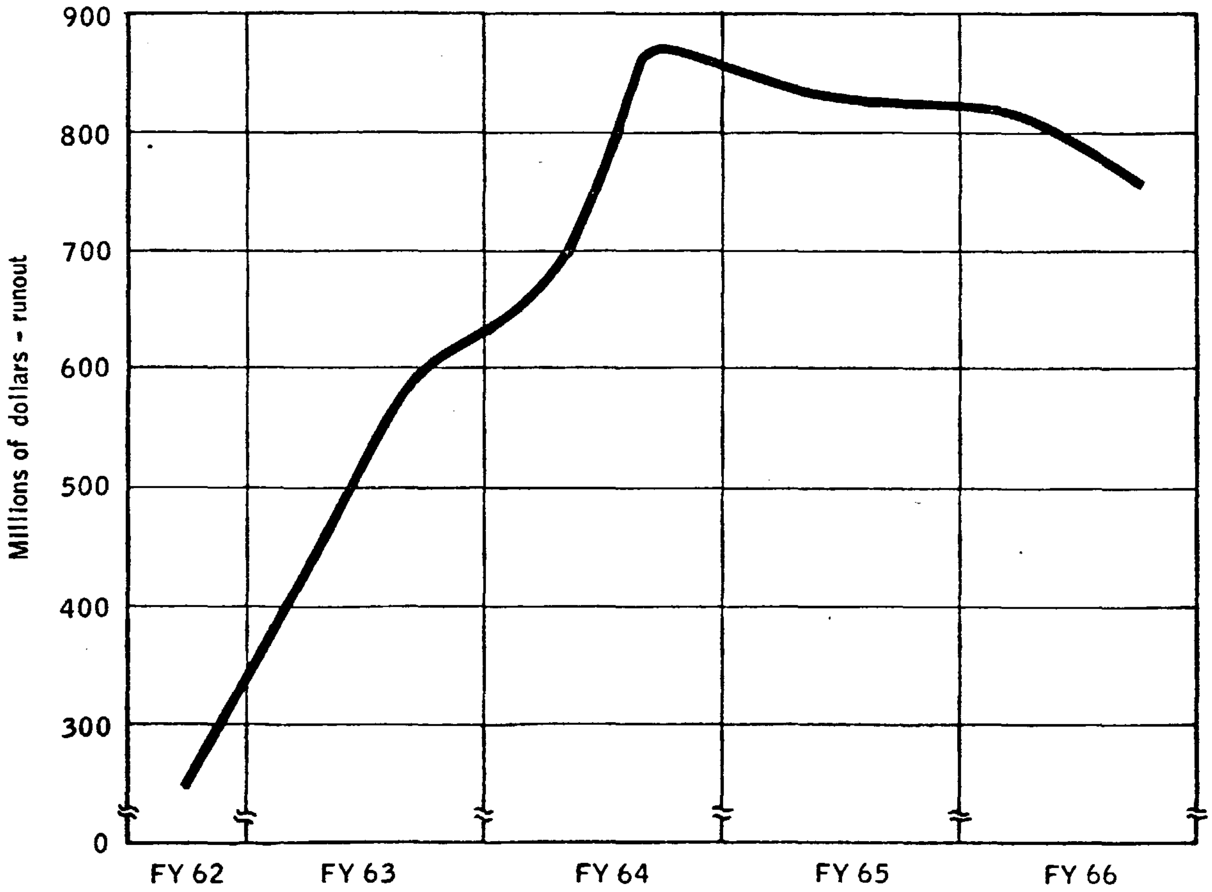

Figure 5.4. - Projected Gemini spacecraft runout obligations - MSC.

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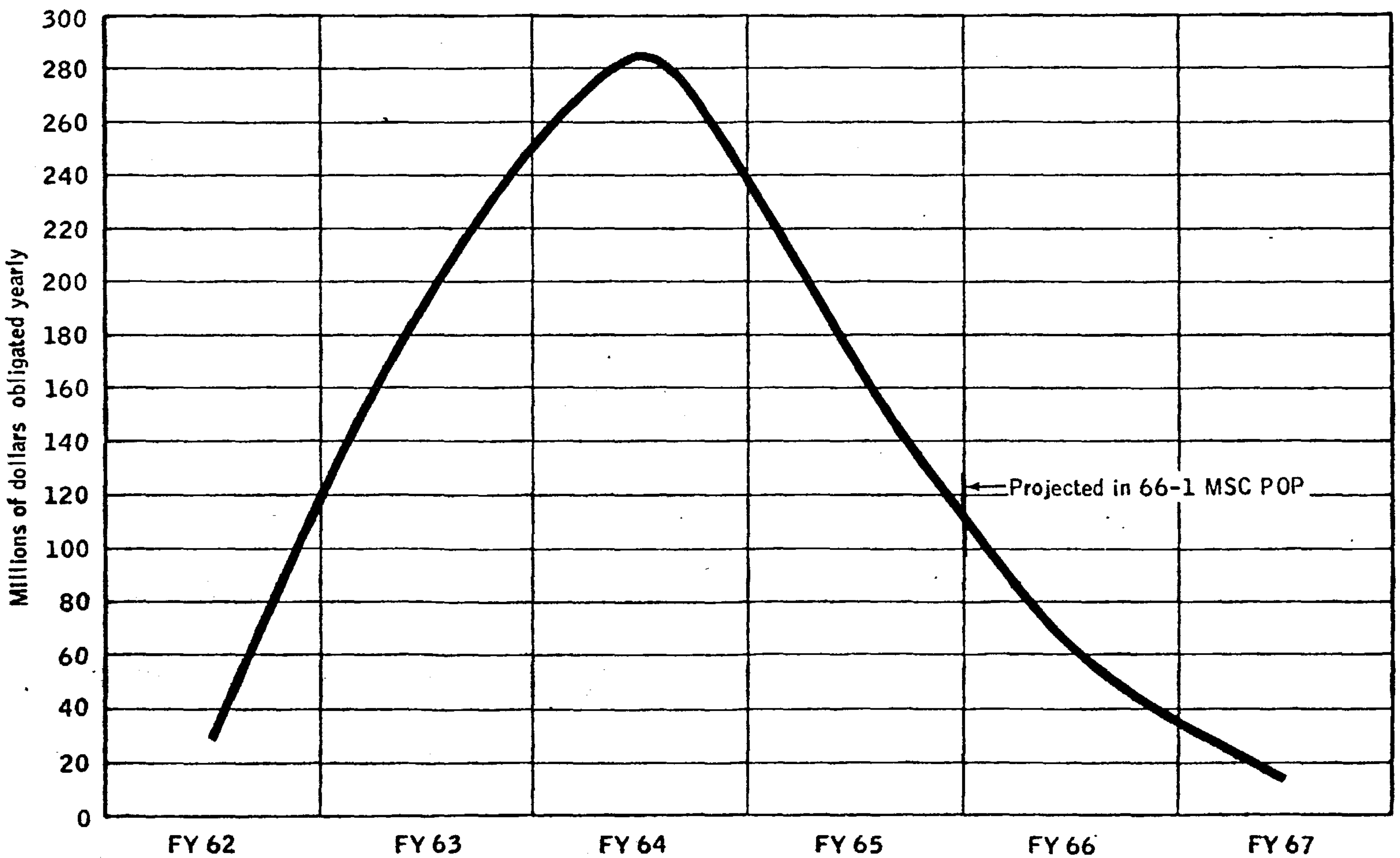

Figure 5.5. - Gemini spacecraft yearly obligations - MSC.

