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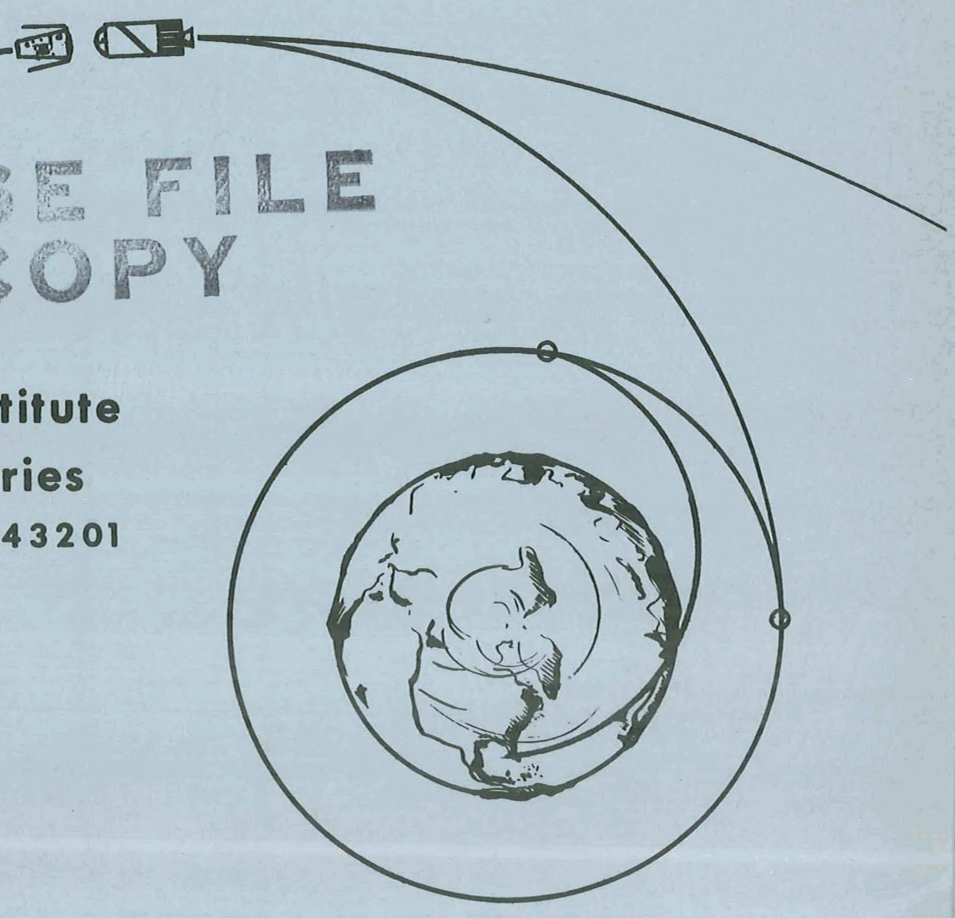
Report To

National Aeronautics and Space Administration

Office of Space Science and Applications

Launch Vehicle and Propulsion Programs

REPORT NUMBER BMI-NLVP-TR-70-1
ON
ESTIMATES OF FUTURE AUTOMATED SPACE MISSION
MODELS FOR USE IN NASA LAUNCH VEHICLE PLANNING
TO
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
UNDER
CONTRACT NUMBER NASw-2018
BY
D. A. NIPPERT AND JERRY L. PITTENGER
MAY 15, 1970



Battelle Memorial Institute
Columbus Laboratories
Columbus, Ohio 43201

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D. A. Nippert - Author

J. L. Pittenger - Author

Approved by: B. W. Davis
Director
NASA Launch Vehicle Project

BATTELLE MEMORIAL INSTITUTE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

STATEMENT OF ATTRIBUTION AND DISCLAIMER

PREFACE

The enabling legislation establishing NASA (Public Law 85-568, 85th Congress, H.R. 12575, July 29, 1958) prescribed that, among other objectives, civilian space activities should contribute materially to (1) the improvement of the usefulness, performance, speed, safety, and efficiency of ... space vehicles; (2) the development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space; and (3) cooperation by the United States with other nations and groups of nations ... in the peaceful application of the results ... . To fulfill its share of these responsibilities, Launch Vehicle and Propulsion Programs must determine the future space transportation requirements for automated missions.

This is the third in a series of studies directed toward development of better estimates of future space transportation system needs for automated missions for which NASA OSSA is the launch agency. In the first study of the series, past allocations of Federal Budgets were analyzed to achieve a better understanding of the competition for resources and the likely allocations of future budgets. In the second study, the relationships of space activities to national purposes were analyzed to obtain a better appreciation for likely emphases in the space program in view of the competition for the limited resources. Starting with this prior background information, this study presents sets of representative mission models of interest in the NASA OSSA Launch Vehicle and Propulsion Programs long range planning. Although they do not completely satisfy this need (for example, the models extend only from 1971 to 1981--a period which may be too short to provide timely information on entirely new technology requirements), they do represent an improved data base to be used in this planning process.

Planning and budgeting are dynamic areas, so it can be expected that by the time of publication some detailed information used in this study early in 1970 will be out of date. This is not expected to detract from the utility of this work for long range planning.

Readers should keep in mind that this study portrays the space program from the point of view of the transportation system planner. Responsible NASA officials should be consulted on details of individual space science and applications programs and projects.

Joseph E. McGolrick

Joseph E. McGolrick, Program Manager
Advanced Programs and Technology
Launch Vehicle and Propulsion Programs
Office of Space Science and Applications
National Aeronautics and Space Administration

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CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

Purpose of the Study

This study is the third of a series designed to "improve the rationale for long-range planning of space transportation systems, and related subsystems and technologies."(1)* Specifically, this study presents and discusses sets of mission models derived from consideration of (1) overall NASA and OSSA planning activities, and (2) budget projections based on analysis of the Federal Budget. Accurate and realistic data of this nature must be available to provide sound and comprehensive assistance to decision-makers in the long-range planning of space transportation systems.

Background

The need for mission models covering a long time period results from considerations pertinent to the planning of any space transportation system. Developing and building hardware for launch vehicles requires long lead times, perhaps 7 to 10 years for new technology itself and another 4 to 7 years to translate the technology into operational, high-reliability hardware. Certain missions, such as the Grand Tour flybys and Comet probes, are practical only during specific time intervals (and after certain points in technology development) because of the relative positions of the planets and comets as functions of time and because of the technology levels necessary to perform such missions for purposes of obtaining useful data. Budgetary restrictions will further constrain mission scheduling. Thus, a combination of long-term, relatively stable budgets and long-range planning of missions will be necessary to prevent undue loss of effort, resources, and time-dependent opportunities. Further discussions of these problems, planning rationale, and the service provided to decision-makers by long-range planning methods are presented in Reference (2).

The requirements of a methodology for generating realistic mission models involve critical factors or considerations of an extremely complex nature, in addition to those mission factors already mentioned. Such factors are not always predictable nor do they lend themselves easily to projection. Examples of factors include shifts in public opinion, changes in government policy, and changes or advances in available technology. While these factors are difficult to quantify, decision-makers must consider them in some form, along with other planning elements, because of the influence they exert on immediate and long-term funding levels. Efforts of previous studies to define and delineate more specifically the influence of these critical factors are documented later in this chapter. It is necessary here only to point out that, regardless of the way in which decision-makers choose to consider these factors, considerable preliminary work has been accomplished, and much pertinent information is available for the decision process.

In addition to consideration of factors influencing long-range planning, there is the additional requirement of flexibility. It is virtually a certainty that changes will occur in programs even within a framework of accurate prediction and projection. For example, as any given goal is approached, effort will be diverted to other goals, which are partly determined by shifts in public opinion and governmental policy. Scientific discoveries and technical breakthroughs may necessitate drastic shifts in order that advanced and possibly more economical methods may be incorporated into ongoing programs. In any case, it is necessary that planning activity be fluid and subject to continuing revision and evaluation.

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* Superscript numbers denote references listed at the end of this chapter.

Underlying the work performed in preceding studies of this series is the premise that there exists, or should exist, meaningful relationships between space goals and objectives and National goals. With this basic premise in mind, it can be further assumed that these relationships, together with current relative national priorities, will affect both the level of total space program expenditures and the emphases to be placed on various aspects of the program. Thus, projected estimates of national priorities and expenditures employed in context with the relationships of space activities to national goals should provide a basis for sound evaluation and modification of projected mission models (that is, lists of projected missions, mission parameters, and launch schedules). The resulting range of mission models is expected to yield information that will be useful in long-range space transportation system planning.

Projected estimates of "NASA OSSA (Office of Space Science and Applications) mission plans (i.e., mission models) are the most significant inputs in determining requirements for the future (OSSA) space transportation system and, thus, for related technology programs".(1) NASA OSSA programs are interrelated with the other NASA offices; OMSF (Office of Manned Space Flight), OART (Office of Advanced Research and Technology), and OTDA (Office of Tracking and Data Acquisition); with the USAF (U. S. Air Force), USN (U. S. Navy), USA (U. S. Army); with the AEC (Atomic Energy Commission), ESSA (Environmental Science Services Administration), COMSAT (Communications Satellite Corporation); and with other National and International space related programs. All of the U. S. programs are assumed to be directed toward satisfying National goals and objectives.

There have been various papers, reports, and books in which attempts have been made to classify and define National goals and objectives in terms of functions, administrative operations, and other categories.(3-6) There have also been attempts to weight these categories in terms of costs for purposes of analysis, planning, and management of present and future activities.(4-7) Attempts have been and are being made to model (or otherwise determine) the relationship of space program activities to National problems and programs, and analyses of National and International problems have been performed to determine whether space technology can make a contribution to the solution of these problems.(8-16)

In the first of the present series of related reports(6), the following 13 functional fields of Federal programs pursuing National goals were identified, described, functionally defined, and analyzed on the basis of past and present allocations of Federal budget resources:

National Security	Labor and Manpower
Welfare	Veterans
Health	Space
Commerce, Transportation, and Communications	Housing and Community Development
Education and Knowledge	Natural Resources and Environment
Agriculture	General Government
International Relations	

"Funding allocations to these National functional goals provide a yardstick for measuring priorities among the goals. These quantified relationships are indicators of the nation's willingness to commit funds to translate broad...statements of National purpose into accomplishments."(10) Using such basic data, it is possible to make reasonable forecasts of likely future distributions of budgetary resources.(17) Such a forecast has been included here (Appendix A). Clearly, other projections are also possible.

The second study in this series[10] examined a broad, but not exhaustive, spectrum of NASA interests and activities. A set of space goals and objectives were established and related to National goals qualitatively and, on a subjective basis, quantitatively. Although that report emphasized automated space activities (i.e., such as those for which NASA OSSA has responsibilities), the implications of manned space activities were also considered. However, it was not the purpose of the report to make a comparative evaluation of manned versus automated space activities but, rather, to identify purposes in space and, in particular, to determine their relevancies to National purposes. Topics considered included:

Space Sciences	Space Applications Satellites
Space Physics	Communications
Space Astronomy	Earth Resources
Planetary Exploration	Meteorological
Space Biology	Geodetic
	Navigation and Traffic Control

Further efforts to quantify relative priorities for space objectives and activities using various weighting factors for National functional goals have been made.[18,19]

Rationale

The principal objective of the study presented here is to generate a set of mission models which could be used in long-range planning of OSSA space transportation systems. The models were to represent a range of probable missions and their associated schedules. To establish this set of missions, the results of work by OSSA advanced mission planners were utilized. These results were found, primarily, in reports of the PSG (Planning Steering Group) planning panels. These reports, along with other souces of mission data, are discussed in Chapter III.

Budget projections used in this study (see Appendix A) are a result of considering the entire Federal Government budget and projecting how various competing functional areas might fare during the next 10 years.

The flight schedules associated with the models developed are highly dependent on the budget projections. This is an essential factor, since the amount of money that NASA and OSSA will have in the future will directly determine the amount of flight activity that will be supported. The overall NASA and OSSA funding projections used here are somewhat less than current related budget requests and the funding levels associated with some NASA planning documents, such as the report to the STG (Space Task Group).[20] This is as it should be, if one carefully considers the budget process. Each Federal agency is constantly trying to grow, to innovate, and to present forward-looking plans. It is quite normal for such plans to require greater resources than are likely to be available. This type of planning is appropriate at the agency level; however, such plans are not as useful for long-range planning of launch vehicle families (or space transportation systems). For such planning, use rates play an important role. Thus, for example, if use-rate projections are too high, proposed new launch vehicle projects which appear to have a reasonable pay-off period may, in fact, turn out to be quite costly. Therefore, sound projections of likely, not hoped for, flight schedules are necessary.

Many factors are involved in developing a mission model which is to represent a reasonable projection of the future. One of the most important factors, the available dollars, has already been mentioned. Two other important factors are the state of the art of the technologies involved, and internal NASA plans and policies. In this study, these two factors are included in an indirect manner by utilizing, to the greatest possible extent, plans developed within NASA by people whose work and planning processes are constantly influenced by such factors.

The mission models developed in this study represent only a very small portion of the spectrum of possible models. However, it is felt that these models represent a "most likely future" based on current policies and funding trends. A reasonable effort was made to use the most current and authoritative project plans available, but the reader is cautioned not to use these models out of context. If he requires official space program planning data, he should approach the officials directly responsible for the programs of interest.

Report Organization

The complete report consists of 8 chapters and 4 appendixes. Chapter II contains a summary of the report and a discussion of implications. Chapter III discusses the data sources used and the approach followed in the study. Chapters IV - VII present guidelines and 10 related mission models for each OSSA program division (Bioscience, Lunar and Planetary, Physics and Astronomy, and Applications). Included in each chapter are descriptions of all of the projects used in the models, funding plots and flight schedules for each model, and a discussion of information pertinent to launch vehicle planning.

Chapter VIII contains 10 OSSA level mission models. Guidelines, launch vehicle procurement plots, OSSA funding plots and flight schedules are presented for each model. Chapter VIII also contains a discussion of future launch vehicle requirements implied by the mission models presented.

Other information and data used in and pertinent to understanding the main body of the report are presented in the appendixes. Appendix A presents and discusses the budget projections used. A discussion of the Prospectus computer program which was utilized to assemble and process the data used in this study is presented in Appendix B. Appendix C identifies non-OSSA missions for which OSSA is the launch agency and presents several mission models for "outside users". Launch vehicle recurring and support costs used are presented in Appendix D.

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CHAPTER II. SUMMARY

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CHAPTER II. SUMMARY

Introduction

The purpose of this study was to develop a set of mission models for the 1971-1981 period which would be useful in obtaining estimates of the future requirements for OSSA launch vehicles. These mission models were derived from consideration of NASA OSSA and overall NASA planning activities and budget projections for NASA OSSA that were developed as a result of previous work in this series of studies. The 1971-1981 period was selected because it was the period most thoroughly covered in the documents produced during the 1969 NASA planning activities.

Summary

Data and Sources

Seven types of information and data were used in this study: (1) project descriptions, (2) space budget projections, (3) program plans (overall NASA and NASA OSSA), (4) fiscal and budget plans, (5) policy statements and discussions, (6) statements on program goals and objectives, and (7) NASA estimates of outside user requirements.

NASA data sources were utilized wherever possible. Sources included the following:

(1) PSG Planning Panel Reports[1-6]*

(2) PSG Prospectus file[7]

(3) NASA's report to the STG[8]

(4) OSSA R&D Program Operating Plan (POP)[9]

(5) Projected 1972-1975 NASA OSSA new starts[10]

(6) "Selected Space Goals and Objectives, and Their Relation to National Goals"[11]

(7) Projections of OSSA Budgets (Appendix A and Reference 12).

Other data sources included memoranda from OSSA Launch Vehicle and Propulsion Programs files, NASA news releases pertinent to the future of the space program, and other NASA OSSA documents.

Approach

The mission models developed can be categorized in two groups: (1) NASA-based models, and (2) alternative models. In the first group, four models were identified; three based on the NASA report to the STG, and the fourth based on PSG activities and documents. To present a spectrum of mission models with funding requirements near those in Appendix A, six alternative models were developed by establishing guidelines and then creating models compatible with these guidelines. First, six alternative models were developed for each of four OSSA programs divisions. Six alternative OSSA mission models were developed by establishing OSSA level guidelines and selecting the alternative division mission models which best satisfied these guidelines.

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* Superscript numbers denote references at the end of this chapter.

To complete each of the OSSA level mission models, non-OSSA projects for which OSSA provides the launch funds were added.

In all cases, the NASA projects included in the models were selected from projects which had been proposed as part of some NASA planning activity. Often project flight schedules were changed, but no new project concepts were developed in this study. The outside user estimates were obtained from NASA sources and were not modified during the study.

NASA OSSA Budget Projections

To establish target funding levels to be considered in developing alternative mission models, it was necessary to estimate what the future OSSA budget might be. The projections used in this study are presented in Appendix A. These projections are based on an analysis of past budgetary data.[10,12] Table II-1 summarizes funding projections for OSSA by division.

TABLE II-1. FUNDING PROJECTIONS FOR OSSA, BY DIVISION

Division	Projected Dollar Outlays, $ Millions 1975	1980	Projected Average Annual Growth Rate, %, 1970 to 1980
Biosciences (SB)	39	47	7.0
Lunar and Planetary (SL)	222	268	4.7
Physics and Astronomy (SG)	193	233	6.9
Space Applications (SA)[a]	231	279	8.7
LV Procurement (SV)	202	244	6.1
OSSA Total	887	1,071	6.5

(a) This division has been divided into two divisions: Communications (SC) and Earth Observations (SR). They were considered jointly as Space Applications here to permit application of historical data.

Mission Model Discussions

Bioscience (SB). The SB models presented in this study cover a spectrum of Bioscience activities ranging from no flights to as many as 33 flights over the 1971-1981 period. The launch rate for SB programs is highly dependent upon such factors as the availability of the manned Skylabs and the space station on which many of the SB experiments may be performed. Also, the smaller sizes and weights of the Bioscience experiments lend themselves to "piggyback" launches with other spacecraft.

The flight projects in the Bioscience plans presented consist of Biopioneers, Bioexplorers, Biosatellites (Improved), and Advanced Biosatellites. Of these projects, the Biopioneers and Bioexplorers received the highest priority in all of the NASA models. Therefore, Biopioneers and Bioexplorers seem to be the most likely prospects to be included in any future Bioscience program, with the addition of Biosatellites (Improved) and Advanced Biosatellites only if funds permit.

Lunar and Planetary (SL). In view of the projected SL available funds presented in Appendix A, analysis of the NASA-based models indicated that they were probably overly ambitious. In creating SL programs with Mars Viking missions in 1975 and 1977 and Grand Tour missions in 1977 and 1979, it was found that they, alone, absorbed nearly all the projected funds. Therefore, the creation of the alternative models depended mainly upon two factors: when and how many Viking missions are to be launched and the number and type of launch(es) planned in response to the Grand Tour opportunities.

Many of the proposed planetary projects require relatively large launch vehicles. Approximately half of the missions in the SL models require a TITAN/CENTAUR* vehicle.

The number of launches in the 4 NASA-based models ranges from 21 to 33 for the years 1971-1981. For the six alternative models the number of launches ranges from 15 to 20 for the same time period.

Physics and Astronomy (SG). In developing the alternative SG models, the principal task was that of scheduling three major programs so that the estimated funding requirements would be within projected budget constraints. These three programs are the High Energy Astronomical Observatories (HEAO), the Large Space Telescopes (LST), and the Large Telescope Mount (LTM). Most of the variations between the SG alternative models occur in the projects scheduled for the last half of the time period considered. The total number of launches in the 10 SG models ranges from 29 (PSG-LOW) to 88 (STG Option I). The total number of launches for the 6 alternative models varies between 59 and 81.

Space Applications (SA). Space Applications** is the only OSSA program which has been growing while overall NASA and OSSA have been declining. All of the SA models presented here assume that this growth will continue. It was found that the current rate of growth, the recent reorganization** of the area, and uncertainty with regard to the needs of potential future users make it difficult to project future SA flight schedules. However, the six alternative mission models presented are considered to reflect a reasonable range of launch vehicle requirements for future SA activities.

The number of launches in the 4 NASA-based models ranges from 38 to 52 in the 1971-1981 time period. In the six alternative models, the projected number of launches ranges from 51 to 65. The number of launches is higher for the alternative models since they include more complete estimates of the projects that might be pursued in the later part of the time period. The four NASA-based models included few new projects after 1976.

Outside Users. Five outside user models (SV1-SV5) are presented in Appendix C. The outsider users were divided into five groups; OART, DOD, International, Communications, and Earth Observations. It was assumed that all of the launch vehicles for OART and 60% of the vehicles for International Programs would be funded by OSSA. The remaining vehicles were assumed to be funded by the outside user procuring the OSSA launch.

* This general title includes various configurations such as TITAN IIID/CENTAUR, TITAN IIID(7)/CENTAUR, and TITAN IIID/CENTAUR/BII.

** Although the Space Applications Programs division has now been divided into two divisions, Communications Programs (SC) and Earth Observations Programs (SR), it is considered as a single division in this study.

In the past*, outside users have accounted for 30 to 55% (from 6 to 15 launches) of the total number of OSSA vehicles launched each year. The outside user models SV1-SV5 contain a range from 13 to 17, 12 to 18, 11 to 14, 17 to 23, and 11 to 15 launches per year, respectively, for the 11-year period. Outside users are expected to have a significant effect upon use rates of OSSA launch vehicles during the 1971-1981 time period. The launch vehicles required are expected to include SCOUT, DELTA, ATLAS/CENTAUR, and TITAN IIID/CENTAUR.

Total OSSA. The four NASA-based OSSA mission models are made up of the corresponding NASA-based OSSA program division models. The 6 alternative OSSA models were developed by establishing OSSA level guidelines and then selecting appropriate alternative division models. Then estimates of non-OSSA requirements for OSSA funded vehicles were added to the combination of division models in order to obtain estimates of total OSSA funding requirements.

A summary of the OSSA model characteristics are presented in Table II-2.

TABLE II-2. SUMMARY OF OSSA MISSION MODEL CHARACTERISTICS

Model	Characteristics, in Brief
OSSA1 (Baseline I)	Automated Portion of Programs II and III from the NASA report to the STG
OSSA2 (Baseline II)	Modification of Baseline I to reflect data from the NASA FY 1971 submission to the Bureau of the Budget
OSSA3 (STG-Option I)	Automated portion of Program I from the NASA report to the STG
OSSA4 (PSG-LOW)	A combination of the lowest (funding) plans from each of the OSSA-related PSG Planning Panels
OSSA5 (Alternative I)	Combination of each division model with individual funding levels providing the "best fit" projections to the Appendix A OSSA division funding
OSSA6 (Alternative II)	Combination of division models yielding the total funding which "best fits" the total OSSA funding projections from Appendix A
OSSA7 (Alternative III)	Combination of the alternative division models with the lowest funding requirements
OSSA8 (Alternative IV)	A strong SA plan, a moderate SL plan, and funding requirements close to the total OSSA projection
OSSA9 (Alternative V)	A moderate-to-strong SL plan, moderate SA and SG plans, and a low SB plan
OSSA10 (Alternative VI)	Combination of division models with funding levels approximately 10% higher than their corresponding projections from Appendix A

* Data were analyzed for the period 1962-1969.

Table II-3 presents the total OSSA funding requirements for each mission model by year. As can be seen in Table II-3, the NASA-based models all have high funding levels for the first 4 years. The funding levels of three of these four models decline after 1975. The funding requirements for the alternative models are generally consistent with the OSSA funding projection from Appendix A, but some are moderately above or below this projection.

TABLE II-3. OSSA FUNDING REQUIREMENTS ($, MILLIONS)

Model	Year										
	71	72	73	74	75	76	77	78	79	80	81
OSSA1(Baseline I)	842	801	822	777	795	807	772	687	656	481	312
OSSA2(Baseline II)	865	919	980	938	946	915	798	660	539	416	286
OSSA3(STG Option I)	870	1107	1231	1207	1333	1450	1300	1222	1231	1008	559
OSSA4(PSG-LOW)	980	1126	1190	930	787	701	703	757	671	700	765
OSSA5(Alternative I)	645	658	770	805	816	896	887	856	878	740	487
OSSA6(Alternative II)	632	643	758	768	813	897	921	891	861	774	550
OSSA7(Alternative III)	585	569	646	682	765	783	865	882	874	654	402
OSSA8(Alternative IV)	606	618	722	781	872	857	918	974	953	742	547
OSSA9(Alternative V)	649	653	764	777	840	887	955	912	890	825	655
OSSA10(Alternative VI)	613	643	781	843	927	983	1055	1055	1035	823	554

Table II-4 presents the number of launches, by year, contained in each OSSA model.

TABLE II-4. LAUNCHES FOR EACH OSSA MODEL BY YEAR*

Model	Year											
	71	72	73	74	75	76	77	78	79	80	81	Total
OSSA1(Baseline I)	13	15	17	24	21	14	17	13	16	12	12	174
OSSA2(Baseline II)	13	13	18	26	22	17	23	11	17	11	12	184
OSSA3(STG Option I)	15	23	23	36	27	21	25	18	16	17	12	232
OSSA4(PSG-LOW)	12	17	24	25	27	9	11	10	8	8	6	157
OSSA5(Alternative I)	13	15	17	23	21	20	19	22	17	18	16	201
OSSA6(Alternative II)	13	14	17	23	20	19	19	21	19	19	17	201
OSSA7(Alternative III)	11	10	17	19	16	15	17	13	19	18	13	168
OSSA8(Alternative IV)	11	10	17	21	15	17	18	16	19	20	14	178
OSSA9(Alternative V)	13	13	16	21	19	16	19	16	19	16	16	184
OSSA10(Alternative VI)	11	10	17	23	18	18	21	20	22	21	15	196

* Does not include reimbursable launches.

To provide projections of the total requirements for OSSA launch vehicles (both reimbursable and OSSA funded), estimates of the reimbursable requirements were added to 3 selected alternative OSSA models. The three different total launch projections were made to correspond with low, nominal, and high estimates. These total estimates are presented in Table II-5.

TABLE II-5. LOW, NOMINAL AND HIGH ESTIMATES OF TOTAL OSSA LAUNCH VEHICLE REQUIREMENTS*

Total Requirement Level	Year											Total
	71	72	73	74	75	76	77	78	79	80	81	
Low	21	19	27	30	27	22	28	26	33	28	24	285
Nominal	23	23	27	34	31	27	30	33	32	29	28	314
High	24	23	34	36	35	33	34	34	41	31	30	355

* Table II-5 was extracted from Table VIII-17.

Brief Review of Results

Three different categories of estimates of future OSSA launch activity (1971-1981) are presented in this report: (1) four mission models derived from NASA reports, (2) six alternative models created to be consistent with funding projections for NASA OSSA, (3) three projections of total OSSA launch vehicle requirements including reimbursable launches. The first two categories contain only automated missions for which OSSA would be expected to fund the launches. The third category consists of all projects for which OSSA is expected to be the launch agency.

Preliminary analysis of these estimates indicate the following: (1) it appears likely that no major problems will be encountered in satisfying future launch requirements, (2) the average total number of launches per year for OSSA launch vehicles ranges from 26 to 32, and (3) in any one year, non-OSSA space missions account for 42 to 70% of the launches.

The proportion of launches for each vehicle does not differ significantly among these various estimates of requirements. The Delta has the highest use rate in each of the estimates, accounting for 40 to 50% of the launches. Scout has the next highest use rate and accounts for 25 to 33% of the launches. The ATLAS/CENTAUR, TITAN IIIC, and TITAN IIID/CENTAUR satisfy the requirements for most of the remaining launches. All of these vehicles are in the current launch vehicle family or have been approved for introduction in the near future. The TITAN IIID(7)/CENTAUR, TITAN IIID, and SATURN INT20/CENTAUR complete the list of vehicles which might be required and appear only in models which are considered to be aggressive. The few missions requiring this additional launch vehicle capability are identified in Chapters IV through VIII.

Implications

The mission models presented in this report were developed in order to obtain estimates of future requirements for OSSA launch vehicles for the period 1971-1981. Preliminary analysis indicates that major problems are not likely to be encountered in satisfying the requirements with the current and planned OSSA launch vehicle family. However, it should be understood that the launch vehicle assignments used in this study are tentative and are subject to further analysis and revision. More detailed analyses of mission requirements, as well as detailed launch vehicle family studies, need to be conducted before definitive and conclusive statements regarding launch vehicle needs can be made.

Besides utilizing the models developed in studies of launch vehicle needs, consideration should also be given to updating and improving the models. There are two primary areas in which updates and improvements might be obtained: (1) estimates of outside user requirements, and (2) inclusion of new projects and program planning information.

In this study, outside user requirements were utilized directly as received from appropriate NASA sources. In view of the significance of these requirements (42 to 70% of the projected OSSA vehicle launches), a better understanding of the factors affecting these estimates is imperative. Preliminary work has been done towards obtaining a better understanding of these factors by examining future plans of various civilian federal agencies for the use of space technology in light of projected R&D funds.[13] Factors affecting another area of outside user requirements, that is, the plans of foreign organizations who expect to use OSSA launch vehicles, also need to be examined. In particular, the impact of foreign launch vehicle programs (e.g., ELDO and Japanese) needs to be studied. An improved understanding of conditions influencing the use of OSSA launch vehicles by corporations (e.g., Comsat), and DOD is also desirable. Continued cooperation and study of mutual requirements with the DOD are needed in regard to the proposed space shuttle being studied by the Office of Manned Space Flight (OMSF). Updates of the models will be required because program plans and project data are continually changing. Since studies such as the one undertaken here take time, updated estimates already exist for some of the data utilized in this work.

Before updating and improving any particular type of information used in this study, analyses should be performed to determine which of the input factors considered here have the greatest effect on the mission models and their implications in terms of launch vehicle requirements. In particular, such sensitivity analyses should be conducted with regard to cost estimates and projections for various outside users.

Besides updating and improving the information used in the development of the models, it is also important to determine what length planning period would best be suited to long-range launch vehicle planning. Experience has shown that it takes 7 to 10 years to develop entirely new propulsion system technology and another 4 to 7 years to introduce new technology into operational systems. As a result, advanced launch vehicle and propulsion system planning perhaps should extend more than 17 years to identify needs for vehicular systems involving entirely new technology which may be difficult to develop. It is possible to obtain 15 to 20-year plans by extending the 11-year plans developed in this study using the OSSA programs projected for 1981 as the starting point for the extensions. However, plans for longer periods might not have to be so detailed or definitive as those presented in this study. The principal requirement of plans covering the period 10 to 20 years into the future is that they highlight any special problems that might arise or significant shifts that might occur in projected trends.

As with project data and program plans, budget projections need to be updated and redefined on a periodic basis as more specific data and information become available. The continuing change in the overall geopolitical and economic environment, new congressional actions, revised administrative policies, and changes in social viewpoints may demand redefinition of scientific, social, economic and political goals. Allocation of Federal resources may exhibit corresponding shifts. Also, changes of program emphases within NASA may occur independently of, or in response to, shifts in National emphases and would necessitate reevaluation of current projections.

If the planning period is to be extended there is also a need to extend the budget projections further into the future. However, such projections for more than 10 years might be used more as rough guidelines rather than as assumed constraints.

The foregoing observations indicate some areas in which the models presented in this report might be improved and extended. While utilizing the models in long-range launch vehicle planning activities, it is likely that other areas of desired changes or improvements will be found. To determine the continuing validity of the projections developed in this study, periodic comparisons of NASA and NASA OSSA division and implemented programs with the models presented will be required. Items for comparison would include funding schedules, new start dates, program content, and the prevailing NASA environment. Such comparisons over a period of time may also suggest the best means and timing for updating the models for use in long-range planning of space transportation systems.

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CHAPTER III. APPROACH

Introduction

Developing a set of mission models to be used in long-range planning of OSSA space transportation systems required the use of many sources of information such as individual mission plans, projections of the Federal Budget, and projections of NASA's share of the Federal Budget for a period of 10 years into the future (1971-1980). This chapter discusses how these and other types of data were used to develop the mission models presented in Chapters IV through VIII.

Before the types and uses of the data are discussed, the terms "project" and "mission model" need to be defined.

Project

A project is an activity which requires funding. It may or may not be a flight project, that is, one that involves spacecraft which must be launched. In general, most of the projects discussed in this report are flight projects, since they established the requirements for launch vehicles. Projects may have five attributes of interest in launch vehicle planning:

(1) Name: Title of the activity

(2) Funding requirements: Millions of dollars by year, excluding launch vehicle procurement cost

(3) Flight Schedule: Schedule for launch of a spacecraft

(4) Spacecraft Weight: Given in pounds

(5) V_C: Characteristic velocity, a measure of the energy required to launch the spacecraft on the desired trajectory in ft/sec.

In this study, three different types of projects are discussed: OSSA flight projects, OSSA nonflight projects, and non-OSSA flight projects. Non-OSSA organizations include various Government agencies, corporations, Foreign Governments, and International organizations that procure launches from NASA OSSA. Table III-1 shows the attributes (defined above) required in this study for each of the three project types.

TABLE III-1. PROJECT ATTRIBUTES BY PROJECT TYPES

	Attributes				
Project Type	Name	Funding Schedule	Flight Schedule	Weight	V_C
OSSA flight	●	●	●	●	●
OSSA nonflight	●	●			
Non-OSSA flight[(a)]	●		●	●	●

(a) In some cases non-OSSA requirements are stated only in terms of annual rates for classes of launch vehicles (e.g., two SCOUT launches per year).

Mission Model

A mission model is a collection of projects which represents one plan for the time period under consideration. Mission models can exist for various organizational levels; for instance, there are mission models for Bioscience Programs (an OSSA division) and for all of OSSA. Both levels are presented in this study.

Data Types and Uses

The following seven types of information and data were utilized in this study:

- Project descriptions
- Space budget projections
- Program plans
- Fiscal and budget plans
- Policy statements and discussions
- Program goals and objectives
- Outside user requirements.

Project Descriptions

These are descriptions of the various space projects that might be funded and, in the case of a flight project, launched. The descriptions include the five project attributes mentioned earlier and references to the project purpose and relevant program area. Projects were the basic units used to construct the various mission models and, therefore, considerable effort went into obtaining project descriptions that were as complete and accurate as possible. These data were found in varying degrees of completeness and accuracy; project descriptions ranged from a minimum of name and flight schedule to 3 or 4 pages of data. The most difficult project data to obtain were spacecraft weights. For example, many project descriptions contain phrases such as, "S/C (spacecraft) to be defined as Titan Class"[(1)*], "Scout Class"[(1)], or (worse), "S/C might exceed capability of uprated Delta".[(2)] For most projects, the required V_C data were either stated or could be determined from year of launch, destination and flight time, or from the prescribed orbit.

Undoubtedly, the least accurate data for each project were the funding estimates. This was especially true for projects for which no preliminary studies had been performed. It is not known what methods were used to develop these cost estimates nor what price index, if any, was considered. Uncertainties associated with the cost estimates appeared to overshadow inflationary and other considerations. Therefore, the cost estimates were used without attempting to modify them to reflect inflation or other effects.

Project data were obtained from NASA documents wherever possible. However, where project data corresponding directly to a desired flight schedule could not be found it was necessary to make estimates of the required data based on comparisons with related projects. In such cases, the project funding was derived from funding estimates for the project most closely resembling the project in question.

* Superscript numbers denote references at the end of this chapter.

Space Budget Projections

The future level of space activity obviously depends on the amount of funds available for space. When making a forecast of future OSSA launch vehicle requirements, it is desirable to consider the amount of funds likely to be available for user activities. For this reason, the projections presented in Appendix A of this report were generated.* Although, as stated in Appendix A, the projections are to be considered only as estimates of limited accuracy and as representing one possibility out of many, it is felt that the projections are reasonably good and, certainly, useful for these purposes. There are no known published projections with which to compare the OSSA projections used in this study.

Both the total OSSA projections and those for each of the OSSA Program divisions given in Appendix A have been used. The accuracy associated with total OSSA projections is believed to be much better than that for the OSSA divisions. The division projections were used in developing guidelines for the corresponding mission models. For each OSSA division, models were developed which require both higher and lower funding than that projected. The OSSA projection likewise provided a guideline for several proposed OSSA mission models. As with the division models, OSSA models which lie above and below the projected levels were developed.

Program Plans

During 1969, most of the NASA planning activity was directed at supporting the work of the Space Task Group (STG). The principal NASA group assigned to provide planning support for the STG was the Planning Steering Group (PSG). The PSG was supported by planning panels corresponding to discipline areas, such as astronomy and space biology, each of which developed various mission models as part of their activities. Selected mission models derived from the OSSA-related planning panels are presented in this study. In many cases, these plans were recorded and stored in the PSG Prospectus file(1) at Goddard Space Flight Center (GSFC) and could be obtained by using the Prospectus computer program (see Appendix B).

The other principal source (i.e., other than the PSG reports) of specific program plans was the NASA report to the STG.(3) This report proposed three different overall NASA plans; the major differences in the three plans was the pace at which various manned space flight activities would be pursued. These plans were presented to the STG, which accepted them and passed them on to the President.(4) The plans represent NASA desires, given sufficient funding, and this is the context in which these plans were considered.

Fiscal and Budget Plans

The program plans discussed in the previous section can be described as long-range plans. Fiscal and budget plans, in contrast, are usually short-range, near-term plans. In general, they present the next fiscal year in detail and consider, at the most, the next 5 years in less detail.

Data representing the current fiscal year and plans represented by the FY 71 budget submission were used as the starting point for most of the plans in this study since, obviously, any long-range plans must evolve from current and near-term plans. The budget plans indicate which projects are being proposed as new starts in the near future and the latest funding estimates for existing projects.

* Appendix A is based on the work performed in the first study in this series. [See Reference (5)].

Policy Statements and Discussions

When attempting to estimate what is likely to happen in the future, it is desirable to have a set of guidelines. The more definitive the guidelines, the more accurate the estimates tend to be. It is in this context that recent discussions and statements relating to U. S. space policy were considered. For example, because of current stress on the quality of the environment, several models presented here represent a relatively high growth rate for the Earth Observations programs.

One of the principal values in considering policy statements(6-8) is that they increase confidence in the budget projections used in this study. These policy statements and discussions may also have influenced the authors in development of the various alternative models presented.

Recent policy statements indicate that, for the near future, the NASA budget will be closely scrutinized by both the Executive and Legislative branches of the Government, and that the type of growth associated with the Apollo era is not likely to be repeated.

Program Goals and Objectives

This type of information describes the various programs that NASA is, or might be, involved with and states the purpose of the involvement. This same information is used by public officials when they are required to make decisions regarding the funding of programs. The term program as used here can mean a specific project, such as Viking; all of the activities of a specific discipline, such as Space Physics; or an OSSA division, such as Biosciences. The important point is that the goals and objectives are the statements that explain what each program is designed to accomplish. The goals and objectives provide direction for a program and determine the types of experiments and equipment that are required. When selecting projects to be included in a mission model, it is necessary to consider goals and objectives and to select missions which are relevant to those goals and objectives. Determining such relationships requires judgments that are, at best, imprecise. For this reason, several alternative mission models are presented in this report.

Outside User Requirements

The term "outside users" refers to all users of OSSA launch vehicles except NASA OSSA. Such users include NASA OART, DOD, ESSA, other government agencies, corporations, foreign countries and international organizations. Estimates of these requirements were obtained primarily from information provided to OSSA Launch Vehicle and Propulsion Programs by the various NASA program offices which work with the outside users. These requirements and variations on them are presented in Appendix C. The non-OSSA users account for a large percentage of OSSA launch vehicle utilization and, therefore, have a significant effect on use rates.

Data Sources

As stated earlier in the report, NASA data were used to the greatest possible extent in this study. This is particularly true for the project data. This section reviews briefly the data sources used in the study.

PSG Planning Panel Reports[2,8-12]

The PSG planning panel reports provided most of the information concerning program goals and objectives as well as detailed project descriptions. Most of the reports also present program plans. These reports also provided guidelines which permitted creation of modified projects (flight schedule changes, program stretch-out, etc). Information concerning the interdependence among different projects and launch schedules was also presented. This type of information was particularly well documented for the Planetary program.[13]

PSG Prospectus File[1]

Many of the PSG planning panels used the Prospectus computer program* to help generate and document their plans. The Prospectus file is the magnetic tape containing all of the projects and plans created by the panels using the program. The PSG Prospectus file provided the basis for the project file used in this study. The Prospectus computer program was used extensively in this study to generate and document the mission models presented in this report.

NASA's Report to the STG[3]

NASA's report to the STG provides three published "official" NASA plans. As a result, it must be considered the best source of top level NASA thoughts and plans. By taking the automated portion of these plans, two OSSA mission models were obtained. The automated portions of two plans were identical; therefore three NASA plans yielded only two OSSA mission models. The models are referred to in this report as STG Option I and Baseline I (from Programs II and III). Besides directly providing two OSSA models, the NASA report also yielded insights regarding priorities to be considered in developing alternative models.

OSSA R&D Program Operating Plan (POP 69-2)[14]

The OSSA POP 69-2 report contained up-to-date cost estimates for current projects and proposed FY 1971 new starts. It also presented the current OSSA plans from which any long-range plans must evolve.

Projected 1972-1975 New Starts[15]

The "Projected 1972-1975 New Starts" was back-up information given to the Bureau of the Budget while the FY 1971 NASA budget was being discussed. The data included up-to-date cost estimates as well as near-term program plans. The models extracted from these data and the OSSA R&D POP data are referred to in this report as Baseline II. Again, besides directly supplying a mission model, the document indicated priorities to be considered when developing alternative models.

* The Prospectus computer program is described in Appendix B.

Selected Space Goals and Objectives and Their Relation to National Goals[16]

This report provided descriptions of program goals, objectives, and projects. It was utilized primarily as an aid to understanding the purpose of various projects and programs. It was also used to obtain specific project data (such as orbits required) for projects where such information was lacking in the PSG planning panel reports. In addition, this document, along with current policy statements, provided insight into current relationships between space activities and national purposes.

Projections of OSSA Budgets

These budget projections (Appendix A) were prepared specifically for use in this study. The purpose of these projections was to provide a guide to the amount of money that might be available for future OSSA space activities. In the past, OSSA has developed mission models projecting 20 years into the future, but the funding level projections associated with these models proved to be optimistic. It is necessary that such budget projections and resulting mission models be as realistic as possible, since, in launch vehicle planning, use rates play a vital role in determining future launch vehicle needs. Reasonable estimates of these use rates can be determined only by estimating the amount of future space activity, which is directly influenced by the funds available.

It should be stressed again that the budget projections given here were used only as guidelines. There are several models presented in this report which fall both above and below the projected funding levels.

Other Data Sources

Besides the principal data sources just described, there were many other items that provided useful information for the study. One such source included memoranda[17-23] which contain estimates of the requirements for vehicles by outside users. Other documents considered included the Level 0[24] and Level 1[25] OSSA Management reports, Planetary program Review documents[26], NASA Pocket Statistics[27], and BMI-NLVP memoranda.[28,29]

Summary

The types of information used in this study were often obtained from more than one of the principal data sources. Table III-2 relates the various information types to these sources.

Mission Model Development Process

In considering how best to determine the future requirements for OSSA launch vehicles, it was concluded that a good approach would be to develop a set of mission models which would represent a spectrum of future possibilities consistent with funding projections from Appendix A. Since this study was concerned with future requirements for OSSA launch vehicles only, the mission models developed were limited to those missions for which OSSA is the launch agency. These missions include those for NASA OSSA, NASA OART, and various users outside of NASA (such as DOD, Comsat, foreign organizations, and ESSA).

TABLE III-2. TYPES OF INFORMATION DERIVED FROM PRINCIPAL DATA DOCUMENTS

Data Sources	Information Type: Project Description	Program Plans	Fiscal and Budget Plans	Policy Statements and Discussions	Program Goals and Objectives	Space Budget Projections	Outside User Requirements	Reference Numbers
PSG Planning Panels	●	●			●			2,8-12
PSG Prospectus File	●	●						1
NASA's Report to STG		●		●	●			3
OSSA R&D POP	●	●	●					14
Projected 72-75 New Starts		●	●					15
Space Goals and Objectives Report	●				●			16
Projections of OSSA Budgets						●		Appendix A
Other Data	●	●		●		●	●	17-29

The mission models presented in Chapters IV through VIII can be divided into two groups: those that were derived directly from NASA documents and those developed in the course of this study. Both types of models include only projects proposed by NASA planners and outside user estimates provided by the appropriate NASA organization. In developing the alternative models, flight and funding schedules were often modified, but no projects representing new mission concepts, new objectives or new approaches were created.

NASA-Based Models

From the planning documentation associated with the PSG and STG efforts, four different OSSA mission models were identified. Two of the models are based on the NASA report to the STG(3), one was derived using the FY 1971 NASA submission to the Bureau of the Budget, and the fourth is based on the PSG activities and documents.

To develop detailed models from the NASA report to the STG, it was necessary to identify the specific projects included in the report. In some cases this was easy and straightforward; for example, the name Viking is associated with a set of specific program plans. At the time the NASA report to the STG was published, the number of alternative Viking approaches being considered was small.

In other cases, the problem was much more difficult because the project names used were not necessarily associated with a set of definitive plans. As noted previously, the types of information required for each project were flight schedules (included in the NASA report to the STG), funding schedules, spacecraft weights, and mission destination (with flight time) or orbit. Most of these data were found by relating projects described in the PSG reports and Prospectus file to the project names in the NASA report to the STG.

The STG Option I and Baseline I models used here are the automated program portions of the models presented in the NASA report to the STG. STG Option I is from Program I; Baseline I is from Programs II and III, which result in only one OSSA model. Option I is the most ambitious of the programs, and Baseline I represents the lowest funding program from the report. A model called Baseline II was developed from Baseline I by modifying Baseline I to be consistent with the OSSA portion of the FY 1971 NASA budget submission and the back-up material for projected 1972-1975 new starts.

PSG-LOW is the fourth model of this group. This model is based on the lowest plans of each of the OSSA related PSG Planning Panels from the PSG Prospectus file. The funding estimates for the projects contained in these plans were updated to agree with the POP 69-2.(14) Some of these plans were developed by the panels themselves, while other plans were developed by the PSG staff.

The models derived from the NASA reports contain only automated NASA programs for OSSA and OART. To obtain estimates of total OSSA funding and launch vehicle requirements it was necessary to add estimates of non-NASA programs for which OSSA is the launch agency. Estimates of such non-NASA programs and the requirements of NASA OART are discussed in Appendix C.

Alternative Models

The NASA-based mission models discussed above appear to be unrealistic when compared with the funding projections of Appendix A. Therefore, in order to develop mission models useful in determining future OSSA launch vehicle requirements, models were generated with funding levels approximating the budget projections from Appendix A. Six such models were developed for each OSSA division and, by selecting from these, six OSSA models were created.

Alternative models were first developed at the OSSA program division level.* In the development of each model, the first step was to establish a set of guidelines. Included in these guidelines were assumptions regarding available funds, areas of emphasis (e.g., Mars, Venus, etc), NASA environment (e.g., when the space shuttle and space station would be operational), and/or a specific technology to be used (e.g., solar electric propulsion). In most cases, guidelines concerning areas to be emphasized were variations of those derived from NASA documents. These guidelines provided a basis (or filter) for selecting projects to be included in a given model. This selection process was possible only after thorough familiarization with the many projects approved, planned, and proposed for the division under study. Familiarization was obtained by careful analysis of appropriate and available documents. Having tentatively selected a set of projects for incorporation in a mission model, the funding requirements were totaled. For many models considered, the estimated funding requirements were not near the established funding guideline. In those cases, it was necessary to modify the models in order to achieve the desired funding levels.