Also, the Gemini Spacecraft had modulation of its systems for installation outside rather than inside the spacecraft. This made repair and replacement actions easier, yet represented a new concept in spacecraft development. An Adapter Module provided much of the necessary volume for the new long orbital duration systems – it marks one of the most distinguishing external differences between the Mercury and Gemini Spacecraft. In other words, MSC and the participating contractors did not leave the complex arena of advanced Research and Development with the consummation of the Mercury Program, but conversely this team confronted even more difficult problems as their aerospace knowledgeability expanded.

The reader should note that the Gemini Spacecraft runout budget peaked at approximately the same time its yearly obligational budget summit was reached. Subsequently, as the spacecraft's funding requirements decreased and MSC entered the production and flight operation phases of the program, diminutions were realized in the runout budget. We shall explore the casual factors behind this behavior pattern shortly.

The burgeoning runout budget may be attributed to two broad contingencies. First and foremost, were the traditional, characteristic adversities associated with the R&D function that were previously advanced in chapter 2. For it was during FY 1963 and much of FY 1964 that many of the prime and sub-contractors were encountering difficulties in their assigned development projects. Accordingly, the requisite performance capabilities were not achieved and cost harassment continued.

Moreover, schedule effects imputed additional cost amplifications to the Gemini Spacecraft runout budget. For initially there were to be launches every sixty days when manned flight operations began. However, in late FY 1963 this was deemed impossible as a ninety day interval was adopted. The runout budget received yet another incremental increase due to the related extension of the Gemini Program by one year. Such a program elongation inflated all projected obligational levels including those in the Gemini Spacecraft in a manner related in chapter 2.

Suddenly in FY 1964 two things occurred which in fact lowered the prognosis on the spacecraft's runout budget. It is only unfortunate such windfalls, if they may so be designated, do not occur with more frequency and consistency.

First and most important, the developmental enigmas were conquered and the ultimate program definition was reached. Second, the major (prime) contractor for the Gemini Spacecraft (McDonnell) was awarded a large fighter plane contract. Both of these action's provided for greater efficiency and lower cost on the spacecraft effort.

As the Gemini Program passed into the latter phases of production and mid-phases of flight operations, a further reduction in predicted runout value is seen. This is due to savings realized under the recently negotiated incentive contract for the Gemini Spacecraft.[3]

Once again, before perlustrating the Apollo Spacecraft budget, the writer will reinterate several conspicuous facts whose significance was also related in the Mercury Spacecraft budget. First of course, are the dire connotations advanced when budgeting under substantial variances in projected runout growth. It should be mentioned that the problem is all the more serious because these increased resource needs occur particularly while approaching the apex of the

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[3]The reader should recognize that any cost reduction effected by the prime contractor will extend to him a larger fee over direct cost when the contract is on an incentive basis if schedule and technical performance criteria are obtained.

yearly obligational bell curve. The tendency for this resource summit to expand vertically and horizontally will typically not be arrested until the extrapolated runout curve peaks out at a stable plateau. This was the case in the Mercury Spacecraft budget, the Gemini Spacecraft budget, and particularly so, in the Apollo Spacecraft budget as we shall soon learn.

Such phenomena generate genuine problems for those responsible for budget formulation. If an agency had but one program characterized by the bell curve funding phenomenon, they could at least breathe easier while riding down the final phases of the yearly obligational curve. However, as is the case with NASA/MSC several significant programs are in progress, and each is at a different point on the bell curve as the graphs provided herein show. Changing program definition adds to this problem. Therefore, the pressures on MSC's preview and final budget estimates are constant and formidable.

Before entering the final budget analysis, several conditions defining the Apollo Spacecraft budget should be illuminated. First, the term "spacecraft" is somewhat different in this program than in the previous two. Inclusive of the Apollo Spacecraft are the following: (1) Command Module; (2) Service Module; (3) Lunar Excursion Module; and, (4) Navigation and Guidance Equipment to mention the most important components. Thus, it comprises many more systems than were realized in either the Mercury or Gemini Spacecraft. Yet, the writer's definition of "spacecraft" groups all of these modules and other equipment together. For it is to be expected that the hardware equating a spacecraft will encompass increasingly more items as space missions assume greater complexity over the years.

Apollo Spacecraft Budget

The ensuing analysis will be more incisively developed than was the case in the Mercury and Gemini Spacecraft budgets. The author will use the Apollo Spacecraft budget to epitomize the stark realities of advanced R&D budgeting and MSC's relationship to the overall NASA budget will also be studied.

The reader should now examine figures 5.6, 5.7, and 5.8 which are identical in format to the schematics presented earlier with one exception. Figure 5.8 gives essentially a yearly obligational budget depiction, only it represents Apollo Spacecraft budgets as they were engendered at finite periods of time.

Upon inspection of the Apollo Spacecraft runout budget, one is immediately cognizant of an important fact. Namely, that runout is still rising – yet, the writer believes that the upward variance has been exhausted and the approximate summit plateau reached. For MSC is approaching the peak in its Apollo Spacecraft yearly obligational bell curve as related in figure 5.7. Therefore, the data generated in the 66-1 POP may be judged as sufficiently accurate projections for the author's purposes.

First we will consider the runout curve. Comparison of it to the Mercury and Gemini Spacecraft runout data will reveal that Apollo required approximately twice as long to peak out. This situation is quite understandable if one remembers the contrasting scopes and objectives of the missions under discussion.

Another interesting feature of figure 5.6 is the "extended S" configuration it resembles. In other words, a relatively slow growth in runout predictions for a year and a half followed by a quick, massive increase, and subsequently a languid accretion until arriving at what the author believes is near the total runout value.

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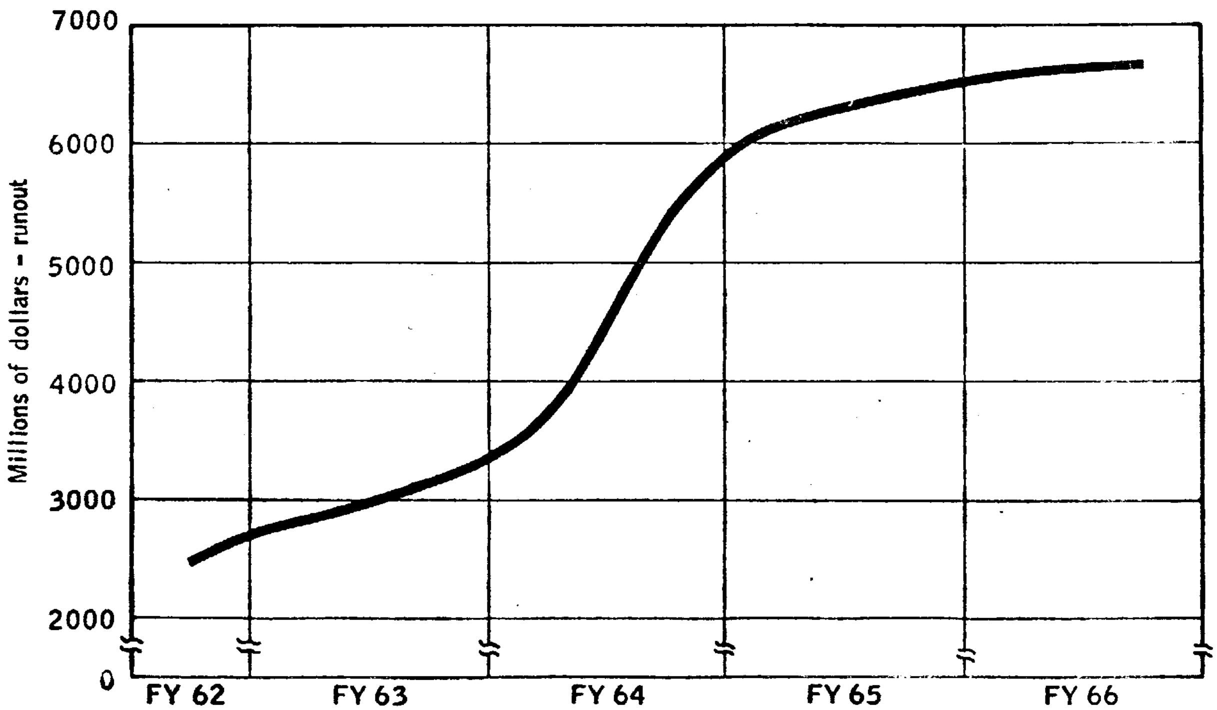

Figure 5.6. - Projected Apollo spacecraft runout obligations - MSC.

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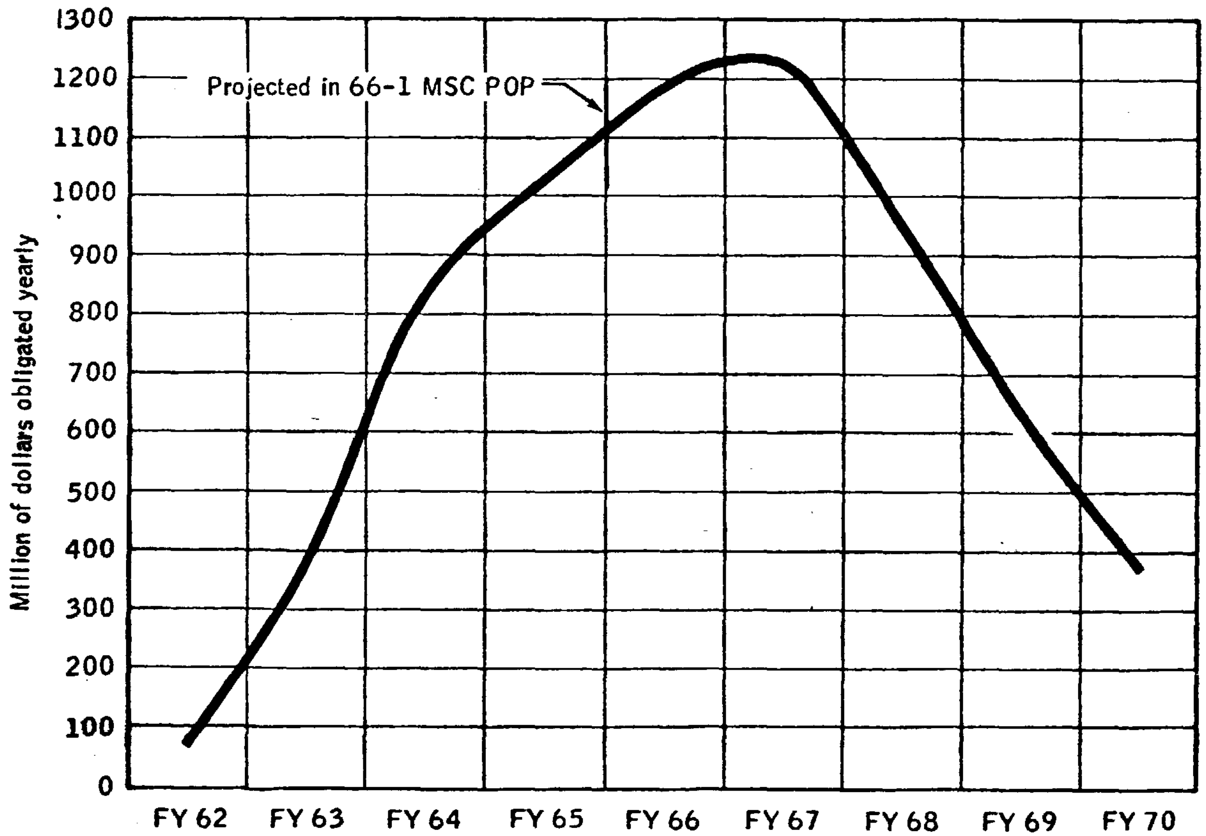

Figure 5.7. - Apollo spacecraft yearly obligations - MSC.

To what may we attribute the characteristics of the Apollo Spacecraft runout curve? The succeeding discussion attempts to isolate the most notable and significant factors which extend insight upon this question.

First, one must realize the tenor of the Apollo Program up through early FY 1964. For the Command and Service Modules contract was not awarded until December of 1961 – just three months before the initial spacecraft runout extrapolation was courageously postulated. Moreover, the other major spacecraft contract (on the Lunar Excursion Module) was not let until December of 1962 – nine months after the referred to projection was made. Considering the basic nature of R&D programs of this magnitude and singularity, is it surprising these early estimates were so low? This writer does not think so!

As figure 5.6 relates, the tremendous tumescence in predicted runout occurs after about a year and a half. It was during this time that the major contractors were engaged primarily in extensive design efforts. Even over this period the MSC-contractor perception of the lunar venture improved as some of the program's cryptic components were distilled away. Also, the program's definition and scope were becoming increasingly broad at this time. Essentially the MSC-contractor team was formulating a more knowledgeable definition of what the job entailed. Thusly, additional runout value was affixed the earlier projections to yield a fair increase by early FY 1964.

Yet, it was not until advanced design problems and increased program definition occurred that runout value displayed its malignant growth. It is typically in this phase that tangible and serious R&D contingencies germinate. These phenomena, if promptly recognized and candidly evaluated, can necessitate gross reevaluations in runout value similar to the magnitude seen between FY 1964 and FY 1965. Moreover, it was over this period that the post lunar landing effort was included in the Apollo Spacecraft budget which added measurably to predicted runout value.

As the test phase matured and a more sophisticated overview of the Apollo Spacecraft resource needs was formulated, we see runout value leveling off throughout FY9s) 1965 and 1966. The small growth in runout over this span was essentially due to the inclusion of various experiments in the spacecraft's budget. Now (FY 1966) we are commencing to fly unmanned spacecraft and relatively substantial increases in runout value are not foreseen.

Examination of the two yearly obligational curves will also advance our understanding of the Apollo Spacecraft budget. Figure 5.8 is of particular utility in emphasing much of what has expounded heretofore. Figure 5.7 relates exactly the same thing as the line marked 1/66 in figure 5.8. It was plotted individually to provide a graph with may be compared with similar ones constructed for the Mercury and Gemini Spacecraft.

Basically, figure 5.8 affords the identical information found in the runout schematic. However, in this case the data are plotted as projected yearly obligational levels required to fund the project to runout. There are four discrete plots made over time and they are so designated through a month/calendar year code.

These data are a vivid portrayal of what the writer briefly mentioned earlier in the chapter. Specifically, that advanced R&D budgets have an inherent propensity to expand their horizontal and vertical parameters over time spans. In digesting this presentation the reader is reminded of the conditions governing the growth of runout as put forth earlier. These conditions apply equally for figure 5.8. However, there are several other factors depicted in this figure which warrant accentuation.