Several methods of changing model funding were used. Projects were changed by adding or deleting flights, by stretching out the launch schedule, and by shifting first launch dates of projects, which, in turn, modified the estimates for project funding schedules. Thus, for example, a project involving 10 flights in the period 1971-1975 might be reduced to 6 flights and stretched out over the 1971-1980 time period. When changing flight schedules, precautions were taken to insure that the project was still feasible after the change. Other methods used for changing funding requirements included substituting, adding, and deleting projects.

The development of mission models to satisfy the established guidelines was an iterative process. Often many model configurations were examined before a model was found that was consistent with the establish guidelines.

Six alternative OSSA level mission models were generated by combining selected alternative division models. Again, for each model, guidelines were established to provide the basis for selection. The OSSA level guidelines include statements on funding levels and areas to be emphasized.

The total funding requirements for OSSA projects were computed by year for all possible OSSA models ($6^4 = 1,296$) which could be developed from all combinations of the six alternative SA, SB, SG, and SL division plans. The resulting OSSA models were then ordered according to how close each came to the projected available funds for the OSSA model desired. From this ordered list, it was then possible to select models that were most consistent with the established guidelines.

Non-OSSA projects, for which the launch funds are expected to be included in the OSSA budget, were added to each model (both NASA-based and alternative) to obtain the total OSSA funding requirements. The combination of one model for each division plus the non-OSSA, nonreimbursable estimate constitutes an OSSA mission model.

To develop estimates of total future OSSA launch vehicle requirements, outside user reimbursable launches were added to 3 selected alternative OSSA models. The 3 models were selected as representing low, nominal, and high estimates of launch activity.

* In this study, as noted earlier, SA(Space Applications) was treated as a single division.

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(22) Pittenger, J. L., "Telecon to J. E. McGolrick Regarding Funding Sources for International Program LV Support, April 21, 1970", BMI-NLVP-ICM-70-73, Battelle Memorial Institute, Columbus Laboratories, April 24, 1970.

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(24) "Program Management Report, Level 0", NASA Office of Space Science and Applications. Data contained in this document are updated and reviewed monthly.

(25) "Program Management Report, Level 1", NASA Office of Space Science and Applications, monthly program status review.

(26) "Planetary Program Review", NASA Office of Space Science and Applications, July 11, 1969.

(27) "NASA Pocket Statistics", Program and Special Reports Division, Executive Secretariat, National Aeronautics and Space Administration, January, 1970.

(28) Nippert, D. A., "Visit to NASA Headquarters to Talk to Mission Planners Concerning NLVP Mission Models (11/18/69 and 11/19/69)", BMI-NLVP-MM-69-59, Battelle Memorial Institute, Columbus Laboratories, November 25, 1969.

(29) Nippert, D. A., and Pittenger, J. L., "Trip to NASA Headquarters, 12/8/69, To Deliver Mission Models to R. J. Gutheim for Use by P. G. Thome", BMI-NLVP-MM-69-64, Battelle Memorial Institute, Columbus Laboratories, December 9, 1969.

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CHAPTER IV. BIOSCIENCE (SB)

Introduction

The U. S. Space Biology program was originally directed towards determining the human safety requirements of manned space flight. Thus, it was tied to the manned space flight program. As certain basic requirements were established and confirmed by actual flights, wider areas of investigation, based on data from these flights, were defined.[(1)*]

Today, the primary goal of the Bioscience Programs Division(SB) can be explicitly stated as follows:

> "(To) Contribute substantially to the development of a body of fundamental unifying theory of biology by using the unique capabilities of space flights to increase our understanding of life processes and structures, especially the interaction of living organisms with gravity and time.
>
> Utilization of theoretical biological understanding to bring new predictive powers to the fields of biology, medicine, agriculture, and space exploration, and to enable man to intelligently manage his environment."[(2)]

A more complete discussion of Bioscience goals and objectives is available in References (1), (2), and (3).

The ten Bioscience mission models (SB1-SB10) presented in this Chapter are considered representative of future Bioscience activities. Creation of each model was based on a set of stated guidelines and involves assumptions (discussed later in this Chapter) concerning the overall space program. This provides a set of possible Bioscience plans covering a representative spectrum of Bioscience levels of effort for use in long range space transportation system planning.

In the past the Bioscience program has absorbed only a small percentage (3 to 8%) of the total OSSA budget. Fluctuations of funding level between low and high plans (corresponding to a minimum and maximum level of effort) are so small in relation to the total OSSA budget that, within limits, either a high or low plan may be feasible regardless of the total OSSA budget.

Each Bioscience mission model presented in this study consists of similar proposed projects which were designed to support the Bioscience goals. The aggressiveness (high or low plan) desired in any program, plus the state of the overall space program (availability of space station, space shuttle, manned space flight, etc.) determined the selection of projects which constituted the given program. Project contents and purpose are given in detail, by project, in the following section of this Chapter.

Program Areas[(1-8)]

The following summarizes the various approved, planned and proposed projects considered in developing the Bioscience mission models presented. All funding is in millions of dollars; all spacecraft weights are given in pounds. Launch Vehicle is designated LV and the appropriate vehicle is named**. Characteristic velocity (V_C) is given in feet per second.

* Superscript numbers denote references given at the end of this Chapter.
** See Appendix D for a discussion of launch vehicle nomenclature.

Supporting Activities

Supporting activities include funding required to sustain on-ground operations in the Bioscience Program.

BIOSCIENCE SR&T AND ADVANCED STUDIES

Purpose: To provide supporting research and technology, and advanced studies for the various bioscience subdiscipline areas.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	12.3	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Flights	(Non-flight project)										

BIOSCIENCE SR&T AND ADVANCED STUDIES (LOW)

Purpose: To provide supporting research and technology, and advanced studies for the various bioscience subdiscipline areas.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	12.3	12.4	12.4	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Flights	(Non-flight project)										

PLANETARY QUARANTINE

Purpose: To provide studies concerned with the possibility of transport of life between planets.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.4	4.0	5.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Flights	(Non-flight project)										

Biosatellites

BIOSATELLITES (PHASE-OUT FUNDING)

Purpose: To study biological functions of cellular, tissue, organ, and organism levels in a wide variety of plants and animals.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.5 (Phase-out funding)										
Flights	(Last launch 1969)										

	SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
BIOSCIENCE SR&T AND ADVANCED STUDIES	•	•	•	•	•	•	•		•	•
BIOSCIENCE SR&T AND ADVANCED STUDIES (LOW)								•		
PLANETARY QUARANTINE	•	•	•	•	•	•	•	•	•	•
BIOSATELLITES (PHASE-OUT FUNDING)	•	•	•	•	•	•	•	•	•	•

Wildlife Applied Research

The Wildlife Applied Research Program is a study of the migration, orientation, and navigation of wild animals. The instrumentation is to be included in Nimbus or other similar spacecraft.

WILDLIFE APPLIED RESEARCH PROJECT

Purpose: To study the migration, orientation, and navigation of wild animals.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.5	1.0	1.1	1.2	1.2	1.4	1.3	1.3	1.5	1.5	1.5
Flights	(Non-flight projects)										

Biopioneers

The objective is to launch spacecraft with biological experiments in approximately 1 a.u. heliocentric orbit for durations of about 1 year. The experiments will supply data to study the effects of the space environment on Earth organisms.

BIOPIONEERS A-C LV: TAT/DELTA/FW4 WT: 250 V_C: 36,480

Purpose: To carry various payloads to study long term orbital effects upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	1.0	4.2	8.0	6.2	8.0	6.2	7.0	2.0	-
Flights	-	-	-	-	1	-	1	-	1	-	-

BIOPIONEERS A-D (74) LV: TAT/DELTA/FW4 Wt: 250 V_C: 36,480

Purpose: To carry various payloads to study long term orbital effects upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	4.0	6.1	11.3	10.7	9.5	5.6	2.2	-	-	-
Flights	-	-	-	1	1	1	1	-	-	-	-

BIOPIONEERS A-D (73) LV: TAT/DELTA/FW4 Wt: 250 V_C: 36,480

Purpose: To carry various payloads to study long term orbital effects upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.0	6.1	11.3	10.7	9.5	5.6	2.2	-	-	-	-
Flights	-	-	1	1	1	1	-	-	-	-	-

	SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
Wildlife Applied Research Project	●									
Biopioneers A-C			●	●	●	●				
Biopioneers A-D (74)		●					●			●
Biopioneers A-D (73)	●								●	

Bioexplorers

The Bioexplorers will carry rodents into 150 to 300 n.mi. circular orbits to study the biorhythms of Earth inhabitants in the space environment.

BIOEXPLORERS A-F LV: Scout Wt: 180 V_C: 26,140

Purpose: To study the effects of space environment upon the biorhythms of Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.5	1.5	3.0	4.0	3.5	3.0	2.0	2.0	2.0	1.5	1.0
Flights	-	-	1	1	1	1	-	1	-	1	-

BIOEXPLORERS A-H LV: Scout Wt: 180 V_C: 26,140

Purpose: To study the effects of space environment upon the biorhythms of Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.5	0.5	1.5	3.0	4.0	4.0	4.5	3.5	4.5	3.0	2.5
Flights	-	-	-	1	1	1	1	1	1	1	1

BIOEXPLORERS A-N LV: Scout Wt: 180 V_C: 26,140

Purpose: To study the effects of space environment upon the biorhythms of Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	8.0	10.0	10.0	10.0	10.0	5.0	5.0	5.0	5.0	4.0	1.0
Flights	-	2	2	2	2	1	1	1	1	1	-

BIOEXPLORERS A-O(I) LV: Scout Wt: 180 V_C: 26,140

Purpose: To study the effects of space environment upon the biorhythms of Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	8.0	10.0	10.0	10.0	10.0	5.0	5.0	5.0	5.0	5.0	4.0
Flights	-	2	2	2	2	1	1	1	1	1	1

	SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
BIOEXPLORERS A-F			●							
BIOEXPLORERS A-H				●	●	●				
BIOEXPLORERS A-N		●								●
BIOEXPLORERS A-O(I)	●								●	

BIOEXPLORERS A-O(II) LV: Scout Wt: 180 V_C: 26,140

SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
						•			

Purpose: To study the effects of space environment upon the biorhythms of Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.0	5.0	5.0	5.0	5.0	10.0	10.0	10.0	10.0	10.0	9.0
Flights	-	1	1	1	1	2	2	2	2	2	-

Biosatellites (Improved)

The Improved Biosatellites are recoverable spacecraft which are to examine a broad spectrum of the effects of a space environment upon Earth organisms. They are to serve as a continuation of the earlier Biosatellite (C,D,E,F) program.

BIOSATELLITES (IMPROVED) A-E LV: TAT(6C)/DELTA Wt: 1,930 V_C: 25,900

SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
				•					

Purpose: To study the effects of extended orbital flights upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	10.0	14.8	15.0	5.0	15.0	5.0	15.0	5.0	15.0	5.0	15.0
Flights	-	-	1	-	1	-	1	-	1	-	1

BIOSATELLITES (IMPROVED) A-L LV: TAT(6C)/DELTA Wt: 1,930 V_C: 25,900

SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
								•	

Purpose: To study the effects of extended orbital flights upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	6.2	7.0	9.0	12.9	20.9	27.1	20.9	20.9	11.6	3.1	0.7
Flights	-	-	-	2	2	2	2	2	2	2	-

BIOSATELLITES (IMPROVED) A-H LV: TAT(6C)/DELTA Wt: 1,930 V_C: 25,900

SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
					•				

Purpose: To study the effects of extended orbital flights upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	6.2	9.5	18.4	21.3	21.4	21.4	21.4	21.4	21.4	14.9	7.0
Flights	-	-	-	1	1	1	1	1	1	1	1

	SB1 (PSG-LOW)	SB2 (STG OPTION I)	SB3 (BASELINE I)	SB4 (BASELINE II)	SB5 (ALTERNATIVE I)	SB6 (ALTERNATIVE II)	SB7 (ALTERNATIVE III)	SB8 (ALTERNATIVE IV)	SB9 (ALTERNATIVE V)	SB10 (ALTERNATIVE VI)
Biosatellites (Improved) A-C							•			
Biosatellites (Improved) A-J										•
Advanced Biosatellites A-C									•	

BIOSATELLITES (IMPROVED) A-C LV: TAT(6C)/DELTA Wt: 1,930 V_C: 25,900

Purpose: To study the effects of extended orbital flights upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	6.2	9.5	16.4	18.3	18.4
Flights	-	-	-	-	-	-	-	-	-	1	1

BIOSATELLITES (IMPROVED) A-J LV: TAT(6C)/DELTA Wt: 1,930 V_C: 25,900

Purpose: To study the effects of extended orbital flights upon Earth organisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	6.2	9.5	16.4	18.3	18.4
Flights	-	-	-	-	-	-	-	-	-	1	1

Advanced Biosatellites

The Advanced Biosatellite will be capable of sustaining a 25-lb primate in a circular orbit for up to six months. These satellites are an alternative to a space station. Their purpose is to study the role of gravity on aging of Earth inhabitants.

ADVANCED BIOSATELLITES A-C LV: TITAN IIIB/CENTAUR Wt: 8,000 V_C: 25,900

Purpose: To conduct primate physiological and behavioral experiments under space flight conditions.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	7.0	18.0	21.0	33.0	30.2	32.2
Flights	-	-	-	-	-	-	-	-	-	1	1

Bioscience (SB) Mission Models

Ten mission models, SB1-SB10, are presented in this chapter to illustrate a variety of possible Bioscience plans that might be pursued during the 1971-1981 time period. Each model was developed around a set of guidelines which is included with each model. These guidelines represent a range of possible states that may exist within NASA OSSA during the next decade. The first four models (SB1-SB4) were derived from NASA plans (see individual models for data source) and the last six models (SB5-SB10) are possible alternative plans developed as part of this study.

The models presented in this chapter consist primarily of Biopioneers, Bioexplorers, Improved Biosatellites, and Advanced Biosatellites. Of these projects, the Biopioneers and Bioexplorers received highest priority. Therefore, the Improved and Advanced Biosatellites were included in a Bioscience plan only after a flight schedule for the Biopioneers and Bioexplorers had been established and only if available funds remained.

The remainder of this section presents guidelines for each model (SB1-SB10), its characteristics, funding plot (Figures IV-1 through IV-10), and flight schedule (Tables IV-1 through IV-10). A general discussion of the mission models is contained in the next section of this chapter.

Model Guidelines and Description: SB1(PSG-LOW)

SB1 is the lowest level plan found in the PSG Prospectus File.[5] The model was developed on the basis of the following guidelines:

- A low funding ceiling exists for the Bioscience Division in the 1970 decade
- All major payloads will be fully automated.

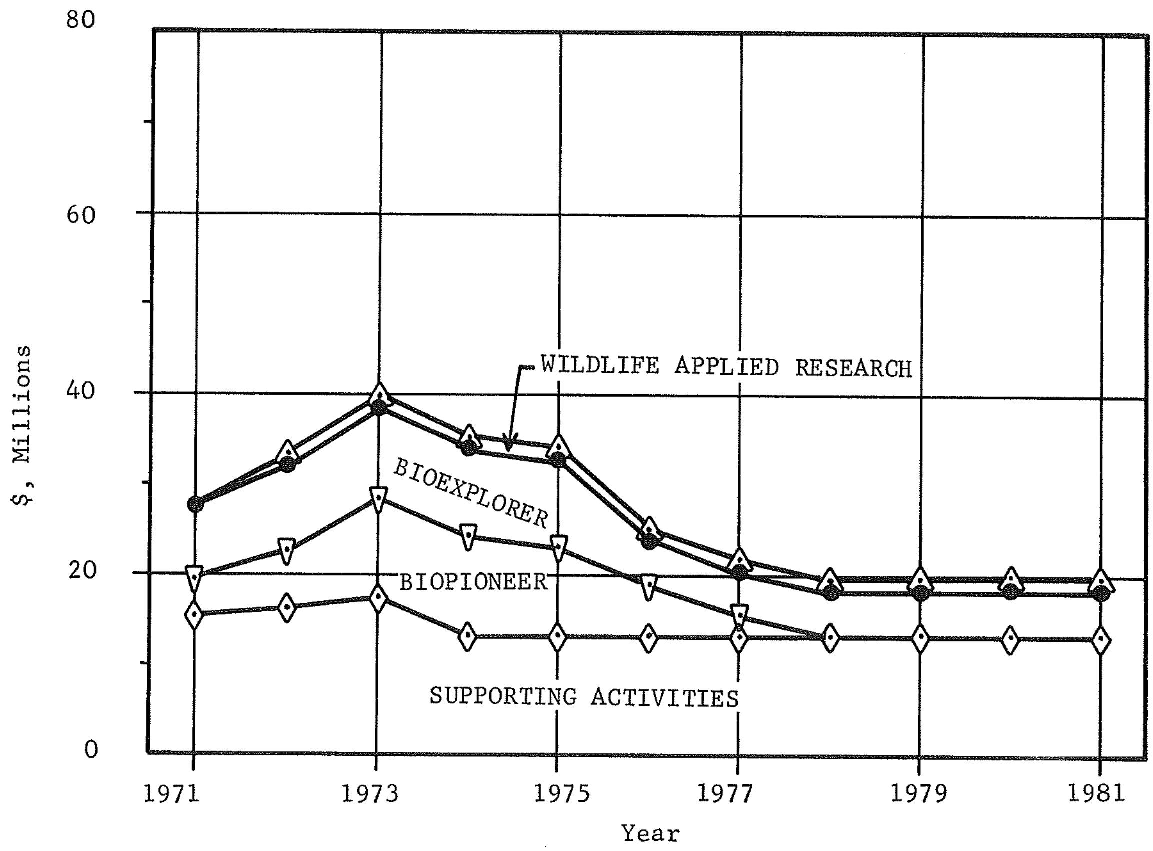

FIGURE IV-1. SB1 FUNDING PLOT

TABLE IV-1. SB1 FLIGHT SCHEDULE

Project	Launch Vehicle	Year										
		71	72	73	74	75	76	77	78	79	80	81
BIOEXPLORERS A-O(I)	SCOUT	-	2	2	2	2	1	1	1	1	1	1
BIOPIONEERS A-D(73)	TAT/DELTA/FW4	-	-	1	1	1	1	-	-	-	-	-

Model Guidelines and Description: SB2(STG Option I)

The Bioscience model SB2 was extracted from NASA's Report to the Space Task Group[4] where it appeared as Program I under Life Sciences. The plan represented an aggressive Bioscience program. Program I, as presented in the report, included the following guidelines:

- A 12-man space station in 1976 supported by a space shuttle
- The expansion of the space station to facilitate 50 people by 1980 and 100 people by 1985
- A 12-man geosynchronous station launched in 1981 which would be expanded to a 50-man base later in the 1980s
- Program would include space station laboratory work, nonrecoverable biological satellites and probes, and both ground and space research on terrestrial life in space.

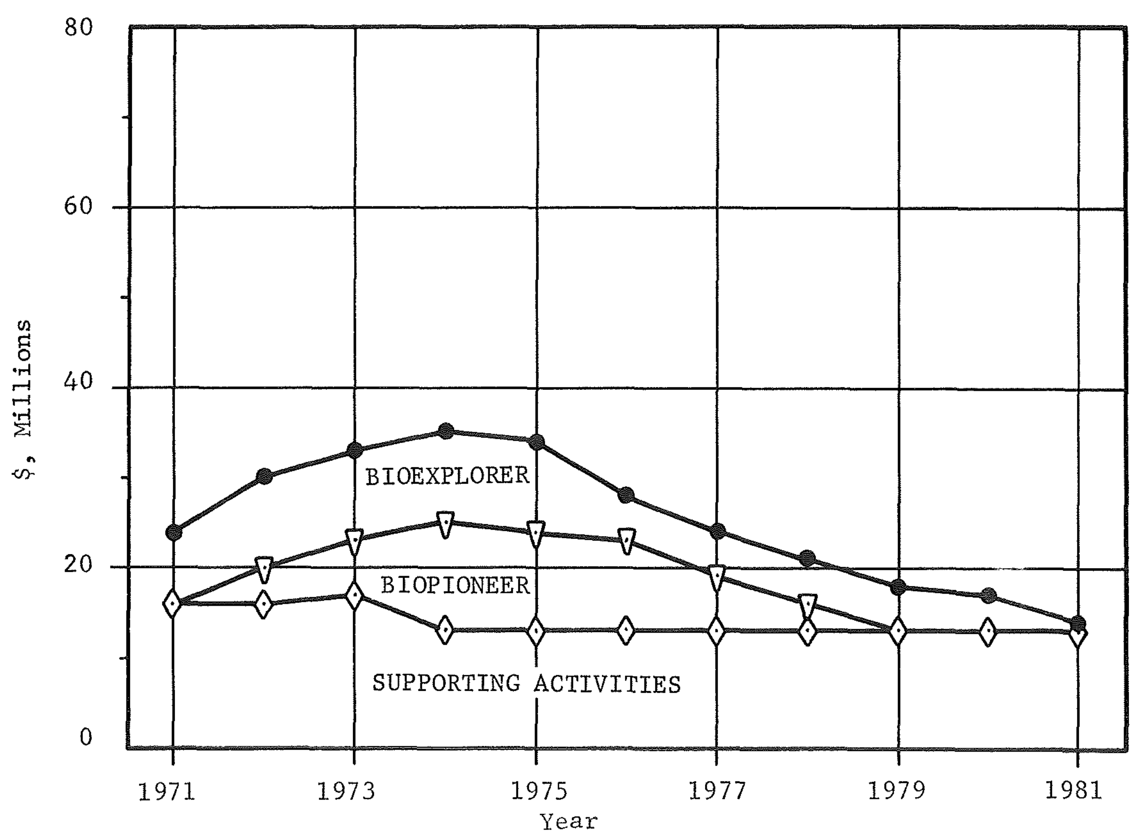

FIGURE IV-2. SB2 FUNDING PLOT

TABLE IV-2. SB2 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
BIOPIONEERS A-D(74)	TAT/DELTA/FW4	-	-	-	1	1	1	1	-	-	-	-
BIOEXPLORERS A-N	SCOUT	-	2	2	2	2	1	1	1	1	1	1

Model Guidelines and Description: SB3(Baseline I)

Bioscience model SB3 is derived from NASA's report to the Space Task Group[(4)] in which the plan appears as the automated portion of Programs II and III. The following guidelines were a part of Programs II and III:

- An operational space station with supporting shuttle in 1977
- Expansion of the space station to support 50 men by 1984 and 100 men by the end of the 1980 decade
- Plan is constrained by a $4 billion NASA ceiling in FY 1971
- Bioexplorer missions to begin in 1973 and Biopioneer in 1975.

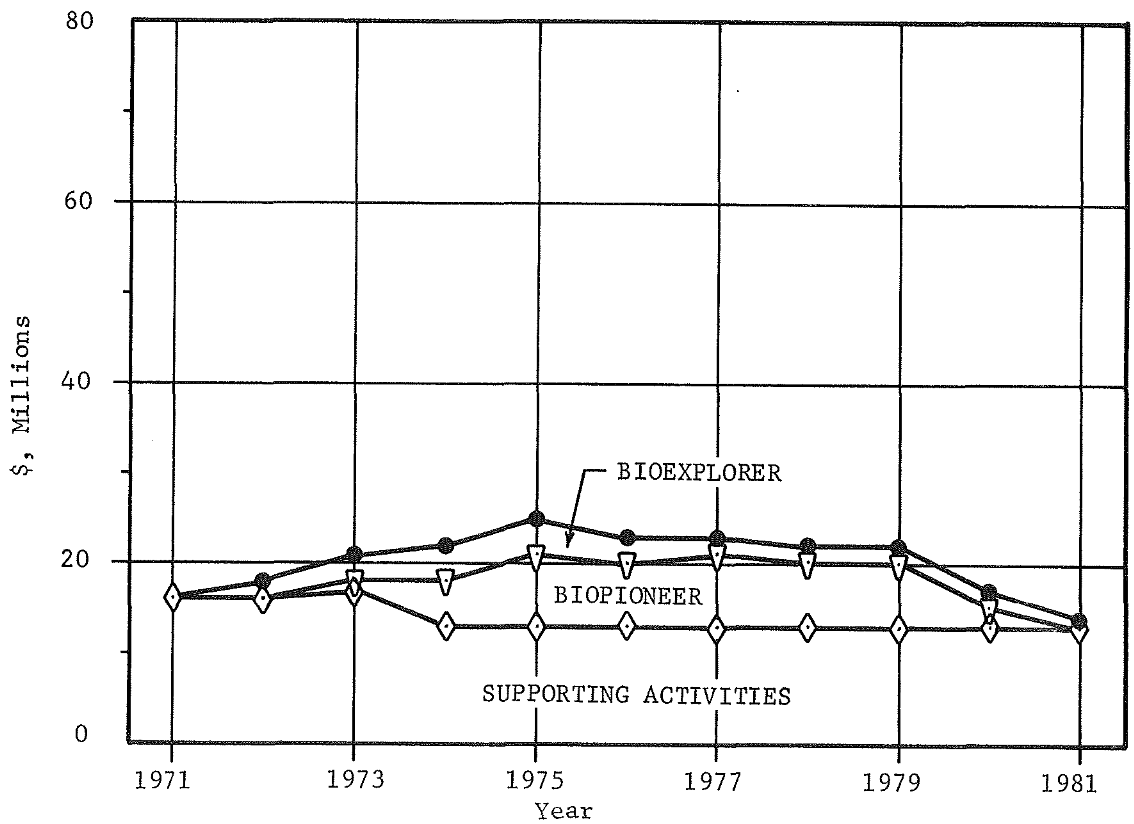

FIGURE IV-3. SB3 FUNDING PLOT

TABLE IV-3. SB3 FLIGHT SCHEDULE

Project	Launch Vehicle	Year										
		71	72	73	74	75	76	77	78	79	80	81
BIOPIONEERS A-C	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-
BIOEXPLORERS A-F	SCOUT	-	-	1	1	1	1	-	1	-	1	-

Model Guidelines and Description: SB4(Baseline II)

Bioscience model SB4 is a modification of model SB3 reflecting the funds requested for the Bioscience Program in the FY 1971 submission to the Bureau of the Budget and a projection of OSSA FY 1972-1975 New Efforts.(7) The characteristics of this plan are as follows:

- Dry workshop (Number 2) to be launched in 1975
- An operational space station with supporting shuttle in 1976
- Approved new-start funding for Biopioneers and Bioexplorers in the 1972-1975 budgets.

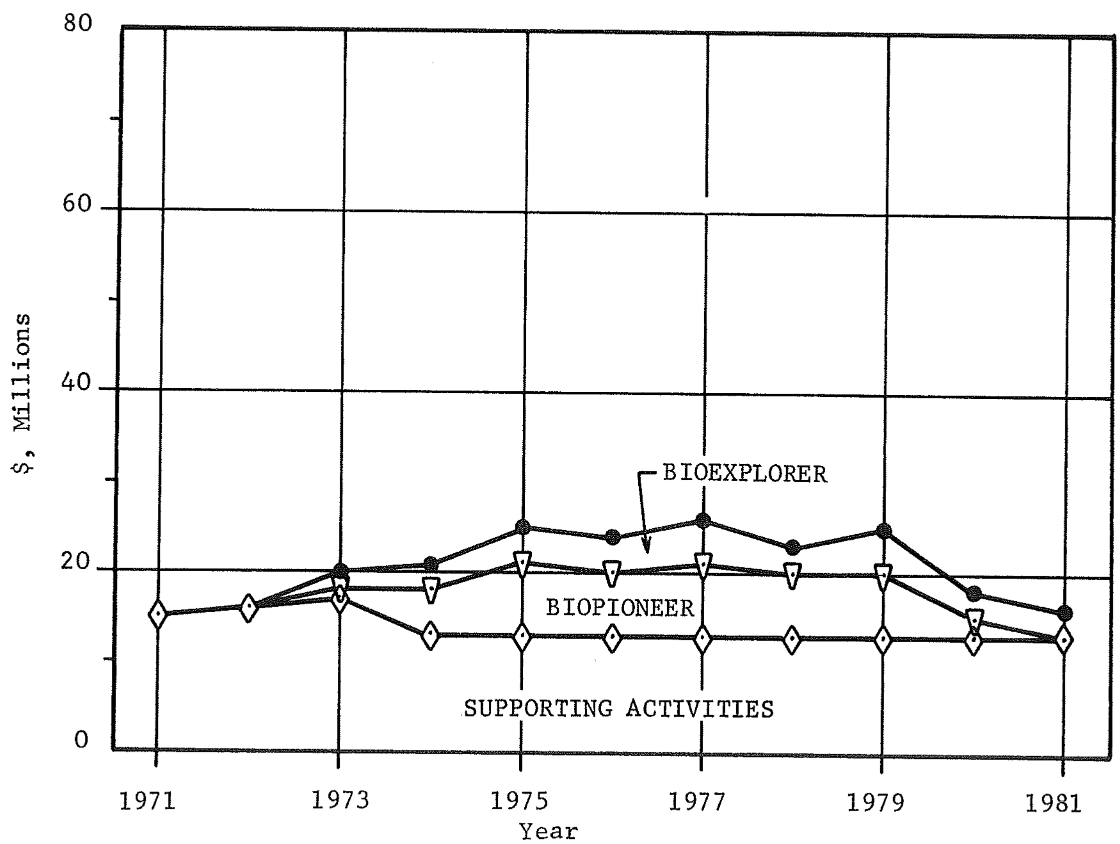

FIGURE IV-4. SB4 FUNDING PLOT

TABLE IV-4. SB4 FLIGHT SCHEDULE

Project	Launch Vehicle	Year										
		71	72	73	74	75	76	77	78	79	80	81
BIOPIONEERS A-C	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-
BIOEXPLORERS A-H	SCOUT	-	-	-	1	1	1	1	1	1	1	1

Model Guidelines and Description: SB5(Alternative I)

Bioscience model SB5 is a modification of model SB4. The guidelines for Model SB5 reflect a possible flight schedule that might transpire under the following conditions:

- Dry workshop number 2 cancelled
- Space station launched in 1976 but no scientific experiments to be included until 1978
- Supporting space shuttle for space station delayed until 1981
- Entry of the Improved Biosatellites in 1973 launched every other year due to the delays in the space station
- Approved new-start funding for Biopioneers and Bioexplorers in the 1972-1975 budgets due to the delays in the space station.

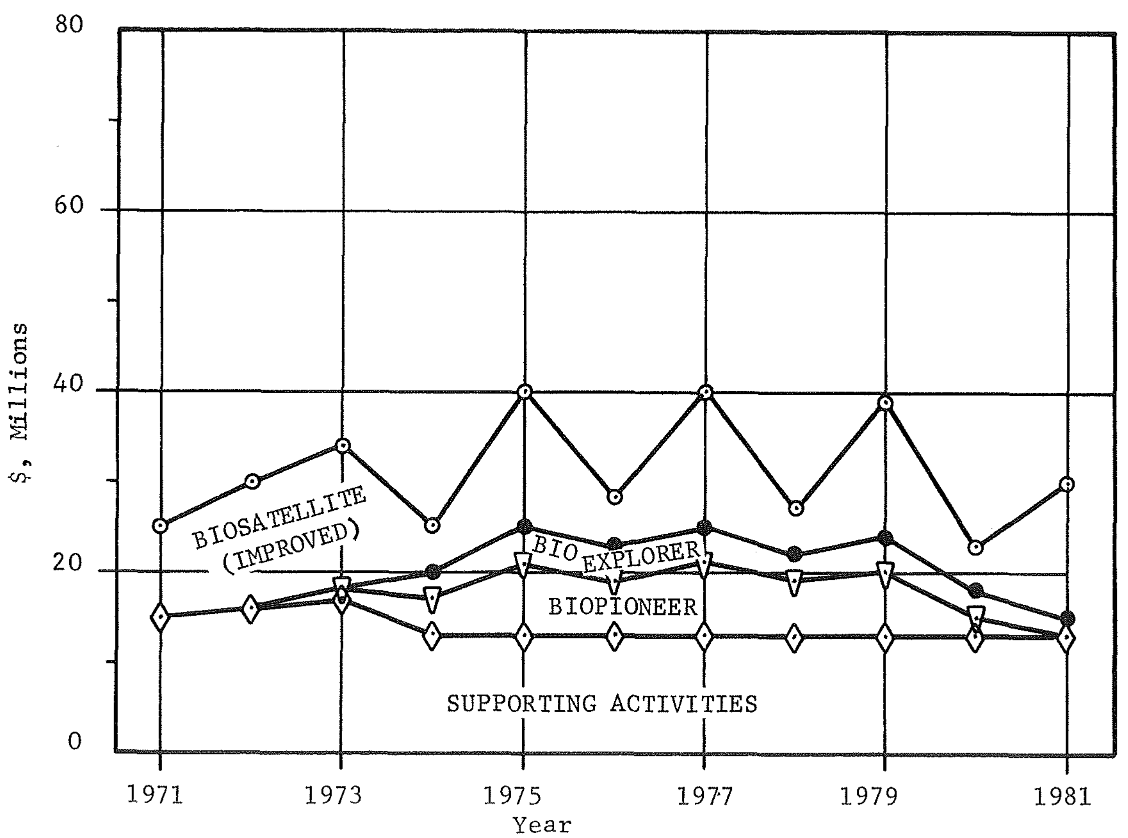

FIGURE IV-5. SB5 FUNDING PLOT

TABLE IV-5. SB5 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
BIOPIONEERS A-C	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-
BIOEXPLORERS A-H	SCOUT	-	-	-	1	1	1	1	1	1	1	1
BIOSATELLITES (IMPROVED) A-E	TAT(6C)/DELTA	-	-	1	-	1	-	1	-	1	-	1

Model Guidelines and Description: SB6(Alternative II)

Bioscience model SB6 has been created in this study as a possible alternative model to the NASA Bioscience plans (SB1-SB4). The following guidelines were assumed for this plan:

- Neither the space station nor the space shuttle will be operational until the early 1980 decade
- The available funds will be near the funding projections presented in Appendix A
- Flight program is to consist of Biopioneers, Bioexplorers and Improved Biosatellites.

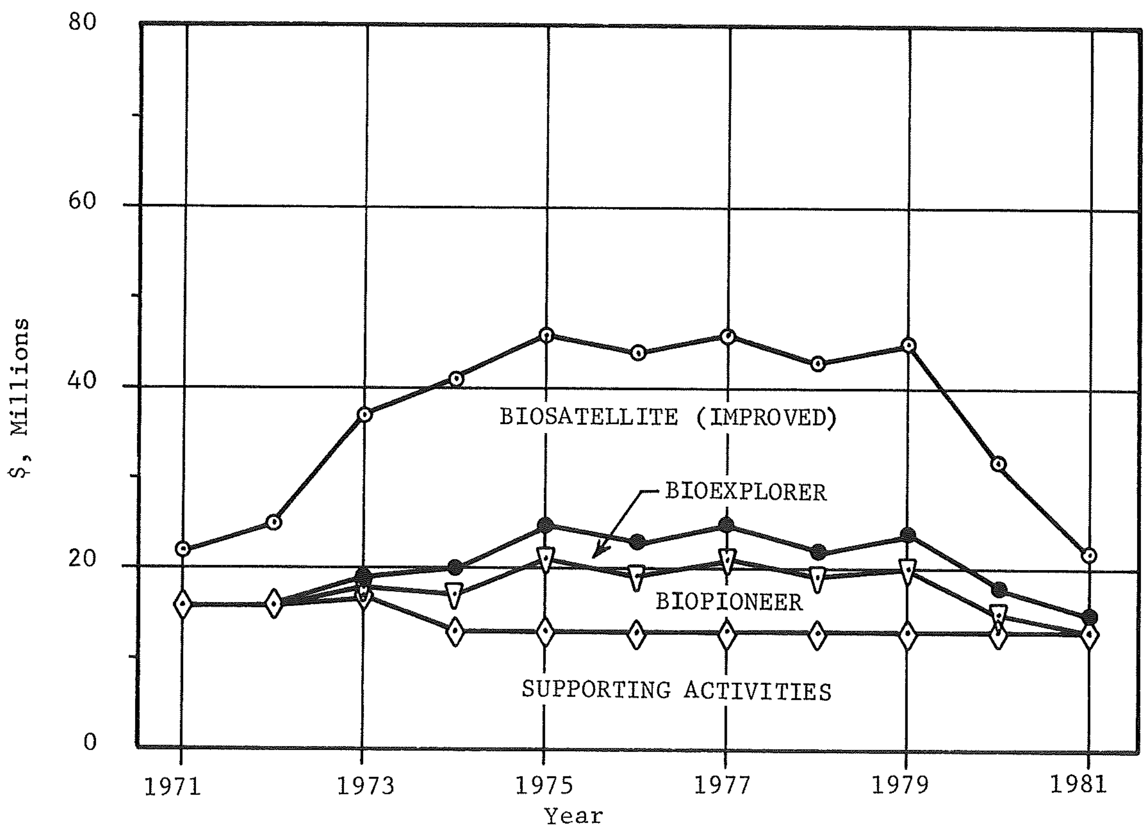

FIGURE IV-6. SB6 FUNDING PLOT

TABLE IV-6. SB6 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
BIOPIONEERS A-C	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-
BIOEXPLORERS A-H	SCOUT	-	-	-	1	1	1	1	1	1	1	1
BIOSATELLITES (IMPROVED) A-H	TAT(6C)/DELTA	-	-	-	1	1	1	1	1	1	1	1

Model Guidelines and Description: SB7(Alternative III)

Model SB7 is a third alternative Bioscience model. The following guidelines were made for this plan:

- The space station and space shuttle will not be available for Bioscience experiments until the mid-1980s
- The available funds will be approximately 20% below the funding projections presented in Appendix A
- The flight program is to consist of Biopioneers, Bioexplorers, and Improved Biosatellites.

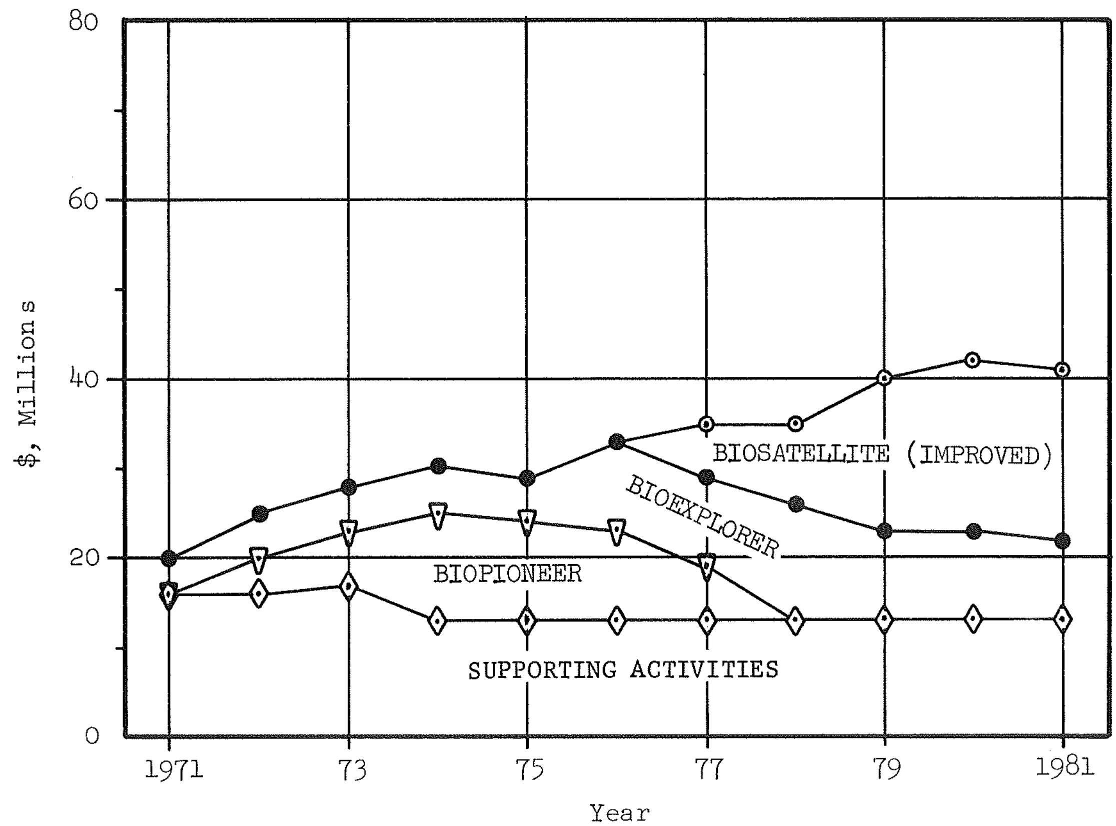

FIGURE IV-7. SB7 FUNDING PLOT

TABLE IV-7. SB7 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
BIOPIONEERS A-D(74)	TAT/DELTA/FW4	-	-	-	1	1	1	1	-	-	-	-
BIOEXPLORERS A-O(II)	SCOUT	-	1	1	1	1	2	22	22	2	2	-
BIOSATELLITES (IMPROVED) A-C	TAT(6C)/DELTA	-	-	-	-	-	-	-	-	-	1	1

Model Guidelines and Description: SB8(Alternative IV)

Bioscience model SB8 is the fourth alternative plan. The model was developed on the basis of the following guidelines:

- The Bioscience flight program will be cancelled following phase-out funding necessary for Biosatellites A-C
- There will be a continuation of ground activities, supporting programs for other program offices, and advanced studies at a level of approximately $11.0 million per year
- Any space flight experiments will be carried out by some other division in NASA.

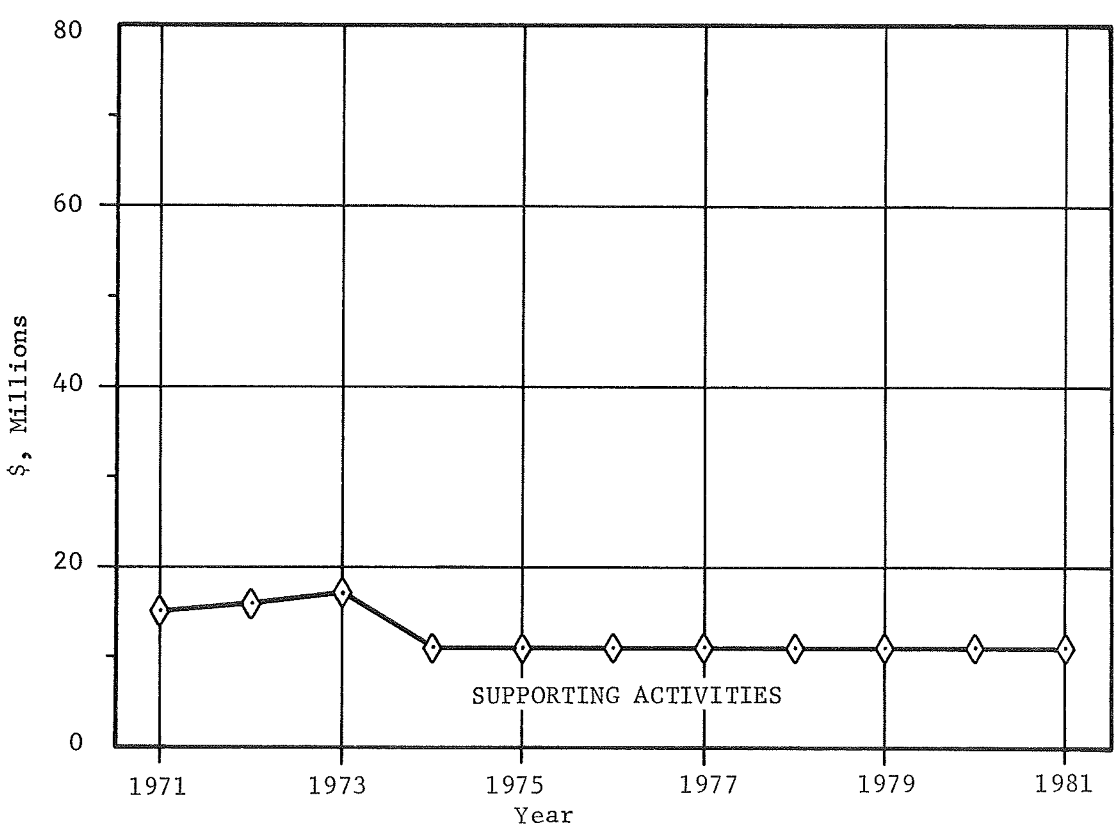

FIGURE IV-8. SB8 FUNDING PLOT

TABLE IV-8. SB8 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
None						None						

Model Guidelines and Description: SB9(Alternative V)

Bioscience model SB9 has been created as another alternative plan using the following guidelines.

- A moderately aggressive Bioscience program will be pursued at a level approximately 20 to 25% higher than the Bioscience funding projections for the 1970 decade presented in Appendix A
- Neither the space station nor the space shuttle will be available until the 1980s
- The flight program will consist of Bioexplorers, Biopioneers, Improved Biosatellites, and Advanced Biosatellites.

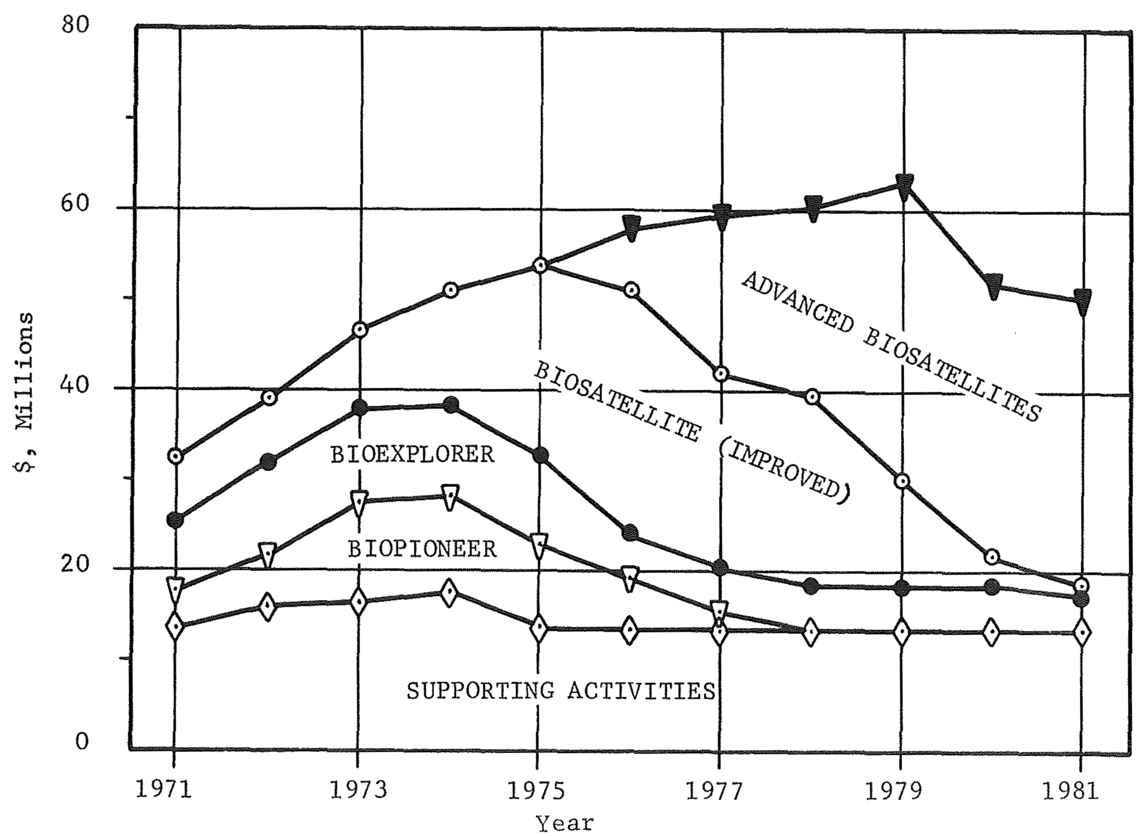

FIGURE IV-9. SB9 FUNDING PLOT

TABLE IV-9. SB9 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
BIOEXPLORERS A-O(I)	SCOUT	-	2	2	2	2	1	1	1	1	1	1
BIOPIONEERS A-D(73)	TAT/DELTA/FW4	-	-	1	1	1	1	-	-	-	-	-
BIOSATELLITES (IMPROVED) A-L	TAT(6C)/DELTA	-	-	-	2	2	2	2	2	2	2	-
ADVANCED BIOSATELLITES A-C	TITAN IIIB/ CENTAUR	-	-	-	-	-	-	-	-	-	1	1

Model Guidelines and Description: SB10(Alternative VI)

Bioscience model SB10 is the last alternative Bioscience model created in this study. The following guidelines were used in this plan:

- Neither the space station nor the space shuttle will be available in the early 1980s
- The flight program will consist of Biopioneers, Bioexplorers, and Improved Biosatellites
- Funding level near the Appendix A SB projection.