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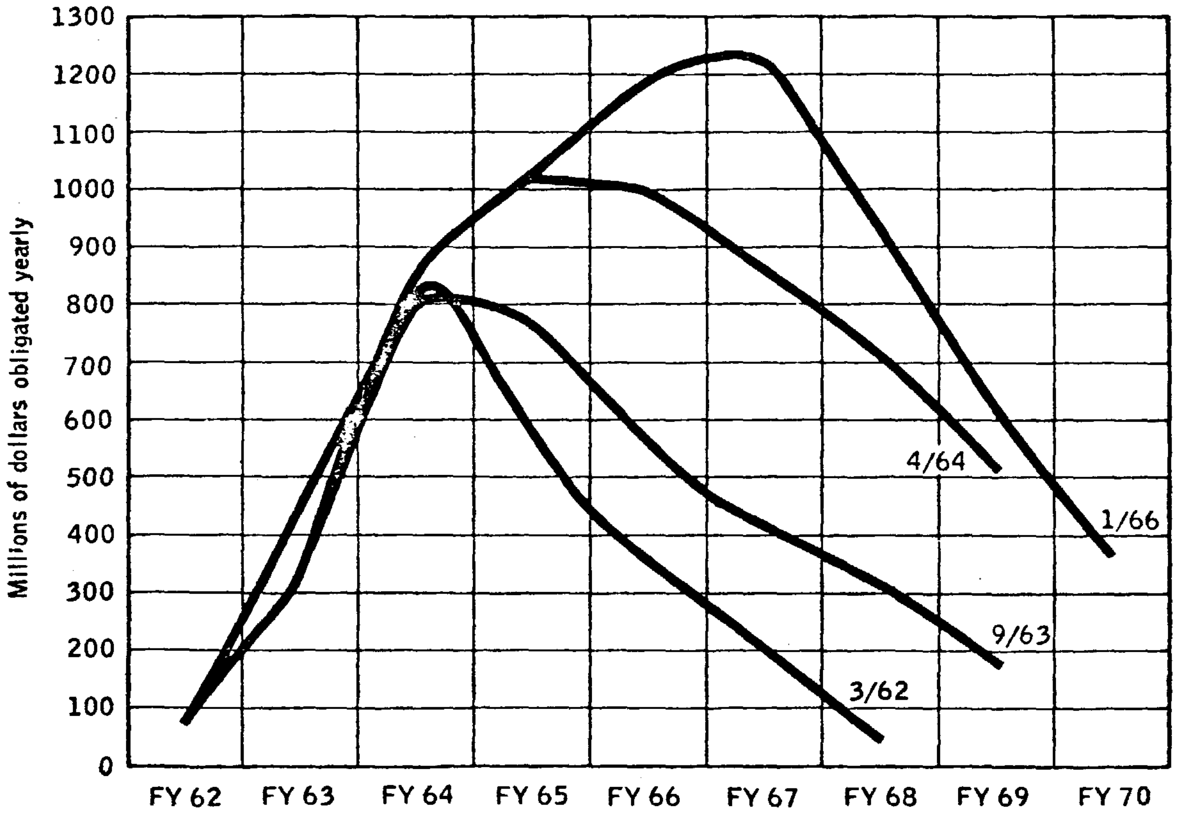

Figure 5.8. - Apollo spacecraft obligational levels projected to runout - MSC.

First, we see that the incipient obligational estimates maintain their integrity through FY 1964. Also, one can ascertain that the extrapolated obligational levels all decrease at approximately the same rate after peaking out. Inspection of their slopes which range from -1.0 to -0.7 substantiates this fact.

However, the critical phenomenon under scrutiny here is the inclination of these obligational estimates to expand in their horizontal and vertical dimensions just as they are approaching the previous yearly obligational summit. This dual magnification of the yearly obligational curve's apex will typically occur during the phases of early testing, changing program definition, and development.[4]

The author will now make an effort to integrate the previous budget revelations with the fundamental problem. It is only hoped that the antecedent discussion sufficiently documented the peculiar R&D budget traits operative in the aerospace field. The writer also expects the connotations of such fiscal behavior upon NASA/MSC budget formulation were assimilated at least partially by the reader. We shall study this next.

NASA/MSC – The R&D Budget Dilemma

The author stated in chapter 3 that agency budgets are frequently subjected to the "shrinking summit" phenomenon throughout the budget cycle. Figure 5.9 corrobrates this fact in hard figures. This diagram shows the total NASA R&D requests submitted to Congress and the subsequent amounts of NOA appropriated for FY(s) 1964, 1965, and 1966.

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[4]While the plot codified at 1/66 was cast from data generated in January 1966, the reader should be cautioned that essentially the same configuration existed as early as September 1964.

Unfortunately the schematic does not relate the preview and final estimates put forth to the Budget Bureau, but if this was the case the differentials for especially the last two FY(s) would be substantially greater. The significant fact is the same in either case though – namely, that agency budgets receive an undenyable dilution throughout the FBC. In fact, the most recent NASA total budget (R&D; C of F; and, AO) for FY 1967 has evolved from a preview estimate approximating 5.7 billion dollars down to a sum slightly in excess of 5 billon dollars which was submitted to Congress.

While keeping these happenings in mind, the reader should look at figure 5.10. The data therein are indicatory of the principal R&D budget enigmas implied throughout this paper. Explicitly, that the preview and final budget estimates in hard core R&D projects may not always be equated to the NOA alloted a designated project.

Thus, we see that for each of the three FY(s) neither the preview estimate nor the final budget estimate for the Apollo Spacecraft was equal to the NOA applied to the project. Furthermore, the only reason FY 1964 exhibits such little variance is that Congress inflicted a burdensome cut on that year's R&D budget as shown in figure 5.9.

The gross under-estimation of the preview and final estimates for FY 1965 may be rationalized in retrospect. For it was in FY 1964 there was a Herculean jump in the Apollo Spacecraft runout value, yet this occurred after the two estimates had been rendered to the Budget Bureau. With the ensuing contingencies there were two alternatives available to NASA/MSC: (1) operate in FY 1965 at the level programmed in the final estimate; or, (2) reprogram other money into the Apollo Spacecraft Project. The latter course of action was chosen so that schedule slippage could be held to a minimum. Such action advances dubio

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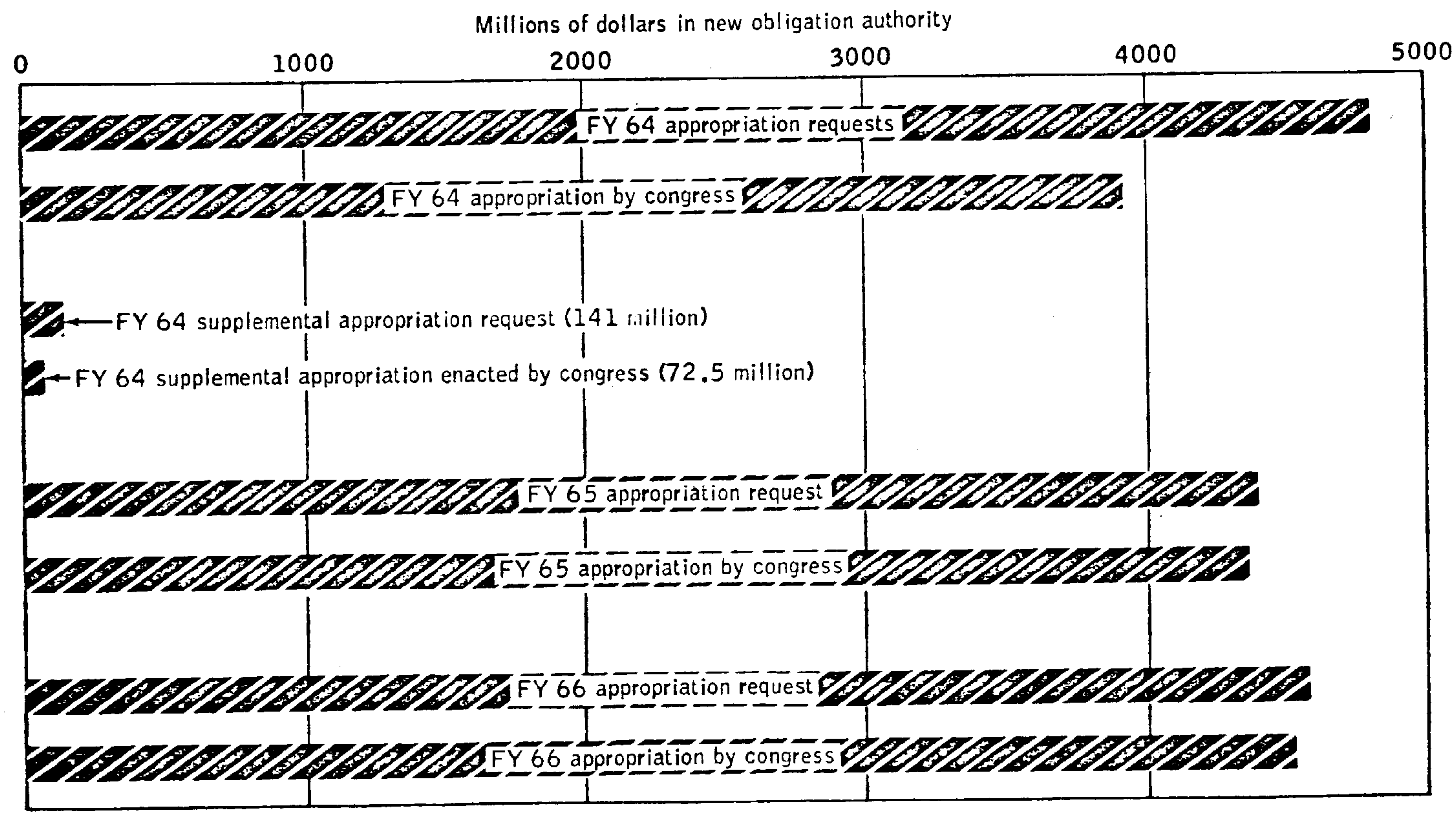

Figure 5.9. - Total NASA R&D appropriations requested and granted - FY 64, 65, and 66.

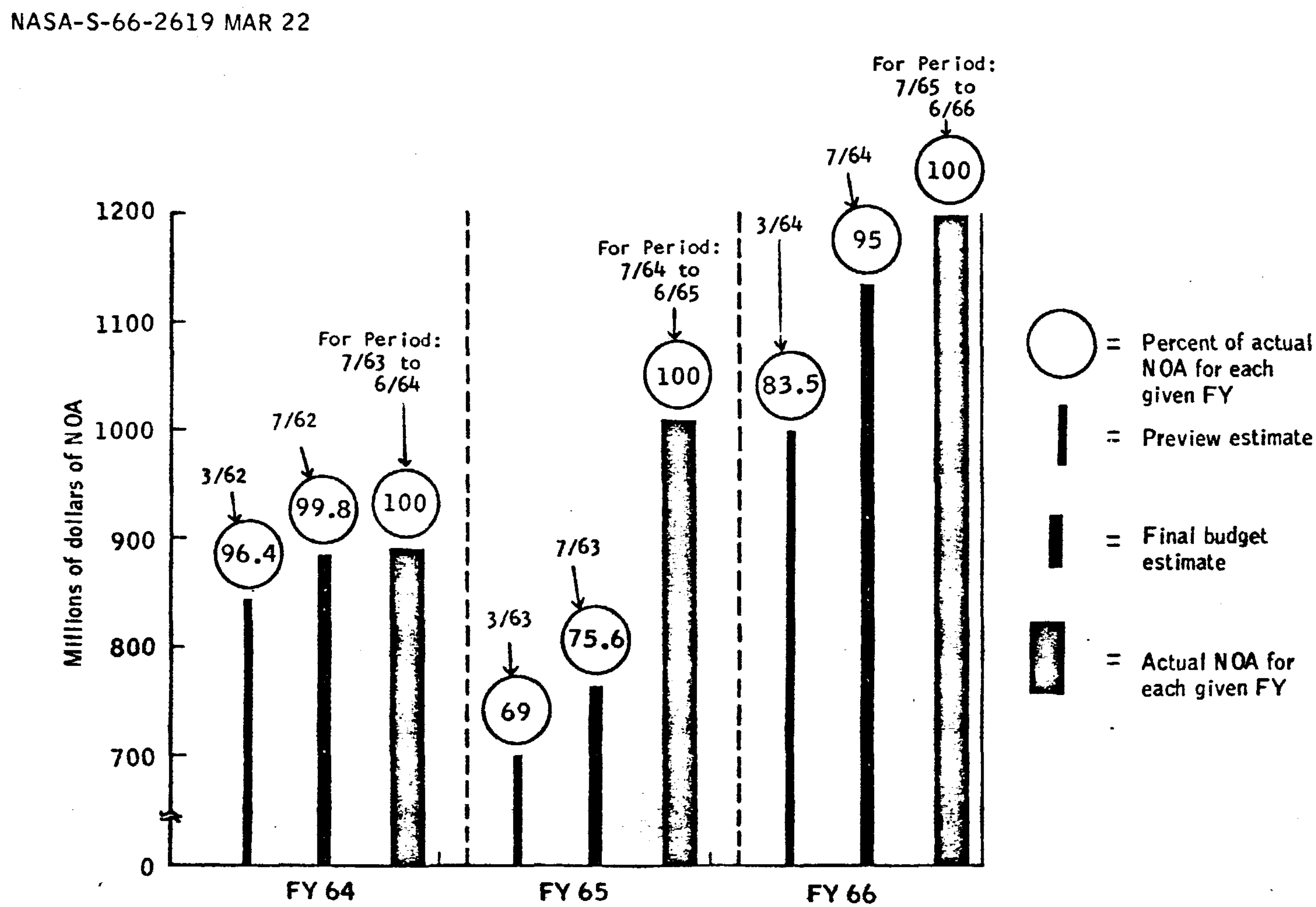

Figure 5.10. - Apollo spacecraft NOA data for FY 64, 65, and 66 -MSC.

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implications toward the programs of less appeal that were in effect "robbed" to maintain the momentum of the Apollo Spacecraft Project.

The development of the FY 1966 spacecraft budget shows substantial improvement over the case for FY 1965. The preview was a poor projection of changing scope and contingency effects upon resource needs; but it had not been fully affected by the reevaluated runout value. The final estimate was adjusted accordingly and was not too far off the mark.

The primary phenomenon to be remembered from these data is that historically in substantial R&D efforts the preview and final estimates are not accurate designations of resource needs. This is particularly true when in the middle of a program and approaching or at the apex of the bell obligational curve.

NASA is a dynamic agency which will continue to assume new and more ambitious programs as her existing programs become history. It is only natural then to expect continuing problems of the gender related herein.