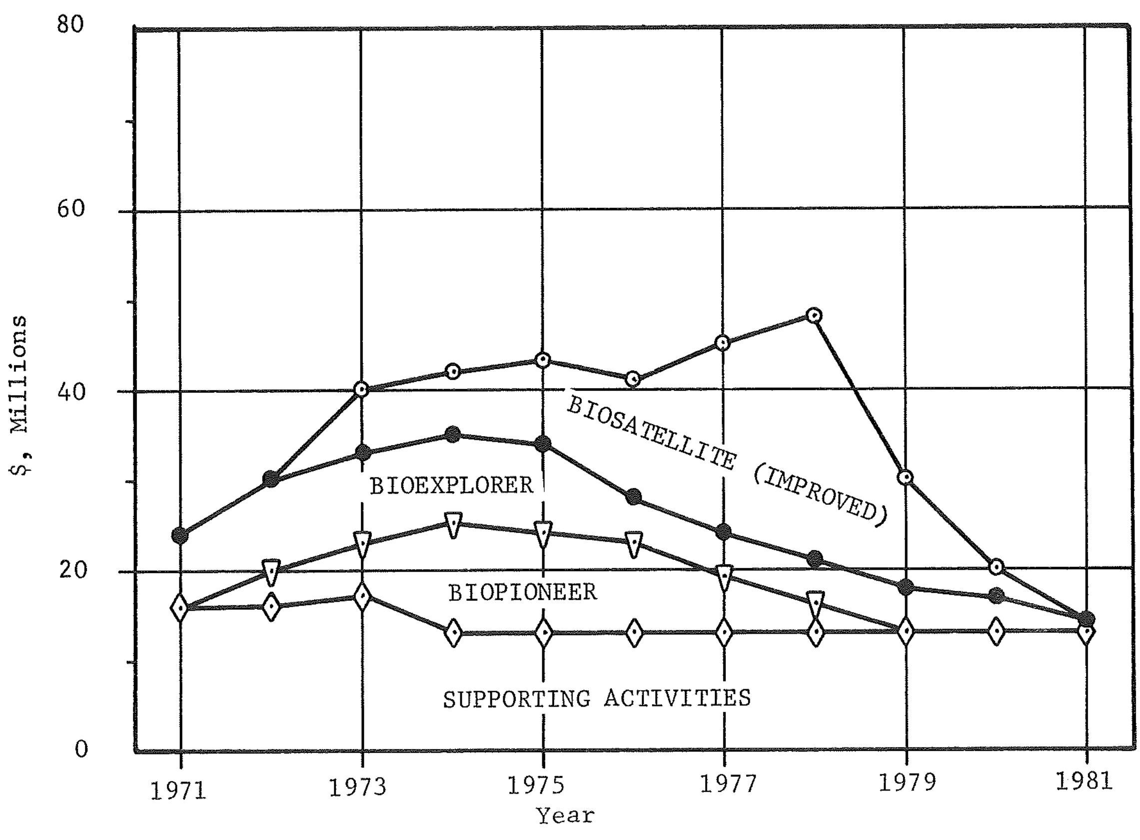

FIGURE IV-10. SB10 FUNDING PLOT

TABLE IV-10. SB10 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
BIOPIONEERS A-D(74)	TAT/DELTA/FW4	-	-	-	1	1	1	1	-	-	-	-
BIOEXPLORERS A-N	SCOUT	-	2	2	2	2	1	1	1	1	1	-
BIOSATELLITES (IMPROVED) A-J	TAT(6C)/DELTA	-	-	-	-	-	2	2	2	2	2	0

Discussion

SB Models

Since fiscal funding is a primary constraint for the Bioscience program, several plans involving various funding levels need to be considered. Figures IV-11 and IV-12 indicate the estimated total funding required to accomplish any NASA-based plan (SB1 through SB4) or alternative plan (SB5 through SB10) created in this study. The dashed line on each plot is the SB funding projection as presented in Appendix A for the 1970-1980 time period. The funding plots shown for each model should be considered only as estimates of resources required for any given model. The total resource requirements are more accurate than the year-by-year estimates. For example, model SB5 is shown with a very erratic funding level using NASA's funding schedule.(5) It is likely that the funding would actually be spread (with little change in total funds) much more evenly over the decade. The decrease in funding indicated in two of the NASA-based mission models (SB1, SB2) in the late 1970s must be attributable to either or both of the following two factors: (1) a reliance upon the space station in the later years to carry out the necessary Bioscience experiments, which would eliminate several Bioscience launches, and (2) the difficulty of projecting and planning 10 years into the future.

The number and type of projects constituting a model are dependent upon the guidelines under which the plan was developed. For example, if it is assumed that the space station would not be available, Advanced Biosatellites could be substituted as a form of compensation, if the necessary funds were available. This hypothetical case was presented as alternative plan SB9.

In creating a range of plans, the average funds available were assumed to be near the SB funding projections presented in Appendix A. Using this funding schedule as a reference, the different Bioscience models can be classified as either a high level, low level, or average plan. For example, models SB3, SB4, SB7, and SB8 can be classified as low level plans, models SB9 and SB10 as high level plans, and model SB6 as an average plan. Thus, a possible Bioscience flight program is presented for various degrees of emphasis which NASA OSSA might pursue for the period 1971-1981.

The Bioscience plans presented in this chapter are considered feasible under the stated assumptions. The selection of these projects from the total number of Bioscience projects that exist was made on the basis of the following assumption: The projects presented in NASA programs (SB1 through SB4) are the highest priority projects in the Bioscience program. Therefore, the SB programs developed in this study consist of projects similar to those in the NASA plans.

Table IV-11 shows the activity for each Bioscience program presented in this study. It is interesting to note that each NASA plan (SB1-SB4) contains Biopioneers and Bio-explorers, which was considered to indicate that these projects should be included in any feasible active flight program for the 1971-1981 time period. SR&T, advanced studies, and planetary quarantine work are expected to be carried out even if a flight schedule is not approved, as indicated in model SB8, with any Bioscience experiments being performed in conjunction with other OSSA missions or launched piggyback as secondary experiments on other flights.

It must be emphasized that the difference in funding between an SB high level program and an SB low level program is very small compared to the OSSA total budget. Thus, it may still be possible to pursue one of the more aggressive programs presented even though the OSSA budget is very low; that is, a 100 or 200% increase in Bioscience funding is small enough that the difference will not be noticeable at the OSSA level of funding.

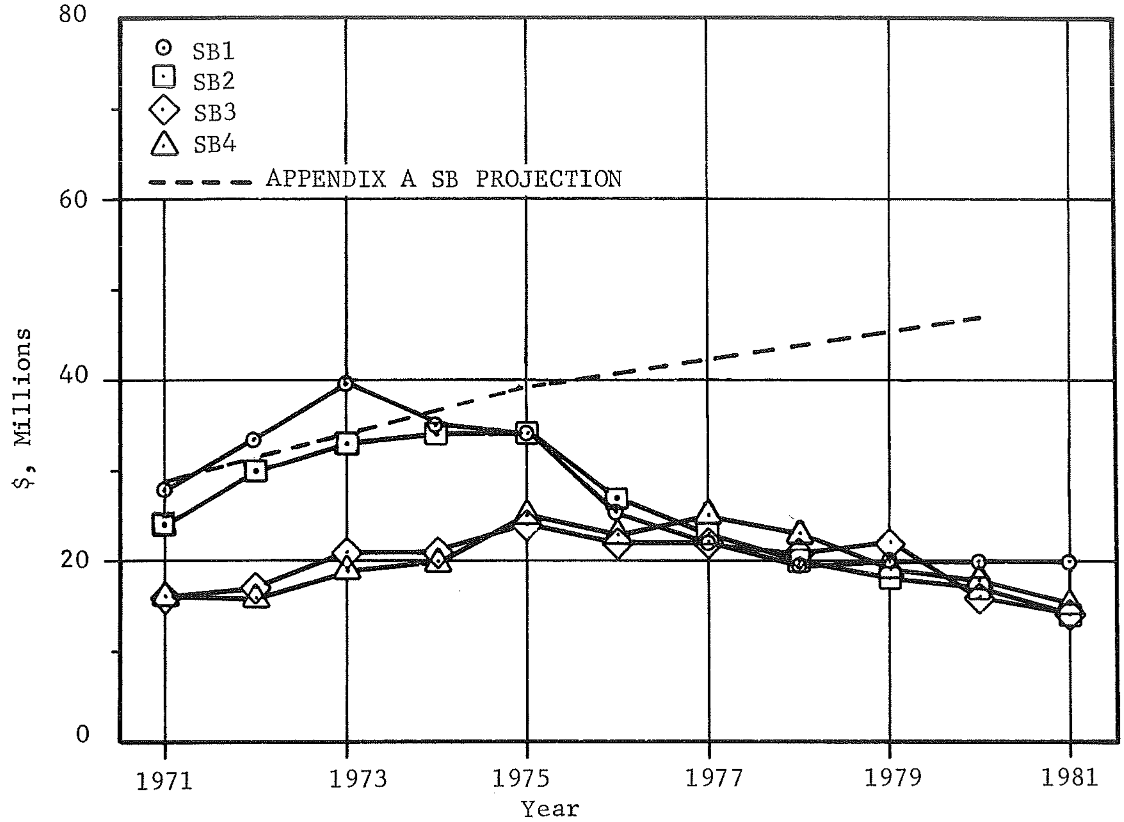

FIGURE IV-11. ESTIMATED FUNDING REQUIRED FOR NASA MODELS SB1-SB4

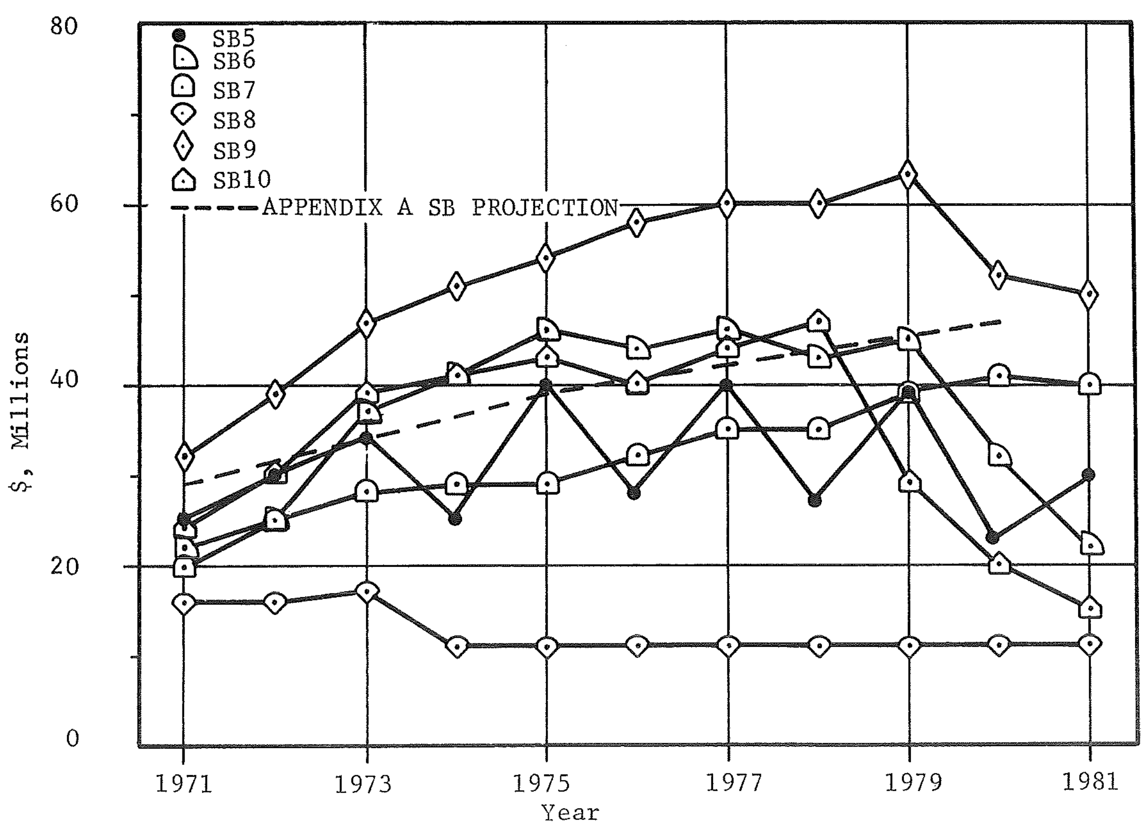

FIGURE IV-12. ESTIMATED FUNDING REQUIRED FOR ALTERNATIVE MODELS SB5-SB10

TABLE IV-11. PROGRAM ACTIVITY BY MODEL

Program Areas	Models									
	SB1	SB2	SB3	SB4	SB5	SB6	SB7	SB8	SB9	SB10
Biopioneers	73[a] 4	74 4	75 3	75 3	75 3	75 3	74 4	-	73 4	74 4
Bioexplorers	72 14	72 13	73 6	74 8	74 8	74 8	72 14	-	72 14	72 13
Biosatellites (Improved)	-	-	-	-	73 5	74 8	80 2	-	74 14	76 10
Advanced Biosatellites	-	-	-	-	-	-	-	-	80 2	-
Wildlife Applied Research	●[b]	-	-	-	-	-	-	-	-	-
SR&T Advanced Studies	●	●	●	●	●	●	●	●	●	●
Planetary Quarantine	●	●	●	●	●	●	●	●	●	●

(a) The upper figure in each group indicates the year of first launch after 1970 and the lower figure indicates the number of launches in the 1971-1981 time period.
(b) Dot (●) means that a non-space-flight program area is included in the indicated model.

Launch Vehicle Requirements

Table IV-12 presents launch vehicle use rates by year for each Bioscience model, SB1 through SB10. The total family of vehicles for any Bioscience program, at the maximum, requires SCOUTs, TAT/DELTAs, TAT(6C)/DELTAs, and TITAN IIIB/CENTAURs. Of these, only the TITAN IIIB/CENTAUR is not presently available. The projected availability date for this vehicle is such that the required launch vehicles should exist for any Bioscience program presented here.

Summary of Most Demanding Missions

The advanced Biosatellites are the most demanding projects presented in this study. They will weigh up to 8,000 lb and require a V_C of 25,900 ft/sec. The launch vehicle for this project could be either an ATLAS/CENTAUR(1) or a TITAN IIIB/CENTAUR. For the earliest dated involved, 1978, one of these two vehicles (or some equivalent capability) is expected to be available.

TABLE IV-12. LAUNCH RATES BY VEHICLE AND MODEL

Model	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81	Total
SB1	SCOUT	-	2	2	2	2	1	1	1	1	1	1	14
	TAT/DELTA/FW4	-	-	-	1	1	1	-	-	-	-	-	4
	TOTAL	-	2	3	3	3	2	1	1	1	1	1	18
SB2	SCOUT	-	2	2	2	2	1	1	1	1	1	-	13
	TAT/DELTA/FW4	-	-	-	1	1	1	1	-	-	-	-	4
	TOTAL	-	2	2	3	3	2	2	1	1	1	-	17
SB3	SCOUT	-	-	1	1	1	1	-	1	-	1	-	6
	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-	3
	TOTAL	-	-	1	1	2	1	1	1	1	1	-	9
SB4	SCOUT	-	-	-	1	1	1	1	1	1	1	1	8
	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-	3
	TOTAL	-	-	-	1	2	1	2	1	2	1	1	11
SB5	SCOUT	-	-	-	1	1	1	1	1	1	1	1	8
	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-	3
	TAT(6C)/DELTA	-	-	1	-	1	-	1	-	1	-	1	5
	TOTAL	-	-	1	1	3	1	3	1	3	1	2	16
SB6	SCOUT	-	-	-	1	1	1	1	1	1	1	1	8
	TAT/DELTA/FW4	-	-	-	-	1	-	1	-	1	-	-	3
	TAT(6C)/DELTA	-	-	-	1	1	1	1	1	1	1	1	8
	TOTAL	-	-	-	2	3	2	3	2	3	2	2	19
SB7	SCOUT	-	1	1	1	1	2	2	2	2	2	-	14
	TAT(6C)/DELTA	-	-	-	-	-	-	-	-	-	1	1	2
	TOTAL	-	1	1	1	1	2	2	2	2	3	1	16
SB8	NONE	-	-	-	-	-	-	-	-	-	-	-	0
SB9	SCOUT	-	2	2	2	2	1	1	1	1	1	-	13
	TAT/DELTA/FW4	-	-	1	1	1	1	-	-	-	-	-	4
	TAT(6C)/DELTA	-	-	2	2	2	2	2	2	-	-	-	12
	TITAN IIIB/CENTAUR	-	-	-	-	-	-	-	1	1	1	1	4
	TOTAL	-	2	5	5	5	4	3	4	2	2	1	33
SB10	SCOUT	-	2	2	2	2	1	1	1	1	1	-	13
	TAT/DELTA/FW4	-	-	-	1	1	1	1	-	-	-	-	4
	TAT(6C)/DELTA	-	-	-	-	-	2	2	2	2	2	-	10
	TOTAL	-	2	2	3	3	4	4	3	3	3	-	27

References

(1) "Space Biology Planning Documentation", prepared by the Space Biology Planning Panel, National Aeronautics and Space Administration, July 1, 1969.

(2) Wukelic, G. E., and Frazier, N. A., "Selected Space Goals and Objectives and Their Relation to National Goals", Prepared by Battelle Memorial Institute, Columbus Laboratories, Columbus, Ohio, for NASA Office of Space Science and Applications, July 15, 1969, Report No. BMI-NLVP-TR-69-2.

(3) "Prospectus 1966, Appendix A, Goals and Objectives 1967-1986", NASA Office of Space Science and Applications. June 1966 Draft, pp 57-85.

(4) "America's Next Decade in Space", A Report for the Space Task Group, prepared by National Aeronautics and Space Administration, September, 1969.

(5) Planning Steering Group (PSG) Prospectus File (Computer Tape), assembled during 1969 PSG exercises. Available at BMI-NLVP and at Goddard Space Flight Center.

(6) "OSSA Research and Development Program Operating Plan, 69-2", Headquarters, National Aeronautics and Space Administration, unpublished as a document; material transmitted to NASA Code SP under BMI-NLVP-IL-69-306, December 5, 1969.

(7) "FY 1971 Budget Data", NASA (SV) Memorandum, March 16, 1970.

(8) Nippert, D. A., and Pittenger, J. L., "Trip to NASA Headquarters to Talk to Mission Planners Concerning Mission Models (11/18/69 and 11/19/69)", Memorandum No. BMI-NLVP-MM-69-59, November 24, 1969.

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CHAPTER V. LUNAR AND PLANETARY (SL)

Introduction

The Lunar and Planetary Programs Division (SL) is one of the major program offices in OSSA. The SL areas of interest include "the genesis, distribution and composition of planets and their satellites, the comets and asteroids, and other solid materials in the solar system. It includes the search for extraterrestrial life, embraces such fields as geology, geography, petrography, mineralogy, seismology, vulcanology, astronomy, and aeronomy, and extends the scope of interest beyond the Earth to include all the condensed material of our solar system. It also includes examination of the interplanetary environment".(1)*

SL activities are structured to attain three major goals:

To further the understanding of

- The origin and evolution of the solar system
- The origin and evolution of life
- Earth by comparative studies of the other planets.

In the past the SL activities have consumed a major portion of the OSSA budget. In 1967, 1968, 1969, and 1970, the SL Division accounted for 27, 23, 14, and 27% of the total OSSA budget, respectively. The SL projections from Appendix A indicate that the SL Division might be expected to receive from 20 to 25% of the OSSA budget during the 1970 decade. These projections indicate SL funding of $170 million in 1970, $222 million in 1975, and $268 million in 1980. These data and the extrapolation of past data support the contention that the SL program will continue to receive a major portion of OSSA funds in the 1970s.

Ten SL mission models are presented in this study. These are indicative of the wide spectrum of activities which might be pursued to achieve the planetary program goals and objectives. Several models are presented to obtain a wide representation of the states in which NASA may find itself during the next decade. From these models an indication of the launch vehicle family needed to support the SL activities during the 1970 decade may be derived.

The remainder of this Chapter presents the Program Areas and the mission models and projects which comprise the plans.

Program Areas(2-6)

This section summarizes the various approved, planned, and proposed projects considered in developing the Planetary Exploration mission models presented. All funding is in millions of dollars; all spacecraft weights are given in pounds. Launch Vehicle is designated LV and the appropriate vehicle is named.** Characteristic velocity (V_C) is given in feet per second.

* Superscript numbers denote references given at the end of this chapter.
** See Appendix D for a discussion of launch vehicle nomenclature.

Supporting Activities

PLANETARY EXPLORATION SR&T

SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
●	●	●	●	●	●	●	●	●	●

Purpose: To provide supporting research and technology for all of the SL program areas.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	15.2	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Flights	(Non-flight project)										

PLANETARY EXPLORATION DATA ANALYSIS

SL1	SL2	SL3	SL4	SL5	SL6	SL7	SL8	SL9	SL10
●	●	●	●	●	●	●	●	●	●

Purpose: To provide follow-on analyses of data of interest beyond the area of a particular flight project.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.9	2.0	1.6	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Flights	(Non-flight project)										

PLANETARY EXPLORATION ADVANCED STUDIES

SL1	SL2	SL3	SL4	SL5	SL6	SL7	SL8	SL9	SL10
●	●	●	●	●	●	●	●	●	●

Purpose: To provide for studies of concepts and ideas related to future planetary exploration.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Flights	(Non-flight project)										

Mars

MARS MARINER(71) LV: ATLAS/CENTAUR Wt: 2,230 V_C: 37,500

SL1	SL2	SL3	SL4	SL5	SL6	SL7	SL8	SL9	SL10
●	●	●	●	●	●	●	●	●	●

Purpose: To provide topographic and thermal mapping of Mars and to study seasonal atmospheric and surface variations.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	29.6	10.5	1.0	-	-	-	-	-	-	-	-
Flights	2	-	-	-	-	-	-	-	-	-	-

MARS VIKING ORB./SL. A,B(73)*
LV: TITAN IIID/CENTAUR Wt: 7,700 V_C: 39,400

Purpose: To provide information regarding the possible existence and and nature of life on Mars, the characteristics of the Martian atmosphere and surface, and the planetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	248.3	217.0	128.0	55.0	5.0	-	-	-	-	-	-
Flights	-	-	2	-	-	-	-	-	-	-	-

MARS VIKING ORB./SL. C,D(75)
LV: TITAN IIID(7)/CENTAUR Wt: 9,700 V_C: 39,400

Purpose: To provide information regarding the possible existence and the nature of life on Mars, the characteristics of the Martian atmosphere and surface, and the planetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	34.0	135.0	106.0	59.0	30.0	4.0	-	-	-	-
Flights	-	-	-	-	2	-	-	-	-	-	-

MARS VIKING ORB./SL. E(77)
LV: TITAN IIID(7)/CENTAUR Wt: 9,700 V_C: 39,250

Purpose: To provide information regarding the possible existence and the nature of life on Mars, the characteristics of the Martian atmosphere and surface, and the planetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	17.0	67.5	53.0	29.5	15.0	2.0	-	-
Flights	-	-	-	-	-	-	1	-	-	-	-

MARS VIKING ORB./SL. A,B(75)
LV: TITAN IIID/CENTAUR Wt: 7,700 V_C: 39,400

Purpose: To provide information regarding the possible existence and the nature of life on Mars, the characteristics of the Martian atmosphere and surface, and the planetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	60.0	90.0	175.0	180.0	128.0	55.0	5.0	-	-	-	-
Flights	-	-	-	-	2	-	-	-	-	-	-

Mission	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
MARS VIKING ORB./SL. A,B(73)	•	•	•	•						
MARS VIKING ORB./SL. C,D(75)	•	•	•	•						
MARS VIKING ORB./SL. E(77)			•	•						
MARS VIKING ORB./SL. A,B(75)						•	•	•	•	•

* ORB./SL. stands for Orbiter/Soft Lander.

MARS VIKING ORB./SL. C,D(79)

LV: TITAN IIID(7)/CENTAUR Wt: 7,700 V_C: 38,400

Purpose: To provide information regarding the possible existence and the nature of life on Mars, the characteristics of the Martian atmosphere and surface, and the planetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	34.0	135.0	106.0	59.0	30.0	4.0
Flights	-	-	-	-	-	-	-	-	2	-	-

MARS VIKING ORB./SL. A,B(77)

LV: TITAN IIID/CENTAUR Wt: 7,700 V_C: 39,250

Purpose: To provide information regarding the possible existence and the nature of life on Mars, the characteristics of the Martian atmosphere and surface, and the planetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	60.0	55.0	65.0	85.0	155.0	165.0	115.0	55.0	5.0	-	-
Flights	-	-	-	-	-	-	2	-	-	-	-

MARS VIKING ORB./SL. C(77)

LV: TITAN IIID(7)/CENTAUR Wt: 9,700 V_C: 39,250

Purpose: To provide information regarding the possible existence and the nature of life on Mars, the characteristics of the Martian atmosphere and surface, and the planetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	25.4	100.0	80.0	45.0	22.0	3.0	-	-
Flights	-	-	-	-	-	-	1	-	-	-	-

MARS SOFT LANDER/ROVER(77)

LV: TITAN IIID/CENTAUR Wt: 6,000 V_C: 39,250

Purpose: To explore and take biological and geophysical measurements of the Martian surface.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	53.0	139.0	185.0	128.0	36.0	9.0	-	-
Flights	-	-	-	-	-	-	2	-	-	-	-

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
MARS VIKING ORB./SL. C,D(79)						●				●
MARS VIKING ORB./SL. A,B(77)					●					
MARS VIKING ORB./SL. C(77)								●		
MARS SOFT LANDER/ROVER(77)		●								

Mission	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
MARS SOFT LANDER/ROVER(79)		•								
MARS SOFT LANDER/ROVER(81)		•					•			
MARS SOFT LANDER/ROVER(84)	•							•		•
MARS HIGH DATA RATE ORBITER(75)					•					

MARS SOFT LANDER/ROVER(79)

LV: TITAN IIID/CENTAUR Wt: 6,000 V_C: 38,400

Purpose: To explore and take biological and geophysical measurements on the Martian surface.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	45.0	119.0	157.0	108.0	30.0	8.0
Flights	-	-	-	-	-	-	-	-	1	-	-

MARS SOFT LANDER/ROVER(81)

LV: TITAN IIID/CENTAUR Wt: 6,000 V_C: 37,800

Purpose: To explore and take biological and geophysical measurements on the Martian surface.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	45.0	119.0	157.0	108.0
Flights	-	-	-	-	-	-	-	-	-	-	1

MARS SOFT LANDER/ROVER(84)

LV: TITAN IIID/CENTAUR Wt: 6,000 V_C: 37,800

Purpose: To explore and take biological and geophysical measurements on the Martian surface.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	-	45.0	119.0
Flights			(Launch in 1984)								

MARS HIGH DATA RATE ORBITER(75)

LV: TITAN IIID/CENTAUR Wt: 7,000 V_C: 39,400

Purpose: Mission will utilize roll-out solar arrays for high power in orbit to provide high data rate transmission (>10^6 bits per second). Spacecraft will also provide support where possible for landed spacecraft.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	10.0	70.0	64.0	25.0	7.0	4.0	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
MARS HIGH DATA RATE ORBITER(77)		●				●	●		●	
MARS HIGH DATA RATE ORBITER(79)	●						●			
MARS HIGH DATA RATE ORBITER(81)		●	●	●	●	●		●	●	●
MARS HIGH DATA RATE ORBITER(84)	●									

MARS HIGH DATA RATE ORBITER(77)
LV: TITAN IIID/CENTAUR Wt: 7,000 V_C: 39,250

Purpose: Mission will utilize roll-out solar arrays for high power in orbit to provide high data rate transmission (>10^6 bits per second). Spacecraft will also provide support where possible for landed spacecraft.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	10.0	70.0	64.0	25.0	7.0	4.0	-	-
Flights	-	-	-	-	-	-	1	-	-	-	-

MARS HIGH DATA RATE ORBITER(79)
LV: TITAN IIID/CENTAUR Wt: 7,000 V_C: 38,400

Purpose: Mission will utilize roll-out solar arrays for high power in orbit to provide high data rate transmission (>10^6 bits per second). Spacecraft will also provide support where possible for landed spacecraft.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	10.0	70.0	64.0	25.0	7.0	4.0
Flights	-	-	-	-	-	-	-	-	1	-	-

MARS HIGH DATA RATE ORBITER(81)
LV: TITAN IIID/CENTAUR Wt: 7,000 V_C: 37,800

Purpose: Mission will utilize roll-out solar arrays for high power in orbit to provide high data rate transmission (>10^6 bits per second). Spacecraft will also provide support where possible for landed spacecraft.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	10.0	70.0	64.0	25.0
Flights	-	-	-	-	-	-	-	-	-	-	1

MARS HIGH DATA RATE ORBITER(84)
LV: TITAN IIID/CENTAUR Wt: 7,000 V_C: 37,800

Purpose: Mission will utilize roll-out solar arrays for high power in orbit to provide high data rate transmission (>10^6 bits per second). Spacecraft will also provide support where possible for landed spacecraft.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	-	10.0	70.0
Flights	(Launch in 1984)										

MARS EXPLORER/ORBITER A(73)

LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 38,400

Purpose: To measure Mars magnetosphere, magnetosheath, detached "Bow Shock" wave and tail and wake region. Also to provide clues to internal composition and structure if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	2.0	9.0	11.0	2.0	-	-	-	-	-	-	-
Flights	-	-	1	-	-	-	-	-	-	-	-

MARS EXPLORER/ORBITER(75)

LV: TAT(9C)/DELTA/TE364 Wt: 685 V_C: 38,400

Purpose: To measure Mars magnetosphere, magnetosheath, detached "Bow Shock" wave and tail and wake region. Also to provide clues to internal composition and structure if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	2.0	9.0	11.0	2.0	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

MARS EXPLORER/ORBITER(77)

LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 38,500

Purpose: To measure Mars magnetosphere, magnetosheath, detached "Bow Shock" wave and tail and wake region. Also to provide clues to internal composition and structure if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	2.0	9.0	11.0	2.0	-	-	-
Flights	-	-	-	-	-	-	1	-	-	-	-

MARS EXPLORER/ORBITER(79)

LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 38,400

Purpose: To measure Mars magnetosphere, magnetosheath, detached "Bow Shock" wave and tail and wake region. Also to provide clues to internal composition and structure if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	2.0	9.0	11.0	2.0	-
Flights	-	-	-	-	-	-	-	-	1	-	-

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
MARS EXPLORER/ORBITER A(73)	•									
MARS EXPLORER/ORBITER(75)	•	•								
MARS EXPLORER/ORBITER(77)	•	•		•		•				•
MARS EXPLORER/ORBITER(79)			•	•	•			•	•	•

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
MARS EXPLORER/ORBITER(81)	•	•	•	•	•	•				
MERCURY/VENUS MARINER FLYBY(73)	•	•	•	•	•	•	•	•	•	•
MERCURY/VENUS MARINER FLYBY(78)	•	•					•	•	•	
MERCURY SOLAR ELECTRIC ORBITER(82)	•									

MARS EXPLORER/ORBITER(81)

LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 38,500

Purpose: To measure Mars magnetosphere, magnetosheath, detached "Bow Shock" wave and tail and wake region. Also to provide clues to internal composition and structure if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	2.0	9.0	11.0
Flights	-	-	-	-	-	-	-	-	-	-	1

Mercury/Venus

MERCURY/VENUS MARINER FLYBY(73)

LV: ATLAS/CENTAUR Wt: 1,200 V_C: 38,900

Purpose: Close-range observation of surface features, light and dark side emissivity and temperature, solar wind interaction, atmosphere, mass density and shape, ephemeris of Mercury. Spacecraft will provide TV transmissions of Venus.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	24.1	33.5	22.3	11.2	0.4	-	-	-	-	-	-
Flights	-	-	1	-	-	-	-	-	-	-	-

MERCURY/VENUS MARINER FLYBY(78)

LV: TITAN IIIC Wt: 800 V_C: 40,400

Purpose: Close-range observation of surface features, light and dark side emissivity and temperature, solar wind interaction, atmosphere, mass density and shape, ephemeris of Mercury. Spacecraft will provide TV transmissions of Venus.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	3.0	25.0	27.0	16.0	10.0	-	-
Flights	-	-	-	-	-	-	-	1	-	-	-

Mercury

MERCURY SOLAR ELECTRIC ORBITER(82)

LV: TITAN IIID/CENTAUR Wt: 8,000 V_C: 39,600

Purpose: To map the topography of Mercury's surface, magnetic field, and atmospheric composition and to measure the gravitational field and spatial/temporal pattern of the surface temperature. Spacecraft to have solar electric propulsion engine.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	30.0	44.0	37.0	32.0
Flights	(Launch in 1982)										

Venus

VENUS EXPLORER ORBITER(72)
LV: TAT(9C)/DELTA/TE364 Wt: 635 V_C: 38,650

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	12.0	16.0	3.0	-	-	-	-	-	-	-	-
Flights	-	1	-	-	-	-	-	-	-	-	-

VENUS EXPLORER ORBITER(73)
LV: TAT(9C)/DELTA/TE364 Wt: 660 V_C: 38,450

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.0	12.0	16.0	3.0	-	-	-	-	-	-	-
Flights	-	-	1	-	-	-	-	-	-	-	-

VENUS EXPLORER ORBITER(75)
LV: TAT(9C)/DELTA/TE364 Wt: 815 V_C: 37,400

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	4.0	12.0	16.0	3.0	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

VENUS EXPLORER ORBITER(76)
LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 37,500

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	4.0	12.0	16.0	3.0	-	-	-	-
Flights	-	-	-	-	-	1	-	-	-	-	-

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
VENUS EXPLORER ORBITER(72)	•	•								
VENUS EXPLORER ORBITER(73)	•									
VENUS EXPLORER ORBITER(75)	•	•			•					•
VENUS EXPLORER ORBITER(76)		•		•		•		•		

VENUS EXPLORER ORBITER(78)
LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 37,500

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	4.0	12.0	16.0	3.0	-	-
Flights	-	-	-	-	-	-	-	1	-	-	-

VENUS EXPLORER ORBITER(80)
LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 37,500

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	4.0	12.0	16.0	3.0
Flights	-	-	-	-	-	-	-	-	-	1	-

VENUS EXPLORER ORBITER(81)
LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 37,400

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	4.0	12.0	16.0
Flights	-	-	-	-	-	-	-	-	-	-	1

VENUS EXPLORER ORBITER(83)
LV: TAT(9C)/DELTA/TE364 Wt: 650 V_C: 37,500

Purpose: To measure the planet's magnetosphere, magnetosheath, detached "Bow Shock" wave, and tail and wake region. To collect data about internal composition and structure, if magnetic field exists.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	-	-	4.0
Flights			(Launch in 1983)								

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
VENUS EXPLORER ORBITER(78)		•	•	•			•		•	
VENUS EXPLORER ORBITER(80)	•		•	•	•	•		•	•	•
VENUS EXPLORER ORBITER(81)			•	•				•		
VENUS EXPLORER ORBITER(83)	•									

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
VENUS EXPLORER FLYBY/PROBES(75)				•						
VENUS MARINER FLYBY/PROBES(75)	•									
VENUS MARINER FLYBY/PROBES(77)		•								
VENUS MARINER ORBITERS(78)	•	•								

VENUS EXPLORER FLYBY/PROBES(75)
LV: TAT(9C)/DELTA/TE364 Wt: 600 V_C: 37,400

Purpose: To study the nature and composition of Venusian clouds, the structure of the atmosphere, and atmospheric circulation.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	8.0	20.0	31.0	10.0	6.0	1.0	-	-	-	-
Flights	-	-	-	-	2	-	-	-	-	-	-

VENUS MARINER FLYBY/PROBES(75)
LV: TITAN IIIC Wt: 3,000 V_C: 38,000

Purpose: To carry out multiple profile and composition measurements in different zones of the Venusian atmosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.0	36.0	60.0	55.0	20.0	2.0	-	-	-	-	-
Flights	-	-	-	-	2	-	-	-	-	-	-

VENUS MARINER FLYBY/PROBES(77)
LV: TITAN IIIC Wt: 3,000 V_C 38,000

Purpose: To carry out multiple profile and composition measurements in different zones of Venusian atmosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	9.0	42.0	67.0	50.0	10.0	2.0	-	-
Flights	-	-	-	-	-	-	2	-	-	-	-

VENUS MARINER ORBITERS(78)
LV: TITAN IIID/CENTAUR Wt: 5,600 V_C: 38,000

Purpose: To develop a microwave map of the Venusian surface.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	13.0	47.0	44.0	16.0	4.0	4.0	-
Flights	-	-	-	-	-	-	-	1	-	-	-

VENUS MARINER ORBITERS(81)

LV: TITAN IIID/CENTAUR Wt: 5,600 V_C: 38,000

Purpose: To develop a microwave map of the Venusian surface.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	26.0	94.0	88.0	32.0
Flights	-	-	-	-	-	-	-	-	-	-	2

SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
•									

VENUS MARINER ORBITER/ROUGH LANDER(83)

LV: TITAN IIID/CENTAUR Wt: 6,000 V_C: 38,500

Purpose: To analyze surface properties and environment of Venus. Also, to measure the atmospheric properties during descent and surface mapping by orbiter.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	-	26.0	100.0
Flights	(Launch in 1983)										

SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
•									

VENUS HIGH DATA RATE ORBITER(81)

LV: TITAN IIID/CENTAUR Wt: 7,000 V_C: 38,500

Purpose: To develop a detailed surface mapping of Venus to 50 meter's resolution using radar imaging.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	20.0	70.0	66.0	24.0
Flights	-	-	-	-	-	-	-	-	-	-	1

SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
				•		•		•	•

Jupiter

JUPITER PIONEER F,G

LV: PIONEER F: ATLAS/CENTAUR; PIONEER G* TITAN IIID/CENTAUR Wt: 515 V_C: 47,700

Purpose: To measure particles and field environment to 5 a.u., particle density of asteroid belt, magnetic and radiation fields of Jupiter, and to provide Jupiter imaging.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	29.1	14.2	6.3	2.7	2.3	2.0	1.6	-	-	-	-
Flights	-	1	1	-	-	-	-	-	-	-	-

SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
•	•	•	•	•	•	•	•	•	•

* Pioneer G will be launched on an ATLAS/CENTAUR if the Development of the TITAN IIID/CENTAUR is delayed.

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
JUPITER MARINER ORBITER(78)	•	•					•		•	
JUPITER MARINER ORBITER(80)								•		
JUPITER FLYBY/PROBES(78)				•						
JUPITER FLYBY/PROBES(80)-HIGH		•								

JUPITER MARINER ORBITER(78)

LV: TITAN IIID/CENTAUR/BII Wt: 2,200 V_C: 49,000

Purpose: To conduct mapping, composition analysis, and time-dependent measurements of the atmosphere; determine extent and intensity of planetary fields; observe satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	2.0	15.0	70.0	80.0	58.0	15.0	10.0	-
Flights	-	-	-	-	-	-	-	1	-	-	-

JUPITER MARINER ORBITER(80)

LV: TITAN IIID/CENTAUR/BII Wt: 2,200 V_C: 48,000

Purpose: To conduct mapping, composition analysis, and time-dependent measurements of the atmosphere; determine extent and intensity of planetary fields; observe satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	2.0	15.0	70.0	80.0	58.0	15.0
Flights	-	-	-	-	-	-	-	-	-	1	-

JUPITER FLYBY/PROBES(78)

LV: TITAN IIID/CENTAUR/BII Wt: 2,400 V_C: 47,800

Purpose: To obtain atmosphere profile of pressure and temperature and probe underlying planetary surfaces.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	3.0	4.5	5.0	15.0	90.0	110.0	83.0	25.0	10.0	-
Flights	-	-	-	-	-	-	-	1	-	-	-

JUPITER FLYBY/PROBES(80)-HIGH

LV: TITAN IIID/CENTAUR/BII Wt: 2,400 V_C: 48,500

Purpose: To obtain atmosphere profile of pressure and temperature and probe underlying planetary surfaces.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	7.0	25.0	90.0	110.0	83.0	25.0
Flights	-	-	-	-	-	-	-	-	-	1	-

JUPITER FLYBY/PROBES(80)-LOW
LV: TITAN IIID/CENTAUR/BII Wt: 2,400 V_C: 48,500

Purpose: To obtain atmosphere profile of pressure and temperature and probe underlying planetary surfaces. Mission funded with assumption that it is to be preceded by a Jupiter Mariner Flyby(74).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	3.0	15.0	65.0	79.0	57.0	15.0
Flights	-	-	-	-	-	-	-	-	-	1	-

JUPITER FLYBY/PROBES(83)
LV: TITAN IIID/CENTAUR/BII Wt: 2,400 V_C: 47,400

Purpose: To obtain atmosphere profile of pressure and temperature and probe underlying planetary surfaces.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	7.0	25.0	90.0	110.0
Flights	(Launch in 1983)										

JUPITER FLYBY/PROBES(84)
LV: TITAN IIID/CENTAUR/BII Wt: 2,400 V_C 47,400

Purpose: To obtain atmosphere profile of pressure and temperature and prove underlying planetary surfaces. Mission funded with assumption that it is to be preceded by a Jupiter Mariner Flyby(74).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	7.0	25.0	90.0
Flights	(Launch in 1984)									3.0	15.0

JUPITER MARINER FLYBY/SOLAR ESCAPE(74)
LV: TITAN IIID/CENTAUR/BII Wt: 1,300 V_C: 52,500

Purpose: Will emphasize Jupiter science with optimized encounter; to check out new outer planet spacecraft design, and measure particles and field environment to 50 a.u.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	18.0	65.0	71.0	35.0	7.0	4.0	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
JUPITER FLYBY/PROBES(80)-LOW	●									
JUPITER FLYBY/PROBES(83)									●	●
JUPITER FLYBY/PROBES(84)	●									
JUPITER MARINER FLYBY/SOLAR ESCAPE(74)	●									

Outer Planets

JUPITER-SATURN-PLUTO MARINER FLYBY(77)
LV: TITAN IIID/CENTAUR/BII Wt: 1,500 V_C: 51,500

Purpose: To obtain first-generation flyby data of Saturn and Pluto, to monitor temporal variation of solar and galactic influence with solar distance.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	14.0	100.0	115.0	50.0	14.0	7.0	-	-
Flights	-	-	-	-	-	-	2	-	-	-	-

JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)
LV: TITAN IIID/CENTAUR/BII Wt: 1,500 V_C: 51,000

Purpose: To obtain first-generation flyby data of Uranus and Neptune and to correlate spatial effects in cosmic flux and solar wind with the Jupiter-Saturn-Pluto mission.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	14.0	100.0	115.0	50.0	14.0	7.0
Flights	-	-	-	-	-	-	-	-	2	-	-

JUPITER-SATURN-PLUTO MARINER FLYBY(77)-LOW
LV: TITAN IIID/CENTAUR/BII Wt: 1,500 V_C: 51,000

Purpose: To obtain first-generation flyby data of Saturn and Pluto, to monitor temporal variation of solar and galactic influence with solar distance. Funded with the assumption that the mission would be preceded by a Jupiter Mariner Flyby(74).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	10.0	60.0	62.0	25.0	7.0	4.0	-	-
Flights	-	-	-	-	-	-	2	-	-	-	-

JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)-LOW
LV: TITAN IIID/CENTAUR/BII Wt: 1,500 V_C: 51,000

Purpose: To obtain first-generation flyby data of Uranus and Neptune and to correlate spatial effects in cosmic flux and solar wind with the Jupiter-Saturn-Pluto mission. Funded with the assumption that the mission would be preceded by a Jupiter Mariner Flyby(74).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	10.0	60.0	62.0	25.0	7.0	4.0
Flights	-	-	-	-	-	-	-	-	2	-	-

Mission	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
JUPITER-SATURN-PLUTO MARINER FLYBY(77)		•	•	•						•
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)		•	•	•	•	•		•	•	•
JUPITER-SATURN-PLUTO MARINER FLYBY(77)-LOW	•									
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)-LOW	•									

SATURN MARINER ORBITER/PROBES(81)-HIGH
LV: SIC/SIVB/CENTAUR Wt: 3,100 V_C: 53,300

Purpose: To monitor particles and field environment, measure ring composition, and measure atmospheric characteristics and profiles.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	32.0	65.0	95.0	120.0	73.0
Flights	-	-	-	-	-	-	-	-	-	-	1

SATURN MARINER ORBITER/PROBES(81)-LOW
LV: SIC/SIVB/CENTAUR Wt: 3,100 V_C: 53,300

Purpose: To monitor particles and field environment, measure ring composition, and measure atmospheric characteristics and profiles. Funded with assumption that the 1974 Jupiter Mariner Flyby is flown.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	5.0	20.0	90.0	105.0	75.0
Flights	-	-	-	-	-	-	-	-	-	-	1

Comets and Asteroids

ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(75)
LV: ATLAS/CENTAUR Wt: 1,500 V_C: 38,500

Purpose: To define the micrometeoroid and particle and field environment in asteroid belt; to test solar electric propulsion over long duration (>2 years) time period.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	2.0	6.0	9.0	6.0	2.0	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)
LV: ATLAS/CENTAUR Wt: 1,500 V_C: 38,500

Purpose: To define the micrometeoroid and particle and field environment in asteroid belt; to test solar electric propulsion over long duration (>2 years) time period.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	2.0	6.0	9.0	6.0
Flights	-	-	-	-	-	-	-	-	-	-	1

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
SATURN MARINER ORBITER/PROBES(81)-HIGH		•								
SATURN MARINER ORBITER/PROBES(81)-LOW	•									
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(75)	•	•								
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)			•	•		•	•	•		•

ASTEROID EROS MARINER FLYBY(81)
LV: ATLAS/CENTAUR Wt: 1,000 V_C: 37,400

Purpose: To determine the size, shape, and general surface properties of the asteroid.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	8.0	25.0	31.0	25.0
Flights	-	-	-	-	-	-	-	-	-	-	1

COMET D'ARREST MARINER FLYBY(76)
LV: ATLAS/CENTAUR Wt: 1,000 V_C: 37,200

Purpose: Close-range investigation of comet to determine physical state, structure, composition, and mode of interaction with interplanetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	8.0	20.0	36.0	25.0	5.0	1.0	-	-	-
Flights	-	-	-	-	-	1	-	-	-	-	-

COMET KOPFF MARINER RENDEZVOUS(83)
LV: TITAN IIID/CENTAUR Wt: 8,500 V_C: 39,000

Purpose: A long duration (several months) investigation of size, shape, and dynamics of planet. Also to provide rendezvous experience for the Comet Halley Mariner Flyby(85).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	10.0	35.0	38.0
Flights	(Launch in 1983)										

COMET HALLEY MARINER FLYBY(85)
LV: ATLAS/CENTAUR Wt: 1,200 V_C: 38,500

Purpose: To investigate comet at close range to determine its physical state, structure, composition, and mode of interaction with interplanetary environment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	-	-	10.0
Flights	(Launch in 1985)										

	SL1 (PSG-LOW)	SL2 (STG OPTION I)	SL3 (BASELINE I)	SL4 (BASELINE II)	SL5 (ALTERNATIVE I)	SL6 (ALTERNATIVE II)	SL7 (ALTERNATIVE III)	SL8 (ALTERNATIVE IV)	SL9 (ALTERNATIVE V)	SL10 (ALTERNATIVE VI)
Asteroid Eros Mariner Flyby(81)	•	•								
Comet D'Arrest Mariner Flyby(76)	•	•		•						
Comet Kopff Mariner Rendezvous(83)	•									
Comet Halley Mariner Flyby(85)	•									

SL Mission Models

This section presents 10 Planetary mission models (SL1-SL10). Included with each mission model are the guidelines, characteristics, funding plot (Figures V-1 through V-10), and flight schedule (Tables V-1 through V-10) which describe the model. Comparisons and discussions of the models follow in the next section of this chapter.

Model Guidelines and Description: SL1(PSG-LOW)

SL1 is the lowest level Planetary model found in the PSG Prospectus file[3]. In this study SL1 is considered an aggressive SL plan.

The principal characteristics of this model are as follows:

- Mars Vikings in 1973 and 1975
- Jupiter Flyby Solar Escape in 1974
- Grand Tour in 1977 and 1979
- Active flight schedule to the Comets and Asteroids.

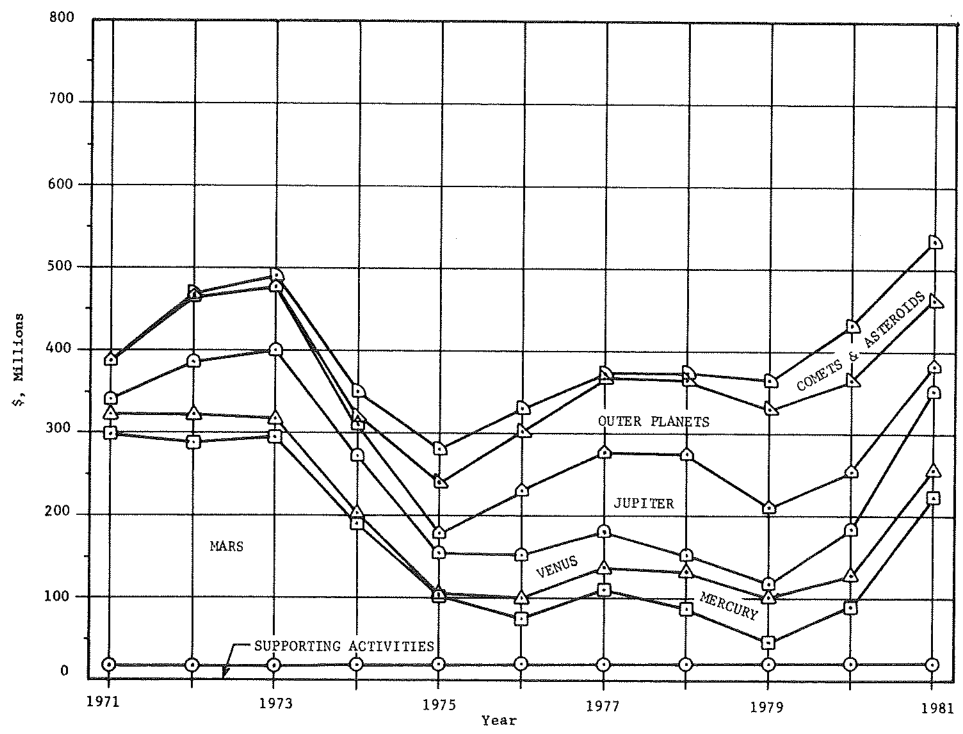

FIGURE V-1. SL1 FUNDING PLOT

TABLE V-1. SL1 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
						Mars						
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(73)	TITAN IIID/CENTAUR	-	-	2	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. C,D(75)	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS SOFT LANDER/ROVER(84)	TITAN IIID/CENTAUR				(Launch in 1984)							
MARS HIGH DATA RATE ORBITER(79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	-
MARS HIGH DATA RATE ORBITER(84)	TITAN IIID/CENTAUR				(Launch in 1984)							
MARS EXPLORER/ORBITER A(73)	TAT(9C)/DELTA/TE364	-	-	1	-	-	-	-	-	-	-	-
MARS EXPLORER/ORBITER(75)	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
MARS EXPLORER/ORBITER(77)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
						Mercury						
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(78)	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-
MERCURY SOLAR ELECTRIC ORBITER(82)	TITAN IIID/CENTAUR				(Launch in 1982)							
						Venus						
VENUS MARINER FLYBY/PROBES(75)	TITAN IIIC	-	-	-	-	2	-	-	-	-	-	-
VENUS MARINER ORBITERS(78)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(72)	TAT(9C)/DELTA/TE364	-	1	-	-	-	-	-	-	-	-	-
VENUS EXPLORER ORBITER(73)	TAT(9C)/DELTA/TE364	-	-	1	-	-	-	-	-	-	-	-
VENUS EXPLORER ORBITER(75)	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(83)	TAT(9C)/DELTA/TE364				(Launch in 1983)							
VENUS MARINER ORBITER/ROUGH LANDER(83)	TITAN IIID/CENTAUR				(Launch in 1983)							
						Jupiter						
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
JUPITER MARINER FLYBY/ SOLAR ESCAPE(74)	TITAN IIID/CENTAUR/BII	-	-	-	1	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	1	-	-	-
JUPITER FLYBY/PROBES(80)-LOW	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	-	1	-
JUPITER FLYBY/PROBES(84)	TITAN IIID/CENTAUR/BII				(Launch in 1984)							
						Outer Planets						
JUPITER-SATURN-PLUTO MARINER FLYBY(77)-LOW	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)-LOW	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-
SATURN MARINER ORBITER/ PROBE(81)-LOW	SIC/SIVB/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
						Comets and Asteroids						
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(75)	ATLAS/CENTAUR	-	-	-	-	1	-	-	-	-	-	-
ASTEROID EROS MARINER FLYBY(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
COMET D'ARREST MARINER FLYBY(76)	ATLAS/CENTAUR	-	-	-	-	-	1	-	-	-	-	-
COMET HALLEY MARINER FLYBY(85)	ATLAS/CENTAUR				(Launch in 1985)							
COMET KOPFF MARINER RENDEZVOUS(83)	TITAN IIID/CENTAUR				(Launch in 1983)							

Model Guidelines and Description: SL2(STG Option I)

The Lunar and Planetary model SL2 was extracted from NASA's Report to the Space Task Group(4), where it appeared as Program I in the Planetary Program Schedule. The primary guideline concepts associated with Model SL2 are excerpted from the Space Task Group report as follows:

> "The most effective way to proceed with the exploration of the nearby planets Mars and Venus is with an integrated exploration program utilizing both automated and manned systems. ...The approach of the automated Mars exploration program is to proceed from the recent flyby missions to orbiters and then to orbiters with surface landers. ...Exploration of Venus will continue with automated flybys and orbiters, some with atmospheric probes."
>
> "...In the late 1970's, the outer planets are so uniquely positioned that multiple planet flyby missions, referred to as 'Grand Tours', are feasible with a single spacecraft. ...Utilization will be made of both of these Grand Tour opportunities."(4)

This model was based upon the following:

- A 12-man space station and space shuttle in 1976
- A 50-man space station by 1980
- An active Mars automated program in support of a manned Mars expedition in 1983
- An active Venus Program
- Grand Tour in 1977 and 1979.

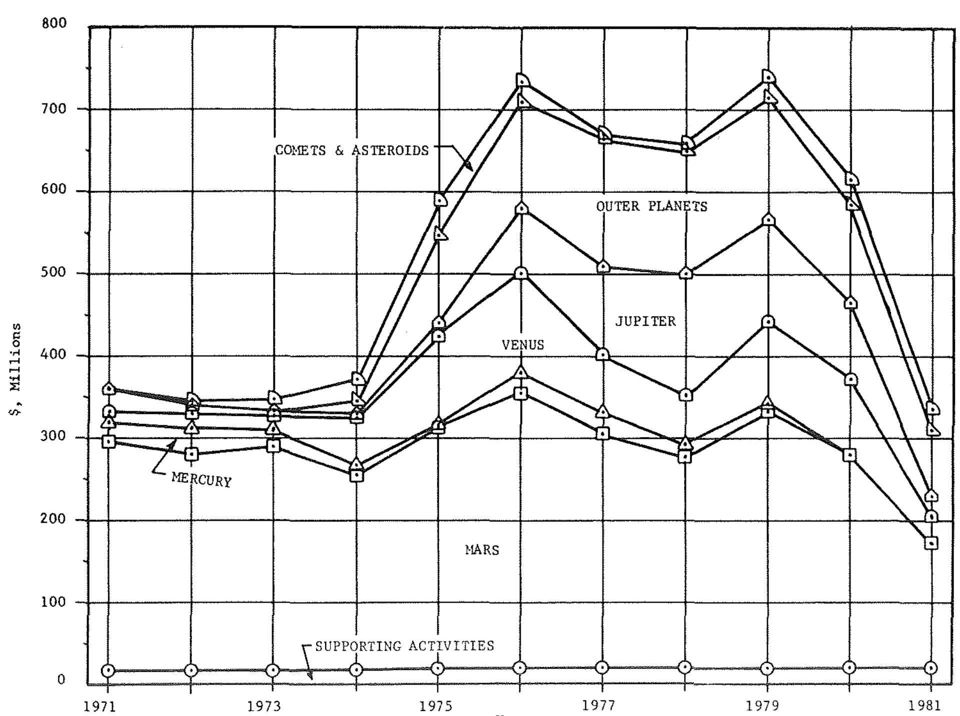

FIGURE V-2. SL2 FUNDING PLOT

TABLE V-2. SL2 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
		Mars										
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(73)	TITAN IIID/CENTAUR	-	-	2	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. C,D(75)	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS SOFT LANDER ROVER(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
MARS SOFT LANDER ROVER(79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	-
MARS SOFT LANDER ROVER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS HIGH DATA RATE ORBITER(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(75)	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
MARS EXPLORER/ORBITER(77)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
		Mercury										
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(78)	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-
		Venus										
VENUS MARINER ORBITER(78)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
VENUS MARINER ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	2
VENUS MARINER FLYBY/PROBES(77)	TITAN IIIC	-	-	-	-	-	-	2	-	-	-	-
VENUS EXPLORER ORBITER(72)	TAT(9C)/DELTA/TE364	-	1	-	-	-	-	-	-	-	-	-
VENUS EXPLORER ORBITER(75)	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	1	-	-	-	-	-
VENUS EXPLORER ORBITER(78)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-
		Jupiter										
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	1	-	-	-
JUPITER FLYBY/PROBES(80)-HIGH	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	-	1	-
		Outer Planets										
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-
SATURN MARINER ORBITER/ PROBE(81)-HIGH	SIC/SIVB/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
		Comets and Asteroids										
COMET D'ARREST MARINER FLYBY(76)	ATLAS/CENTAUR	-	-	-	-	-	1	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(75)	ATLAS/CENTAUR	-	-	-	-	1	-	-	-	-	-	-
ASTEROID EROS MARINER FLYBY(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SL3(Baseline I)

The Lunar and Planetary model SL3 was derived from NASA's Report to the Space Task Group[4], where it appeared as Programs II and III in the Planetary Program Schedule. The guidelines are similar to the excerpt presented with Model SL2.

The model, as presented in this present study, was based upon the following:

- A space station and shuttle in 1977
- A 50-man space station in 1984
- A budgetary constraint of $4.0 billion for NASA in FY 1971
- Mars missions flown at each opportunity
- Grand Tours in 1977 and 1979.

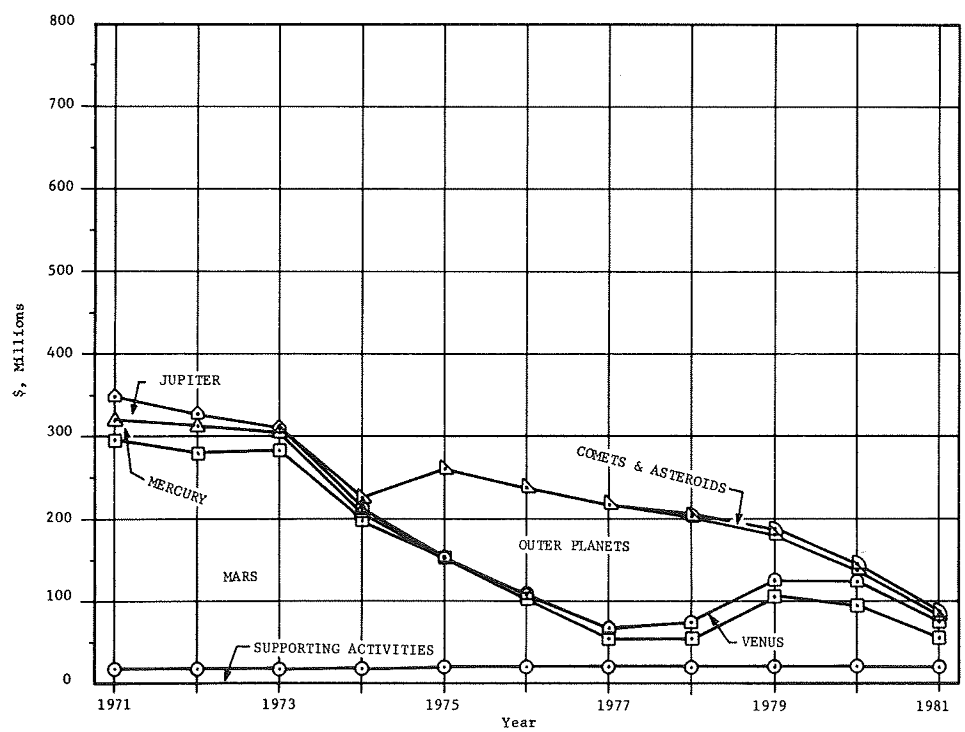

FIGURE V-3. SL3 FUNDING PLOT

TABLE V-3. SL3 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
		Mars										
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(73)	TITAN IIID/CENTAUR	-	-	2	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. C,D(75)	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS VIKING ORB./SL. E(77)	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(79)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	1	-	-
MARS EXPLORER/ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
		Mercury										
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
		Venus										
VENUS EXPLORER ORBITER(78)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
		Jupiter										
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
		Outer Planets										
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-
		Comets and Asteroids										
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SL4(Baseline II)

Lunar and Planetary model SL4 is a modification of model SL3 and reflects the Lunar and Planetary program presented in the NASA FY 1971 submission to the Bureau of the Budget.(5,6)

The principal characteristics of this model are as follows:

- Dry workshop (Number 2) to be launched in 1975
- Space station and shuttle in 1976
- An added Jupiter probe in 1978
- Comet D'Arrest mission in 1976
- Mars missions flown at each opportunity
- Grand Tours in 1977 and 1979.

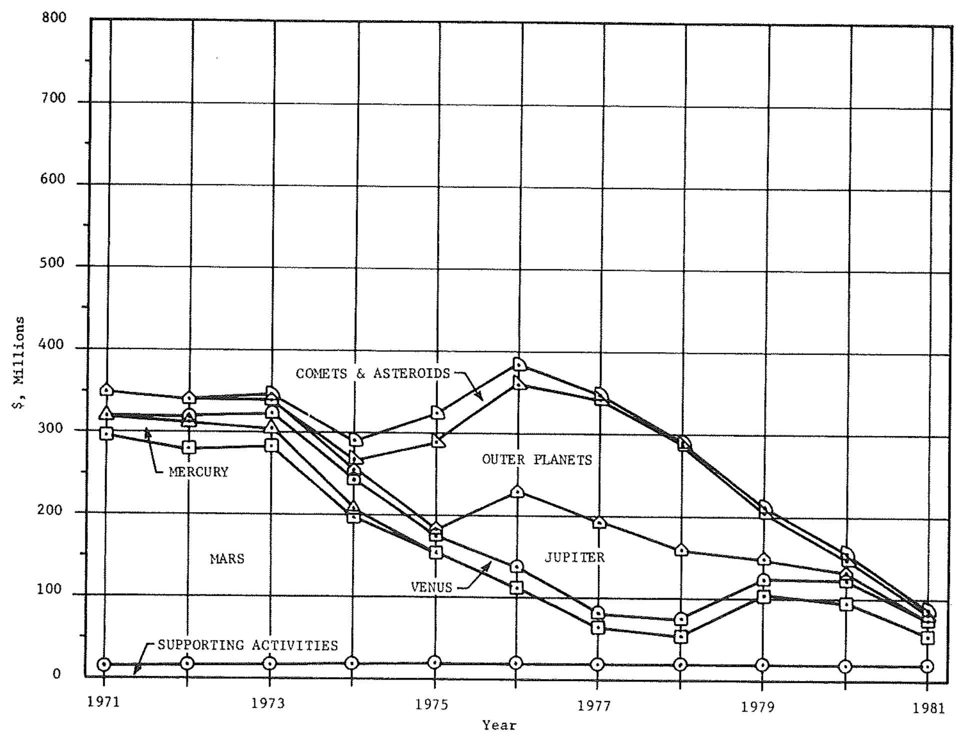

FIGURE V-4. SL4 FUNDING PLOT

TABLE V-4. SL4 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Mars												
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(73)	TITAN IIID/CENTAUR	-	-	2	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. C,D(75)	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS VIKING ORB./SL. E(77)	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(77)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(79)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	1	-	-
MARS EXPLORER/ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
Mercury												
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
Venus												
VENUS EXPLORER ORBITER(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	1	-	-	-	-	-
VENUS EXPLORER ORBITER(78)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER FLYBY/PROBES(75)	TAT(9C)/DELTA/TE364	-	-	-	-	2	-	-	-	-	-	-
Jupiter												
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
JUPITER FLYBY/PROBES(78)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	1	-	-	-
Outer Planets												
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-
Comets and Asteroids												
COMET D'ARREST MARINER FLYBY(76)	ATLAS/CENTAUR	-	-	-	-	-	1	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SL5(Alternative I)

The Lunar and Planetary model SL5 was created in this study as a possible alternative to the NASA models SL1-SL4. The principal guideline for this plan was to obtain a model in which funding was less than the 1971-1981 SL funding projections presented in Appendix A.

The major characteristics of this plan are as follows:

- A single pair of Mars Viking spacecraft launched in 1977
- Grand Tour in 1979.

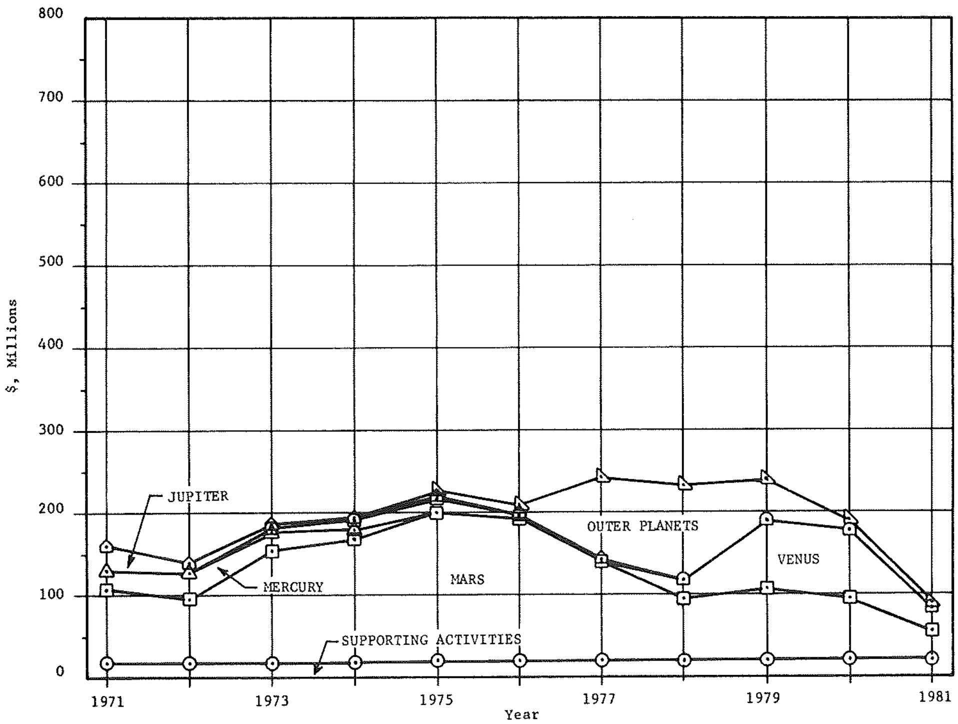

FIGURE V-5. SL5 FUNDING PLOT

TABLE V-5. SL5 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
		Mars										
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
MARS HIGH DATA RATE ORBITER(75)	TITAN IIID/CENTAUR	-	-	-	-	1	-	-	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(79)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	1	-	-
MARS EXPLORER/ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
		Mercury										
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
		Venus										
VENUS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER ORBITER(75)	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
		Jupiter										
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
		Outer Planets										
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-

Model Guidelines and Description: SL6(Alternative II)

The Lunar and Planetary model SL6 was created in this study as a second alternative to the NASA models (SL1-SL4). The principal guidelines for this model were to have an active Mars program with a launch at every Mars opportunity starting in 1975, and maintain a funding level near the SL funding projections presented in Appendix A.

The primary characteristics of this model are as follows:

- Mars Vikings in 1975 and 1979 and High Data Rate Orbiters in 1977 and 1981
- Grand Tour in 1979.

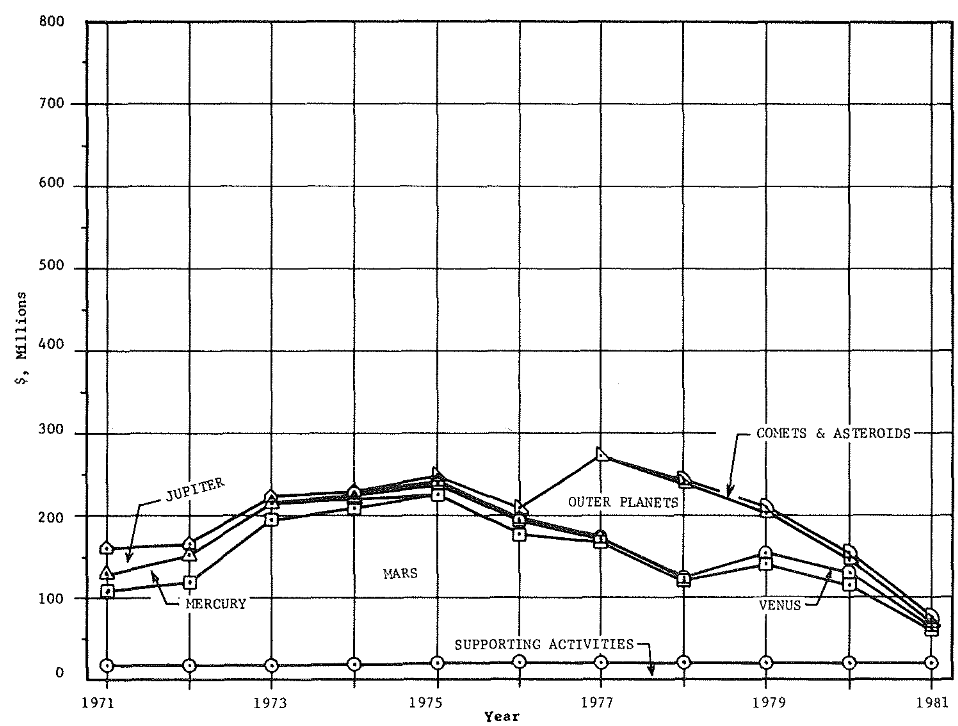

FIGURE V-6. SL6 FUNDING PLOT

TABLE V-6. SL6 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
						Mars						
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(75)	TITAN IIID/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS VIKING ORB./SL. C,D(79)	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	-	-	2	-	-
MARS HIGH DATA RATE ORBITER(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(77)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
						Mercury						
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
						Venus						
VENUS EXPLORER ORBITER(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	1	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
						Jupiter						
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
						Outer Planets						
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-
						Asteroids						
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SL7(Alternative III)

The principal guidelines for model SL7 was the shift of primary interest in Mars to include Jupiter and Mercury launches in the later 1970s and a Soft Lander Rover in 1981. The cost of these missions forced the Mars program to include only one pair of Mars Vikings in 1975 and to rely upon High Data Rate Orbiters in 1977 and 1979.

The primary characteristics in this model are as follows:

- A funding level from 0 to 10% higher than the SL funding projections presented in Appendix A
- A Jupiter Mariner Orbiter in 1978
- A Mercury/Venus flyby in 1978
- No Grand Tour missions
- One pair of Mars Vikings in 1975
- Mars High Data Rate Orbiters in 1977 and 1979
- Mars Soft Lander/Rover in 1981.

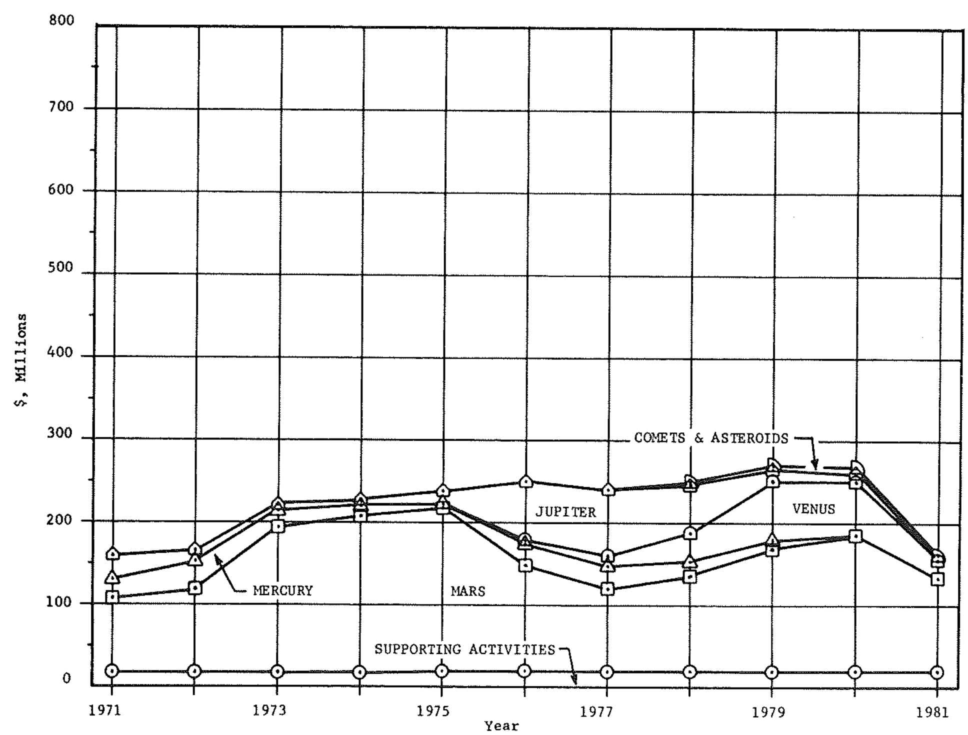

FIGURE V-7. SL7 FUNDING PLOT

TABLE V-7. SL7 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
		Mars										
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(75)	TITAN IIID/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS SOFT LANDER/ROVER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS HIGH DATA RATE ORBITER(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA RATE ORBITER(79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	-
		Mercury										
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(78)	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-
		Venus										
VENUS EXPLORER ORBITER(78)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-
VENUS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
		Jupiter										
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	1	-	-	-
		Asteroids										
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SL8(Alternative IV)

The Lunar and Planetary model SL8 is presented as a fourth alternative to the NASA -based models (SL1-SL4). The principal guidelines followed in this model was a launch schedule of one pair of Mars Viking Orbiters in 1975 followed by a single Mars Viking in 1977.

The principal characteristics of this model are as follows:

- The available funds peaking at approximately $270 million in 1975
- One pair of Mars Vikings in 1975 and a single Viking in 1977
- A Grand Tour in 1979
- A Jupiter Mariner Orbiter in 1978.

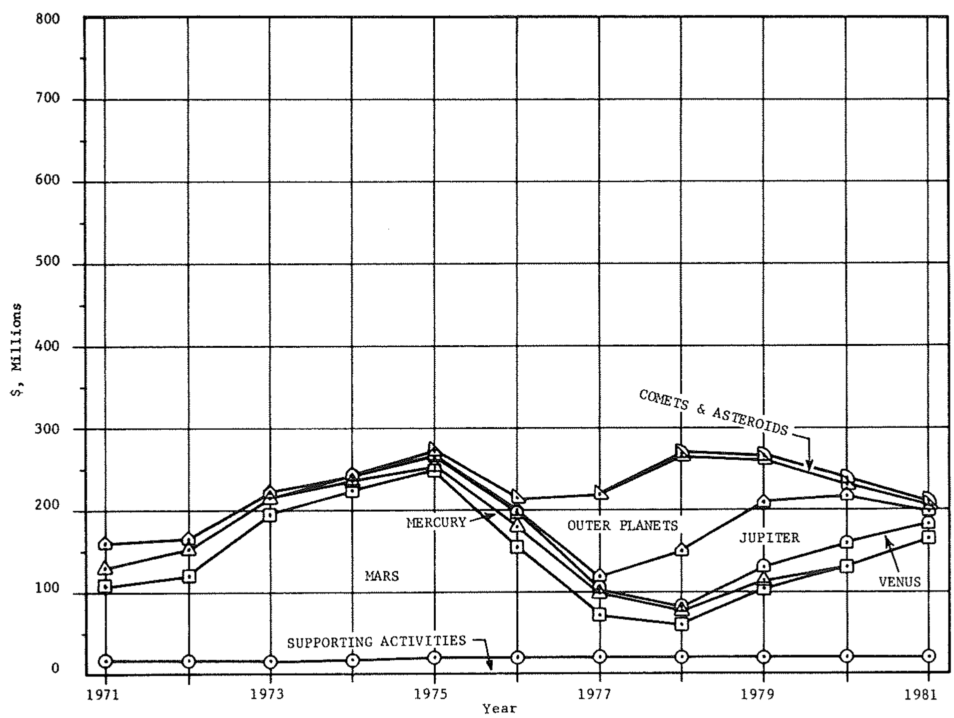

FIGURE V-8. SL8 FUNDING PLOT

TABLE V-8. SL8 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
						Mars						
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(75)	TITAN IIID/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS VIKING ORB./SL. C(77)	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
MARS SOFT LANDER/ROVER(84)	TITAN IIID/CENTAUR			(Launch in 1984)								
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(79)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	1	-	-
						Mercury						
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(78)	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-
						Venus						
VENUS EXPLORER ORBITER(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	1	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	1
						Jupiter						
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(80)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	-	1	-
						Outer Planets						
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-
						Asteroids						
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SL9(Alternative V)

The Lunar and Planetary model SL9 was created as a fifth alternative to the NASA -based models (SL1-SL4). The principal guidelines of this model are a funding level from 5 to 15% higher than the SL funding projections presented in Appendix A and an emphasis on the three planets Mars, Venus, and Jupiter during the 1971-1981 period.

The principal characteristics of this model are as follows:

- A funding level slightly higher (5 to 15%) than the funding projections presented in Appendix A
- Mars program consisting of one pair of Vikings in 1975 followed by High Data Rate Orbiters in 1977 and 1981
- A Jupiter Mariner Orbiter in 1978
- Grand Tour in 1979.

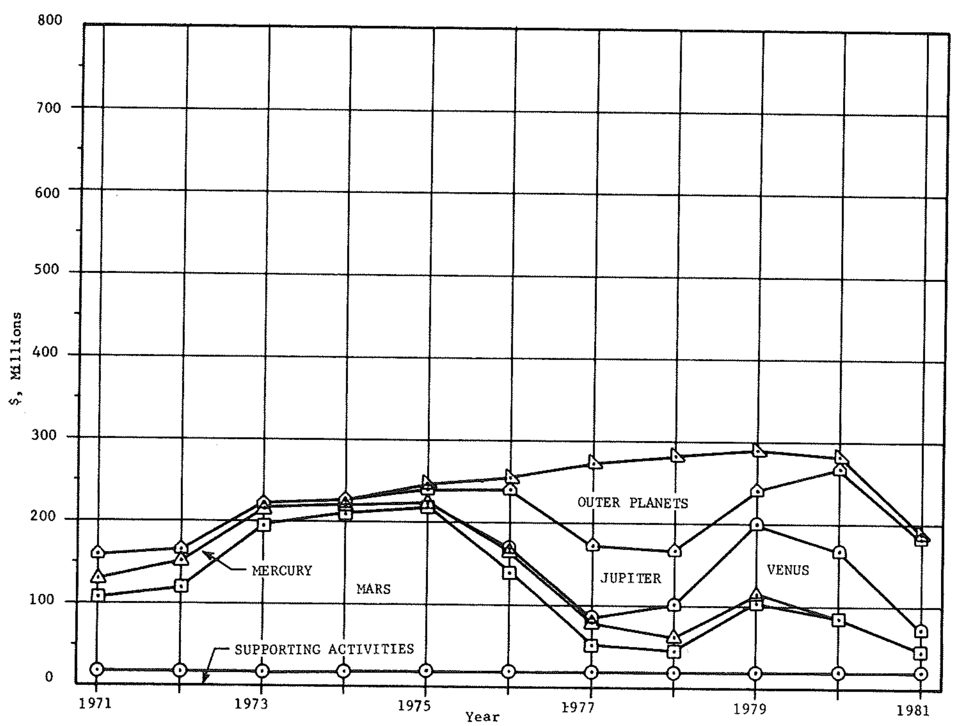

FIGURE V-9. SL9 FUNDING PLOT

TABLE V-9. SL9 FLIGHT SCHEDULE

Project	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81
		Year										
					Mars							
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL A,B(75)	TITAN IIID/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS HIGH DATA RATE ORBITER(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(79)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	1	-	-
					Mercury							
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(78)	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-
					Venus							
VENUS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER ORBITER(78)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
					Jupiter							
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
JUPITER FLYBY/PROBES(83)	TITAN IIID/CENTAUR/BII				(Launch in 1983)							
JUPITER MARINER ORBITER(78)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	1	-	-	-
					Outer Planets							
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-

Model Guidelines and Description: SL10(Alternative VI)

Lunar and Planetary model SL10 was created as a sixth possible alternative to the NASA models (SL1-SL4). The principal guideline underlying this model was a desire to pursue both the 1977 and 1979 Grand Tour opportunities along with a viable Mars Viking program with the first launch in 1975.

The primary characteristics of this model are as follows:

- A funding level ranging from 15 to 30% higher than the SL projection from Appendix A
- Mars Vikings in 1975 and 1979
- Grand Tours in both 1977 and 1979.

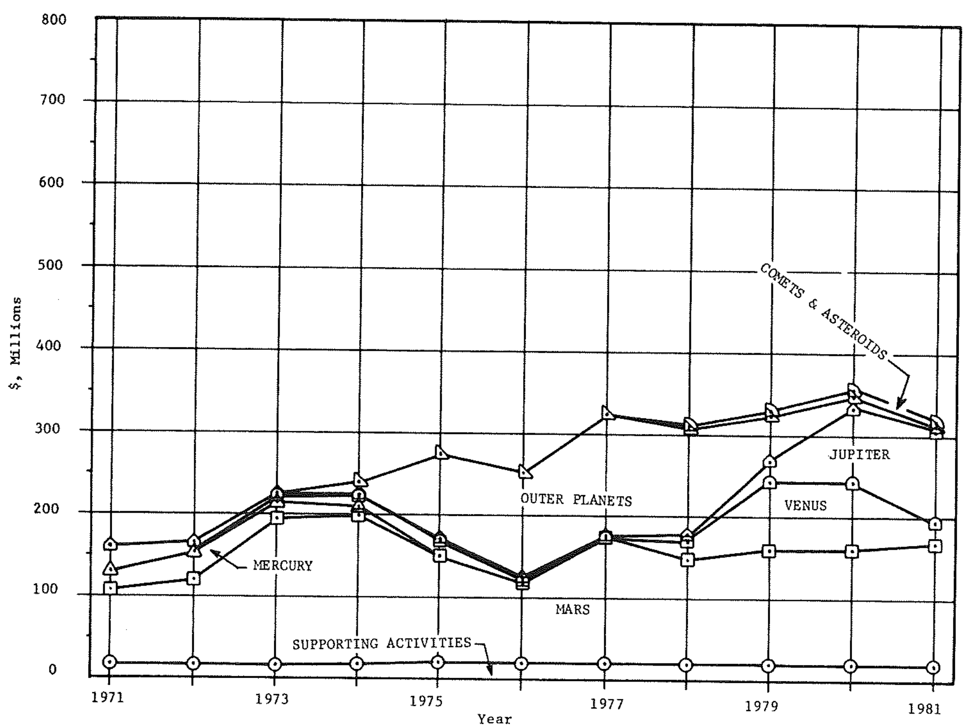

FIGURE V-10. SL10 FUNDING PLOT

TABLE V-10. SL10 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
						Mars						
MARS MARINER(71)	ATLAS/CENTAUR	2	-	-	-	-	-	-	-	-	-	-
MARS VIKING ORB./SL. A,B(75)	TITAN IIID/CENTAUR	-	-	-	-	2	-	-	-	-	-	-
MARS VIKING ORB./SL. C,D(79)	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	-	-	2	-	-
MARS SOFT LANDER/ROVER(84)	TITAN IIID/CENTAUR			(Launch in 1984)								
MARS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(77)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(79)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	1	-	-
						Mercury						
MERCURY/VENUS MARINER FLYBY(73)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	-
						Venus						
VENUS HIGH DATA RATE ORBITER(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER ORBITER(75)	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	-	-	1	-
						Jupiter						
JUPITER PIONEER F,G	PIONEER F: ATLAS/CENTAUR PIONEER G: TITAN IIID/CENTAUR	-	1	1	-	-	-	-	-	-	-	-
JUPITER FLYBY/PROBES(83)	TITAN IIID/CENTAUR/BII			(Launch in 1983)								
						Outer Planets						
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	TITAN IIID/CENTAUR/BII	-	-	-	-	-	-	-	-	2	-	-
						Asteroids						
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Discussion

SL Models

The 10 Lunar and Planetary mission models presented in the preceding section consist of four NASA models (SL1-SL4) and six alternative models (SL5-SL10) created in this study. The NASA mission models were created prior to the announced delay of Viking from 1973 to 1975 but are still indicative of the type of Planetary missions which NASA would like to pursue during the 1971-1981 time period.

Figures V-11 and V-12 present the required funding levels to support the ten Planetary models SL1-SL10. Figure V-11 presents the NASA models (SL1-SL4) and Figure V-12 presents the alternative models (SL5-SL10). The dashed line shown in each graph is the Appendix A projection of SL funding for the period 1971 to 1980. The NASA models require funding levels that exceed the funding projections by as much as 100%. For example, mission model SL4 has a total required funding level of approximately $5,771 million as compared to the projected $2,531 million for the period 1971 to 1981. The other NASA models (i.e., SL1, SL2, and SL3) have a total cost estimate of $4,225 million, $2,524 million, and $3,237 million, respectively. The high costs of some NASA models are due to the desire to undertake several expensive projects over the time span. Included in this list of high funding level projects are Mars Viking Orbiter Soft Landers, Mars Soft Lander Rovers, Mars and Venus High Data Rate Orbiters, Grand Tour Missions, plus several other missions*. The remaining six plans (SL5-SL10) represent a set of possible optional plans that might be pursued under certain constraints, which have been identified with each plan. An attempt was made to provide a well-balanced SL program in each of these plans in consonance with "...the set of goals in planetary exploration...cannot be completely achieved by the investigation of any one planet".[7] Although it would be advantageous to pursue the exploration of all planets with equal emphasis, this is not possible because of constraints (primarily funding). Therefore, it is necessary to place priorities on the different planets to be explored. The planetary exploration priority list adopted in this study was developed by the OSSA Senior Council, April 10-11, 1968[8]. This list is as follows (in descending priority):

(1)	Mars	(6)	Uranus
(2)	Venus	(7)	Neptune
(3)	Jupiter	(8)	Comets
(4)	Mercury	(9)	Asteroids
(5)	Saturn	(10)	Pluto.

With these assumed planetary priorities, the projection of available SL funds for the 1970s, the high funding levels required for the planned Mars exploration, and the unique Grand Tour opportunities[9]** for exploring the outer planets, it was found that the creation of any plan depends mainly upon two factors:

(1) When and how many Mars Viking orbiter/landers are to be launched
(2) The number and type of launch(es) planned in response to the unique Grand Tour opportunities.

After having developed a program for Mars and for the Grand Tour opportunities, the remaining funds were distributed to include as many other planetary opportunities as possible so as to provide a well balanced program that included missions to the comets

* See funding for SL projects in the section "Program Areas" of this chapter.
** For a complete discussion of the Grand Tour opportunities, see Reference (9).

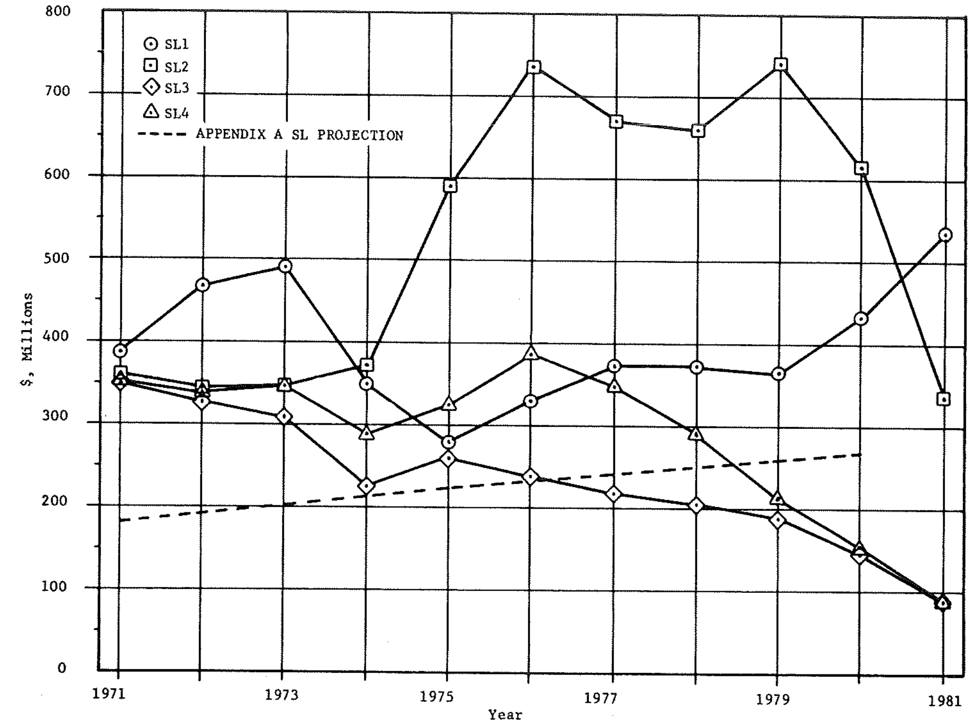

FIGURE V-11. ESTIMATED FUNDING REQUIRED FOR NASA MODELS SL1-SL4

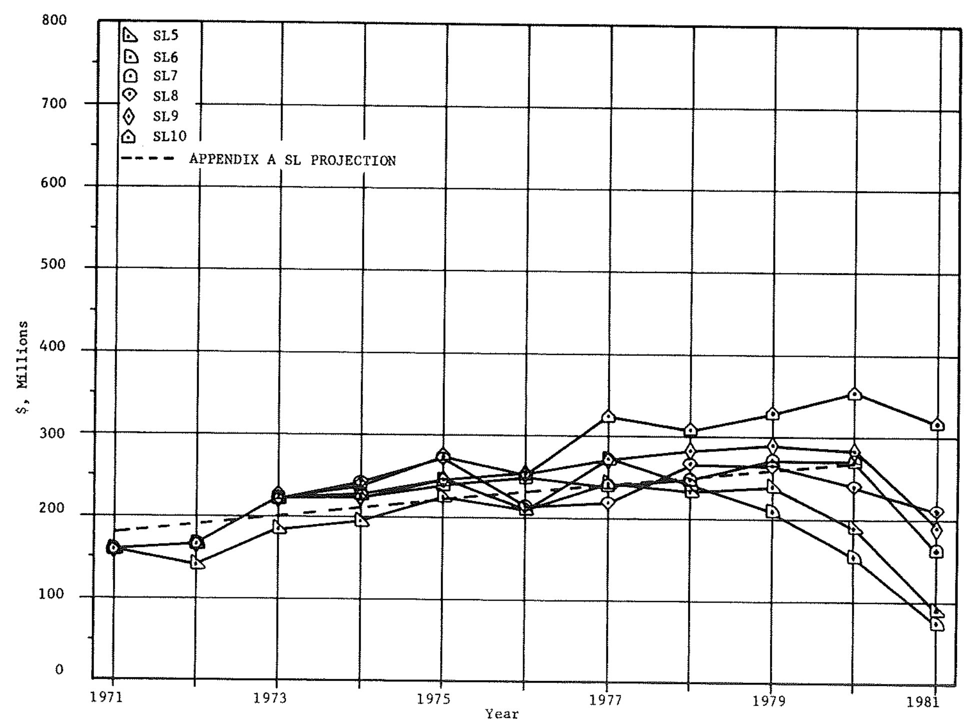

FIGURE V-12. ESTIMATED FUNDING REQUIRED FOR ALTERNATIVE MODELS SL5-SL10 and to other planets, such as Venus, Mercury, etc. This proved to be difficult since a Mars program (consisting of four or five Viking spacecraft) and the Grand Tour missions can easily absorb nearly all of the funds that are projected to be available. Thus, for example, a program consisting of a pair of Mars Vikings in 1975 and 1977, the Grand Tour opportunities in 1977 and 1979, plus the ongoing programs in the FY 1971 budget [Mars Mariner Orbiter(71), Mercury Venus Flyby(73), Pioneer F and G(72,73), and Supporting Activities] consume $2,250 million (or nearly 90%) of the $2,531.2 million projected in Appendix A. This basic model is very close to that presented as model SL2.

Of the alternative models (SL5-SL10) developed in this study, only SL5 falls below the SL funding projection of Appendix A. This was accomplished by delaying the first Mars Viking project until 1977, pursuing only the 1979 Grand Tour opportunity, and relying heavily upon High Data Rate Orbiters and Explorers Orbiters which would doubtless significantly decrease both the quality as well as the quantity of data returned.

Model SL7 resulted in a funding level near the Appendix A funding projections. This was accomplished by launching only one pair of Mars Vikings (in 1975) and relying on Mars High Data Rate Orbiters throughout the remainder of the period.

The remaining alternative models developed in this study present plans which require funding levels above the projected (in Appendix A) funding level for the SL program. Even though several of the plans have funding levels near one another, they differ in content.

Table V-11 presents the activities included in each Planetary model (SL1-SL10). The data given represent the first year of launch plus the total number of launches of that mission type included in the program. As mentioned previously, the most important features of each model are the number of Vikings and Grand Tour missions. Therefore, Table V-11 provides a concise comparison of flight activity between each individual SL model.