The writer believes modifications may be instituted both within NASA and the Nation's FBC to alleviate some of these advanced R&D budget formulation problems. The phenomena described in this treatise may not be attributed any single factor — there are many. Some of the causal factors lie within the Agency while others are definitely inherent in the budget process itself. While solutions to such an esoteric system are most difficult to arrive at, the subsequent and concluding chapter will be directed toward advancing a hypothesis on just how they might be effected.

CHAPTER 6

A Recommended Solution

Summary Analysis

The author's intensions here are not to initiate a complete restatement of the preceding chapters, but rather afford the reader a recapitulation of the principal phenomena and facts central to this dissertation. Such an overview is absolutely vital if the recommendations advanced in this chapter are to be entirely appreciated.

We have learned that the schedule and procedural mechanics of the Federal Budgetary Cycle imposes formidable constraints on the NASA/MSC R&D budget formulation process. This is partially because the FBC's existing cyclical structure demands long lead time resource projections from a dynamic agency whose intrinsic program characteristics are not in consonance with such a schedule. Yet, some of the problem may also be traced to insufficient program definition on NASA's part. In addition, the estimating abilities of NASA, aerospace contractors, the Budget Bureau, and Congress may leave something to be desired.

We learned in the preceding chapters that all of these factors upon summation create an atmosphere in which R&D runout value displays a ceaseless tendency to increase until a project's operational phases are attained. Such a phenomenon subjects agency statements on a given program's total cost to questions concerning their credibility. Yet, of greater significance is the effect this has upon preview and final budget estimates. For as was depicted in chapter 5, the MSC spacecraft estimates in the Apollo Program have never equated the NOA ultimately alloted the Center.

Obviously, a modification in the procedures for funding R&D efforts would seem advisable. Yet, we must remember the methodology relied upon in the allocation of these finite dollars is primarily dependent upon the American political system and any adjustment of this process is a very delicate matter. So the basic question then becomes, "How may we improve R&D budgetary procedures while accommodating the indigenous realities of the body politic." Naturally this encompasses a scrutinization of internal as well as external (to the agency) phenomena. It is to this enigma that the remainder of the chapter is devoted.

Before yielding to such an effort, one further point desires clarification. Specifically, that the writer is concerned with synthesizing a more rational substratum around which the substantive R&D budget issues may be resolved. This does not imply any indictment of political decision making in budgetary affairs – the NOA any agency is destined to receive is assuredly a political judgement and this is the way it should be under our system. The author is simply recommending ways in which all involved parties may operate more efficiently and rationally.

<u>The Supplemental Appropriation</u>

Essentially the author is searching for viable procedures which will lend more flexibility to the NASA/MSC R&D budget formulation process. Yet, before advancing any recommendations, the writer will briefly discuss a budgetary tool which is not fully understood by the general public – the <u>supplemental appropriation</u>.

Broadly speaking, the supplemental appropriation is structured to accommodate off-cycle occurrances of relative importance. For example, the majority of all supplemental appropriations are enacted to provide the money necessary in meeting additional agency obligations incurred through recent legislation finalized after said agencies' appropriation bill has been passed. This usually entails pay raise bills and new program legislation which display urgent funding needs. Supplemental appropriations will prove of most utility to agencies who have traditionally possessed trivial funding flexibility.

However, NASA's annual R&D appropriation is of enormous size, under no obligational time limit, and marked by specific transfer capabilities at the Headquarters level. In all candor then, the supplemental appropriation is a poor tool for yielding program flexibility to NASA's R&D effort. As we shall learn there are several reasons for this.

First, a supplemental appropriation must be of massive proportions to really solve NASA's fiscal program adversities. Due to the flexibility mentioned above, NASA can usually meet contingencies approaching 50 million dollars, and therefore a supplemental appropriation should conservatively approximate at least 100 million dollars to be justified. Such monies are most difficult to obtain for two reasons: (1) the President must give full concurrence; and, (2) the "tight fisted" members of the Supplemental Appropriations Subcommittee must support the request.

Even aside from political roadblocks, there exist other procedural and legal constraints which are in effect the primary factors limiting the flexibility of supplemental appropriations in complex R&D projects. For example, consider what would happen if a crisis developed in the Apollo Program in November of a FY and approximately 100 million dollars is needed soon if serious schedule lags are to be averted. In such a case, the probability is near unity that serious schedule lags would actually develop.

This is because the earliest possible date this gender of legislation could become law is May of the given FY — regardless of the political climate. In the meantime, NASA must operate at the previously programmed levels for the Apollo Program. To do otherwise would expose the official responsible for authorizing Apollo Program funds to a most ominous plight.

For example, if he were to authorize operating centers increased obligational parameters to the supplemental appropriation being sought, the program contingency could very likely be met. This would be absurd in all reality though — for if the NASA request was either cut or totally negated, this individual would be in a very serious predicament. The Anti-Deficiency Act lucidly defines the rewards for such unsurpations of authority as ranging from a substantial fine to/or including a prison sentence.

Understandably then, a "bird in the hand" is the only type that counts and similarly so for supplemental appropriations. NASA cannot assume additional program funds will be allowed via the supplemental appropriation until these monies have been legally consigned to the agency. This usually occurs late in the FY at which time irreparable program damage has resulted.

It should be clear that the supplemental appropriation is not a realistic construct for meeting NASA's dynamic program responsibilities. The writer will now attempt to find at least a partial solution to this quandry.

Recommendations

As we have learned, the development of the NASA/MSC R&D budget encompasses several distinct levels of the bureaucracy. Consequently, the writer will scrutinize areas of significance and subsequently suggest changes where the probability for implementation is promising. This necessitates both internal and external alterations in relation to NASA – the latter will be pursued first.

External Modifications

First, the author sincerely hopes unanimity may be soon realized in program budgeting. The initial step has been taken by the Executive Branch and thus this plea is directed more toward the Legislative Branch. The work required to attain program budgeting in both branches will represent a most strenuous effort, yet the author believes this new orientation in budgeting would go a long way in overcoming the fundamental problems in the R&D function.

In conjunction with the emphasis on program budgeting, there would almost have to be augmentations to the Budget Bureau and substantive Congressional committee staffs. This should not be taken as an indication that program budgeting necessitates more work on all participating parties, but rather that both of these impressive institutions are presently understaffed. Moreover, the National budget is with each passing day becoming more esoteric and complicated – the writer sees no curtailment of this growth in the near future.

However, the author's primary concern is for suggesting a tool which will provide the R&D function with the flexibility so essential for its efficient management. In so doing, the writer will be concerned with postulating a viable medium which in addition to being operationally feasible will also be politically acceptable. For regardless of the merits any plan may advance, it must realistically display congruence to our system of government and thereby stand a chance for implementation before it can garner any substantive support.

The principal recommendation advanced herein is not controversial or a threat to existing procedures and mores relating to the budgetary process. In fact, it is a budget instrument analogous to that enjoyed by the Department of Defense.

Specifically, the author strongly recommends establishing a Research and Development Contingency Fund (RADCF) for the National Aeronautics and Space Administration. The nature and purpose of this fund will be as follows:

First, the monies available under RADCF will be used to confront serious R&D contingencies in any given FY. Implicit in the use of RADCF monies is the fact that they would be relied upon only under conditions similar to those justifying a supplemental appropriation request. In other words, there would have to be determined administrative restraint in drawing upon these funds. For the continued success of this new NASA R&D budget technique without question will depend on the initial and continuing support of the Congress.