The program activity for each model as given in Table V-11 also dictates the launch vehicle requirements needed to support a program, which is the purpose of of this study. The launch vehicle requirements for each SL model (SL1-SL10) are presented in the next section.

Launch Vehicle Requirements

Table V-12 presents the launch vehicle requirements by year for each SL mission model included in this study. The launch vehicle family required to support the SL models consists of TAT(9C)/DELTAs (including the TAT(9C)/DELTA and the TAT(9C)/DELTA/TE364), ATLAS/CENTAURs, TITAN IIICs, TITAN/CENTAURs (including TITAN IIID/CENTAURs, TITAN IIID/CENTAUR/BIIs) and the SIC/SIVB/CENTAUR. The predominant launch vehicle in all of the SL models (SL1-SL10) is the TITAN/CENTAUR which accounts for approximately 50% of launch vehicles in each plan. The TITAN IIID/CENTAUR has been assigned to the first pair of Mars Viking launches and the TITAN IIID(7)/CENTAUR to the remaining Viking missions. The TITAN IIID/CENTAUR/BII has been assigned to those missions (primarily Jupiter and Grand Tour launches) requiring a relatively high characteristic velocity of the order 45,000 to 50,000 ft/sec. The earliest date at which the TITAN IIID/CENTAUR is needed is 1973 for the Jupiter Pioneer G*. The TAT(9C)/DELTA class launch vehicle has the second highest use rate. These vehicles are primarily used for Mars and Venus Explorer Orbiters. Therefore, the number required for any given model is dependent upon the emphasis placed on Explorer/Orbiter missions. The earliest date shown for a TAT(9C)/DELTA vehicle is 1972 with a Venus Explorer Orbiter. ATLAS/CENTAURS have the next highest use rate. The ATLAS/CENTAUR vehicles are needed primarily for the Mars Mariner in 1971, the Jupiter Pioneer F in 1972*, the Mercury/Venus Mariner Flyby in 1978, and several Comet

* It now appears that Pioneer G would be transferred to the ATLAS/CENTAUR with the first TITAN/CENTAUR launch being for Helios in 1974.

TABLE V-11. PROGRAM ACTIVITY BY MODEL

Program Areas	Models SL1	SL2	SL3	SL4	SL5	SL6	SL7	SL8	SL9	SL10
Supporting Activities	•(a)	•	•	•	•	•	•	•	•	•
Mars Mariner Orbiter	71 2(b)	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2
Mars Viking Orbiter/Soft Lander	73 4	73 4	73 5	73 5	77 2	75 4	75 2	75 3	75 2	75 4
Mars Soft Lander/Rovers	(84 1)(c)	77 4	-	-	-	-	-	(84 1)		(84 1)
Mars High Data Rate Orbiters	(79 2)(d)	77 2	81 1	81 1	75 2	77 2	77 2	81 1	77 2	81 1
Mars Explorer Orbiters	73 4	75 3	79 2	77 3	79 2	77 2	-	79 1	79 1	77 2
Mercury/Venus Flybys	73 2	73 2	73 1	73 1	73 1	73 1	73 2	73 2	73 2	73 1
Mercury Solar Electric Orbiter	(82 1)	-	-	-	-	-	-	-	-	-
Venus Mariner Orbiter	78 1	78 3	-	-	-	-	-	-	-	-
Venus Mariner Flyby/Probes	75 2	77 2	-	-	-	-	-	-	-	-
Venus Explorer Flyby/Probes	-	-	-	75 2	-	-	-	-	-	-
Venus Orbiter/Rough Landers	(83 4)	-	-	-	-	-	-	-	-	-
Venus High Data Rate Orbiters	-	-	-	-	81 1	-	81 1	-	81 1	81 1
Venus Explorer Orbiters	(72 5)(e)	72 4	78 3	76 4	75 2	76 2	78 1	76 3	78 2	75 2
Jupiter Pioneers F&G	72 2	72 2	72 2	72 2	72 2	72 2	72 2	72 2	72 2	72 2
Jupiter Mariner Orbiters	78 1	78 1	-	-	-	-	78 1	80 1	78 1	-
Jupiter Flyby/Probes	(80 2)(d)	80 1	-	78 1	-	-	-	-	(83 1)	(83 1)
Jupiter Mariner-Class Flyby/Solar Escape	74 1	-	-	-	-	-	-	-	-	-
Grand Tour Mission	77 4	77 4	77 4	77 4	79 2	79 2	-	79 2	79 2	77 4
Saturn Mariner Orbiter/Probes	81 1	81 1	-	-	-	-	-	-	-	-
Asteroid Belt Solar Electric Fly-Through	75 1	75 1	81 1	81 1	-	81 1	81 1	81 1	-	81 1
Asteroid Eros Mariner Flyby	81 1	81 1	-	-	-	-	-	-	-	-
Comet D'Arrest Mariner Flyby	76 1	76 1	-	76 1	-	-	-	-	-	-
Comet Kopff Mariner Rendezvous	(83 1)	-	-	-	-	-	-	-	-	-
Comet Halley Mariner Flyby	(85 1)	-	-	-	-	-	-	-	-	-

(a) Dot (•) means that a non-space-flight program is included in the indicated model.
(b) Upper figure of each group indicates the year of first launch and the lower figure indicates the number of launches in the 1971-1981 time period.
(c) Funding is included to support a launch even though the launch is outside the time period under consideration (1971-1981).
(d) Second launch in 1984.
(e) Fifth launch in 1983.

TABLE V-12. LAUNCH SCHEDULE BY MODEL AND VEHICLE

Model	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81	Total
		Year											
SL1	TITAN IIID/CENTAUR*	-	-	3	1	-	-	2	2	3	1	-	12
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-	2
	TITAN IIIC	-	-	-	-	2	-	-	1	-	-	-	3
	ATLAS/CENTAUR	2	1	1	-	1	1	-	-	-	-	1	7
	TAT(9C)/DELTA/TE364	-	1	2	-	2	-	1	-	-	1	1	8
	SIC/SIVB/CENTAUR	-	-	-	-	-	-	-	-	-	-	1	1
	TOTAL	2	2	6	1	7	1	3	3	3	2	3	33
SL2	TITAN IIID/CENTAUR	-	-	3	-	-	-	5	2	3	1	4	18
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-	2
	TITAN IIIC	-	-	-	-	-	-	2	1	-	-	-	3
	ATLAS/CENTAUR	2	1	1	-	1	1	-	-	-	-	1	7
	TAT(9C)/DELTA/TE364	-	1	-	-	2	1	1	1	-	-	1	7
	SIC/SIVB/CENTAUR	-	-	-	-	-	-	-	-	-	-	1	1
	TOTAL	2	2	4	-	5	2	8	4	3	1	7	38
SL3	TITAN IIID/CENTAUR	-	-	3	-	-	-	2	-	2	-	1	8
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	1	-	-	-	-	3
	ATLAS/CENTAUR	2	1	1	-	-	-	-	-	-	-	1	5
	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	1	1	2	5
	TOTAL	2	1	4	-	2	-	3	1	3	1	4	21
SL4	TITAN IIID/CENTAUR	-	-	3	-	-	-	2	1	2	-	1	9
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	1	-	-	-	-	3
	ATLAS/CENTAUR	2	1	1	-	-	1	-	-	-	-	1	6
	TAT(9C)/DELTA/TE364	-	-	-	-	2	1	1	1	1	1	2	9
	TOTAL	2	1	4	-	4	2	4	2	3	1	4	27
SL5	TITAN IIID/CENTAUR	-	-	1	-	1	-	2	-	2	-	2	8
	ATLAS/CENTAUR	2	1	1	-	-	-	-	-	-	-	-	4
	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	-	-	1	1	1	4
	TOTAL	2	1	2	-	2	-	2	-	3	1	3	16

* Includes both TITAN IIID/CENTAURs and TITAN IIID/CENTAUR/BIIs.

TABLE V-12. LAUNCH SCHEDULE BY MODEL AND VEHICLE
(Continued)

Model	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81	Total
SL6	TITAN IIID/CENTAUR	-	-	1	-	2	-	1	-	2	-	1	7
	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	-	-	2	-	-	2
	ATLAS/CENTAUR	2	1	1	-	-	-	-	-	-	-	-	5
	TAT(9C)/DELTA/TE364	-	-	-	-	-	1	1	-	-	1	1	4
	TOTAL	2	1	2	-	2	1	2	-	4	1	3	18
SL7	TITAN IIID/CENTAUR	-	-	1	-	2	-	1	1	1	-	2	8
	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-	1
	ATLAS/CENTAUR	2	1	1	-	-	-	-	-	-	-	1	5
	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-	1
	TOTAL	2	1	2	-	2	-	1	3	1	-	3	15
SL8	TITAN IIID/CENTAUR	-	-	1	-	2	-	-	-	2	1	1	7
	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	1	-	-	-	-	1
	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-	1
	ATLAS/CENTAUR	2	1	1	-	-	-	-	-	-	-	1	5
	TAT(9C)/DELTA/TE364	-	-	-	-	-	1	-	-	1	1	1	4
	TOTAL	2	1	2	-	2	1	1	1	3	2	3	18
SL9	TITAN IIID/CENTAUR	-	-	1	-	2	-	1	1	2	-	2	9
	TITAN IIIC	-	-	-	-	-	-	-	1	-	-	-	1
	ATLAS/CENTAUR	2	1	1	-	-	-	-	-	-	-	-	4
	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	1	1	1	-	3
	TOTAL	2	1	2	-	2	-	1	3	3	1	2	17
SL10	TITAN IIID/CENTAUR	-	-	1	-	2	-	2	-	2	-	2	9
	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	-	-	2	-	-	2
	ATLAS/CENTAUR	2	1	1	-	-	-	-	-	-	-	1	5
	TAT(9C)/DELTA/TE364	-	-	-	-	1	-	1	-	1	1	-	4
	TOTAL	2	1	2	-	3	-	3	-	5	1	3	20

and Asteroid missions. The TITAN IIIC launch vehicle is used primarily for a Mercury/ Venus Mariner Flyby in 1978 and certain Venus Mariner type missions flown in the late 1970s.

The remaining vehicle used in this study is the SIC/SIVB/CENTAUR. This Saturn-based vehicle is used in NASA models SL1 and SL2 for a Saturn Mariner Orbiter Probe in 1981. This mission is considered highly unlikely considering its high cost and timing with relation to other high-cost projects.

The TITAN IIID/CENTAUR should be the launch vehicle of primary concern since the majority of the missions receiving the highest priority in the SL program (Mars Vikings, all High Data Rate Orbiters, Jupiter missions, Grand Tours) fly on some version of that vehicle.

Summary of Most Demanding Missions

The largest launch vehicles needed in any of the Planetary mission models (SL1-SL10) are the SIC/SIVB/CENTAUR, TITAN IIID/CENTAUR, TITAN IIID(7)/CENTAUR, and the TITAN IIID/ CENTAUR/BII. The Saturn vehicle is used in the NASA models SL1 and SL2 for a Saturn Mariner Orbiter/Probes in 1981. As mentioned previously in the Launch Vehicle Requirement discussion, the probability that this mission will be funded for flight in 1981 is considered low because of its timing and high cost. The TITAN/CENTAUR class vehicles have the highest use rate (approximately 50%) in all 10 models presented in this study. The TITAN/CENTAUR vehicles are not operational at this time, but an integration program is currently under way. The first launch of a TITAN IIID/CENTAUR vehicle is scheduled for Jupiter Pioneer G* in 1973 but the real demand for the vehicle is in 1975 for the Mars Viking program. The TITAN IIID/CENTAUR/BURNER II launch vehicles are assigned to the missions to the outer planets (Grand Tour, Saturn, and Jupiter missions). The TITAN IIID(7)/CENTAUR is the most advanced TITAN/CENTAUR launch vehicle that is needed in any of the 10 SL models and is assigned to Mars Viking launches C, D, and E following Vikings A and B. Mars Viking launches C, D, and (or) E appear in all models except SL5, 7, and 9. Therefore, the probability of needing a TITAN IIID(7)/CENTAUR for a continuing Viking project is high, and the pertinent question appears to be when the TITAN IIID(7) will be needed. The demand for the vehicle, at the earliest, appears to be 1975 in the NASA models SL1-SL4, but with the delay of Vikings A and B to 1975, this need is unrealistic. The alternative models, SL5-SL10, would require the 7-segment Titan vehicle in 1977 in SL8 and in 1979 in SL6 and SL10.

The TITAN IIID(7)/CENTAUR would also be beneficial to other missions in the SL program such as the outer planet missions, which require long trip times. The V_Cs shown with each project are minimum energy requirements associated with a launch date. The TITAN IIID(7)/CENTAUR would provide an increase in V_C, thus reducing the trip time or could provide for the capability of increased spacecraft weight.

Table V-13 is a summary of the projects with the most demanding launch vehicle requirements.

* If the TITAN IIID/CENTAUR integration is not completed by 1973, it is possible to fly Pioneer G on an ATLAS/CENTAUR.

TABLE V-13. SL PROJECTS HAVING THE MOST DEMANDING LV REQUIREMENTS

Project	Launch Vehicle	Weight, lb	V_C, ft/sec	First Launch
SATURN MARINER ORBITER/PROBES(81)-HIGH	SIC/SIVB/CENTAUR	3,100	53,300	1981
MARS VIKING ORB./SL. C,D(75)	TITAN IIID(7)/CENTAUR	9,700	39,400	1975
MARS VIKING ORB./SL. E(77)	TITAN IIID(7)/CENTAUR	9,700	39,250	1977
MARS VIKING ORB./SL. C,D(79)	TITAN IIID(7)/CENTAUR	9,700	38,400	1979
MARS VIKING ORB./SL. C(77)	TITAN IIID(7)/CENTAUR	9,700	39,250	1977

References

(1) "Planetary Program Review", NASA Office of Space Science and Applications, July 11, 1969.

(2) "Lunar and Planetary Position Paper", Lunar and Planetary Planning Panel of the Planning Steering Group, August 1, 1969.

(3) Planning Steering Group(PSG) Prospectus File (Computer Tape), assembled during 1969 PSG exercise. Available at BMI-NLVP and at Goddard Space Flight Center.

(4) "America's Next Decades in Space", NASA's Report to the Space Task Group, Prepared by the National Aeronautics and Space Administration, September, 1969.

(5) "FY 1971 Budget Data", NASA (SV) memorandum, March 16, 1970.

(6) "POP Accrual Data, from POP 69-1 and POP 69-2", NASA (SV) memorandum, March 10, 1970.

(7) Wukelic, G. E., and Frazier, N. A., "Selected Space Goals and Objectives and Their Relation to National Goals", Prepared by Battelle Memorial Institute, Columbus Laboratories, Columbus, Ohio, for NASA Office of Space Science and Applications, July 15, 1969, Report No. BMI-NLVP-TR-69-2.

(8) "Space Science and Applications, Future Program Alternatives", prepared for Consideration at NASA OSSA Senior Council Meeting, April 10-11, 1968, NASA Office of Space Science and Applications, March, 1968.

(9) Long, James E., "To the Outer Planets", Astronautics and Aeronautics, Vol. 7, No. 6, 32-47 (June, 1969).

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CHAPTER VI. PHYSICS AND ASTRONOMY (SG)

Introduction

The Physics and Astronomy Programs Division (SG) is responsible for planning, directing, and managing OSSA space physics and astronomy programs. The programs in space physics are concerned specifically with studies of the Earth's environment above 60 km, the study *in situ* of interplanetary and interstellar space, and the conduct of physics and chemistry space laboratory experiments.[1]* The astronomy program provides for observations of the Sun, stars, galaxies, interstellar material, and planets from near-Earth satellites. High-altitude balloons, sounding rockets, and high-flying aircraft are also used to obtain astronomical observations.[2] The primary objective of both the space physics and astronomy programs is to increase basic knowledge about fundamental laws and relationships. They also are concerned with conducting research in areas that will be the basis of future applications and will provide information needed by other programs.

To work toward satisfying these goals and objectives, the division maintains several flight programs, as well as the necessary supporting activities. Besides managing its current programs, the division also considers a number of future programs designed to continue the coordinated effort directed at satisfying its goals and objectives.

This chapter presents 10 mission models, SG1 through SG10, which represent a spectrum of possibilities that indicate the type of choice that the division might follow in the period 1971-1981. Thus, these models present a range of future launch vehicle requirements necessary to support the activities of the SG division. Each year, since 1963, SG has accounted for about 25% of the total OSSA budget.[3] In 1968, SG projects accounted for 4 out of a total of 12 OSSA launches and, in 1969, 7 of a total of 12 launches.[4] Most of these launches were on the Delta vehicle. As these figures indicate, the Physics and Astronomy Program is responsible for a significant portion of OSSA activity.

The remainder of this chapter presents the mission models and the projects that were considered in constructing these models.

Program Areas[1,2,4-9]

This section summarizes the proposed projects that are used in the Physics and Astronomy mission models presented later in this chapter. All funding is in millions of dollars; all spacecraft weights are given in pounds. Launch Vehicle is designated LV and the appropriate vehicle is named.** Characteristic velocity (V_C) is given in feet per second.

* Superscript numbers denote references given at the end of this Chapter.

** See Appendix D for a discussion of launch vehicle nomenclature.

Supporting Activities

This program area contains Supporting Research and Technology programs, data analysis efforts, and contract administration.

PHYSICS AND ASTRONOMY SR&T

Purpose: To provide supporting research and technology for the flight programs in all of the subdiscipline areas of space physics and astronomy.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6
Flights	(Non-flight project)										

PHYSICS AND ASTRONOMY DATA ANALYSIS

Purpose: To provide follow-on analyses of data of interest beyond the area of a particular flight project.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Flights	(Non-flight project)										

CONTRACT ADMINISTRATION

Purpose: To provide support for the overhead associated with monitoring contracts.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	1.2	0.9	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Flights	(Non-flight project)										

AIRPLANE AND BALLOON PROGRAMS

Purpose: To perform experiments in the lower atmosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Flights	(Non-space-flight project)										

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
PHYSICS AND ASTRONOMY SR&T	●	●	●	●	●	●	●	●	●	●
PHYSICS AND ASTRONOMY DATA ANALYSIS	●	●	●	●	●	●	●	●	●	●
CONTRACT ADMINISTRATION	●	●	●	●	●	●	●	●	●	●
AIRPLANE AND BALLOON PROGRAMS	●	●	●	●	●	●	●	●	●	●

COOPERATIVE PROGRAMS

Purpose: To provide support for studying possibilities of cooperative efforts with other governments

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.9	0.8	0.7	0.4	0.3	0.1	-	-	-	-	-
Flights	(Non-flight project)										

Sounding Rockets

SOUNDING ROCKETS

Purpose: To study the physics of the upper atmosphere, ionosphere, and near space up to 1 Earth radius. Also, study the reaction of incoming energetic particles and solar radiation. Also to provide a coordinated astronomy program.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9
Flights	(Non-space-flight project)										

Orbiting Astronomical Observatories (OAO)

The objective of the OAO program is to perform precision telescopic observations of the celestial sphere from above the Earth's atmosphere. Measurements range from the visible to the gamma ray region of the electromagnetic spectrum.

OAO C LV: ATLAS/CENTAUR Wt: 4,660 V_C: 26,600

Purpose: To obtain high resolution in the 1,000-3,000 Å region of hot stars and brighter planets.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	27.1	6.4	3.2	0.9	-	-	-	-	-	-	-
Flights	1	-	-	-	-	-	-	-	-	-	-

OAO D LV: ATLAS/CENTAUR Wt: 4,660 V_C: 26,600

Purpose: To obtain moderate resolution in the 1,000-3,000 Å region, to study a wide variety of objects such as quasers, normal and peculiar stars, close binary stars, planets, and galactic nebulae.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	15.0	18.0	18.0	8.0	3.0	2.0	1.0	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
COOPERATIVE PROGRAMS	•	•	•	•	•	•	•	•	•	•
SOUNDING ROCKETS	•	•	•	•	•	•	•	•	•	•
OAO C	•	•	•	•	•	•	•	•	•	•
OAO D	•	•	•		•	•	•	•	•	•

OAO E-G (77) LV: ATLAS/CENTAUR Wt: 6,000 V_C: 26,600

Purpose: To conduct high-resolution ultraviolet studies of bright stars and planets. Moderate resolution for faint astronomical objects. May have high resolution of 2,000-7,000 Å.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	3.0	17.0	30.0	46.0	49.0	50.0	46.0	13.0	6.0
Flights	-	-	-	-	-	-	1	1	1	-	-

OAO E-G (75) LV: ATLAS/CENTAUR Wt: 6,000-8,000 V_C: 26,000

Purpose: To conduct high-resolution ultraviolet studies of bright stars and planets. Moderate resolution for faint astronomical objects. May have high resolution of 2,000-7,000 Å.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.0	17.0	30.0	46.0	49.0	50.0	46.0	13.0	6.0	-	-
Flights	-	-	-	-	1	1	1	-	-	-	-

Large Space Telescopes (LST)

This program would be a follow-on to OAO. The observatories would be general purpose and as advanced as telescope technology would permit.

LST A-C (76,77,79) LV: TITAN IIIC Wt: 14,000 V_C: 26,600

Purpose: Uses large aperture optical systems to obtain very high resolution observations.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	19.2	35.6	49.5	64.0	40.0	40.0	35.0	22.0	10.0	6.0
Flights	-	-	-	-	-	1	1	-	1	-	-

LST A-C (76,78,80) LV: TITAN IIIC Wt: 14,000 V_C: 26,000

Purpose: Uses large aperture optical systems to obtain very high resolution observations.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	15.0	36.0	50.0	55.0	45.0	40.0	35.0	22.0	10.0	-
Flights	-	-	-	-	-	1	-	1	-	1	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
OAO E-G (77)	•									
OAO E-G (75)			•			•				
LST A-C (76,77,79)		•					•			•
LST A-C (76,78,80)					•			•		

Large Telescope Mounts

This program would provide very large telescopic observatories in space. These observatories would be general purpose and as advanced as technology would permit. They would be man-tended and operated as a national facility.

LTM A (80) LV: TITAN IIID Wt: 25,000 V_C: 26,000

Purpose: General purpose observatory, 120-in. telescope, a computer, and high accuracy pointing capability.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	10.0	30.0	60.0	70.0	70.0	75.0	70.0	68.0	40.0	15.0
Flights	-	-	-	-	-	-	-	-	-	1	-

LTM A (79) LV: TITAN IIID Wt: 25,000 V_C: 26,000

Purpose: General purpose observatory, 120-in. telescope, a computer, and high accuracy pointing capability.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	30.0	60.0	70.0	70.0	75.0	70.0	68.0	40.0	15.0	12.0
Flights	-	-	-	-	-	-	-	-	1	-	-

LTM A (83) LV: TITAN IIID Wt: 25,000 V_C: 26,000

Purpose: General purpose observatory, 120-in. telescope, a computer, and high accuracy pointing capability.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	10.0	30.0	60.0	70.0	70.0	75.0	70.0
Flights	(Flight is in 1983)										

Orbiting Solar Observatories (OSO)

OSO H LV: TAT/DELTA Wt: 1,164 V_C: 26,300

Purpose: To observe the active physical processes of the Sun by which the Sun influences the Earth and its space environment and to study the Sun's constitution and behavior.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	5.1	1.6	0.7	0.5	-	-	-	-	-	-	-
Flights	1	-	-	-	-	-	-	-	-	-	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
LTM A (80)	•									
LTM A (79)			•							
LTM A (83)						•				
OSO H	•	•	•	•	•	•	•	•	•	•

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
OSO I-K (73-75)	●		●	●	●	●				
OSO I-K (73-76)		●					●	●	●	●
OSO L,M (79)	●	●	●		●		●	●	●	●
OSO L,M (77)				●		●				

OSO I-K (73-75) LV: TAT/DELTA Wt: 700-800 V_C: 26,300

Purpose: To conduct minimum and quiescent solar studies of coronal structure, X-ray polarization effects, ultraviolet and X-ray spectra from localized (small) solar regions. Exploration of hard X-ray spectrum will begin.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	12.6	17.0	16.2	12.6	7.4	4.9	0.9	-	-	-	-
Flights	-	-	1	1	1	-	-	-	-	-	-

OSO I-K (73-76) LV: TAT/DELTA Wt: 700-800 V_C: 26,300

Purpose: To conduct minimum and quiescent solar studies of coronal structure, X-ray polarization effects, ultraviolet and X-ray spectra from localized (small) solar regions. Exploration of hard X-ray spectrum will begin.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	12.2	15.4	16.2	7.8	4.0	4.0	2.0	0.9	-	-	-
Flights	-	-	1	1	-	1	-	-	-	-	-

OSO L,M (79) LV: TAT/DELTA/FW-4 Wt: 900-1,000 V_C: 26,300

Purpose: To study various types of solar activity, emphasizing good spectral, spatial, and time resolution, and to conduct measurements during the increasing portion of the next solar activity cycles.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	1.0	3.0	6.0	12.1	18.0	17.9	12.1	4.5
Flights	-	-	-	-	-	-	-	-	1	1	-

OSO L,M (77) LV: TAT/DELTA/FW-4 Wt: 900-1,000 V_C: 26,300

Purpose: To study various types of solar activity, emphasizing good spectral, spatial, and time resolution, and to conduct measurements during the increasing portion of the next solar activity cycles.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	1.0	3.0	6.0	12.1	18.0	17.9	12.1	4.5	2.5	1.5
Flights	-	-	-	-	-	-	1	1	-	-	-

High Energy Astronomical Observatories (HEAO)

This program is designed to provide instruments which are heavier and more sensitive than those that can be carried on balloons and small satellites. This will permit long duration observations to characterize the high energy but lower flux radiation of importance to astrophysicists and cosmologists.

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSC-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
HEAO A-C (73)			•			•				
HEAO A-C (74)		•		•						
HEAO A-C (77-79)										•
HEAO A-C (77-81)							•	•		

HEAO A-C (73) LV: TITAN IIIC Wt: 23,600 V_C: 25,900

Purpose: To conduct an all-sky survey in cosmic ray, X-ray, and gamma-ray energies in the range of 10^4 ev and 10^{15} ev.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	16.0	47.0	58.0	40.0	14.0	5.0	3.0	-	-	-	-
Flights	-	-	1	1	1	-	-	-	-	-	-

HEAO A-C (74) LV: TITAN IIIC Wt: 23,600 V_C: 25,900

Purpose: To conduct an all-sky survey in cosmic ray, X-ray, and gamma-ray energies in the range of 10^4 ev and 10^{15} ev.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.0	45.5	47.0	44.0	40.0	14.0	5.0	3.0	-	-	-
Flights	-	-	-	1	1	1	-	-	-	-	-

HEAO A-C (77-79) LV: TITAN IIIC Wt: 23,600 V_C: 25,900

Purpose: To conduct an all-sky survey in cosmic ray, X-ray, and gamma-ray energies in the range of 10^4 ev and 10^{15} ev.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	4.0	45.5	47.0	44.0	40.0	14.0	5.0	3.0
Flights	-	-	-	-	-	-	1	1	1	-	-

HEAO A-C (77-81) LV: TITAN IIIC Wt: 23,600 V_C: 25,900

Purpose: To conduct an all-sky survey in cosmic ray, X-ray, and gamma-ray energies in the range of 10^4 and 10^{15} ev.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	3.0	70.0	40.0	35.0	35.0	30.0	26.0	20.0	10.0
Flights	-	-	-	-	-	-	1	-	1	-	1

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
HEAO (77)		●	●	●	●					
HEAO (81)	●				●					●
HEAO (82)							●			
SMALL ASTRONOMY SATELLITE A,B	●	●	●	●	●	●	●	●	●	●

HEAO (77) LV: TITAN IIID/CENTAUR Wt: >23,600 V_C: 25,900

Purpose: To investigate, structure, and identify point sources of X-ray and gamma radiations, both from galactic and extra-galactic sources.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	5.0	15.5	16.0	29.2	26.0	10.0	6.0	3.0	-	-
Flights	-	-	-	-	-	-	1	-	-	-	-

HEAO (81) LV: TITAN IIID/CENTAUR Wt: >23,600 V_C: 25,900

Purpose: To investigate, structure, and identify point sources of X-ray and gamma radiations, both from galactic and extra-galactic sources.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	2.0	5.0	20.0	35.0	45.0	26.0	18.0
Flights	-	-	-	-	-	-	-	-	-	-	1

HEAO (82) LV: TITAN IIID/CENTAUR Wt: >23,600 V_C: 25,900

Purpose: To investigate, structure, and identify point sources of X-ray and gamma radiations, both from galactic and extra-galactic sources.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	5.0	15.5	16.0	29.2	26.0
Flights	(Launch is in 1982)										

Small Astronomy Satellites

This program area includes a wide range of projects which involve various small spacecraft containing Explorer class astronomy experiments.

SMALL ASTRONOMY SATELLITE A,B LV: SCOUT Wt: 320-340 V_C: 26,200

Purpose: To survey the celestial sphere and search for sources radiating in the X-ray, gamma-ray, ultraviolet (UV), and other spectral regions both inside and outside of our Galaxy.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	10.0	3.5	1.7	0.5	0.5	-	-	-	-	-	-
Flights	1	-	-	-	-	-	-	-	-	-	-

ASTRONOMY EXPLORERS-SCOUT LV: SCOUT Wt: Various V_C: Various

Purpose: This project represents various possible small satellites containing Explorer-class experiments.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	4.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Flights	-	-	1	1	1	1	1	1	1	1	1

ASTRONOMY EXPLORERS-DELTA LV: TAT/DELTA* Wt: Various V_C: Various

Purpose: This project represents possible small Astronomy satellites containing Explorer-class experiments.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	4.0	7.0	17.5	13.6	13.0	13.0	13.0	13.0	13.0	13.0
Flights	-	-	-	1	1	1	1	1	1	1	1

ASTRONOMY EXPLORERS-SCOUT (high plan) LV: SCOUT Wt: Various V_C: Various

Purpose: This project represents various possible small satellites containing Explorer-class experiments.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	8.0	6.0	6.0	12.0	6.0	12.0	6.0	12.0	6.0	12.0	6.0
Flights	2	1	1	2	1	2	1	2	1	2	1

ASTRONOMY EXPLORERS-DELTA (high plan) LV: TAT/DELTA* Wt: Various V_C: Various

Purpose: This project represents possible small Astronomy satellites containing Explorer-class experiments.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	4.0	10.0	13.4	19.6	25.0	19.0	25.0	19.0	25.0	19.0
Flights	-	-	-	1	2	1	2	1	2	1	2

* These projects may use any of the various Delta class vehicles.

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
ASTRONOMY EXPLORERS-SCOUT	●	●			●		●	●	●	●
ASTRONOMY EXPLORERS-DELTA	●	●			●					
ASTRONOMY EXPLORERS-SCOUT (high plan)			●			●				
ASTRONOMY EXPLORERS-DELTA (high plan)			●			●				

ASTRONOMY EXPLORERS-DELTA (low plan)
LV: TAT/DELTA* Wt: Various V_C: Various

SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
						●	●	●	●

Purpose: This project represents possible small Astronomy satellites containing Explorer-class experiments.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	4.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Flights	-	-	-	1	-	1	-	1	-	1	-

RADIO ASTRONOMY EXPLOER C,D
LV: TAT/DELTA/TE364 Wt: 700 V_C: 36,100

SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9	SG10
			●						

Purpose: To perform detailed investigation of radio emission from solar system and study a number of discrete cosmological radio sources.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.5	12.0	10.0	6.0	2.0	1.0	-	-	-	-	-
Flights	-	-	-	1	1	-	-	-	-	-	-

Atmosphere Explorers

The Atmosphere Explorer program is designed to study both the phot-chemistry of the Earth's atmosphere and the solar-radiation and physical forces responsible for the structure and behavior of the atmosphere at an altitude of 60 to 200 km.

ATMOSPHERE EXPLORERS C,D LV: TAT/DELTA/FW4 Wt: 300-400 V_C: 29,800

SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9	SG10
●		●		●	●				

Purpose: To study atmospheric structural properties.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.0	2.0	0.9	0.6	-	-	-	-	-	-	-
Flights	1	1	-	-	-	-	-	-	-	-	-

ATMOSPHERE EXPLORERS (81) LV: TAT/DELTA/FW4 Wt: 600 V_C: 29,800

SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9	SG10
●	●			●		●	●	●	●

Purpose: To study atmospheric structural properties.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	5.3	8.0	7.1
Flights	-	-	-	-	-	-	-	-	-	-	2

* These projects may use any of the various Delta class vehicles.

ATMOSPHERE EXPLORERS C-E (73-75) LV: TAT/DELTA/FW4 Wt: 600 V_C: 29,800

SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
	●		●			●	●	●	●

Purpose: To study atmospheric structural properties, specifically the response of the upper atmosphere to a period of low solar energy input.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.6	10.1	10.5	6.7	3.6	1.0	-	-	-	-	-
Flights	-	-	1	1	1	-	-	-	-	-	-

ATMOSPHERE EXPLORERS F,G LV: TAT/DELTA/FW4 Wt: 600 V_C: 29,800

SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9	SG10
	●					●	●	●	●

Purpose: To study the thermal particles in the upper atmosphere processes occurring in the magnetosphere and the response of the upper atmosphere to a period of high solar energy input.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	2.6	4.0	6.2	4.5	3.8	0.5	0.2
Flights	-	-	-	-	-	-	1	-	1	-	-

ATMOSPHERE EXPLORERS (76,79) LV: TAT/DELTA/FW4 Wt: 600 V_C: 29,800

SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9	SG10
		●			●				

Purpose: To study the thermal particles in the upper atmosphere processes occurring in the magnetosphere and the response of the upper atmosphere to a period of high solar energy input.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	5.3	8.0	7.1	3.6	4.4	3.6	0.5	0.2
Flights	-	-	-	-	-	2	-	-	1	-	-

<u>Small Scientific Satellites (SSS)</u>

This group of projects provides highly sophisticated Scout class spacecraft to conduct specialized studies of specific phenomena in the magnetosphere or near-interplanetary space.

SSS A-D LV: SCOUT Wt: 110 V_C: 33,100

SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9	SG10
●	●	●		●	●	●			

Purpose: To conduct investigations of various phenomena occurring in the magnetosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	10.3	9.3	5.1	1.6	-	-	-	-	-	-	-
Flights	1	1	1	-	-	-	-	-	-	-	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
SSS E-J	•	•			•		•			
SSS E-F			•	•		•				
SSS G-L			•			•				
SSS A				•				•	•	•

SSS E-J LV: SCOUT Wt: 110-140 V_C: 33,100

Purpose: To investigate atmosphere-ionosphere and magnetospheric related phenomena.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.5	2.0	4.1	6.1	6.1	6.0	6.5	6.0	4.5	2.5	0.5
Flights	-	-	-	1	1	1	1	1	1	-	-

SSS E-F LV: SCOUT Wt: 110-140 V_C: 33,100

Purpose: To investigate atmospheric-ionospheric and magnetospheric related phenomena.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	3.0	4.0	4.0	1.0	-	-	-	-	-	-
Flights	-	-	-	2	-	-	-	-	-	-	-

SSS G-L LV: SCOUT Wt: 110-140 V_C: 33,100

Purpose: To provide a continuation of the SSS program.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	0.5	1.5	4.0	6.0	6.5	6.5	6.0	4.5	2.5	0.5
Flights	-	-	-	-	1	1	1	1	1	1	-

SSS A LV: SCOUT Wt: 110 V_C: 33,100

Purpose: To conduct investigations of various phenomena occurring in the magnetosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.7	0.2	-	-	-	-	-	-	-	-	-
Flights	(Launch in 1970)										

<u>Interplanetary Monitoring Platforms (IMP)</u>

This program area is concerned with the study of the interplanetary media, solar and galactic cosmic rays, and the outer portions of the Earth's magnetosphere.

IMP I-J LV: TAT/DELTA/TE364 Wt: 400-730 V_C: 39,000

Purpose: To study the interplanetary magnetic field, and its dynamical relationships with solar particles.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	7.5	6.7	1.6	1.0	-	-	-	-	-	-	-
Flights	1	1	-	-	-	-	-	-	-	-	-

IMP I-J (72,73) LV: TAT/DELTA/TE364 Wt: 400-730 V_C: 39,000

Purpose: To study the interplanetary magnetic field, and its dynamical relationships with solar particles.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	6.5	6.0	3.8	1.6	1.0	-	-	-	-	-	-
Flights	-	1	1	-	-	-	-	-	-	-	-

IMP KK-LL (75,76) LV: TAT(9C)/DELTA/TE364 Wt: 675 V_C: 35,700

Purpose: To use mother-daughter spacecraft combination to study temporal and spatial boundary effects and identify and other specific physical mechanisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	3.0	4.5	10.1	10.6	7.0	5.0	2.0	-	-	-
Flights	-	-	-	-	1	1	-	-	-	-	-

IMP KK-LL (74,75) LV: TAT/DELTA/TE364 Wt: 675 V_C: 35,700

Purpose: To use mother-daughter spacecraft combination to study temporal and spatial boundary effects and identify and other specific physical mechanisms.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.0	4.5	10.1	10.6	7.0	5.0	2.0	-	-	-	-
Flights	-	-	-	1	1	-	-	-	-	-	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
IMP I-J	•		•			•				
IMP I-J (72,73)		•		•	•		•	•	•	•
IMP KK-LL (75,76)	•	•			•		•	•	•	•
IMP KK-LL (74,75)			•	•		•				

Program	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
IMP (78,81)	•	•			•		•	•	•	•
IMP M-R			•			•				
ISIS C,D (72,74)	•		•			•				
ISIS B-D (71,73,74)		•					•	•	•	•

IMP (78,81) LV: TAT(9C)/DELTA/TE364 Wt: 600-800 V_C: 39,000

Purpose: To help determine the mechanisms involved in the formation of collisionless plasma shocks, the acceleration of particles, and wave-particle interactions.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	10.0	17.0	11.0	7.0	8.5	5.5
Flights	-	-	-	-	-	-	-	2	-	-	1

IMP M-R LV: TAT(9C)/DELTA/TE364 Wt: 600-800 V_C: 39,000

Purpose: To help determine the mechanisms involved in the formation of collisionless plasma shocks, the acceleration of particles, and wave-particle interactions.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	10.0	10.0	21.0	29.5	28.8	20.5	7.8	1.0
Flights	-	-	-	-	-	-	2	1	2	1	-

International Satellites for Ionospheric Studies (ISIS)

This program is a cooperative effort with the Canadian Government. The spacecraft carry various experiments to study the ionosphere.

ISIS C,D (72,74) LV: TAT/DELTA/FW4 Wt: 575 V_C: 29,620

Purpose: To conduct various measurements in the ionosphere for one-half of a solar cycle.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.8	4.5	5.4	1.0	0.3	0.2	-	-	-	-	-
Flights	-	1	-	1	-	-	-	-	-	-	-

ISIS B-D (71,73,74) LV: TAT/DELTA/FW4 Wt: 575 V_C: 29,620

Purpose: To conduct various measurements in the ionosphere for one-half of a solar cycle.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.5	1.8	2.2	1.3	0.5	0.2	-	-	-	-	-
Flights	1	-	1	1	-	-	-	-	-	-	-

ISIS B,C (71,73)   LV: TAT/DELTA/FW4   Wt: 575 V_C: 29,620

Purpose: To conduct various measurements in the ionosphere for one-half of a solar cycle.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	2.2	2.6	1.5	0.6	0.4	-	-	-	-	-	-
Flights	1	-	1	-	-	-	-	-	-	-	-

Cluster

This program area represents a concept of launching several small satellites (2 to 4) in the same Earth orbit within a few thousand feet of each other to conduct particles and fields research.

CLUSTER (77,80)   LV: TAT/DELTA/TE364   Wt: 800 V_C: 39,000

Purpose: To permit direct resolution of three-dimensional spatial and temporal effects within the magnetosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	2.0	8.0	9.0	11.0	6.0	5.0	5.0	2.0
Flights	-	-	-	-	-	-	1	-	-	1	-

CLUSTER (75)   LV: TAT/DELTA/TE364   Wt: 800 V_C: 39,000

Purpose: To permit direct resolution of three-dimensional spatial and temporal effects within the magnetosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	2.0	10.0	7.0	2.0	2.0	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

CLUSTER (78,80)   LV: TAT/DELTA/TE364   Wt: 800 V_C: 39,000

Purpose: To permit direct resolution of three-dimensional spatial and temporal effects within the magnetosphere.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	2.0	8.0	9.0	11.0	11.0	5.0	2.0
Flights	-	-	-	-	-	-	-	1	-	1	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
ISIS B,C (71,73)				●	●					
CLUSTER (77,80)	●	●			●	●	●	●	●	●
CLUSTER (75)			●	●		●				
CLUSTER (78,80)			●							

Solar Probes

This area encompasses all of the solar probe missions. The principal objective of the missions is to study the near-Sun interplanetary environment. The ultimate goal is to obtain observations of the process of the solar wind detachment from the solar corona.

HELIOS — LV: ATLAS/CENTAUR* — Wt: 250 — V_C: 48,000-67,000

Purpose: To conduct primary studies of particles and fields in the near-solar environment. This is a joint project with West Germany.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.9	1.7	1.4	1.0	1.0	1.2	-	-	-	-	-
Flights	-	-	-	1	1	-	-	-	-	-	-

SOLAR PROBE TO 0.05 a.u. — LV: TITAN IIID/CENTAUR — Wt: 4,500 — V_C: 44,000

Purpose: To obtain observations of the interplanetary environment to within 0.05 a.u. of the Sun. The spacecraft requires the use of a solar electric propulsion system.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	3.0	7.0	15.0	20.0	10.0	5.0
Flights	-	-	-	-	-	-	-	-	-	1	-

SOLAR PROBE-CLOSE IN PRECURSOR — LV: TITAN IIID/CENTAUR — Wt: 900 — V_C: 42,000

Purpose: To obtain observations of the interplanetary environment to within 0.2 a.u. of the Sun and to develop the necessary technological experience for designing missions for closer approach to the Sun.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	1.0	3.0	10.0	15.0	10.0	7.0	2.0	1.0
Flights	-	-	-	-	-	-	-	-	1	-	-

SOLAR PROBE 0.1-0.05 a.u. — LV: TITAN IIID/CENTAUR — Wt: 5,000 — V_C: 43,200

Purpose: To obtain observations of the interplanetary environment in the area of 0.1 to 0.05 a.u. of the Sun. Spacecraft requires a solar electric propulsion system.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	3.0	8.0	16.0	27.0	27.0	27.0	12.0	5.0
Flights	-	-	-	-	-	-	-	-	1	1	-

Mission	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
HELIOS	•	•	•	•	•	•	•	•	•	•
SOLAR PROBE TO 0.05 a.u.							•	•	•	
SOLAR PROBE-CLOSE IN PRECURSOR							•	•	•	
SOLAR PROBE 0.1-0.05 a.u.										•

* HELIOS A (1974) may be transferred to TITAN IIID/CENTAUR as "proof-flight" prior to Viking.

SOLAR PROBE 0.2 a.u. SOLAR QUAD MOMENT

LV: TITAN IIID/CENTAUR Wt: 6,000 V_C: 42,000

Purpose: To provide a precursor mission for closer solar probes and observe the orbital perturbation produced by the Sun's quadruple moment.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	1.0	3.0	15.0	20.0	25.0	15.0	5.0	2.0	1.0	-
Flights	-	-	-	-	-	-	1	-	-	-	-

SMALL INTERPLANETARY SATELLITES

LV: SCOUT Wt: 60-80 V_C: 40,000

Purpose: To study the interplanetary environment toward the Sun using small inexpensive spacecraft.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	2.0	2.0	1.5	1.5	1.5	1.5	-	-	-	-	-
Flights	-	1	1	1	1	1	-	-	-	-	-

Space Weather Probes

This group of projects would provide continuing coverage of solar flare activity and character of the interplanetary medium near 1 a.u. after completion of the present Pioneer missions. The missions would also provide baseline information for future far interplanetary and solar probe missions. The spacecraft would be similar to Pioneers or Planetary explorers.

SPACE WEATHER PROBE A LV: TAT(6C)/DELTA/TE364 Wt: 200 V_C: 41,000

Purpose: Would be the first launch to obtain objectives mentioned above.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	5.5	3.8	1.7	1.8	1.8	0.9	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

SPACE WEATHER PROBES B,C LV: TAT(6C)/DELTA/TE364 Wt: 200 V_C: 41,000

Purpose: Would provide approximately 6 years of observations of the interplanetary environment near 1 a.u.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	5.5	3.8	3.7	5.3	5.6	2.6	1.8
Flights	-	-	-	-	-	-	1	-	-	1	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
Solar Probe 0.2 a.u. Solar Quad Moment										•
Small Interplanetary Satellites	•		•							
Space Weather Probe A	•	•	•		•	•	•	•	•	•
Space Weather Probes B,C			•			•	•	•	•	

Out of Ecliptic

This area consists of missions designed to study the interplanetary environment out of the ecliptic plane.

OUT OF ECLIPTIC - PIONEER (78,79)
LV: TITAN IIID/CENTAUR Wt: 460 V_C: 50,000

Purpose: Would provide for observations of the interplanetary environment in an orbit with 45° inclination to the ecliptic plane.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	8.0	12.0	8.0	5.0	1.0	0.5
Flights	-	-	-	-	-	-	-	1	1	-	-

OUT OF ECLIPTIC - PIONEER (75,76)
LV: TITAN IIID/CENTAUR Wt: 460 V_C: 50,000

Purpose: Would provide for observations of the interplanetary environment in an orbit with 45° inclination to the ecliptic plane.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	8.0	12.0	8.0	5.0	1.0	0.5	0.5	0.5	-
Flights	-	-	-	-	1	1	-	-	-	-	-

OUT OF ECLIPTIC - SOLAR ELECTRIC
LV: TITAN IIID/CENTAUR Wt: 3,300 V_C: 46,000

Purpose: To obtain observations along a trajectory with an inclination of 34° to the ecliptic plane. The spacecraft requires a solar electric propulsion system.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	2.0	3.0	10.0	28.0	35.0	25.0	12.0	3.0
Flights	-	-	-	-	-	-	-	-	1	1	-

Relativity

This area consists of missions that are designed to test Einstein's general relativity theory.

GENERAL RELATIVITY (76) LV: TITAN IIIC Wt: 1,200 V_C: 41,000

Purpose: To measure the relativistic red shift in the Earth's gravitational field using two hydrogen maser clocks.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	2.7	4.4	5.7	6.4	1.5	-	-	-	-	-
Flights	-	-	-	-	-	1	-	-	-	-	-

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
OUT OF ECLIPTIC - PIONEER (78,79)	•	•			•		•	•	•	
OUT OF ECLIPTIC - PIONEER (75,76)			•			•				
OUT OF ECLIPTIC - SOLAR ELECTRIC										•
GENERAL RELATIVITY (76)		•					•	•	•	•

RELATIVITY RED SHIFT - SOLAR PROBE
LV: TITAN IIID/CENTAUR Wt: 1,200 V_C: 47,500

Purpose: To investigate variations in red shift under different gravitational conditions to within 0.5 a.u. of the Sun. Spacecraft would use hydrogen maser clocks.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	1.0	3.0	8.0	10.0	5.0	2.0	1.0	-
Flights	-	-	-	-	-	-	-	1	-	-	-

RELATIVITY RED SHIFT - DEEP SPACE
LV: TITAN IIID/CENTAUR Wt: 1,000 V_C: 50,000

Purpose: To investigate variations in red shift under different gravitational conditions to distances of 1.0 a.u. or greater.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	1.0	3.0	8.0	13.0	8.0	2.0
Flights	-	-	-	-	-	-	-	-	-	1	-

GYROSCOPE PRECESSION - PRECURSOR
LV: TAT/DELTA Wt: 500 V_C: 26,200

Purpose: To test Einstein's general relativity theory using a spacecraft containing two sets of gyroscopes with their axes perpendicular to each other.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.0	4.4	2.7	0.4	0.1	-	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

Titan Explorers

These missions would provide for initial experimentation with Earth environment modification, particularly of the trapped radiation regions.