RADCF would also assist NASA in funding programs which would otherwise be adversely affected by periods of "Continuing Resolution." For example, programs which call for increasing obligational levels in a new FY will suffer under the present "Continuing Resolution" funding methods, however, under the author's proposal these difficulties could be overcome until the monies for that FY are ultimately apportioned. Such an arrangement would also reinforce Congressional desire to appropriate NASA monies by the inception of each FY.

The NASA Administrator would have plenary control over these funds and concurrence from Congress regarding their use should not be required. Of course, the Administrator would report to the Appropriations Committees of the Congress on a tri-yearly basis regarding the status of RADCF for the current year. Annual review of these monies would be a part of the regular Legislative Authorization and Appropriation phase of the FBC.

The proximal magnitude of RADCF should be 150 million dollars and once enacted these funds would be apportioned through the Budget Bureau on a basis of need. Assuming Congress endorses the employment of the monies (if they are used at all), the fund would be replenished to the 150 million dollar level each year.

Finally, the author would endorse using the same language found in the authorization and appropriation acts for FY 1966. Therefore, all the provisions detailed in chapter 3 would be maintained. However, one must remember this action is recommended only if the Research and Development Contingency Fund becomes incorporated into the authorization and appropriation legislation.

Internal Modifications

The writer truly believes that all parties concerned would realize substantial benefits if the preceding recommendations are instituted. However, all R&D budget problems are not attributable to the inherent characteristics of the FBC and its schedule constraints. NASA also is plagued by genuine obstacles within its own organization.

Two of these are closely related and intrinsically a part of the R&D function. First, as stated repeatedly in the antecedent chapters, is the fact that from the time a program begins until much of it has been accomplished, its definition and scope are continually evolving. As program substance changes so do the estimates equating cost in the program. This affects the second factor – a poor estimating capability. It should be clear that until NASA/MSC devises some means for establishing specific knowledge of exactly what a program incompasses, and does so early in the program, its estimating capability will be less than desirable.

This remark is also apropos for the Budget Bureau and the Congress — particularly as concerning initial actions taken by them authorizing long range programs. An authentic adoption of program budgeting should partially alleviate the problem. Remember this implies a concerted analysis of futuristic needs versus simply trying to work around current year difficulties.

Therefore, NASA/MSC must improve the accuracy of its long duration definitions, and accordingly its ability to estimate resource needs. This is an arduous task — the author is relatively unknowledgeable in this area and he will not hazard postulating suggestions here. In all fairness, it should be mentioned that the problem is receiving constant attention and undoubtedly progress will be made in this area as the Agency continues to mature.

The author believes one additional change will better facilitate the NASA budget formulation process. This action would require deleting one of the quarterly POP's. The writer thinks four POP compilations per year subjects the organization to an unnessary strain. Considering NASA's existing internal reporting and planning system, the agency could easily meet its myriad data requirements even while adhering to a tri-annual POP submission rate. The author suggests the following schedule be implemented.

Beginning in July at the field centers, the first POP for the new FY would be generated and forwarded to Headquarters for the August "mark-up." This document will function as the financial operating plan for the current FY. Accordingly, it would designate the programmed rate for line item obligations pursuant to the appropriations recently enacted. Or, if the current FY legislation was still pending, the July-August POP would relate the extent to which RADCF monies are to be applied on programs demanding higher obligational levels than was the case in the preceding FY. The July-August PCP would also be used for formulating the Agencies' final budget estimates. Therefore, the initial POP generated over the July-August span of each new FY would be a very important submission.

The next POP would be produced in November and December. Essentially it would represent a status check on all line items and relate any changes in the present FY's plan. Moreover, it would prove valuable in evaluating any significant variances over the previous POP which might have a considerable bearing on the final budget if this is deemed advisable.

Finally, in May and April the last POP for the FY would be formed. Inclusive in this generation are the Agencies' preview estimates. Moreover, the plans for reprogramming and year end adjustments would be designated in this document.

Conclusion

Of course, all recommendations advanced in this chapter are highly dependent upon one-another. Summarily, we see the following suggestions have been made:

(1) A stronger emphasis upon a program budget orientation - especially in the Congress;

(2) Augmentation of Budget Bureau and substantive committees in the Congress;

(3) Implementation of a Research and Development Contingency Fund;

(4) Better definition of program substance and correspondingly improved predicting capabilities; and,

(5) The use of three POP's per year versus the existing four per year.

The author is adamant in his conviction that these postulations if effected will be very instrumental in Achieving several significant improvements in the NASA Research and Development budget formulation process. These are:

SELECTED BIBLIOGRAPHY

(1) The degree of flexibility necessary in aerospace R&D programs;

(2) Better definition and predictive capabilities both within NASA and externally, hence;

(3) Greater efficiency in the space program;

(4) A better understanding of aerospace R&D management problems and the subsequent realization of more sophisticated solutions thereof;

(5) Increased rapport and confidence between the Executive and Legislative Branches on R&D matters; and,

(6) Ultimately a more optimal allocation of scarce National resources.

In the writer's estimation all of these things are within our grasp if the recommendations related herein are implemented.

It should be emphasized that all of the author's suggestions could realistically be operationalized without even a slight upheaval of the existing budgetary system. They are primarily procedural changes, although admittedly <u>true</u> program budgeting will be the most revolutionary and the hardest to embody throughout the system. Yet, the writer unequivocally believes NASA, the Budget Bureau, the Congress, and all other involved parties are equal to the task!

Official Sources

Anticipated Total Program Cost For Mercury Spacecraft, Monthly reports, (Houston: NASA-Manned Spacecraft Center, December, 1959-January,1963), unpublished data.

Budget Estimates: Fiscal Year 1964, Volume I, (Washington, D.C.: NASA Headquarters, 1963).

Budget Estimates: Fiscal Year 1965, Volume I, (Washington, D.C.: NASA Headquarters, 1963).

Budget Estimates: Fiscal Year 1966, Volumes I and II, (Washington, D.C.: NASA Headquarters, 1964).

Budget Estimates: Fiscal Year 1967, Volume II, (Washington, D.C.: NASA Headquarters, 1965).

"Budget Formulation and Execution," Headquarters Management Seminar, Unit III, (Washington, D.C.: NASA Headquarters, 1965).

"The Budget," U. S. Code: Congressional and Adminstrative News, Volume I, (St. Paul: West Publishing Co., 1965).

Emme, Eugene M., Aeronautics and Astronautics: An American Chronology of Science and Technology in the Exploration of Space 1915-1960, (Washington, D.C.: Government Printing Office, 1961).

Executive Office of the President, Bureau of the Budget, Planning-Programming-Budgeting, Bulletin No. 66-3, (Washington, October 12, 1965).

Executive Office of the President, Bureau of the Budget, Report to the President on Government Contracting For Research and Development, (Washington, D.C.: Government Printing Office, April, 1962).

Executive Office of the President, Bureau of the Budget, Special Analysis I: Federal Research, Development, and Related Programs, (Washington, D.C.: U. S. Government Printing Office, January, 1966).

Executive Office of the President, Bureau of the Budget, Supplement to Bulletin No. 66-3: Planning-Programming-Budgeting, (Washington, D.C., February 21, 1966).

Executive Office of the President, Bureau of the Budget, The Budget in Brief, (Washington, D.C.: U. S. Government Printing Office, 1965).

Final Budget Estimate: Fiscal Year 1964, (Houston: NASA-Manned Spacecraft Center, September, 1962), unpublished data.

Final Budget Estimate: Fiscal Year 1965, (Houston: NASA-Manned Spacecraft Center, September, 1963), unpublished data.