TITAN EXPLORERS LV: TITAN IIID/CENTAUR Wt: 10,000 V_C: 35,600

Purpose: To overload the natural Van Allen Belt so as to induce its instability.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	3.0	8.0	11.0	12.0	10.0	4.0
Flights	-	-	-	-	-	-	-	-	1	-	1

	SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
Relativity Red Shift - Solar Probe							●	●	●	
Relativity Red Shift - Deep Space							●	●	●	
Gyroscope Precession - Precursor				●						
Titan Explorers							●	●	●	●

Automated Physics and Chemistry Laboratory

This program provides the capability to conduct physics and chemistry experiments aboard automated spacecraft.

PHYSICS AND CHEMISTRY LAB - AUTOMATED
LV: ATLAS/CENTAUR Wt: 5,000 V_C: 26,900

Purpose: To study the physics of solids and liquids and various chemical reactions in the zero-g environment of space.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	1.0	3.0	9.0	15.0	12.0	13.0	13.0	13.0	7.0	1.0
Flights	-	-	-	-	-	1	-	1	-	1	-

SG1 (BASELINE I)	SG2 (BASELINE II)	SG3 (STG OPTION I)	SG4 (PSG-LOW)	SG5 (ALTERNATIVE I)	SG6 (ALTERNATIVE II)	SG7 (ALTERNATIVE III)	SG8 (ALTERNATIVE IV)	SG9 (ALTERNATIVE V)	SG10 (ALTERNATIVE VI)
								●	

SG Mission Models

In this section 10 mission models (SG1 through SG10) are presented. Each model is described by its guidelines, characteristics, funding plot (Figures VI-1 through VI-10), and flight schedule (Tables VI-1 through VI-10). Comparisons and discussions of the models follow in the next section of this chapter.

Model Guidelines and Description: SG1(Baseline I)

This model was developed directly from the automated projects portion of Programs II and III in the NASA report to the STG.(9) The basic guidelines governing the areas of Astronomy and Physics for all three programs presented in the report were as follows:

> "In Astronomy the main focus would be on developing large (100-in.) telescope systems for use with the manned systems as well as aggressive development of high energy experiments that could lead to an eventual manned laboratory. Explorer and OSO-class automated satellites would be continued."(9)

> "In Space Physics, the major developments would include relativity experiments, space weather probes, out-of-the-ecliptic probes, and a cluster of magnetosphere satellites. The Explorer class satellites would also continue."(9)

The major characteristics of the model are as follows:

- Space station and shuttle available 1977
- FY 1971 funding ceiling of $4 billion
- Moderately paced program after FY 1971
- 1 HEAO launched in 1981
- 1 LTM (Large Telescope Mount) launched in 1980.

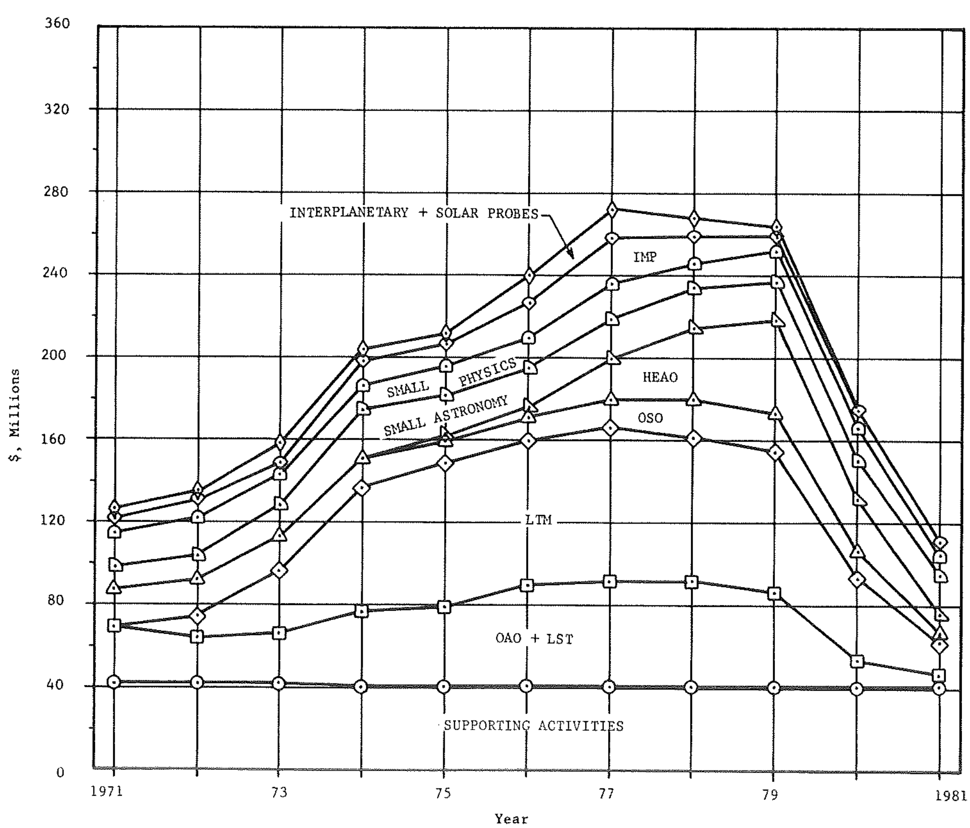

FIGURE VI-1. SG1 FUNDING PLOT

TABLE VI-1. SG1 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
	Orbiting Astronomical Observatories and Telescopes											
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
OAO E-F(77)	ATLAS/CENTAUR	-	-	-	-	-	-	1	1	1	-	-
	Large Telescope Mounts											
LTM A(80)	TITAN IIID	-	-	-	-	-	-	-	-	-	1	-
	Orbiting Solar Observatories											
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	TAT/DELTA	-	-	1	1	1	-	-	-	-	-	-
OSO L-M(79)	TAT/DELTA	-	-	-	-	-	-	-	-	1	1	-
	High Energy Astronomical Observatories											
HEAO(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
	Small Astronomy Satellites											
SMALL ASTRONOMY SATS A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	SCOUT	-	-	1	1	1	1	1	1	1	1	1
ASTRONOMY EXPLORERS-DELTA	TAT/DELTA/FW4	-	-	-	1	1	1	1	1	1	1	1
	Various Small Physics Satellites											
ATMOSPHERE EXPLORERS C,D	TAT/DELTA/FW4	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(81)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	-	-	2
SSS A-D	SCOUT	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	SCOUT	-	-	-	1	1	1	1	1	1	1	1
ISIS C,D(72,74)	TAT/DELTA/FW4	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(77,80)	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
	Interplanetary Monitoring Platforms											
IMP-I-J	TAT/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	TAT(9C)/DELTA/TE364	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	2	-	-	1
	Interplanetary and Solar Probes											
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SMALL INTERPLANETARY SATELLITE	SCOUT	-	1	1	1	1	1	-	-	-	-	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
OUT OF ECLIPTIC - PIONEER(78,79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	1	-	-

Model Guidelines and Description: SG2(Baseline II)

This model was developed by modifying SG1(Baseline I) to agree with the plans represented by the SG portion of the OSSA FY 1971 budget submission to the Bureau of the Budget. The principal changes made were as follows:

- LST (Large Space Telescopes) replaced OAO(E-G)
- LTM (Large Telescope Mount) - deleted
- HEAO first launch changed to 1974
- More Atmosphere Explorers - added
- Small Interplanetary Satellites - deleted
- General Relativity (76) - added.

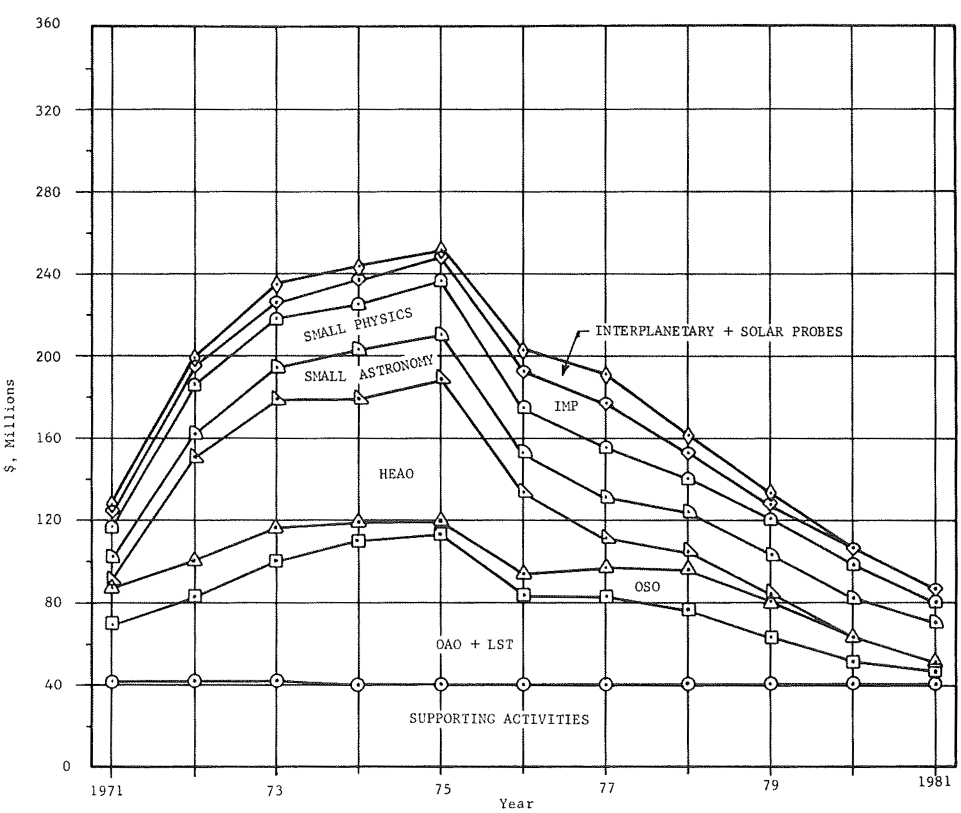

FIGURE VI-2. SG2 FUNDING PLOT

TABLE VI-2. SG2 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Orbiting Astronomical Observatories and Telescopes												
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
LST A-C(76,77,79)	TITAN IIIC	-	-	-	-	-	1	1	-	1	-	-
Orbiting Solar Observatories												
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	TAT/DELTA	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	1	1	-
High Energy Astronomical Observatories												
HEAO A-C(74)	TITAN IIIC	-	-	-	1	1	1	-	-	-	-	-
HEAO(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
Small Astronomy Satellites												
SMALL ASTRONOMY SATELLITE A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	SCOUT	-	-	1	1	1	1	1	1	1	1	1
ASTRONOMY EXPLORERS-DELTA	TAT/DELTA/FW4	-	-	-	1	1	1	1	1	1	1	1
Various Small Physics Satellites												
ATMOSPHERE EXPLORERS C-E(73-75)	TAT/DELTA/FW4	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	TAT/DELTA/FW4	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	-	-	2
SSS A-D	SCOUT	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	SCOUT	-	-	-	1	1	1	1	1	1	-	-
ISIS B-D(71,73,74)	TAT/DELTA/FW4	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
GENERAL RELATIVITY(76)	TITAN IIIC	-	-	-	-	-	1	-	-	-	-	-
Interplanetary Monitoring Platforms												
IMP I-J(72,73)	TAT/DELTA/TE364	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	TAT/DELTA/TE364	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	TAT/DELTA/TE364	-	-	-	-	-	-	-	2	-	1	-
Interplanetary and Solar Probes												
OUT OF ECLIPTIC - PIONEER(78,79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	1	-	-
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SPACE WEATHER PROBE A	TAT/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-

Model Guidelines and Description: SG3(STG Option I)

This model was derived from the automated portion of Space Physics and Astronomy plans included in Program I of the NASA report to the STG.(9) Program I was the most aggressive of the three programs presented in the report. The guidelines associated with the Space Physics and Astronomy areas are the same as those quoted in SG1 Guidelines. The starting dates for most major proposed new programs were 1 or 2 years earlier in this model compared with the first two models.

Major features of the model are as follows:

- 12-man space station and shuttle 1976
- 50-man Space Station 1980
- HEAO starts in 1973
- LTM launched in 1979 for 1980 space station.

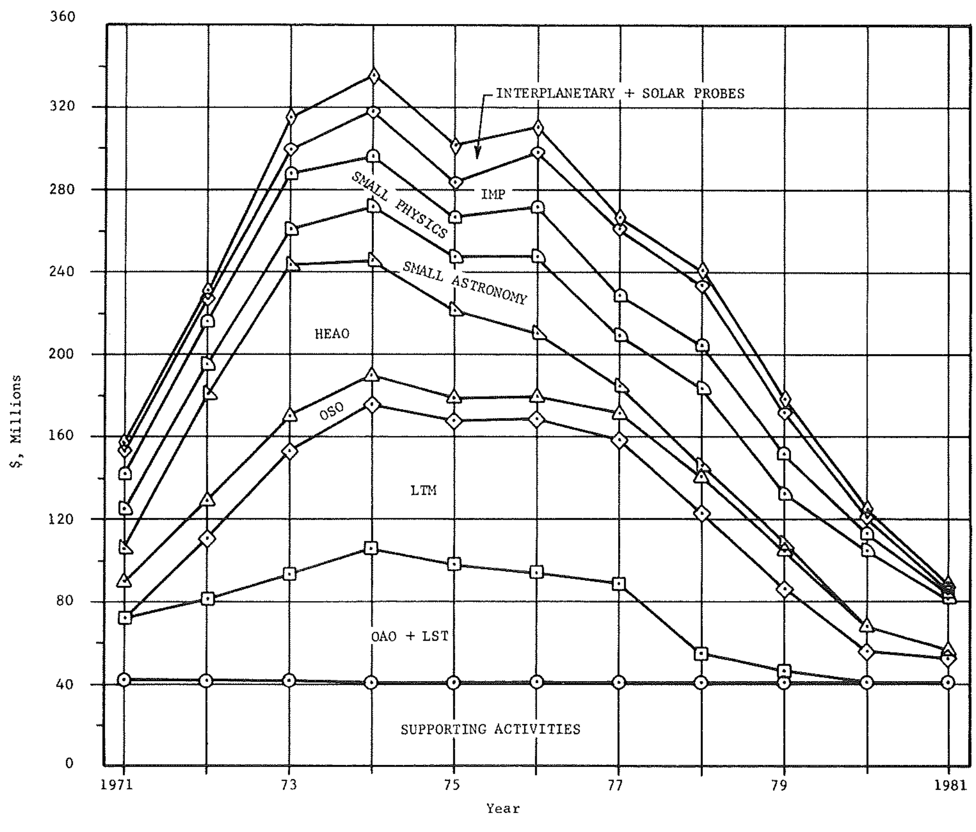

FIGURE VI-3. SG3 FUNDING PLOT

TABLE VI-3. SG3 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Orbiting Astronomical Observatories and Telescopes												
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
OAO E-G(75)	ATLAS/CENTAUR	-	-	-	-	1	1	1	-	-	-	-
Large Telescope Mounts												
LTM A(79)	TITAN IIID	-	-	-	-	-	-	-	-	1	-	-
Orbiting Solar Observatories												
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	TAT/DELTA	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(79)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	1	1	-
High Energy Astronomical Observatories												
HEAO A-C(73)	TITAN IIIC	-	-	1	1	1	-	-	-	-	-	-
HEAO(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
Small Astronomy Satellites												
SMALL ASTRONOMY SATELLITE A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT (high plan)	SCOUT	2	1	1	2	1	2	1	2	1	2	1
ASTRONOMY EXPLORERS-DELTA (high plan)	TAT/DELTA	-	-	-	1	2	1	2	1	2	1	2
Various Small Physics Satellites												
ATMOSPHERE EXPLORERS C,D	TAT/DELTA/FW4	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(76,79)	TAT/DELTA/FW4	-	-	-	-	-	2	-	-	1	-	-
SSS A-D	SCOUT	1	1	1	-	-	-	-	-	-	-	-
SSS E-F	SCOUT	-	-	-	2	-	-	-	-	-	-	-
SSS G-L	SCOUT	-	-	-	-	1	1	1	1	1	1	-
ISIS C,D(72,74)	TAT/DELTA/FW4	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(75)	TAT/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
CLUSTER(78,80)	TAT/DELTA/TE364	-	-	-	-	-	-	-	1	-	1	-
Interplanetary Monitoring Platforms												
IMP I-J	TAT/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
IMP KK-LL(74,75)	TAT(9C)/DELTA/TE364	-	-	-	1	1	-	-	-	-	-	-
IMP M-R	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	2	1	2	1	-
Interplanetary and Solar Probes												
OUT OF ECLIPTIC - PIONEER(75-76)	TITAN IIID/CENTAUR	-	-	-	-	1	1	-	-	-	-	-
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SMALL INTERPLANETARY SATELLITES	SCOUT	-	1	1	1	1	1	-	-	-	-	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBE B,C	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-

Model Guidelines and Description: SG4(PSG-LOW)

Guidelines for model SG4 were obtained by combining the lowest plans for Space Physics and the lowest plans for Astronomy found in the PSG Prospectus File.(8) It is believed that these plans were created by the PSG staff rather than the Space Physics and Astronomy planning panels.

Three major characteristics of this model are as follows:

- No follow-on plans for OAO or LST (Large Space Telescope)
- HEAO starts in 1974
- Appears that no new starts after 1974 were considered.

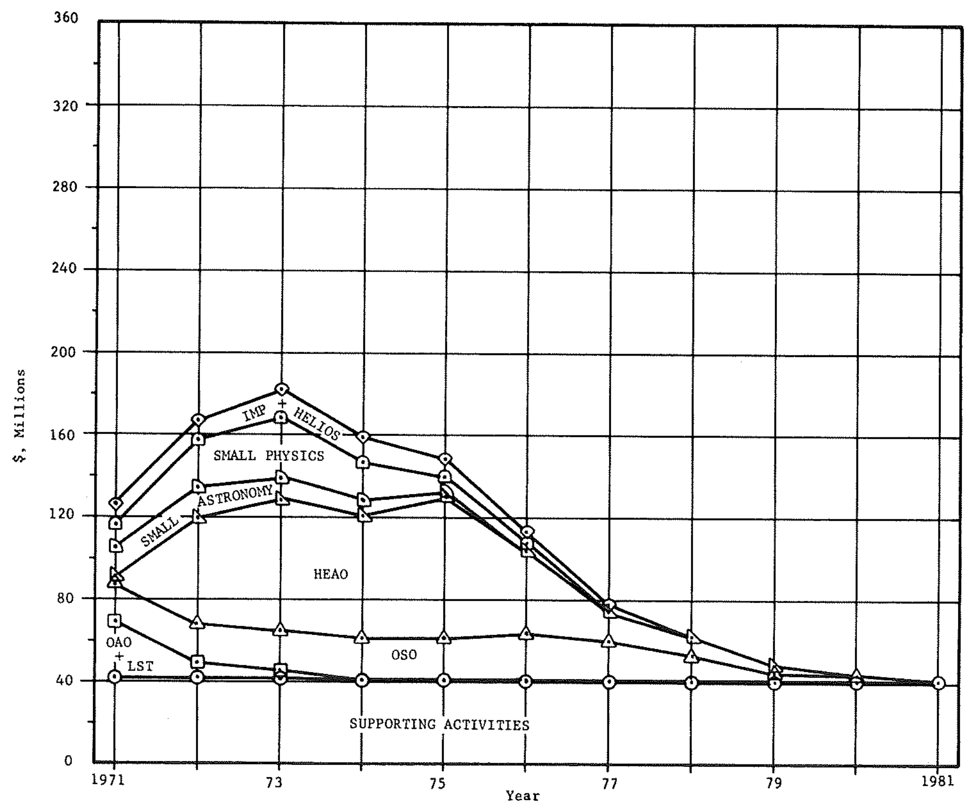

FIGURE IV-4. SG4 FUNDING PLOT

TABLE VI-4. SG4 FLIGHT SCHEDULE

Project	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81
		Year										
	Orbiting Astronomical Observatories											
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
	Orbiting Solar Observatories											
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	TAT/DELTA	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(77)	TAT/DELTA/FW4	-	-	-	-	-	-	1	1	-	-	-
	High Energy Astronomical Observatories											
HEAO A-C(74)	TITAN IIIC	-	-	-	1	1	1	-	-	-	-	-
HEAO(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
	Small Astronomy Satellites											
SMALL ASTRONOMY SATELLITES A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
RADIO ASTRONOMY EXPLORERS C,D	TAT/DELTA/TE364	-	-	-	1	1	-	-	-	-	-	-
	Various Small Physics Satellites											
ATMOSPHERE EXPLORERS C-E(73-75)	TAT/DELTA/FW4	-	-	1	1	1	-	-	-	-	-	-
SSS E-F	SCOUT	-	-	-	2	-	-	-	-	-	-	-
ISIS B,C(71,73)	TAT/DELTA/FW4	1	-	1	-	-	-	-	-	-	-	-
CLUSTER(75)	TAT/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
GYROSCOPE PRECESSION - PRECURSOR	TAT/DELTA	-	-	1	-	-	-	-	-	-	-	-
	Interplanetary Monitoring Platforms											
IMP I-J(72,73)	TAT/DELTA/TE364	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(74,75)	TAT/DELTA/TE364	-	-	-	1	1	-	-	-	-	-	-
	Interplanetary and Solar Probes											
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-

Model Guidelines and Descriptions: SG5(Alternative I)

In the development of this model, the principal guideline was the SG funding projection from Appendix A. That projection estimates the SG funding in 1975 to be $193 million and in 1980, $233 million. To stay close to the projection, flight schedules for major projects had to be delayed and stretched out.

The major characteristics of this model are as follows:

- Funding requirements close to Appendix A projections
- HEAO - 2 launches 1977 and 1981
- LST - 3 launches, 24 month centers, first in 1976
- Space station and shuttle available sometime after 1981.

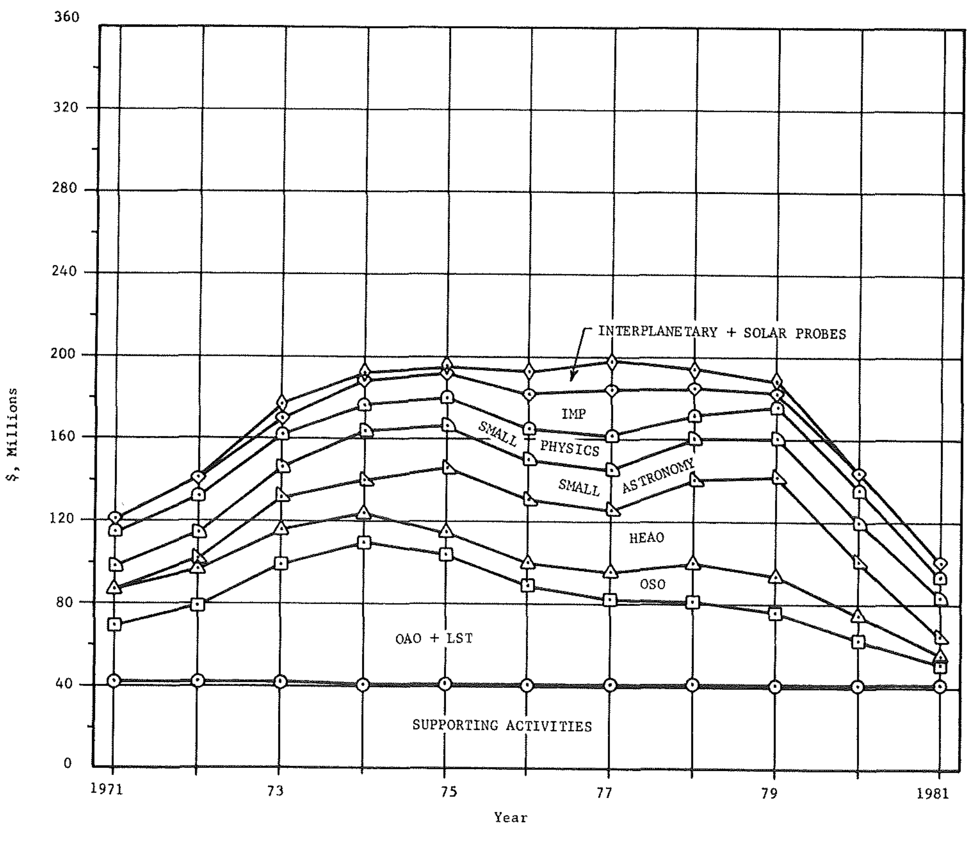

FIGURE VI-5. SG5 FUNDING PLOT

TABLE VI-5. SG5 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Orbiting Astronomical Observatories and Telescopes												
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
LST A-C(76,78,80)	TITAN IIIC	-	-	-	-	-	1	-	1	-	1	-
Orbiting Solar Observatories												
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	TAT/DELTA	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(79)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	1	1	-
High Energy Astronomical Observatories												
HEAO(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
HEAO(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
Small Astronomy Satellites												
SMALL ASTRONOMY SATELLITES A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	SCOUT	-	-	1	1	1	1	1	1	1	1	1
ASTRONOMY EXPLORERS-DELTA	TAT/DELTA/FW4	-	-	-	1	1	1	1	1	1	1	1
Various Small Physics Satellites												
ATMOSPHERE EXPLORERS C,D	TAT/DELTA/FW4	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(81)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	-	-	2
SSS A-D	SCOUT	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	SCOUT	-	-	-	1	1	1	1	1	1	-	-
ISIS C,D(72,74)	TAT/DELTA/FW4	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(77,80)	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
Interplanetary Monitoring Platforms												
IMP I-J(72,73)	TAT/DELTA/TE364	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	TAT(9C)/DELTA/TE364	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	2	-	-	1
Interplanetary and Solar Probes												
OUT OF ECLIPTIC - PIONEER(78,79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	1	-	-
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-

Model Guidelines and Description: SG6(Alternative II)

Guidelines for model SG6 were created to represent a moderately aggressive Physics and Astronomy program. It was accomplished by scaling down the most aggressive model [SG3(STG-Option I)] so that the resulting funding requirements were about half way between the funding for SG3 and the SG funding projection from Appendix A.

The major characteristics of the model are as follows:

- Funding level higher than projection from Appendix A
- HEAO, 3 launches, first in 1973
- LTM (Large Telescope Mount) launched in 1983
- Space station and shuttle available in 1982.

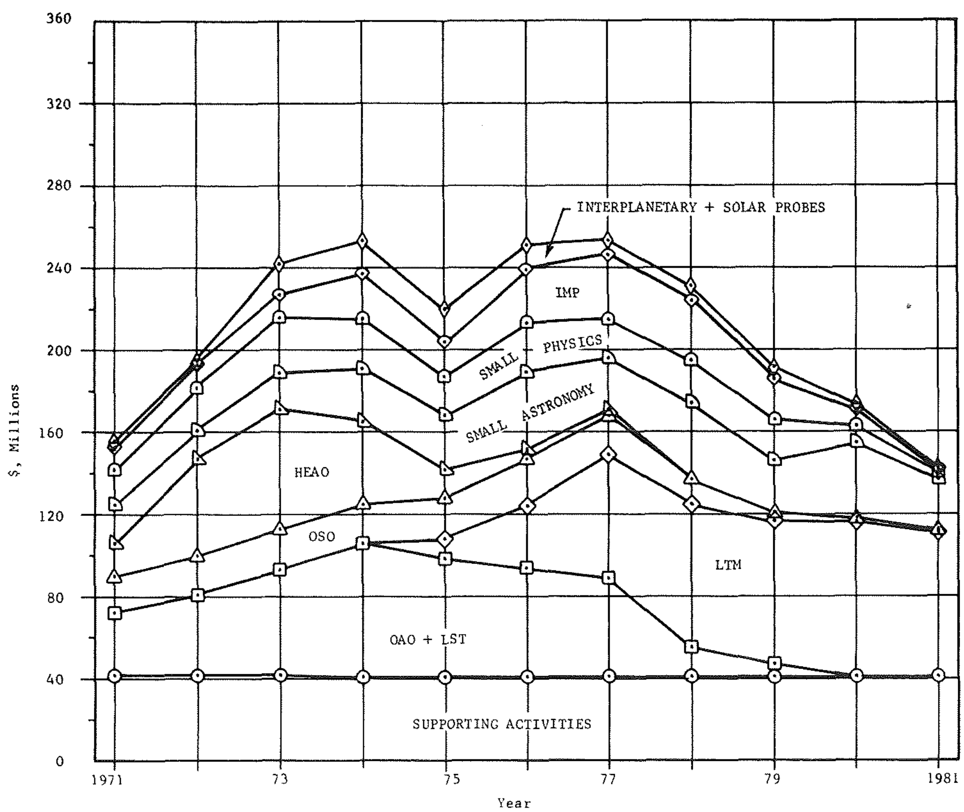

FIGURE VI-6. SG6 FUNDING PLOT

TABLE VI-6. SG6 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
		Orbiting Astronomical Observatories and Telescopes										
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
OAO E-G(75)	ATLAS/CENTAUR	-	-	-	-	1	1	1	-	-	-	-
		Large Telescope Mounts										
LTM A(83)	TITAN IIID	(Launch is in 1983)										
		Orbiting Solar Observatories										
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	TAT/DELTA	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(77)	TAT/DELTA/FW4	-	-	-	-	-	-	1	1	-	-	-
		High Energy Astronomical Observatories										
HEAO A-C(73)	TITAN IIIC	-	-	1	1	1	-	-	-	-	-	-
		Small Astronomy Satellites										
SMALL ASTRONOMY SATELLITES A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT (high plan)	SCOUT	2	1	1	2	1	2	1	2	1	2	1
ASTRONOMY EXPLORERS-DELTA (high plan)	TAT/DELTA/FW4	-	-	-	1	2	1	2	1	2	1	2
		Various Small Physics Satellites										
ATMOSPHERE EXPLORERS C,D	TAT/DELTA/FW4	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(76,79)	TAT/DELTA/FW4	-	-	-	-	-	2	-	-	1	-	-
SSS A-D	SCOUT	1	1	1	-	-	-	-	-	-	-	-
SSS E-F	SCOUT	-	-	-	2	-	-	-	-	-	-	-
SSS G-L	SCOUT	-	-	-	-	1	1	1	1	1	1	-
ISIS C,D(72,74)	TAT/DELTA/FW4	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(75)	TAT/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
CLUSTER(78,80)	TAT/DELTA/TE364	-	-	-	-	-	-	-	1	-	1	-
		Interplanetary Monitoring Platforms										
IMP I-J	TAT/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
IMP KK-LL(74,75)	TAT(9C)/DELTA/TE364	-	-	-	1	1	-	-	-	-	-	-
IMP M-R	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	2	1	2	1	-
		Interplanetary and Solar Probes										
OUT OF ECLIPTIC - PIONEER(75,76)	TITAN IIID/CENTAUR	-	-	-	-	1	1	-	-	-	-	-
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBES B,C	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-

Model Guidelines and Description: SG7(Alternative III)

The approach used in the development of guidelines for this model was to assume that the funding available would be near the SG projection from Appendix A for the first 2 years, 1971 and 1972, and then to exceed the SG projection for the remainder of the time period.

The major characteristics of this model are as follows:

- Funding first 2 years near projection from Appendix A
- Funding for last 9 years exceeds projection from Appendix A
- HEAO 4 launches starting in 1977
- LST (Large Space Telescopes) 4 launches starting in 1976
- No LTM (Large Telescope Mount)
- Space stations and shuttle available after 1981
- 4 solar probe missions in addition to HELIOS
- 3 relativity missions
- 2 Titan Explorers.

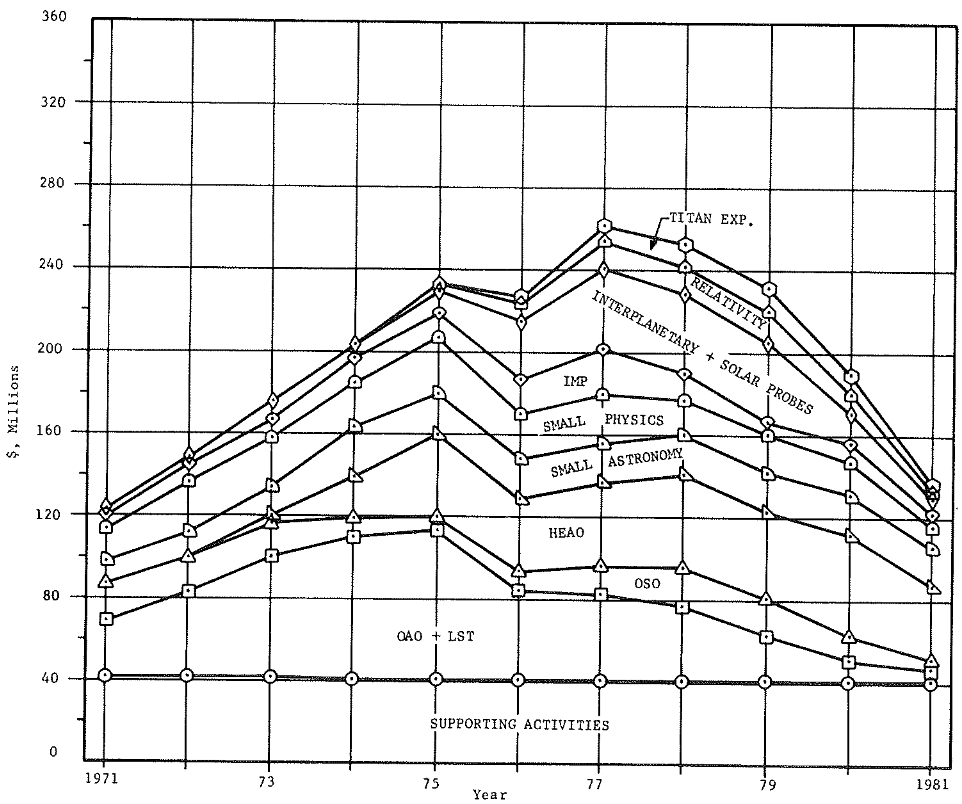

FIGURE VI-7. SG7 FUNDING PLOT

TABLE VI-7. SG7 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Orbiting Astronomical Observatories and Telescopes												
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
LST A-C(76,77,79)	TITAN IIIC	-	-	-	-	-	1	1	-	1	-	-
Orbiting Solar Observatories												
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	TAT/DELTA	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	1	1	-
High Energy Astronomical Observatories												
HEAO A-C(77-81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	1	-	1
HEAO(82)	TITAN IIID/CENTAUR				(Launch in 1982)							
Small Astronomy Satellites												
SMALL ASTRONOMY SATELLITES A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	SCOUT	-	-	1	1	1	1	1	1	1	1	1
ASTRONOMY EXPLORERS-DELTA	TAT/DELTA/FW4	-	-	-	1	1	1	1	1	1	1	1
Various Small Physics Satellites												
ATMOSPHERE EXPLORERS C-E(73-75)	TAT/DELTA/TE364	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	TAT/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	2
SSS A-D	SCOUT	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	SCOUT	-	-	-	1	1	1	1	1	1	-	-
ISIS B-D(71,73,74)	TAT/DELTA/FW4	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
Interplanetary Monitoring Platforms												
IMP I-J(72,73)	TAT/DELTA/TE364	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	TAT(9C)/DELTA/TE364	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	2	-	-	1
Interplanetary and Solar Probes												
OUT OF ECLIPTIC - PIONEER(78,79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	1	-	-
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SOLAR PROBE TO .05 a.u.	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
SOLAR PROBE-CLOSE IN PRECURSOR	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBES B,C	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
Relativity												
GENERAL RELATIVITY(76)	TITAN IIIC	-	-	-	-	-	1	-	-	-	-	-
RELATIVITY RED SHIFT - SOLAR PROBE	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
RELATIVITY RED SHIFT - DEEP SPACE	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
Titan Explorers												
TITAN EXPLORERS	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	1

Model Guidelines and Description: SG8(Alternative IV)

In the development of guidelines for this model, the funding constraint was considered to be approximately 10% higher than the SG funding projection given in Appendix A. The plus-10% values are $212 million in 1975 and $256 million in 1980.

The major characteristics of the model are as follows:

- Funding 10% above projection from Appendix A
- LST (Large Space Telescopes) 3 launch program, first in 1976
- 4 HEAO launches, first in 1977
- 4 solar probe missions in addition to HELIOS
- 3 relativity missions
- 2 Titan Explorers
- Space station and shuttle available after 1981.

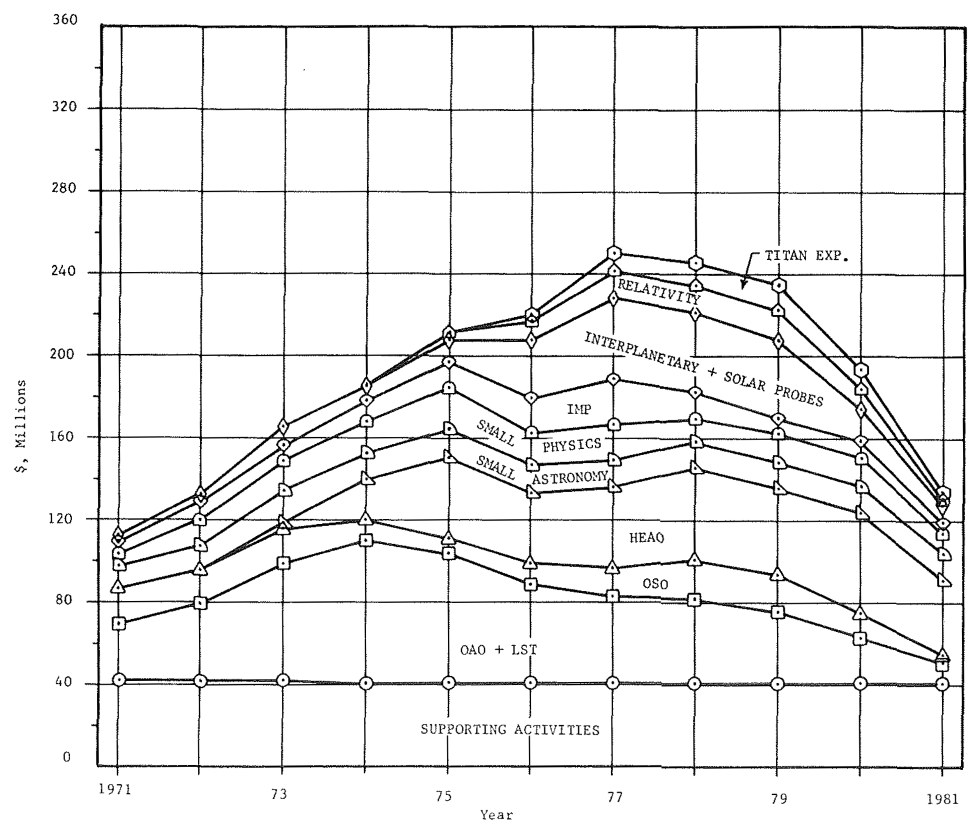

FIGURE VI-8. SG8 FUNDING PLOT

TABLE VI-8. SG8 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Orbiting Astronomical Observatories and Telescopes												
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
LST A-C(76,78,80)	TITAN IIIC	-	-	-	-	-	1	-	1	-	1	-
Orbiting Solar Observatories												
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	TAT/DELTA	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	1	1	-
High Energy Astronomical Observatories												
HEAO A-C(77-81)	TITAN IIIC	-	-	-	-	-	-	1	-	1	-	1
HEAO(82)	TITAN IIID/CENTAUR					(Launch in 1982)						
Small Astronomy Satellites												
SMALL ASTRONOMY SATELLITES A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	SCOUT	-	-	1	1	1	1	1	1	1	1	1
ASTRONOMY EXPLORERS-DELTA(Low Plan)	TAT/DELTA	-	-	-	1	-	1	-	1	-	1	-
Various Small Physics Satellites												
ATMOSPHERE EXPLORERS C-E(73-75)	TAT/DELTA/TE364	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	TAT/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	2
ISIS B-D(71,73,74)	TAT/DELTA/FW4	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
Interplanetary Monitoring Platforms												
IMP I-J(72,73)	TAT/DELTA/TE364	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	TAT(9C)/DELTA/TE364	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	2	-	-	1
Interplanetary and Solar Probes												
OUT OF ECLIPTIC - PIONEER(78,79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	1	-	-
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SOLAR PROBE TO .05 a.u.	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
SOLAR PROBE-CLOSE IN PRECURSOR	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBES B,C	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
Relativity												
GENERAL RELATIVITY(76)	TITAN IIIC	-	-	-	-	-	1	-	-	-	-	-
RELATIVITY RED SHIFT - SOLAR PROBE	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
RELATIVITY RED SHIFT - DEEP SPACE	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
Titan Explorers												
TITAN EXPLORERS	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	1

Model Guidelines and Description: SG9(Alternative V)

The principal guideline used to develop this model was the assumption that the SG funding would increase at a very low rate through FY 1974 and then increase so as to match the SG funding projection from Appendix A for the period 1976-1980.

Major characteristics of the model are as follows:

- Funding nearly level through FY 1974
- Funding for 1976-1981 to match projection from Appendix A
- No LST (Large Space Telescopes)
- HEAO 4 launch program, first in 1977
- 3 automated physics & chemistry labs, first in 1976
- 3 relativity flights
- 4 solar probes in addition to HELIOS
- Space station and shuttle available after 1981.

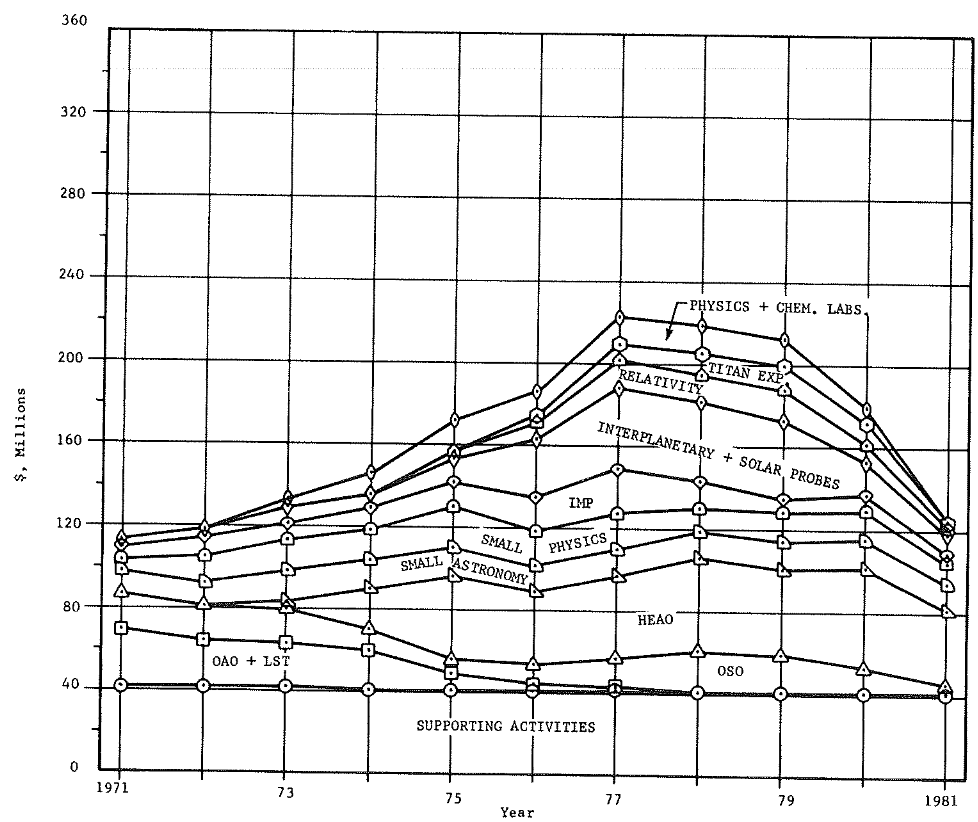

FIGURE VI-9. SG9 FLUNDING PLOT

TABLE VI-9. SG9 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
	Orbiting Astronomical Observatories and Telescopes											
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
	Orbiting Solar Observatories											
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	TAT/DELTA	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	1	1	-
	High Energy Astronomical Observatories											
HEAO A-C(77-81)	TITAN IIIC	-	-	-	-	-	-	1	-	1	-	1
HEAO(82)	TITAN IIID/CENTAUR	(Launch in 1982)										
	Small Astronomy Satellites											
SMALL ASTRONOMY SATELLITES A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	SCOUT	-	-	1	1	1	1	1	1	1	1	1
ASTRONOMY EXPLORERS-DELTA(Low Plan)	TAT/DELTA/FW4	-	-	-	1	-	1	-	1	-	1	-
	Various Small Physics Satellites											
ATMOSPHERE EXPLORERS C-E(73-75)	TAT/DELTA/TE364	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	TAT/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	2
ISIS B-D(71,73,74)	TAT/DELTA/FW4	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
	Interplanetary Monitoring Platforms											
IMP I-J(72,73)	TAT/DELTA/TE364	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	TAT(9C)/DELTA/TE364	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	2	-	-	1
	Interplanetary and Solar Probes											
OUT OF THE ECLIPTIC - PIONEER(78,79)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	1	-	-
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SOLAR PROBE TO .05 a.u.	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
SOLAR PROBE-CLOSE IN PRECURSOR	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBES B,C	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
	Relativity											
GENERAL RELATIVITY(76)	TITAN IIIC	-	-	-	-	-	1	-	-	-	-	-
RELATIVITY RED SHIFT - SOLAR PROBE	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
RELATIVITY RED SHIFT - DEEP SPACE	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
	Titan Explorers											
TITAN EXPLORERS	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	1
	Automated Physics and Chemistry Labs											
PHYSICS AND CHEMISTRY LAB-AUTOMATED	ATLAS/CENTAUR	-	-	-	-	-	1	-	1	-	1	-

Model Guidelines and Description: SG10(Alternative VI)

In creating guidelines for this model, considerable emphasis was placed on the use of the solar-electric propulsion. It was assumed that such a propulsion system would be available in the latter half of the 1970 decade and that a number of projects, particularly solar and out-of-ecliptic probes, would utilize the system. The purpose of creating this model was to determine the amount of funding required by an SG plan to make use of electric propulsion systems.

Major characteristics of this plan are as follows:

- No funding limitation considered
- Include a reasonable number of projects using solar-electric propulsion system
- Include LST and HEAO
- Space station and shuttle available in 1981.