Grimwood, James M., Project Mercury: A Chronology, (Washington, D.C.: Government Printing Office, 1963).

"Independent Offices Appropriation Act, 1966," U. S. Code: Congressional and Administrative News, No. 10, (St. Paul: West Publishing Co., September 5, 1965).

"Management Reporting and Review," Headquarters Management Seminar, Unit V, (Washington, D.C.: NASA Headquarters, 1965).

Mercury Project Summary Including Results of the Fourth Manned Orbital Flight May 15 and 16, 1963, (Washington, D.C.: Government Printing Office, 1963).

"NASA Authorization, 1966," U. S. Code: Congressional and Administrative News, No. 7, (St. Paul: West Publishing Co., July 20, 1965).

NASA Basic Administrative Processes, Edition NPC 107, (Washington, D.C.: NASA, 1964).

"NASA's Basic Management Structure and Concepts," Headquarters Management Seminar, Unit I, (Washington, D.C.: NASA Headquarters, 1965).

NASA Historical Staff, Historical Sketch of NASA, (Washington, D. C.: Government Printing Office, 1965).

"The Planning and Approval Process," Headquarters Management Seminar, Unit II, (Washington, D.C.: NASA Headquarters, 1965).

Preliminary Budget Estimate: Fiscal Year 1964, (Houston: NASA-Manned Spacecraft Center, March, 1962), unpublished data.

Preliminary Budget Estimate: Fiscal Year 1965, (Houston: NASA-Manned Spacecraft Center, March, 1963), unpublished data.

"The Procurement Process," Headquarters Management Seminar, Unit IV, (Washington, D.C.: NASA Headquarters, 1965).

Research and Development: Program Obligational Plan-Manned Space Flight Programs, Designators 64-1 and 64-2, (Houston: NASA-Manned Spacecraft Center, 1964).

Research and Development: Program Operating Plan-Manned Space Flight Programs, Designators 64-3, 64-4, 65-1 65-2, 65-3, 65-4, and 66-1 (Houston: NASA-Manned Spacecraft Center, 1964-1966).

U. S. Congress, House, Subcommittee on Manned Space Flight, 1963 NASA Authorization, Hearings, 87th Congress, 2nd Session, Part 2, (Washington, D.C.: Government Printing Office, 1962).

U. S. Congress, House, Subcommittee on Manned Space Flight, 1964 NASA Authorization, Hearings, 88th Congress, 1st Session, Part 2b, (Washington, D.C.: Government Printing Office, 1963).

U. S. Congress, House, Subcommittee on Manned Space Flight, 1965 NASA Authorization, Hearings, 88th Congress, 2nd Session, Part 2, (Washington, D.C.: Government Printing Office, 1964).

U. S. Congress, House, Subcommittee on Manned Space Flight, 1966 NASA Authorization, Hearings, 89th Congress, 1st Session, edited version, (Houston: NASA-Manned Spacecraft Center, 1965).

Young, E. B., Financial Management History, (Houston, Texas, June 26, 1963), An unpublished documentation of the Project Mercury obligational history.

Unofficial Sources

Blood, Jerome W., ed., AMA Management Report, Number 69, (New York: American Management Association, Inc., 1962).

Burkhead, Jesse, Government Budgeting, (New York: John Wiley & Sons, Inc., 1956).

Due, John F., Government Finance: An Economic Analysis, (Homewood, Illinois: Richard P. Irwin, Inc., 1959), Revised ed.

Eckstein, Otto, Foundations of Modern Economics Series: Public Finance, (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964).

Groves, Harold M., Financing Government, 6th ed., (New York: Holt, Rinehart, and Winston, 1964).

Howard, George W., Common Sense in Research and Development Management, (New York: Vantage Press, 1955).

Jump, W. A., Budgeting and Financial Administration in an Operating Department of the Federal Government, A paper delivered at the Conference of the Governmental Research Association, (September 8, 1939).

Marting, Elizabeth, ed. Research and Development Series, Numbers 1-4, (New York: American Management Association, Inc., 1956).

Ott-Ott, Attiat F. and David J., Federal Budgetary Policy, (Washington, D.C.: The Brookings Institute, 1965).

Peck-Scherer, Merton J. and Frederic M., The Weapons Acquisition Process: An Economic Analysis, (Boston: Harvard University, 1962).

The Research and Policy Committee, Budgeting For National Objectives, (New York: Committee for Economic Development, 1966).

Roberts, Edward B., The Dynamics of Research and Development, (New York: Harper & Row, 1964).

Samuelson, Paul A., Economics: An Introductory Analysis, 6th ed., (New York: Mc Graw-Hill Book Company, 1964).

Scherer, Frederic M., The Weapons Acquisition Process: Economic Incentives, (Boston: Harvard University, 1964).

Smithies, Arthur, The Budgetary Process in the U. S., (New York: Mc Graw-Hill, 1955).

Villers, Raymond, Research and Development: Planning and Control, (New York: Financial Executives Research Foundation, Inc., 1964).

Wildavsky, Aaron, The Politics of the Budgetary Process, (Boston: Little, Brown, & Company, 1964).

Magazines

<u>Aviation Week & Space Technology</u>

<u>Business Week</u>

<u>Data</u>

<u>Missiles and Rockets</u>

<u>News Front</u>

<u>Science</u>

GLOSSARY OF INTERVIEWS

The author's research and writing efforts were aided considerably through gainful and very informative interviews. The listing below is a partial acknowledgement of these interviews and the dates on which they occurred.

Donald R. Bowman, Office of Programming, Policy & Procedures Division Director, National Aeronautics and Space Administration, February 15, 1966.

William Capron, Senior Staff Member, Brookings Institute, February 9, 1966.

Donald Crabill, Assistant Division Chief, NASA, Military Division, Bureau of the Budget, February 17 and 18, 1966.

John Dawson, Program Budget Specialist, Department of the Interior, August 23, 1965 and February 9, 1966.

James J. Gehrig, Committee on Aeronautical and Space Sciences, Staff Director, United States Senate, February 17, 1966.

Walter W. Heller, Department of Economics, University of Minnesota, January 28, 1966,

Wesley L. Hjornevik, Assistant Director for Administration, Manned Spacecraft Center, National Aeronautics and Space Administration, March 7, 1966.

Bernard L. Johnson, Office of Manned Space Flight, Programming Operations Director, National Aeronautics and Space Administration, February 15, 1966.

William E. Lilly, Manned Space Flight Program Control Director, National Aeronautics and Space Administration, February 15, 1966.

Hugh Loweth, Assistant Chief-Education, Manpower, and Science Division, Bureau of the Budget, February 18, 1966.

Thomas P. Murphy, Office of Legislative Affairs-Deputy Assistant Administrator, National Aeronautics and Space Administration, February 16, 1966.

Raymond Romatowski, Office of Administration, Director of Management Analysis, National Aeronautics and Space Administration, February 14, 1966.

Bernard Sisco, Office of Space Science and Applications, Program Review & Resources Management Director, National Aeronautics and Space Administration, February 16, 1966.

Robert F. Steadman, Director-Committee for Improvement of Management in Government, Committee for Economic Development, February 11, 1966.

Hollis Vail, Management Analyst, Department of the Interior, February 14, 1966.

Albert C. Weinstein, Special Assistant to the Deputy Director for Defense Research and Engineering, Department of Defense, February 18, 1966.

James Wilson, Committee on Science and Astronautics, Staff Member, United States House of Representatives, February 17, 1966.