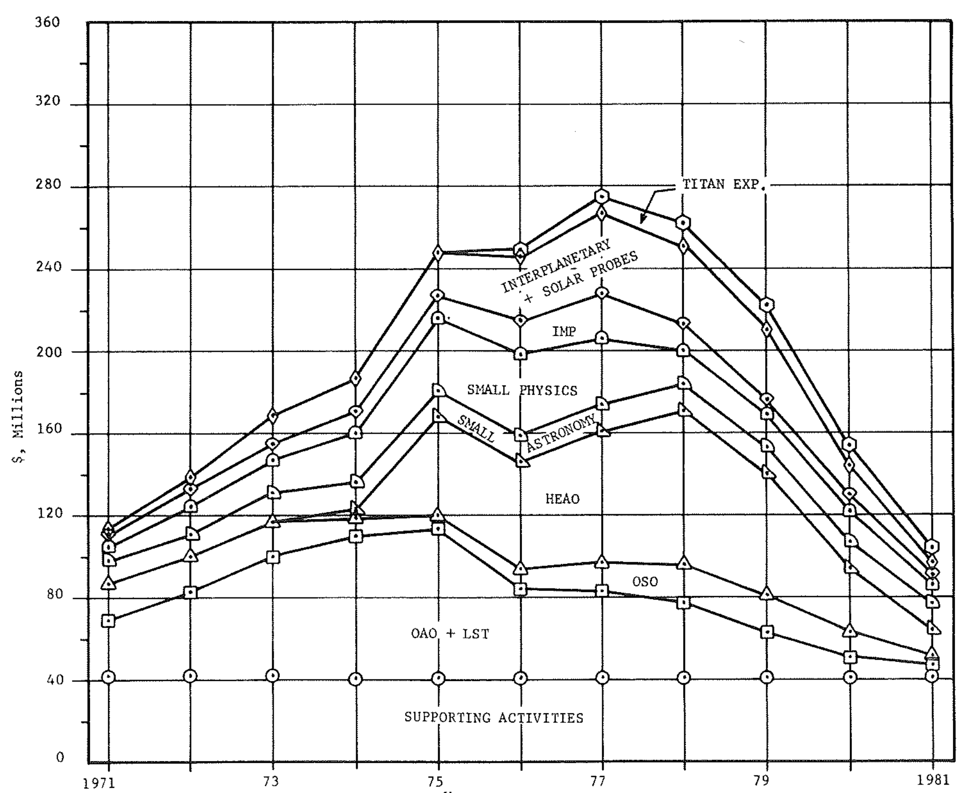

FIGURE VI-10. SG10 FUNDING PLOT

TABLE VI-10. SG10 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
	Orbiting Astronomical Observatories and Telescopes											
OAO C	ATLAS/CENTAUR	1	-	-	-	-	-	-	-	-	-	-
OAO D	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
LST A-C(76,77,79)	TITAN IIIC	-	-	-	-	-	1	1	-	1	-	-
	Orbiting Solar Observatories											
OSO H	TAT/DELTA	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	TAT/DELTA	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	TAT/DELTA/FW4	-	-	-	-	-	-	-	-	1	1	-
	High Energy Astronomical Observatories											
HEAO A-C(77-79)	TITAN IIIC	-	-	-	-	-	-	1	1	1	-	-
HEAO(81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1
	Small Astronomy Satellites											
SMALL ASTRONOMY SATELLITES A,B	SCOUT	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	SCOUT	-	-	1	1	1	1	1	1	1	1	1
ASTRONOMY EXPLORERS - DELTA (low plan)	TAT/DELTA/FW4	-	-	-	1	-	1	-	1	-	1	-
	Various Small Physics Satellites											
ATMOSPHERE EXPLORERS C-E(73-75)	TAT/DELTA/TE364	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	TAT/DELTA/TE364	-	-	-	-	-	-	-	-	-	-	2
ISIS B-D(71,73,74)	TAT/DELTA/FW4	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	TAT/DELTA/TE364	-	-	-	-	-	-	1	-	-	1	-
GENERAL RELATIVITY(76)	TITAN IIIC	-	-	-	-	-	1	-	-	-	-	-
	Interplanetary Monitoring Platforms											
IMP I-J(72,73)	TAT/DELTA/TE364	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	TAT(9C)/DELTA/TE364	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	TAT(9C)/DELTA/TE364	-	-	-	-	-	-	-	2	-	-	1
	Interplanetary and Solar Probes											
HELIOS	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	-
SOLAR PROBE 0.2 a.u. SOLAR QUAD MOMENT	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
SOLAR PROBE 0.1-0.05 a.u.	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	1	-
OUT OF ECLIPTIC - SOLAR ELECTRIC	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	1	-
SPACE WEATHER PROBE A	TAT(6C)/DELTA/TE364	-	-	-	-	-	1	-	-	-	-	-
	Titan Explorers											
TITAN EXPLORERS	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	1	-	-

Discussion

SG Models

Figures VI-11 and VI-12 show the funding requirements for the various SG models along with funding projections (dashed lines) from Appendix A. Figure VI-11 contains the 4 NASA-based models and Figure VI-12 contains the 6 alternative models developed as part of this study. The funding plots in Figure VI-11 indicate that 3 out of the 4 NASA-based models require high funding growth rates in the FY 1971 - FY 1974 period followed by a rapid decline in funding requirements. All of the NASA models were tied to the NASA report to the STG which indicated that a Space Station and Shuttle system would be available in 1976 or 1977. Introduction of such a system would represent such a radical departure from present approaches to mission performance that it is difficult, at this time, to draw inferences concerning the eventual impact of the system. It appears that the 4 NASA models considered here assumed that many missions would be carried out in connection with the space station activities. However, the NASA report to the STG does not identify specific missions (with exception of the Large Telescope Mount) which could or would be incorporated into the station nor is there any discussion of methods for funding such missions.

Since the FY 1971 NASA budget submitted to Congress is considerably lower than the amount needed to support any of the STG options[9], it has been assumed here that the space station and shuttle are not likely to be available until after 1980. This basic assumption was used in developing all of the alternative SG models presented in this report. In other words, these alternative models assume that the approach to performing OSSA-type missions is not likely to change radically prior to the 1980s.[10] The alternative models presented involve the types of SG missions for which conventional OSSA launch vehicles will be required for at least the next 11 years.

As shown in Figure VI-12, all of these alternative models require growth in annual funding with the rate of growth being different for each model. These funding requirements bracket the SG funding projection from Appendix A shown on the figure. It is believed that they represent a reasonable range of possible future activities that might be pursued by the OSSA Physics and Astronomy Division.

In developing the alternative SG models, it was found that there were three major proposed new programs which would require major expenditures. These programs are the High Energy Astronomical Observatories (HEAO), the Large Space Telescopes (LST), and the Large Telescope Mount(LTM). The total costs for these are: HEAO - $313 million; LST - $322 million; and LTM - $500 to 550 million. When developing a model with a funding restriction, the primary task is that of scheduling these 3 major projects so that the funding restriction will not be exceeded. Whether or not LTM should be considered depends on the assumed availability of a 50-man space station. For most of the alternative models, it was assumed that the 50-man station would not be available until late in the 1980s and, therefore, the development of the LTM need not be included in the model. If the LTM is not included in a model, then the primary task is that of deciding how to sequence the LSTs and the HEAOs. OSSA plans associated with the FY 1971 budget submitted to the Bureau of the Budget indicate that HEAO was to be a new start in FY 1971 and LST a new start in FY 1972, with the first launches being 1974 and 1976 respectively. Such a schedule leads to rather sharp increase in the funding required by SG starting in FY 1972. In order to have funding requirements for SG which are close to the projection from Appendix A, it was necessary to modify the HEAO and LST schedules. In the alternative models, this was accomplished by changing both the sequence of the programs and the launch rates of each program.

From the source documents used for this study, it appears that the LST (Large Space Telescope) as defined in this study and the FY 1971 budget backup material is a concept which was formulated after the PSG and STG reports were published. The LST is an automated spacecraft program that merges the objectives of two programs--the follow-on OAO's and the LTM (Large Telescope Mount). For this reason, the LST appears in only one NASA-based model--that is, Baseline II.

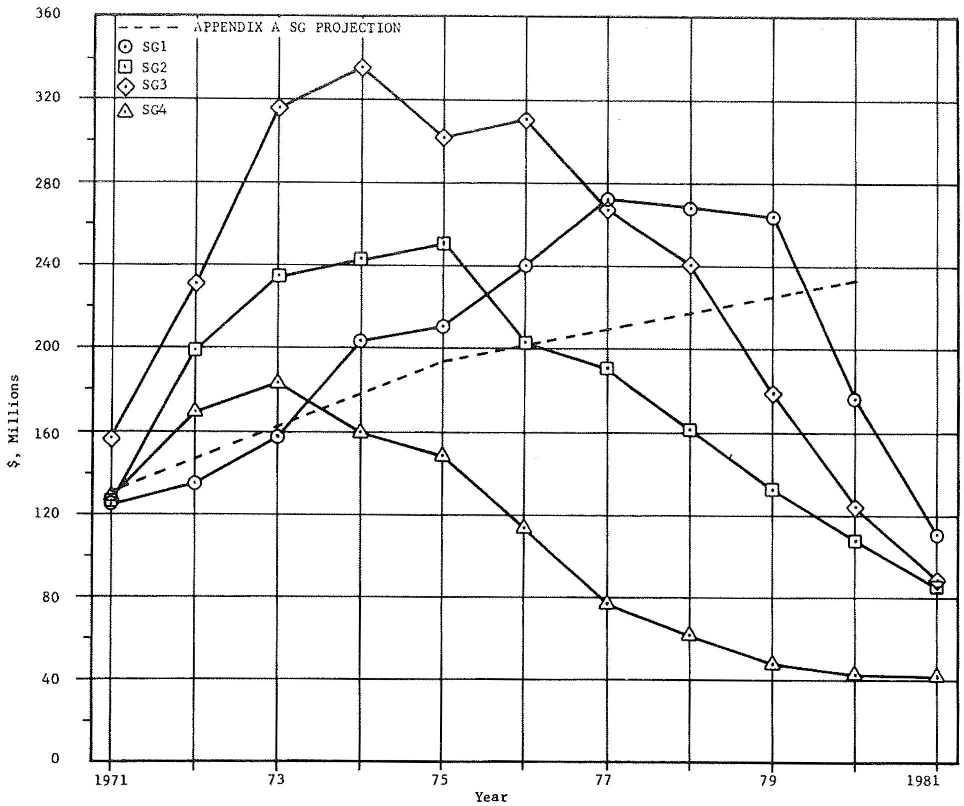

FIGURE VI-11. ESTIMATED FUNDING REQUIRED FOR NASA MODELS SG1-SG4

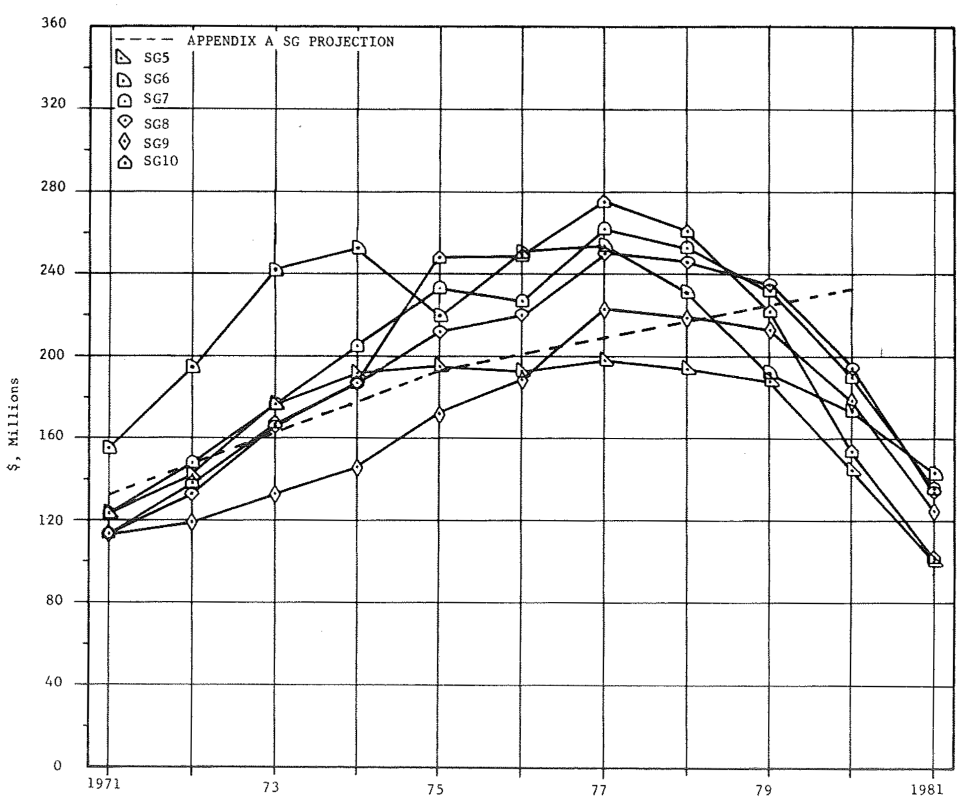

FIGURE VI-12. ESTIMATED FUNDING REQUIRED FOR ALTERNATIVE MODELS SG5-SG10

Models in which the LTM was not scheduled tended to have a noticeable decline in funding requirements after 1975 or 1976. As a result, when the LTM was not included, alternative programs had to be considered for the latter part of the 1970 decade. Typical programs scheduled for that period were the Titan Explorers, Solar Probes and Relativity experiments. These programs were selected because of the emphasis received in the Space Physics and Astronomy Planning Panel documents.[1,2]

Table VI-11 presents the program activities included in each model. For each program, this figure also indicates the first launch (after 1970) and the total number of launches for each program in the period 1971-1981 by model.

Careful study of the Table VI-11 indicates that there are only minor differences between the basic characteristics of the various models. However, the funding plots, Figures VI-11 and VI-12, show that these differences can and do result in a relatively wide range of funding requirements and, thus, represent a fairly broad spectrum of possible Physics and Astronomy future activities.

Launch Vehicle Requirements

Table VI-12 presents launch vehicle requirements by model and year. The family of launch vehicles required to support the SG models presented includes SCOUT, DELTA [ranging from TAT/DELTA to TAT(9C)/DELTA/TE364], CENTAUR (on both ATLAS and TITAN IIID), TITAN IIIC, and TITAN IIID. In all of the models, DELTA has the highest use rate. In fact, DELTA accounts for 40-50% of the launches in each model. SCOUT has the next highest use rate--in most models it accounts for 30-35% of the launches. In most of the models, the TITAN-based launch vehicles are not required until 1975 or later. The only exceptions are SG2 (Baseline II) and SG3 (STG Option I) which require such high funding in the 1971-1974 time period that they are not considered as representative of the near future.

In studying the models, one sees a trend toward increasing spacecraft weights for Earth orbital missions in the future. These increases are the result of the need to fly larger telescope systems, and to make observations in the gamma-ray regions of the electromagnetic spectrum where the sensors are both large and very heavy.

There is also a trend, in most of the models, toward higher launch velocities. This trend results from proposals to fly more solar and interplanetary probes later in the time period.

In the source documents used in this study, missions which require the heavy spacecraft have received more emphasis than have solar and interplanetary probes. Thus, the requirement for launch vehicles capable of placing heavy spacecraft into Earth orbit appears to be the more credible of these two trends.

Summary of Most Demanding Missions

The largest launch vehicles required by SG projects are the TITAN IIID and TITAN IIID/CENTAUR. Neither of these vehicles is currently operational. An integration program is currently in progress to develop the TITAN IIID/CENTAUR vehicle which is to be used by the Viking project in 1975. NASA has no current plans to develop the TITAN IIID as a launch vehicle, although this vehicle may be developed by the USAF. Positive action by NASA may be required since USAF decisions may be independent of NASA's needs.

TABLE VI-11. PROGRAM ACTIVITY BY MODEL

Program Areas	Models									
	SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9	SG10
Supporting Activities	•[a]	•	•	•	•	•	•	•	•	•
Sounding Rockets	•[b]	•	•	•	•	•	•	•	•	•
Orbiting Astronomical Observatories	71 5	71 2	71 5	71 1	71 2	71 5	71 2	71 2	71 2	71 2
Large Space Telescopes	-	76 3	-	-	76 3	-	76 3	76 3	-	76 3
Large Telescope Mounts	80 1	-	79 1	-	-	83[c] -	-	-	-	-
Orbiting Solar Observatories	71 6	71 6	71 6	71 6	71 6	71 6	71 6	71 6	71 6	71 6
High Energy Astronomical Observatories	81 1	74 4	73 4	74 4	77 2	73 3	77 3	77 3	77 3	77 4
Small Astronomy Satellites	71 18	71 18	71 29	71 3	71 18	71 29	71 18	71 14	71 14	71 14
Atmosphere Explorers	71 4	73 7	71 5	73 3	71 4	71 5	73 7	73 7	73 7	73 7
Small Scientific Satellites	71 9	71 9	71 11	74 2	71 9	71 11	71 9	-	-	-
Interplanetary Monitoring Platforms	71 7	72 7	71 10	72 4	72 7	71 10	72 7	72 7	72 7	72 7
International Satellites for Ionospheric Studies	72 2	73 2	72 2	71 2	72 2	72 2	71 3	71 3	71 3	71 3
Clusters	77 2	77 2	75 3	75 1	77 2	75 3	77 2	77 2	77 2	77 2
Solar Probes	72 7	74 2	72 7	74 2	74 2	74 2	74 4	74 4	74 4	74 5
Space Weather Probes	75 1	75 1	75 3	-	75 1	75 3	75 3	75 3	75 3	75 1
Out of Ecliptic	78 2	78 2	75 2	-	78 2	75 2	78 2	78 2	78 2	79 2
Relativity	-	76 1	-	73 1	-	-	76 3	76 3	76 3	76 1
Titan Explorers	-	-	-	-	-	-	79 2	79 2	79 2	79 2
Automated Physics and Chemistry Laboratory	-	-	-	-	-	-	-	-	76 3	-

(a) A dot (•) means a non-spaceflight program area is included in the indicated model.
(b) The upper figure in each group indicates the year of first launch (after 1970) and the lower figure indicates the number of launches in the 1971-1981 time period.
(c) Funding is included to support a launch in 1983, but the launch itself is outside the time period under consideration (1971-1981).

TABLE VI-12. LAUNCH SCHEDULES BY MODEL AND VEHICLE

Model	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81	Total
SG1	SCOUT	2	2	3	3	3	3	2	2	2	1	1	24
	DELTA*	3	3	1	3	4	2	2	3	2	3	4	30
	ATLAS/CENTAUR	1	-	-	2	1	-	1	1	1	-	-	7
	TITAN IIID	-	-	-	-	-	-	-	-	-	1	-	1
	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	1	-	1	3
	TOTAL	6	5	4	8	8	5	5	7	6	5	6	65
SG2	SCOUT	2	1	2	2	2	2	2	2	2	1	1	19
	DELTA	2	1	4	4	4	3	3	3	3	4	3	34
	ATLAS/CENTAUR	1	-	-	2	1	-	-	-	-	-	-	4
	TITAN IIIC	-	-	-	1	1	3	1	-	1	-	-	7
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	-	-	3
	TOTAL	5	2	6	9	8	8	7	6	7	5	4	67
SG3	SCOUT	4	3	3	5	3	6	2	3	2	3	1	33
	DELTA	3	3	1	4	6	3	5	3	6	5	2	41
	ATLAS/CENTAUR	1	-	-	2	2	1	1	-	-	-	-	7
	TITAN IIIC	-	-	1	1	1	-	-	-	-	-	-	3
	TITAN IIID	-	-	-	-	-	-	-	-	1	-	-	1
	TITAN IIID/CENTAUR	-	-	-	-	1	1	1	-	-	-	-	3
	TOTAL	8	6	5	12	13	9	9	6	9	8	3	88
SG4	SCOUT	1	-	-	2	-	-	-	-	-	-	-	3
	DELTA	2	1	5	4	5	-	1	1	-	-	-	19
	ATLAS/CENTAUR	1	-	-	1	1	-	-	-	-	-	-	3
	TITAN IIIC	-	-	-	1	1	1	-	-	-	-	-	3
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-	1
	TOTAL	4	1	5	8	7	1	2	1	-	-	-	29
SG5	SCOUT	2	1	2	2	2	2	2	2	2	1	1	19
	DELTA	2	3	2	3	4	2	2	3	2	3	4	30
	ATLAS/CENTAUR	1	-	-	2	1	-	-	-	-	-	-	4
	TITAN IIIC	-	-	-	-	-	1	-	1	-	1	-	3
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	-	1	4
	TOTAL	5	4	4	7	7	5	5	7	5	5	6	60

* In this table DELTA refers to the following vehicles:

TAT/DELTA
TAT/DELTA/FW4
TAT/DELTA/TE364
TAT(6C)/DELTA/TE364
TAT(9C)/DELTA/TE364

TABLE VI-12. LAUNCH SCHEDULES BY MODEL AND VEHICLE
(Continued)

Model	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81	Total
	SCOUT	4	2	2	4	2	3	2	3	2	3	1	28
	DELTA	3	3	1	4	6	3	6	4	5	4	2	41
SG6	ATLAS/CENTAUR	1	-	-	2	2	1	1	-	-	-	-	7
	TITAN IIIC	-	-	1	1	1	-	-	-	-	-	-	3
	TITAN IIID/CENTAUR	-	-	-	-	1	1	-	-	-	-	-	2
	TOTAL	8	5	4	11	12	8	9	7	7	7	3	81
	SCOUT	2	1	2	2	2	2	2	2	2	1	1	19
	DELTA	2	1	4	4	4	3	4	3	3	4	4	36
SG7	ATLAS/CENTAUR	1	-	-	2	1	-	-	-	-	-	-	4
	TITAN IIIC	-	-	-	-	-	2	1	-	1	-	-	4
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	2	4	2	2	11
	TOTAL	5	2	6	8	7	7	8	7	10	7	7	74
	SCOUT	1	-	1	1	1	1	1	1	1	1	1	10
	DELTA	2	1	4	4	3	3	3	3	2	4	3	32
SG8	ATLAS/CENTAUR	1	-	-	2	1	-	-	-	-	-	-	4
	TITAN IIIC	-	-	-	-	-	2	1	1	1	1	1	7
	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	2	3	2	1	8
	TOTAL	4	1	5	7	5	6	5	7	7	8	6	61
	SCOUT	1	-	1	1	1	1	1	1	1	1	1	10
	DELTA	2	1	4	4	3	3	3	3	2	4	3	32
SG9	ATLAS/CENTAUR	1	-	-	2	1	1	-	1	-	1	-	7
	TITAN IIIC	-	-	-	-	-	1	1	-	1	-	1	4
	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	2	3	2	1	8
	TOTAL	4	1	5	7	5	6	5	7	7	8	6	61
	SCOUT	1	-	1	1	1	1	1	1	1	1	1	10
	DELTA	2	1	4	4	3	3	2	3	2	3	3	30
SG10	ATLAS/CENTAUR	1	-	-	2	1	-	-	-	-	-	-	4
	TITAN IIIC	-	-	-	-	-	2	2	1	2	-	-	7
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	3	2	2	8
	TOTAL	4	1	5	7	5	6	6	5	8	6	6	59

Table VI-13 lists the proposed SG projects with the most demanding launch vehicle requirements. The projects in the table can be divided into two classes: (1) heavy spacecraft to be launched into Earth orbit, and (2) missions requiring high launch velocities. The majority of the projects in Table VI-13 are those requiring high launch velocities. These missions can use as much launch velocity as can be delivered on a reasonable basis, since the higher the velocity the shorter the trip time (or the closer the approach to the Sun) will be.

The HEAO and OUT-OF-ECLIPTIC PIONEER projects appear in most of the 10 SG mission models. The most frequent launch years for these projects are HEAO in 1981 and OUT-OF-ECLIPTIC PIONEER in 1978. However, the earliest dates are 1977 and 1975, respectively. None of these launch dates should present any launch vehicle availability problems since both require the TITAN IIID/CENTAUR which is now scheduled to be available in 1975.

TABLE VI-13. SG PROJECTS HAVING THE MOST DEMANDING LV REQUIREMENTS

Project	Vehicle	Weight, lb	V_C, ft/sec	First Launch
LTM A (79)	TITAN IIID	25,000	26,000	1979
LTM A (80)	TITAN IIID	25,000	26,000	1980
LTM A (83)	TITAN IIID	25,000	26,000	1983
HEAO (77)	TITAN IIID/CENTAUR	>23,600	25,900	1977
HEAO (81)	TITAN IIID/CENTAUR	>23,600	25,900	1981
HEAO (82)	TITAN IIID/CENTAUR	>23,600	25,900	1982
SOLAR PROBE TO 0.05 a.u.	TITAN IIID/CENTAUR	4,500	44,000	1980
SOLAR PROBE-CLOSE IN PRECURSOR	TITAN IIID/CENTAUR	900	42,000	1979
SOLAR PROBE-0.1-0.05 a.u.	TITAN IIID/CENTAUR	5,000	43,000	1979
SOLAR PROBE-0.2 a.u. SOLAR QUAD MOMENT	TITAN IIID/CENTAUR	6,000	42,000	1977
OUT OF ECLIPTIC - PIONEER (75,76)	TITAN IIID/CENTAUR	460	50,000	1975
OUT OF ECLIPTIC - PIONEER (78,79)	TITAN IIID/CENTAUR	460	50,000	1978
RELATIVITY RED SHIFT - SOLAR PROBE	TITAN IIID/CENTAUR	1,200	47,500	1978
RELATIVITY RED SHIFT - DEEP SPACE	TITAN IIID/CENTAUR	1,000	50,000	1980
TITAN EXPLORERS	TITAN IIID/CENTAUR	10,000	35,600	1979

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(7) "FY 1971 Budget Data", NASA (SV) Memorandum, March 16, 1970.

(8) Planning Steering Group (PSG) Prospectus File (Computer Tape), assembled during 1969 PSG exercise. Available at BMI-NLVP and Goddard Space Flight Center.

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CHAPTER VII. SPACE APPLICATIONS (SA)

Introduction

The former Space Applications Programs Division(SA) is now divided into two divisions in OSSA: Communications Programs Division(SC) and Earth Observations Programs Division(SR). In this study, these programs were considered together, primarily because there was not a long enough history of expenditures by either of the two areas on which to base separate future projections. The data available for Space Applications as a whole were used to make the budget estimates for Space Applications presented in Appendix A.

The aims of both Space Applications Programs offices are to develop and apply aerospace technology and techniques[1,2]*, with each division being responsible for its own areas of application.

Earth Observations Programs has as its goal "the survey of the Earth and its environment for:

- The definition of the Earth's gravitational field, geometry, surface characteristics and dynamic body properties;
- The understanding of the physics of the atmosphere, the prediction of weather, and the establishment of a basis for weather modification and climate control;
- The responsible management of the Earth's resources and the human environment".[2]

The goal of Communications Programs is to facilitate continued and expanded application of space technology and satellite systems to better serve the needs for communications with and between Earthbound, airborne, and spacecraft terminals and also to serve the needs for terrestrial, air, and space vehicle navigation and traffic control.[1]

The space applications programs are somewhat different from the other NASA programs since, ultimately, users (or "customers") become involved. The end product of these programs must be useful to those "customers".[3] Usually such customers are from outside of NASA and may represent other U. S. government agencies (such as ESSA) or commercial organizations (such as COMSAT). Thus, to develop and plan a program of space applications, it is necessary to work with potential users and to understand their needs.

Space applications is the only program within OSSA that had a larger budget in FY 1970 than in FY 1967. Thus, it is the only area which has been growing while NASA and OSSA have been declining. The average growth rate projected in Appendix A for space applications for the period 1970 - 1980 is 8.7% per year, the largest for any OSSA division. Appendix A shows SA funding projections of $231 million in 1975 and $279 million in 1980. This projection also predicts that SA will have the largest percent of OSSA funds in 1975 i.e., 26%. In 1969, SA accounted for 20% of OSSA funds and only 13% in 1967.

This chapter presents Space Applications mission models, SA1 through SA10, which represent a spectrum of possibilities indicating the types of plans that might be followed in the period 1971 - 1981. These models illustrate the range of future launch vehicle requirements expected to be necessary to support the activities of the OSSA Earth Observations and the Communications Divisions.

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* Superscript numbers denote references given at the end of this Chapter.

Program Areas(1,2,4-11)

This section summarizes proposed projects included in the Space Applications mission models that are presented later in the chapter. All funding is millions of dollars; Launch Vehicle is designated LV and the assigned vehicle is named*; all spacecraft weights are given in pounds; characteristic velocities (V_C) are given in feet per second.

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* See Appendix D for a discussion launch vehicle nomenclature.

Supporting Activities

This program area contains Supporting Research and Technology programs, data analysis efforts, and contract administration.

COMMUNICATIONS AND NAVIGATION SR&T

Purpose: To provide supporting research and technology for the flight projects of the Communications Program.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Flights	(Non-flight project)										

EARTH OBSERVATIONS SR&T

Purpose: To provide supporting research and technology for the flight projects of the Earth Observations Program.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	19.0	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
Flights	(Non-flight project)										

Sounding Rockets

METEOROLOGICAL SOUNDINGS

Purpose: To explore the upper atmospheric region which is not accessible to sounding balloons or satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Flights	(Non-space-flight project)										

Tiros

The Tiros program objective is to develop prototype operational satellites in support of the National Meteorological Satellite System.

TIROS/TOS IMPROVEMENTS

Purpose: To provide for continuing studies of the TIROS/TOS system in support of the National Meteorological Satellite System.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.5	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Flights	(Launch in 1970, follow-on improvement funds)										

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
COMMUNICATIONS AND NAVIGATION SR&T	•	•	•	•	•	•	•	•	•	•
EARTH OBSERVATIONS SR&T	•	•	•	•	•	•	•	•	•	•
METEOROLOGICAL SOUNDINGS	•	•	•	•	•	•	•	•	•	•
TIROS/TOS IMPROVEMENTS	•	•	•	•	•	•	•	•	•	•

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
TIROS N (74)			•							
TIROS N (75)	•	•		•	•	•	•	•	•	•
NIMBUS E,F	•	•	•	•	•	•	•	•	•	•
NIMBUS G-H			•	•						
NIMBUS G-J	•	•			•	•		•		

TIROS N (74) LV: TAT(6C)/DELTA/TE364 Wt: 1,000-1,500 V_C: 29,400

Purpose: To develop an advanced Earth-orbiting operational prototype spacecraft incorporating state-of-the art advances in support of the National Meteorological Satellite Systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	2.0	12.0	5.0	2.0	1.0	-	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

TIROS N (75) LV: TAT(6C)/DELTA/TE364 Wt: 1,000-1,500 V_C: 29,400

Purpose: To develop an advanced Earth-orbiting operational prototype spacecraft incorporating state-of-the art advances in support of the National Meteorological Satellite Systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	2.0	12.0	5.0	2.0	1.0	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

<u>Nimbus</u>

Nimbus satellites provide global coverage to conduct meteorological research and test technology advancements for both spacecraft and sensors.

NIMBUS E,F LV: TAT(9C)/DELTA Wt: 1,500 V_C: 29,540

Purpose: To test sensors for measuring atmospheric parameters at various altitudes. Particular emphasis will be on vertical soundings in the microwave region.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	31.1	19.6	9.5	3.0	0.1	-	-	-	-	-	-
Flights	-	1	1	-	-	-	-	-	-	-	-

NIMBUS G-H LV: TAT(9C)/DELTA Wt: 1,600-1,800 V_C: 28,840

Purpose: To provide spacecraft to perform follow-on studies consistent with the Nimbus program objectives.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	5.0	13.0	28.0	14.0	7.0	3.0	-	-	-	-	-
Flights	-	-	-	1	1	-	-	-	-	-	-

NIMBUS G-J LV: TAT(9C)/DELTA Wt: 1,600-1,800 V_C: 28,840

Purpose: To provide spacecraft to perform follow-on studies consistent with the Nimbus program objectives.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	5.0	10.0	25.0	18.0	25.0	10.0	11.0	3.0	2.0	-
Flights	-	-	-	-	1	-	1	-	1	-	-

NIMBUS (77,78) LV: TAT(9C)/DELTA Wt: 1,800 V_C: 28,840

Purpose: To provide spacecraft to perform follow-on studies consistent with the Nimbus program objectives.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	1.0	13.0	19.0	13.0	10.0	2.0	-	-	-
Flights	-	-	-	-	-	-	1	1	-	-	-

Synchronous Metorological Satellites (SMS)

This program area is concerned with developing spacecraft using flight-proven hardware to be used to collect meteorological data from geosynchronous altitude.

SMS LV: TAT(9C)/DELTA/TE364 Wt: Unknown V_C: 33,600

Purpose: To provide cloud cover and low resolution radiation data from geosynchronous altitude.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	15.6	3.1	0.1	-	-	-	-	-	-	-	-
Flights	1	1	-	-	-	-	-	-	-	-	-

ATS Meteorological Satellites

This series of satellites would operate in a geosynchronous orbit to conduct meteorological application technology experiments and collect meteorological data.

METEOROLOGICAL ATS (74) LV: ATLAS/CENTAUR Wt: 1,715 V_C: 39,600

Purpose: To develop the technology needed for the next generation of operational meteorological geosynchronous satellites for the Department of Defense and ESSA.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	15.0	20.0	20.0	10.0	20.0	10.0	5.0	-	-	-
Flights	-	-	-	1	-	1	1	-	-	-	-

METEOROLOGICAL ATS (75) LV: ATLAS/CENTAUR Wt: 1,715 V_C: 39,600

Purpose: To develop the technology needed for the next generation of operational meteorological geosynchronous satellites for the Department of Defense and ESSA.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	15.0	20.0	20.0	10.0	20.0	10.0	5.0	-	-
Flights	-	-	-	-	1	-	1	1	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
NIMBUS (77,78)			•	•			•		•	
SMS	•	•	•	•	•	•	•	•	•	•
METEOROLOGICAL ATS (74)			•							
METEOROLOGICAL ATS (75)								•		

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
METEOROLOGICAL ATS (76)						•	•		•	•
GARP EQUATORIAL	•	•	•		•	•	•	•	•	•
GARP GEOSTATIONARY	•	•	•		•	•	•	•	•	•
GARP POLAR ORBITER	•	•	•		•	•	•	•	•	•

METEOROLOGICAL ATS (76) LV: ATLAS/CENTAUR Wt: 1,715 V_C: 39,600

Purpose: To develop the technology needed for the next generation of operational meteorological geosynchronous satellites for the Department of Defense and ESSA.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	15.0	20.0	20.0	10.0	20.0	10.0	5.0	-
Flights	-	-	-	-	-	1	-	1	1	-	-

Global Atmospheric Research Program (GARP)

GARP is an international program organized and directed jointly by the governments of interested nations through the World Meteorological Organization and the International Council of Scientific Unions. The goals of the program are to increase the understanding of the general circulation in the atmosphere and to develop the methods necessary to make extended predictions. The program that follows is a tentative NASA plan to provide 4 out of a total of 7 satellites that will be required.

GARP EQUATORIAL LV: TAT/DELTA/FW4 Wt: 200-400 V_C: 33,600

Purpose: To collect meteorological data for the tropics to be used in the GARP program.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	2.0	2.0	2.0	1.0	-	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

GARP GEOSTATIONARY LV: TAT(9C)/DELTA/TE364 Wt: 1,000 V_C: 33,600

Purpose: To fulfill one-half of the GARP requirement for continuous viewing.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	5.0	5.0	10.0	8.0	2.0	-	-	-	-	-
Flights	-	-	-	2	-	-	-	-	-	-	-

GARP POLAR ORBITER LV: TAT(9C)/DELTA/TE364 Wt: 1,500-2,000 V_C: 28,840

Purpose: To gather data collected from sounding the atmosphere for use in the GARP program.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	5.0	10.0	20.0	10.0	5.0	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

Earth Resources Survey (ERS)

The ERS program is directed towards providing the necessary technology for making surveys of the Earth's resources by using remote sensors both in aircraft and satellites (ERTS, Earth Resources Technology Satellites). The technology development includes sensors, spacecraft, and data-handling systems.

ERTS AIRCRAFT

Purpose: To provide for the definition of remote sensor subsystems and signature data for subsequent spacecraft use.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	12.9	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Flights	(Non-space-flight project)										

ERTS A,B LV: TAT/Delta/FW4 Wt: 1,500 V_C: 27,000

Purpose: To utilize the earliest opportunity for developing the overall systems technology of an Earth resource survey system. These spacecraft are just the start of the program and not intended to satisfy all technology development needs.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	41.5	22.3	15.3	3.7	-	-	-	-	-	-	-
Flights	-	1	1	-	-	-	-	-	-	-	-

ERTS C,D (72) LV: TAT(3C)/DELTA/FW4 Wt: 1,500 V_C: 27,000

Purpose: To provide an early method of obtaining high-resolution records of the Earth's surface by recovering films from camera/hard film systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	9.0	12.0	3.0	2.0	-	-	-	-	-	-	-
Flights	-	1	1	-	-	-	-	-	-	-	-

ERTS C,D (73) LV: TAT/DELTA/FW4 Wt: 1,500 V_C: 27,000

Purpose: To provide an early method of obtaining high-resolution records of the Earth's surface by recovering films from camera/hard film systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	9.0	12.0	3.0	2.0	-	-	-	-	-	-
Flights	-	-	1	1	-	-	-	-	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
ERTS AIRCRAFT	•	•	•	•	•	•	•	•	•	•
ERTS A,B	•	•	•	•	•	•	•	•	•	•
ERTS C,D (72)		•	•	•		•				
ERTS C,D (73)					•		•	•	•	•

ERTS C,D (74) LV: TAT/DELTA/FW4 Wt: 1,500 V_C: 27,000

Purpose: To provide an early method of obtaining high-resolution records of the Earth's surface by recovering films from camera/hard film systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	9.0	12.0	3.0	2.0	-	-	-	-	-
Flights	-	-	-	1	1	-	-	-	-	-	-

ERTS E,F (73) LV: TAT(3C)/DELTA/FW4 Wt: 2,000 V_C: 27,000

Purpose: ERTS-E is to conduct experiments primarily in the areas of oceanography and marine research. ERTS-F is to upgrade the technology needed to perform inventory and predictive surveys of global land and sea areas.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	10.0	14.5	4.5	1.0	-	-	-	-	-	-
Flights	-	-	1	1	-	-	-	-	-	-	-

ERTS E,F (74) LV: TAT/DELTA/FW4 Wt: 1,500 V_C: 27,000

Purpose: ERTS-E is to conduct experiments primarily in the areas of oceanography and marine research. ERTS-F is to upgrade the technology needed to perform inventory and predictive surveys of global land and sea areas.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	10.0	14.5	4.5	1.0	-	-	-	-	-
Flights	-	-	-	1	1	-	-	-	-	-	-

ERTS FOLLOW-ON LV: TAT(9C)/DELTA Wt: 3,000-5,000 V_C: 27,000

Purpose: To provide for a continuing Earth Resources Survey program which would be primarily responsible for developing technology and provide for transition to operational satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	5.0	20.0	35.0	55.0	90.0	110.0	120.0	70.0
Flights	-	-	-	-	-	1	1	2	2	3	3

ERTS FOLLOW-ON (MED-LEVEL) LV: TAT(9C)/DELTA Wt: 3,000-5,000 V_C: 27,000

Purpose: To provide for a continuing Earth Resources Survey program which would be primarily responsible for developing technology and provide for transition to operational satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	10.0	30.0	30.0	40.0	60.0	80.0	70.0	60.0
Flights	-	-	-	-	-	1	1	1	2	2	2

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
ERTS C,D (74)	•									
ERTS E,F (73)			•							
ERTS E,F (74)	•	•		•	•	•	•	•	•	•
ERTS FOLLOW-ON					•			•		
ERTS FOLLOW-ON (MED-LEVEL)						•	•		•	•

Small Applications Technology Satellites (SATS)

SATS are small spacecraft, which are to be used to evaluate various space applications sensors and subsystems. Each flight would include only a few experiments. The program complements other application programs such as ERS.

SMALL ATS A-D (72) LV: SCOUT Wt: 250 V_C: Various

Purpose: To provide for evaluation of subsystems to be subsequently used in the ERTS satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.0	10.5	13.0	6.0	-	-	-	-	-	-	-
Flights	-	1	2	1	-	-	-	-	-	-	-

SMALL ATS A-D (73) LV: SCOUT Wt: 250 V_C: Various

Purpose: To provide for evaluation of subsystems to be subsequently used in the ERTS satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	3.0	10.5	13.0	6.0	-	-	-	-	-	-
Flights	-	-	1	2	1	-	-	-	-	-	-

SMALL ATS-SCOUT LV: SCOUT Wt: Various V_C: Various

Purpose: To provide a low-cost quick reaction method of evaluating space application technology subsystems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	3.0	10.0	10.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Flights	-	-	2	2	2	1	1	1	1	1	1

SMALL ATS-DELTA LV: TAT/DELTA/TE364 Wt: Various V_C: Various

Purpose: To provide a low-cost quick reaction method of evaluating space application technology subsystems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Flights	-	-	-	-	-	1	-	1	-	1	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
SMALL ATS A-D (72)			•	•						
SMALL ATS A-D (73)	•	•				•	•		•	•
SMALL ATS-SCOUT					•			•		
SMALL ATS-DELTA					•			•		

Program	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
SMALL ATS FOLLOW-ON SCOUT						•				
GEOS-C (71)		•		•	•					
GEOS-C (72)			•			•	•	•	•	•
GEOS-C (73)	•									

SMALL ATS FOLLOW-ON SCOUT LV: SCOUT Wt: Various V_C: Various

Purpose: To provide for a continuing program similar to SMALL ATS-SCOUT.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	2.0	8.0	10.0	12.0	12.0	12.0	12.0	12.0	12.0
Flights	-	-	-	-	1	1	2	1	2	1	2

GEOS-C (71) LV: TAT/DELTA/FW4 Wt: 500 V_C: 27,000

Purpose: To establish one World datum, improve positional accuracies of Geodetic Control stations and satellite tracking sites. Also to be the first step in the application of space technology to the development of altimetry.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.5	3.8	1.7	1.7	-	-	-	-	-	-	-
Flights	1	-	-	-	-	-	-	-	-	-	-

GEOS-C (72) LV: TAT/DELTA/FW4 Wt: 500 V_C: 27,500

Purpose: To establish one World datum, improve positional accuracies of Geodetic Control stations and satellite tracking sites. Also to be the first step in the application of space technology to the development of altimetry.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	3.5	3.8	1.7	1.7	-	-	-	-	-	-	-
Flights	-	1	-	-	-	-	-	-	-	-	-

GEOS-C (73) LV: TAT/DELTA/FW4 Wt: 500 V_C: 27,500

Purpose: To establish one World datum, improve positional accuracies of Geodetic Control stations and satellite tracking sites. Also to be the first step in the application of space technology to the development of altimetry.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	3.5	3.8	1.7	1.7	-	-	-	-	-	-
Flights	-	-	1	-	-	-	-	-	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
DRAG-FREE SAT (72)			•	•						
DRAG-FREE SATS (74-79)	•	•			•		•	•	•	
DRAG-FREE SATS (75-79)			•	•		•				•
SAT-TO-SAT (74)			•							
SAT-TO-SAT (75)	•	•		•	•	•	•	•	•	•

DRAG-FREE SAT (72) LV: SCOUT Wt: 155-175 V_C: 27,000

Purpose: To provide information about mass movements on the Earth, such as Earth tides, ocean tides, atmospheric mass transport, and discrete mass shifts. Also would provide for direct measurement of variations in the Earth's gravitational field.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	4.0	0.8	0.7	-	-	-	-	-	-	-	-
Flights	-	1	-	-	-	-	-	-	-	-	-

DRAG-FREE SATS (74-79) LV: SCOUT Wt: 155-175 V_C: 27,000

Purpose: To provide information about mass movements on the Earth, such as Earth tides, ocean tides, atmospheric mass transport, and discrete mass shifts. Also would provide for direct measurement of variations in the Earth's gravitational field.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	0.5	3.0	4.5	1.0	0.5	4.0	3.5	3.0	1.0	-
Flights	-	-	-	1	-	-	1	-	1	-	-

DRAG-FREE SATS (75-79) LV: SCOUT Wt: 155-175 V_C: 27,000

Purpose: To provide information about mass movements on the Earth, such as Earth tides, ocean tides, atmospheric mass transport, and discrete mass shifts. Also would provide for direct measurement of variations in the Earth's gravitational field.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	3.0	4.5	1.5	4.0	3.5	3.0	1.0	-
Flights	-	-	-	-	1	-	1	-	1	-	-

SAT-TO-SAT (74) LV: TAT/DELTA/TE364 Wt: Unknown V_C: Unknown

Purpose: To place a satellite into Earth orbit which can precisely track another satellite in order to develop information which will yield a significant improvement in the Active Earth Model.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	2.5	4.5	1.5	-	-	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

SAT-TO-SAT (75) LV: TAT/DELTA/TE364 Wt: Unknown V_C: Unknown

Purpose: To place a satellite into Earth orbit which can precisely track another satellite in order to develop information which will yield a significant improvement in the Active Earth Model.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	1.0	2.5	4.5	1.5	-	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
SEA-TO-SAT (74-79)	•	•					•		•	•
SEA-TO-SAT (73)				•						
SEA-TO-SAT (73-80)			•							
DATA COLLECTION (74)			•	•						
DATA COLLECTION (76)	•	•			•	•	•	•	•	•

SEA-TO-SAT (74-79) LV: SCOUT Wt: 170-200 V_C: 27,000

Purpose: To provide satellite altimetry to measure mean sea surface height to an accuracy of ±20 cm, each flight providing increasing accuracy. Would also contain at least two precision tracking systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.2	0.5	3.0	4.5	2.2	4.1	3.7	4.4	3.0	1.5	--
Flights	-	-	-	1	-	-	1	-	1	-	-

SEA-TO-SAT (73) LV: SCOUT Wt: 170-200 V_C: 27,000

Purpose: To provide satellite altimetry to measure mean sea surface height to an accuracy of ±50 cm. Would also contain at least two precision tracking systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	3.5	2.5	1.5	-	-	-	-	-	-	-
Flights	-	-	1	-	-	-	-	-	-	-	-

SEA-TO-SAT (73-80) LV: SCOUT Wt: 170-200 V_C: 27,000

Purpose: To provide satellite altimetry to measure mean sea surface height to an accuracy of ±20 cm, each flight providing increasing accuracy. Would also contain at least two precision tracking systems.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	0.5	3.0	4.5	2.2	4.1	3.7	4.4	3.7	4.4	3.0	1.5
Flights	-	-	1	-	-	1	-	1	-	1	-

DATA COLLECTION (74) LV: SCOUT Wt: 300 V_C: 28,300

Purpose: To aid in the development of technology necessary to gather data from a variety of widely distributed remote land and water platforms and sensors.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	1.0	2.0	6.0	4.0	1.0	-	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

DATA COLLECTION (76) LV: SCOUT Wt: 300 V_C: 28,300

Purpose: To aid in the development of technology necessary to gather data from a variety of widely distributed remote land and water platforms and sensors.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	1.0	2.0	6.0	4.0	1.0	-	-	-	-
Flights	-	-	-	-	-	1	-	-	-	-	-

Data Relay Satellite Systems (DRSS)

This program would provide spacecraft in synchronous orbits to command, track, and relay data from low or near Earth orbiting spacecraft to a few centrally located mission control centers. The system would greatly improve the capability of the NASA Tracking and Data Acquisition network.

DRSS (77) LV: ATLAS/CENTAUR Wt: 1,610 V_C: 33,600

Purpose: To provide 2 spin-stabilized spacecraft each of which will support a multi-channel UHF system and a single S-band beam.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	2.0	7.0	12.0	19.0	9.0	2.0	-	-	-
Flights	-	-	-	-	-	-	2	-	-	-	-

DRSS (78) LV: ATLAS/CENTAUR Wt: 1,610 V_C: 33,600

Purpose: To provide 2 spin-stabilized spacecraft each of which will support a multi-channel UHF system and a single S-band beam.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	2.0	7.0	12.0	19.0	9.0	2.0	-	-
Flights	-	-	-	-	-	-	-	2	-	-	-

DRSS (78-1) LV: ATLAS/CENTAUR Wt: 2,000 V_C: 33,600

Purpose: To provide a spin-stabilized spacecraft with multi-channel UHF equipment, 2 S-band beams, and 1 X-band beam.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	9.0	14.0	9.0	7.0	1.0	-	-
Flights	-	-	-	-	-	-	-	1	-	-	-

DRSS DUAL ACCESS (76) LV: ATLAS/CENTAUR Wt: 1,940 V_C: 33,600

Purpose: To provide 2 spin-stabilized spacecraft, each with multi-channel UHF operation, and 2 S-band beams.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	14.0	23.0	14.0	11.0	2.0	-	-	-	-
Flights	-	-	-	-	-	2	-	-	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
DRSS (77)		•			•					
DRSS (78)	•									
DRSS (78-1)			•							
DRSS DUAL ACCESS (76)						•				

DRSS TRIPLE ACCESS (74) LV: ATLAS/CENTAUR Wt: 2,000 V_C:33,600

Purpose: To provide 2 spin-stabilized spacecraft, each with multichannel UHF operation, 2 S-band beams, and 1 X-band beam.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	16.0	27.0	17.0	13.0	2.0	-	-	-	-	-	-
Flights	-	-	-	2	-	-	-	-	-	-	-

DRSS TRIPLE ACCESS (77) LV: ATLAS/CENTAUR Wt: 2,000 V_C: 33,600

Purpose: To provide 2 spin-stabilized spacecraft, each with multichannel UHF operation, 2 S-band beams, and 1 X-band beam.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	16.0	27.0	17.0	13.0	2.0	-	-	-
Flights	-	-	-	-	-	-	2	-	-	-	-

DRSS DUAL PURPOSE LV: ATLAS/CENTAUR/GBII Wt: 1,970 V_C: 33,600

Purpose: To provide two 3-axis-stabilized spacecraft with a large power supply to be used by both automated and manned spacecraft for data relay. Would be able to handle voice, high-data-rate, and low-data-rate users.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	8.0	20.0	54.0	84.0	30.0	-
Flights	-	-	-	-	-	-	-	-	-	2	-

DATA RELAY-NEAR EARTH LV: ATLAS/CENTAUR/GBII Wt: 1,970 V_C: 39,600

Purpose: To provide a 3-axis stabilized spacecraft which has two-way communications and tracking capability simultaneously for one very-high-data-rate user, 3 high-data-rate users, and 15 low data-rate users.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	4.0	10.0	27.0	42.0	15.0	-	-	-
Flights	-	-	-	-	-	-	-	1	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
DRSS TRIPLE ACCESS (74)			●	●						
DRSS TRIPLE ACCESS (77)							●	●	●	●
DRSS DUAL PURPOSE							●	●	●	●
DATA RELAY-NEAR EARTH				●		●				

Communications R&D

This program area is concerned with developing satellite systems and spacecraft technology applicable to space communications needs.

ATS F,G (72) LV: TITAN IIIC Wt: 2,050 V_C: 39,600

Purpose: To investigate and flight-test technology common to a large number of satellite applications - with most equipment being related to communications.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	60.4	48.7	32.2	18.0	11.0	5.0	2.0	2.0	2.0	2.0	2.0
Flights	-	1	-	1	-	-	-	-	-	-	-

ATS F,G (73) LV: TITAN IIIC Wt: 2,050 V_C: 39,600

Purpose: To investigate and flight-test technology common to a large number of satel: te applications - with most equipment being related to communications.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	31.0	40.0	45.0	32.0	18.0	11.0	5.0	2.0	2.0	2.0	2.0
Flights	-	-	1	-	1	-	-	-	-	-	-

COMMUNICATIONS ATS (77,79) LV: ATLAS/CENTAUR Wt: 2,100 V_C: 39,600

Purpose: To develop and test technology needed for various communication satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	3.0	10.0	17.0	30.0	30.0	13.0	3.0	3.0
Flights	-	-	-	-	-	-	1	-	1	-	-

COMMUNICATIONS ATS (77,80) LV: ATLAS/CENTAUR Wt: 2,100 V_C: 39,600

Purpose: To develop and test technology needed for various communication satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	3.0	10.0	17.0	23.0	14.0	23.0	13.0	3.0
Flights	-	-	-	-	-	-	1	-	-	1	-

COMMUNICATIONS R&D (75) LV: TAT(6C)/DELTA/TE364 Wt: 800 V_C: 33,600

Purpose: To carry equipment to measure the basic propagation and absorption characteristic of the atmosphere and near-Earth space in the 1,00GH$_z$ region of the spectrum to measure the effects of the same space on satellite-to-satellite communication and provide for small terminal communication testing.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	7.0	12.0	18.0	5.0	1.0	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
ATS F,G (72)	•	•	•	•	•	•				
ATS F,G (73)							•	•	•	•
COMMUNICATIONS ATS (77,79)					•			•	•	•
COMMUNICATIONS ATS (77,80)	•	•	•				•			
COMMUNICATIONS R&D (75)				•		•				

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
COMMUNICATIONS R&D (78)				•		•				
COMMUNICATIONS R&D (78,80)					•			•	•	•
NAVIGATION T/C (74)		•	•	•						
NAVIGATION T/C (76)	•				•	•	•	•	•	•

COMMUNICATIONS R&D (78) LV: TAT(6C)/DELTA/TE364 Wt: 800 V_C: 33,600

Purpose: To carry wide-band equipment for operating in the $50GH_z$ and $100GH_z$ bands to extend basic measurements to include dispersion effects and perform practical communication tests.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	5.0	11.0	15.0	13.0	2.0	1.0
Flights	-	-	-	-	-	-	-	1	-	-	-

COMMUNICATIONS R&D (78,80) LV: TAT(6C)/DELTA/TE364 Wt: 800 V_C: 33,600

Purpose: To carry wide-band equipment for operating in the $50GH_z$ and $100GH_z$ bands to extend basic measurements to include dispersion effects and perform practical communication tests.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	6.0	13.0	17.0	17.0	12.0	9.0
Flights	-	-	-	-	-	-	-	1	-	1	-

Navigation and Traffic Control

The objective of this program area is to develop the space technology necessary to provide mobile crafts and/or platforms with improved position information and to aid in communication and traffic control activities.

NAVIGATION T/C (74) LV: TAT(9C)/DELTA/TE364 Wt: 1,200 V_C: 33,600

Purpose: To place 2 satellites into geostationary orbit to demonstrate and test new technology for use in navigation and traffic control.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	7.0	19.0	38.0	40.0	14.0	2.0	-	-	-	-	-
Flights	-	-	-	2	-	-	-	-	-	-	-

NAVIGATION T/C (76) LV: TAT(9C)/DELTA/TE364 Wt: 1,200 V_C: 33,600

Purpose: To place 2 satellites into geostationary orbit to demonstrate and test new technology for use in navigation and traffic control.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	7.0	19.0	38.0	40.0	14.0	2.0	-	-	-
Flights	-	-	-	-	-	2	-	-	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
NAVIGATION T/C (77,78)						•	•	•	•	•
NAVIGATION T/C (80,81)								•		
S-BAND TV TECH (74)			•							
S-BAND TV TECH (75)				•		•				
S-BAND TV TECH (77)	•	•								

NAVIGATION T/C (77,78) LV: ATLAS/CENTAUR Wt: 1,130 V_C; 39,600

Purpose: To develop 2 prototype satellites which would provide traffic surveillance and digital data and analog voice communications. Position determination would be by an active range-transponding technique.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	16.5	26.0	15.2	5.0	1.0	0.5
Flights	-	-	-	-	-	-	1	1	-	-	-

NAVIGATION T/C (80,81) LV: ATLAS/CENTAUR Wt: 1,130 V_C: 39,600

Purpose: To develop 2 prototype satellites which would provide traffic surveillance and digital data and analog voice communications. Position determination would be by an active range-transponding technique.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	-	16.5	26.0	15.2
Flights	-	-	-	-	-	-	-	-	-	1	1

Broadcast Satellites

The objective of the program area is to facilitate applications of space technology and satellite systems for broadcast purposes.

S-BAND TV TECH (74) LV: TITAN IIID/CENTAUR Wt: 1,500-1,600 V_C: 39,600

Purpose: To develop and demonstrate high power S-band technology for use in TV broadcasting.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	7.0	11.0	18.0	10.0	2.0	-	-	-	-	-	-
Flights	-	-	-	1	-	-	-	-	-	-	-

S-BAND TV TECH (75) LV: TITAN IIID/CENTAUR Wt: 1,500-1,600 V_C: 39,600

Purpose: To develop and demonstrate high power S-band technology for use in TV broadcasting.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	2.0	7.0	11.0	18.0	10.0	2.0	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

S-BAND TV TECH (77) LV: TITAN IIID/CENTAUR Wt: 1,500-1,600 V_C: 39,600

Purpose: To develop and demonstrate high power S-band technology for use in TV broadcasting.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	2.0	7.0	11.0	18.0	10.0	2.0	-	-	-
Flights	-	-	-	-	-	-	1	-	-	-	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOW)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
X-BAND TV TECH (75)			•							
X-BAND TV TECH (77)					•		•	•	•	
PROTO-INSTR TV SAT			•			•				
UHF-TV-TECH (78)			•		•	•		•		
UHF-TV-TECH (80)				•						

X-BAND TV TECH (75) LV: TITAN IIID/CENTAUR Wt: 1,800 V_C: 39,600

Purpose: To develop and demonstrate high power X-band technology for use in TV broadcasting.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	1.5	11.0	22.0	22.0	4.0	-	-	-	-	-
Flights	-	-	-	-	1	-	-	-	-	-	-

X-BAND TV TECH (77) LV: TITAN IIID/CENTAUR Wt: 1,800 V_C: 39,600

Purpose: To develop and demonstrate high power X-band technology for use in TV broadcasting.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	1.5	11.0	22.0	22.0	4.0	-	-	-
Flights	-	-	-	-	-	-	1	-	-	-	-

PROTO-INSTR TV SAT LV: TITAN IIID/CENTAUR Wt: 1,600 V_C: 39,600

Purpose: To investigate the use of space technology as an aid to instruction in developing countries.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	1.0	3.0	6.0	17.0	12.0	2.0	-	-	-	-
Flights	-	-	-	-	-	1	-	-	-	-	-

UHF-TV-TECH (78) LV: TITAN IIID/CENTAUR Wt: 1,800 V_C: 39,600

Purpose: To develop and test the technology necessary to build UHF broadcast TV satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	2.0	11.0	23.0	22.0	4.0	-	-
Flights	-	-	-	-	-	-	-	1	-	-	-

UHF-TV-TECH (80) LV: TITAN IIID/CENTAUR Wt: 1,800 V_C: 39,600

Purpose: To develop and test the technology necessary to build UHF broadcast TV satellites.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	2.0	11.0	23.0	22.0	4.0
Flights	-	-	-	-	-	-	-	-	-	1	-

	SA1 (BASELINE I)	SA2 (BASELINE II)	SA3 (STG OPTION I)	SA4 (PSG-LOR)	SA5 (ALTERNATIVE I)	SA6 (ALTERNATIVE II)	SA7 (ALTERNATIVE III)	SA8 (ALTERNATIVE IV)	SA9 (ALTERNATIVE V)	SA10 (ALTERNATIVE VI)
PROTO-INFO/ETV SAT. A			•		•		•	•	•	
PROTO-INFO/ETV SAT. B			•				•	•	•	
UHF DIRECT TV PROTO-OP					•	•	•	•	•	

PROTO-INFO/ETV SAT. A LV: TITAN IIID/CENTAUR Wt: 1,700-2,000 V_C: 39,600

Purpose: To develop the technologies and techniques necessary for an operational TV broadcast satellite to be used for both educational TV and high volume information dissemination.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	3.0	6.0	17.0	12.0	2.0	-	-
Flights	-	-	-	-	-	-	-	1	-	-	-

PROTO-INFO/ETV SAT. B LV: TITAN IIID/CENTAUR Wt: 1,700-2,000 V_C: 39,600

Purpose: To develop the technologies and techniques necessary for an operational TV broadcast satellite to be used for both educational TV and high volume information dissemination.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	1.0	3.0	5.0	12.0	10.0	-
Flights	-	-	-	-	-	-	-	-	-	1	-

UHF DIRECT TV PROTO-OP LV: TITAN IIID/CENTAUR Wt: 1,800-2,000 V_C: 39,600

Purpose: To develop the technology and techniques necessary for an operational TV broadcasting satellite using high power UHF equipment. Such satellites would be used for educational TV, instructional TV for developing countries, and for rural area coverage.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Funding	-	-	-	-	-	-	-	2.0	6.0	14.0	15.0
Flights	-	-	-	-	-	-	-	-	-	-	1

SA Mission Models

SA mission models, SA1-SA10, are presented in this section. Each model is described by its guidelines, characteristics, funding plot (Figures VII-1 through VII-10), and flight schedule (Tables VII-1 through VII-10). Comparisons and discussions of the models are presented in a later section of this Chapter.

Model Guidelines and Description: SA1(Baseline I)

This model was developed directly from the automated applications projects contained in Programs II and III of the NASA report to the STG.[7] The guidelines governing the areas of Applications for all three programs presented in the report were as follows:

"In Applications, a vigorous effort would be focused on bringing into operation as quickly as possible new and improved space systems for Earth resources surveys, advanced meteorology, oceanography, data collection and relay, navigation and traffic control, and direct broadcasting."[7]

The major characteristics of the model are as follows:

- Space station and shuttle available in 1977
- FY 1971 funding ceiling for NASA of $4 billion
- Moderately paced program after FY 1971.

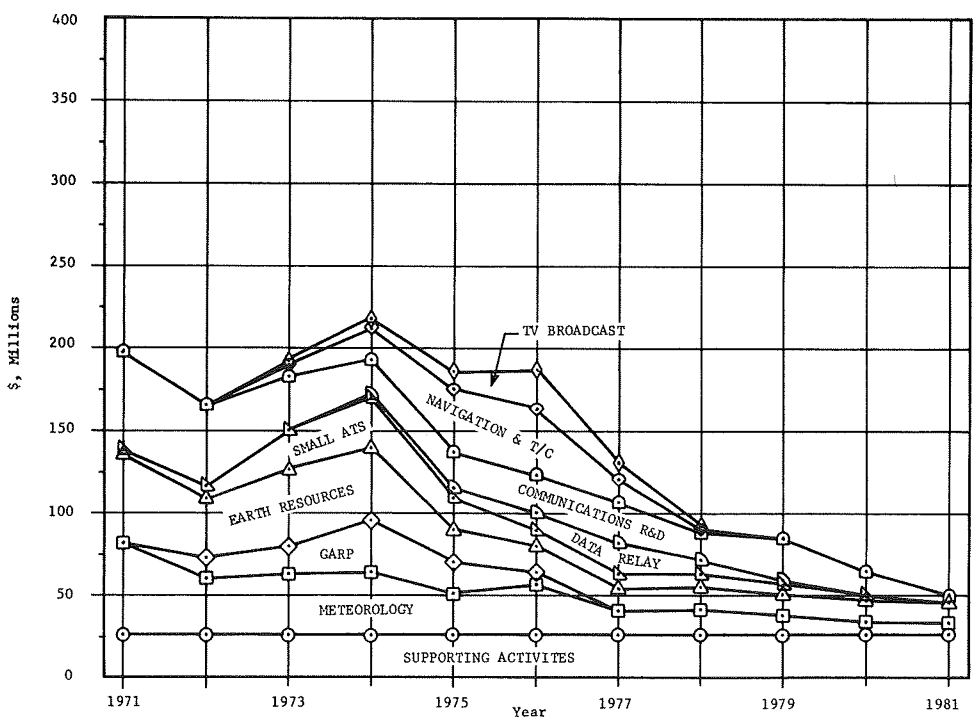

FIGURE VII-1. SA1 FUNDING PLOT

TABLE VII-1. SA1 FLIGHT SCHEDULE

Project	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81
		Year										
	Meteorological Satellites											
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G,H,J	TAT(9C)/DELTA	-	-	-	-	1	-	1	-	1	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
	GARP											
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
	Earth Resources											
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
	Small Applications Technology Satellites											
SMALL ATS A-D(73)	SCOUT	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
GEOS-C(73)	TAT/DELTA/FW4	-	-	1	-	-	-	-	-	-	-	-
SEA-TO-SAT(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
	Data Relay											
DRSS(78)	ATLAS/CENTAUR	-	-	-	-	-	-	-	2	-	-	-
	Communications R&D											
COMMUNICATIONS ATS F,G(72)	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-
COMMUNICATIONS ATS(77,80)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	1	-	-
	Navigation and Traffic Control											
NAVIGATION T/C(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	2	-	-	-	-	-
	TV Broadcast											
S-BAND TV TECH(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-

Model Guidelines and Description: SA2(Baseline II)

This model was developed by modifying SA1(Baseline I) to agree with the plans represented by the SA portion of the NASA FY 1971 submission to the Bureau of the Budget.(5)

The principal changes made were as follows:

- ERTS C,D were changed to 1972, 1973 from 1974, 1975
- GEOS-C was changed to 1971 from 1973
- DRSS A,B were changed to 1977 from 1978.

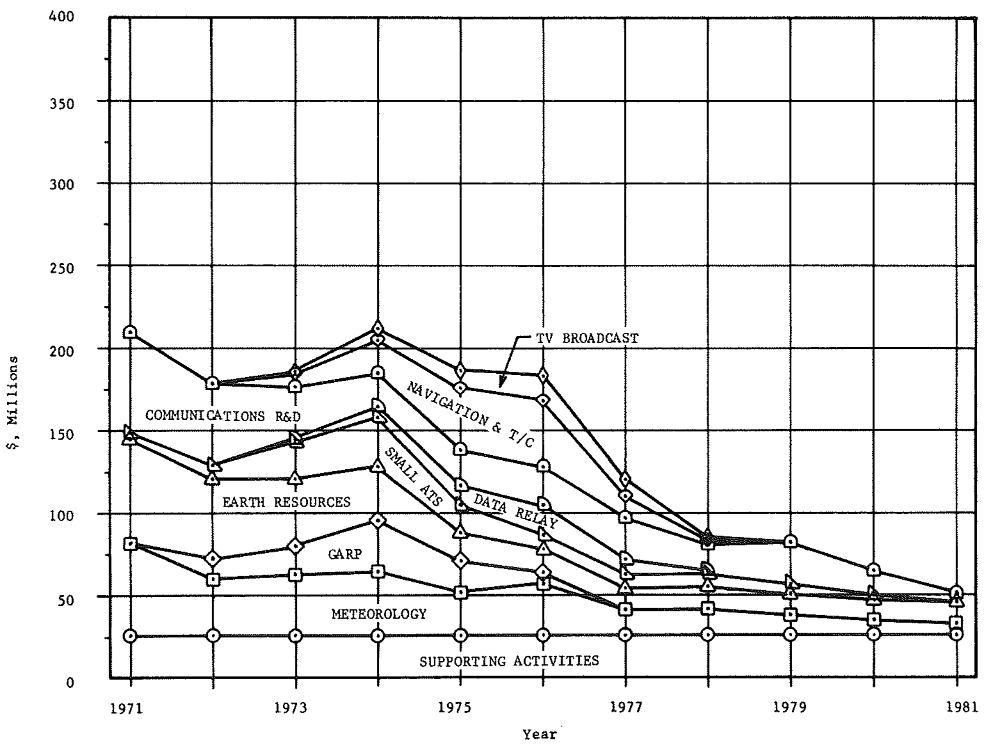

FIGURE VII-2. SA2 FUNDING PLOT

TABLE VII-2. SA2 FLIGHT SCHEDULE

Project	Launch Vehicle	Year										
		71	72	73	74	75	76	77	78	79	80	81
	Meteorological Satellites											
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G-J	TAT(9C)/DELTA	-	-	-	-	1	-	1	-	1	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
	GARP											
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
	Earth Resources											
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(72)	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
	Small Applications Technology Satellites											
SMALL ATS A-D(73)	SCOUT	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
GEOS-C(71)	TAT/DELTA/FW4	1	-	-	-	-	-	-	-	-	-	-
SEA-TO-SAT(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
	Data Relay											
DRSS(77)	ATLAS/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
	Communications R&D											
COMMUNICATIONS ATS F,G(72)	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-
COMMUNICATIONS ATS(77,80)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	-	1	-
	Navigation and Traffic Control											
NAVIGATION T/C(74)	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
	TV Broadcast											
S-BAND TV TECH(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-

<u>Model Guidelines and Description: SA3(STG Option I)</u>

This model was derived from the automated applications projects included in Program I of the NASA report to the STG(7). Program I was the most aggressive of the three programs presented in the report. The guidelines for the Applications area in Program I are the same as those quoted in SA1 guidelines. The starting dates for proposed new projects are 1 or 2 years earlier in this model as compared with SA1. This model has more flights associated with most programs.

Major characteristics of this model are as follows:

- A 12-man space station and shuttle in 1976
- A 50-man space station in 1980
- Strong program of TV Broadcast satellites
- Active meteorological satellites program.

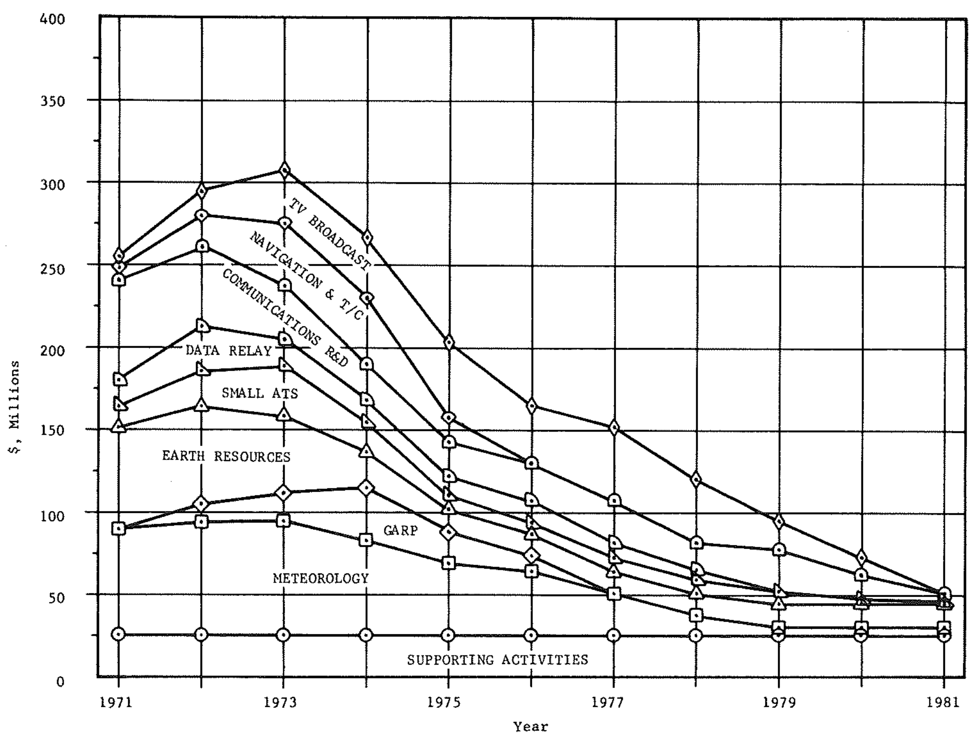

FIGURE VII-3. SA3 FUNDING PLOT

TABLE VII-3. SA3 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Meteorological Satellites												
TIROS N(74)	TAT(6C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G,H	TAT(9C)/DELTA	-	-	-	1	1	-	-	-	-	-	-
NIMBUS(77,78)	TAT(9C)/DELTA	-	-	-	-	-	-	1	1	-	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
METEOROLOGICAL ATS(74)	ATLAS/CENTAUR	-	-	-	1	-	1	1	-	-	-	-
GARP												
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
Earth Resources												
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(72)	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS E,F(73)	TAT/DELTA/FW4	-	-	1	1	-	-	-	-	-	-	-
Small Applications Technology Satellites												
SMALL ATS A-D(72)	SCOUT	-	1	2	1	-	-	-	-	-	-	-
DRAG-FREE SAT(72)	SCOUT	-	1	-	-	-	-	-	-	-	-	-
DRAG-FREE SATS(75-79)	SCOUT	-	-	-	-	1	-	1	-	1	-	-
GEOS-C(72)	TAT/DELTA/FW4	-	1	-	-	-	-	-	-	-	-	-
SEA-TO-SAT(73-80)	SCOUT	-	-	1	-	-	1	-	1	-	1	-
SAT-TO-SAT(74)	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
DATA COLLECTION(74)	SCOUT	-	-	-	1	-	-	-	-	-	-	-
Data Relay												
DRSS TRIPLE ACCESS(74)	ATLAS/CENTAUR	-	-	-	2	-	-	-	-	-	-	-
DRSS(78-1)	ATLAS/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
Communications R&D												
COMMUNICATIONS ATS F,G(72)	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-
COMMUNICATIONS ATS(77,80)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	-	1	-
Navigation and Traffic Control												
NAVIGATION T/C(74)	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
TV Broadcast												
S-BAND TV TECH(74)	TITAN IIID/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
X-BAND TV TECH(75)	TITAN IIID/CENTAUR	-	-	-	-	1	-	-	-	-	-	-
PROTO-INSTR TV SAT	TITAN IIID/CENTAUR	-	-	-	-	-	1	-	-	-	-	-
PROTO-INFO/ETV SAT A	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
UHF TV TECH(78)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
PROTO-INFO/ETV SAT B	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-

Model Guidelines and Description: SA4(PSG-LOW)

The guidelines for this model were obtained by combining the lowest plan found for Earth Observations with the lowest plan found for Communications and Navigation in the PSG Prospectus File.[6]

Major characteristics of this model are as follows:

- First data relay satellites in 1974
- Low level TV broadcast satellite flight program
- Moderate small applications satellite program.

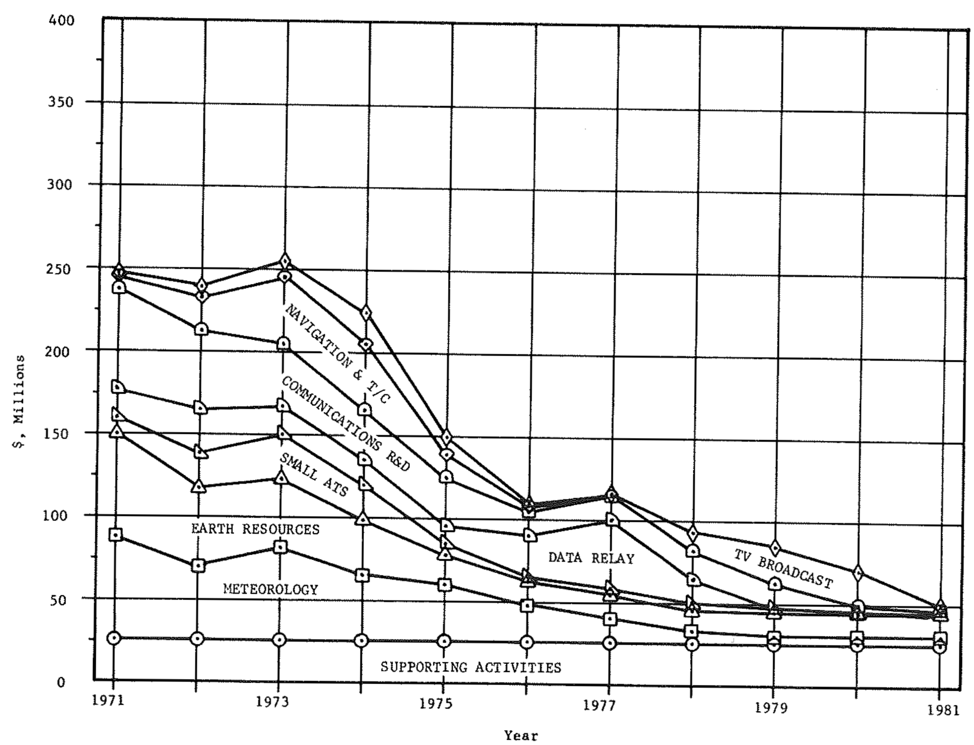

FIGURE VII-4. SA4 FUNDING PLOT

TABLE VII-4. SA4 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
						Meteorological Satellites						
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G,H	TAT(9C)/DELTA	-	-	-	1	1	-	-	-	-	-	-
NIMBUS(77,78)	TAT(9C)/DELTA	-	-	-	-	-	-	1	1	-	-	-
SMS	TAT(9C)/DELTA	1	1	-	-	-	-	-	-	-	-	-
						Earth Resources						
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(72)	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
						Small Applications Technology Satellites						
SMALL ATS A-D(72)	SCOUT	-	1	2	1	-	-	-	-	-	-	-
DRAG-FREE SAT(72)	SCOUT	-	1	-	-	-	-	-	-	-	-	-
DRAG-FREE SATS(75-79)	SCOUT	-	-	-	-	1	-	1	-	1	-	-
GEOS-C(71)	TAT/DELTA/FW4	1	-	-	-	-	-	-	-	-	-	-
SEA-TO-SAT(73)	SCOUT	-	-	1	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(74)	SCOUT	-	-	-	1	-	-	-	-	-	-	-
						Data Relay						
DATA RELAY - NEAR EARTH	ATLAS/CENTAUR/BII	-	-	-	-	-	-	-	1	-	-	-
DRSS TRIPLE ACCESS(74)	ATLAS/CENTAUR	-	-	-	2	-	-	-	-	-	-	-
						Communications R&D						
COMMUNICATIONS ATS F,G(72)	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-
COMMUNICATIONS R&D(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78)	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-
						Navigation and Traffic Control						
NAVIGATION T/C(74)	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
						TV Broadcast						
S-BAND TV TECH(75)	TITAN IIID/CENTAUR	-	-	-	-	1	-	-	-	-	-	-
UHF TV TECH(80)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-

Model Guidelines and Description: SA5(Alternative I)

In developing this model, the principal guideline was to create a model which would have a funding requirement nearly equal to the SA projection from Appendix A for the period 1972 to 1977.

The major characteristics of this model are as follows:

- ERTS A-F were stretched out (1972-1975)
- An aggressive ERTS follow-on program
- A continuing small applications satellite program is included
- First 2 data relay satellites in 1977
- Moderate TV broadcast flight program.

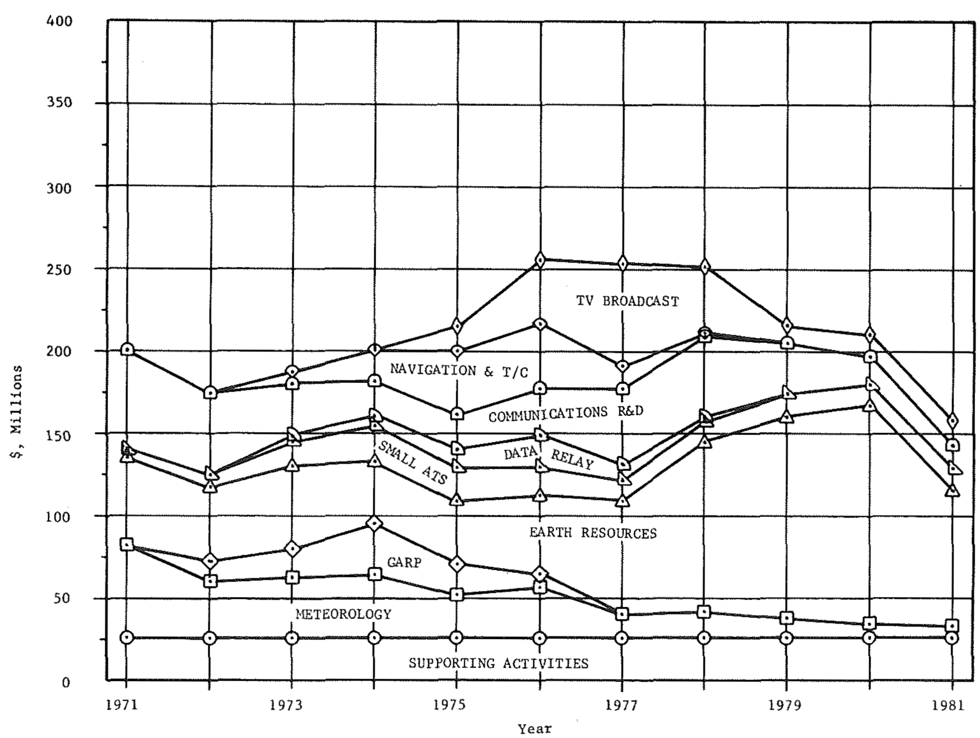

FIGURE VII-5. SA5 FUNDING PLOT

TABLE VII-5. SA5 FLIGHT SCHEDULE

Project	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81
							Year					
	Meteorological Satellites											
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G-J	TAT(9C)/DELTA	-	-	-	-	1	-	1	-	1	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
	GARP											
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
	Earth Resources											
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	TAT/DELTA/FW4	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON	TAT(9C)/DELTA	-	-	-	-	-	1	1	2	2	3	3
	Small Applications Technology Satellites											
SMALL ATS SCOUT	SCOUT	-	-	2	2	2	1	1	1	1	1	1
SMALL ATS DELTA	TAT/DELTA/TE364	-	-	-		-	1	-	1	-	1	-
DRAG-FREE SATS (74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
GEOS-C(71)	TAT/DELTA/FW4	1	-	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
	Data Relay											
DRSS(77)	ATLAS/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
	Communications R&D											
COMMUNICATIONS ATS F,G(72)	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-
COMMUNICATIONS ATS(77,79)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	1	-	-
COMMUNICATIONS R&D(78,80)	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	1	-
	Navigation and Traffic Control											
NAVIGATION T/C(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	2	-	-	-	-	-
	TV Broadcast											
X-BAND TV TECH(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
UHF TV TECH(78)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
UHF DIRECT TV PROTO-OP	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SA6(Alternative II)

Guidelines for model SA6 were created to represent a moderately aggressive applications program in the first half of the time period (1971-1975). This was accomplished by delaying and stretching out the projects included in SA3(STG Option I), which is the most aggressive SA model presented.

The major characteristics of the model are as follows:

- ERTS A-F in (1972-1975)
- Large ERTS follow-on program
- 2 data relay satellites in 1976 and 1 in 1978
- Navigation T/C - 2 in 1976, 1 in 1977 and 1 in 1978
- Moderate TV Broadcast satellite program.

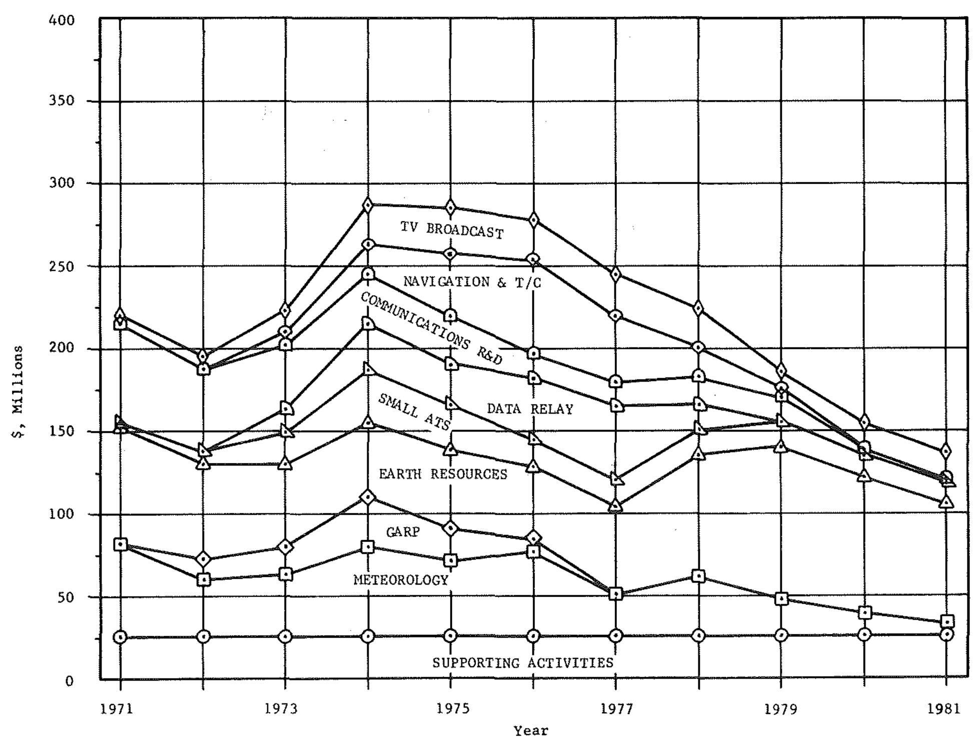

FIGURE VII-6. SA6 FUNDING PLOT

TABLE VII-6. SA6 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
	Meteorological Satellites											
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G,H,J	TAT(9C)/DELTA	-	-	-	-	1	-	1	-	1	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
METEOROLOGICAL ATS(76)	ATLAS/CENTAUR	-	-	-	-	-	1	-	1	1	-	-
	GARP											
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
	Earth Resources											
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(72)	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON(MED-LEVEL)	TAT(9C)/DELTA	-	-	-	-	-	1	1	1	2	2	2
	Small Applications Technology Satellites											
SMALL ATS A-D(73)	SCOUT	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(75-79)	SCOUT	-	-	-	-	1	-	1	-	1	-	-
GEOS-C(72)	TAT/DELTA/FW4	-	1	-	-	-	-	-	-	-	-	-
SMALL ATS FOLLOW-ON SCOUT	SCOUT	-	-	-	-	1	1	2	1	2	1	2
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
	Data Relay											
DRSS DUAL ACCESS(76)	ATLAS/CENTAUR	-	-	-	-	-	2	-	-	-	-	-
DATA RELAY-NEAR EARTH	ATLAS/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
	Communications R&D											
COMMUNICATIONS ATS F,G(72)	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-
COMMUNICATIONS R&D(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78)	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	-	-
	Navigation and Traffic Control											
NAVIGATION T/C(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	2	-	-	-	-	-
NAVIGATION T/C(77,78)	ATLAS/CENTAUR	-	-	-	-	-	-	1	1	-	-	-
	TV Broadcast											
S-BAND TV TECH(75)	TITAN IIID/CENTAUR	-	-	-	-	1	-	-	-	-	-	-
PROTO-INSTR TV SAT	TITAN IIID/CENTAUR	-	-	-	-	-	1	-	-	-	-	-
UHF TV TECH(78)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
UHF DIRECT TV PROTO-OP	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SA7(Alternative III)

The primary guideline used in the development of SA7 was to create a model which would have funding requirements nearly equal to the SA funding projection from Appendix A.

The major characteristics of model SA7 are as follows:

- ERTS A-F (1972-1975)
- A medium level ERTS follow-on program
- First 2 data relay satellites in 1977
- ATS F,G in 1973 and 1975
- Communications ATS H,J in 1977 and 1980
- 3 broadcast TV prototype satellites
- 1 broadcast TV technology demonstration satellite.

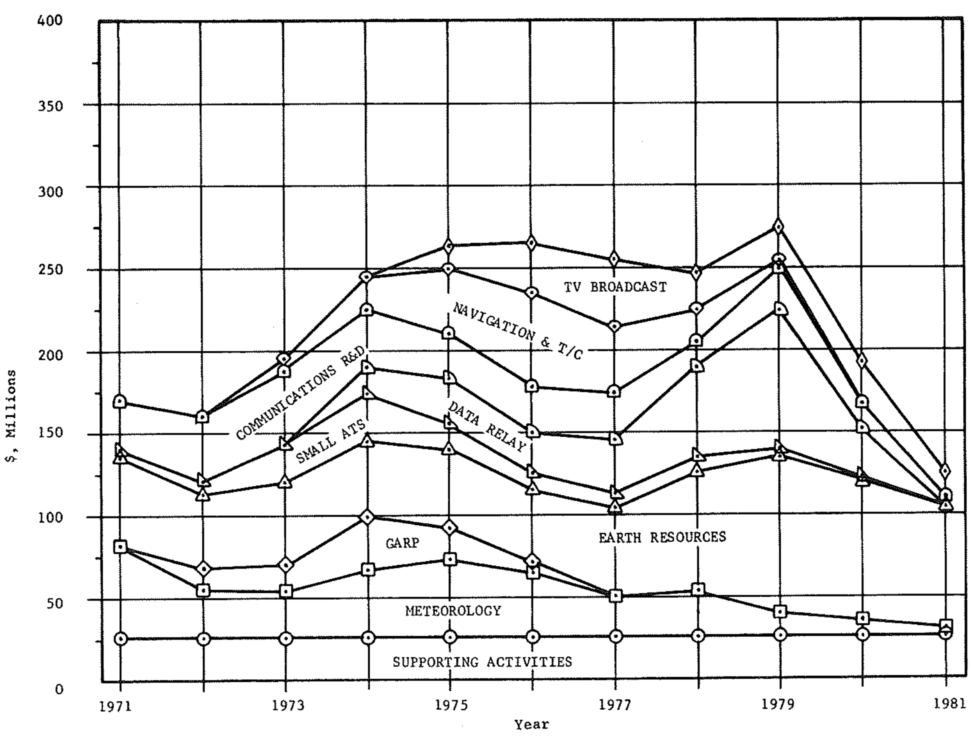

FIGURE VII-7. SA7 FUNDING PLOT

TABLE VII-7. SA7 FLIGHT SCHEDULE

Project	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81
		Year										
Meteorological Satellites												
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS(77,78)	TAT(9C)/DELTA	-	-	-	-	-	-	1	1	-	-	-
SMS	TAT(9C)/DELTA	1	1	-	-	-	-	-	-	-	-	-
METEOROLOGICAL ATS(76)	ATLAS/CENTAUR	-	-	-	-	-	1	-	1	1	-	-
GARP												
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
Earth Resources												
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	TAT/DELTA/FW4	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON(MED.-LEVEL)	TAT(9C)/DELTA	-	-	-	-	-	1	1	1	2	2	2
Small Applications Technology Satellites												
SMALL ATS A-D(73)	SCOUT	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
GEOS-C(72)	TAT/DELTA/FW4	-	1	-	-	-	-	-	-	-	-	-
SEA-TO-SAT(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
Data Relay												
DRSS TRIPLE ACCESS(77)	ATLAS/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
DRSS DUAL PURPOSE	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	2	-
Communications R&D												
COMMUNICATIONS ATS F,G(73)	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-
COMMUNICATIONS ATS(77,80)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	-	1	-
Navigation and Traffic Control												
NAVIGATION T/C(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	2	-	-	-	-	-
NAVIGATION T/C(77,78)	ATLAS/CENTAUR	-	-	-	-	-	-	1	1	-	-	-
TV Broadcast												
X-BAND TV TECH(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
PROTO-INFO/ETV SAT B	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
UHF DIRECT TV PROTO-OP	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SA8(Alternative IV)

Guidelines for model SA8 were created by assuming that there would be an active flight schedule in the period 1975-1981, and that the SA availalbe funds would exceed those projected in Appendix A for the same period.

The major characteristics of the model are as follows:

- ATS F,G in 1973 and 1975
- Meteorological ATS in 1975, 1977, 1978
- Aggressive ERTS follow-on program
- Active SMALL ATS follow-on program
- 1 Communications satellite per year (1977-1980)
- 6 Navigation and Traffic Control satellites (1976-1981)
- 2 Broadcast TV technology satellites
- 3 Broadcast TV prototype satellites.

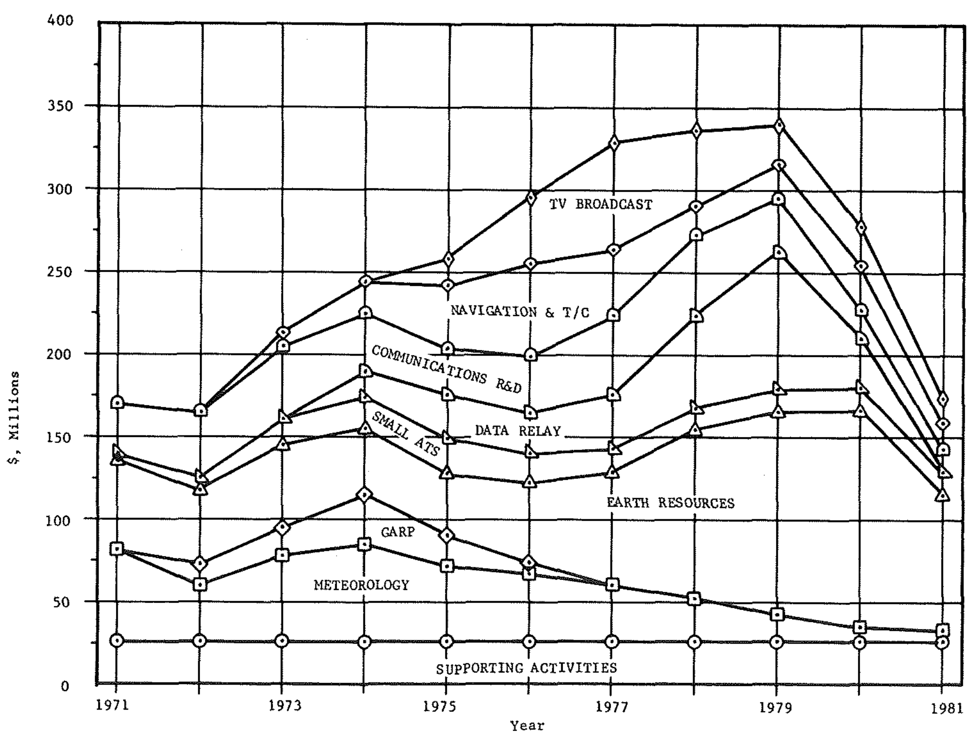

FIGURE VII-8. SA8 FUNDING PLOT

TABLE VII-8. SA8 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
Meteorological Satellites												
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G,H,J	TAT(9C)/DELTA	-	-	-	-	1	-	1	-	1	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
METEOROLOGICAL ATS(75)	ATLAS/CENTAUR	-	-	-	-	1	-	1	1	-	-	-
GARP												
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
Earth Resources												
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	TAT/DELTA/FW4	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON	TAT(9C)/DELTA	-	-	-	-	-	1	1	2	2	3	3
Small Applications Technology Satellites												
SMALL ATS-SCOUT	SCOUT	-	-	2	2	2	1	1	1	1	1	1
SMALL ATS-DELTA	DELTA	-	-	-	-	-	1	-	1	-	1	-
DRAG-FREE SATS(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
GEOS-C(72)	TAT/DELTA/FW4	-	1	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
Data Relay												
DRSS TRIPLE ACCESS(77)	ATLAS/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
DRSS DUAL PURPOSE	ATLAS/CENTAUR/BII	-	-	-	-	-	-	-	-	-	2	-
Communications R&D												
COMMUNICATIONS ATS F,G(73)	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-
COMMUNICATIONS ATS(77,79)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	1	-	-
COMMUNICATIONS R&D(78,80)	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	1	-
Navigation and Traffic Control												
NAVIGATION T/C(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	2	-	-	-	-	-
NAVIGATION T/C(77,78)	ATLAS/CENTAUR	-	-	-	-	-	-	1	1	-	-	-
NAVIGATION T/C(80,81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	-	-	1	1
TV Broadcast												
X-BAND TV TECH(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
UHF TV TECH(78)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
PROTO-INFO/ETV SAT B	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
UHF DIRECT TV PROTO-OP	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: SA9(Alternative V)

In establishing guidelines for model SA9 it was assumed that the SA funding would grow at a high rate for the period 1971 to 1975, such that the 1975 funding would be 10 to 15% higher than the 1975 SA projection from Appendix A. For the second half of the period the growth in funding was to slow down so that the 1980 funding would nearly equal the SA projection (from Appendix A) for 1980.

The major characteristics of SA9 are as follows:

- ATS, F,G in 1973 and 1975
- Meteorological ATS in 1976, 1978, 1979
- Medium level ERTS follow-on program
- 2 data relay satellites in 1977 and 2 in 1980
- 1 Communications satellite per year (1977-1980)
- 1 Broadcast TV technology satellite
- 3 Broadcast TV prototype satellites.

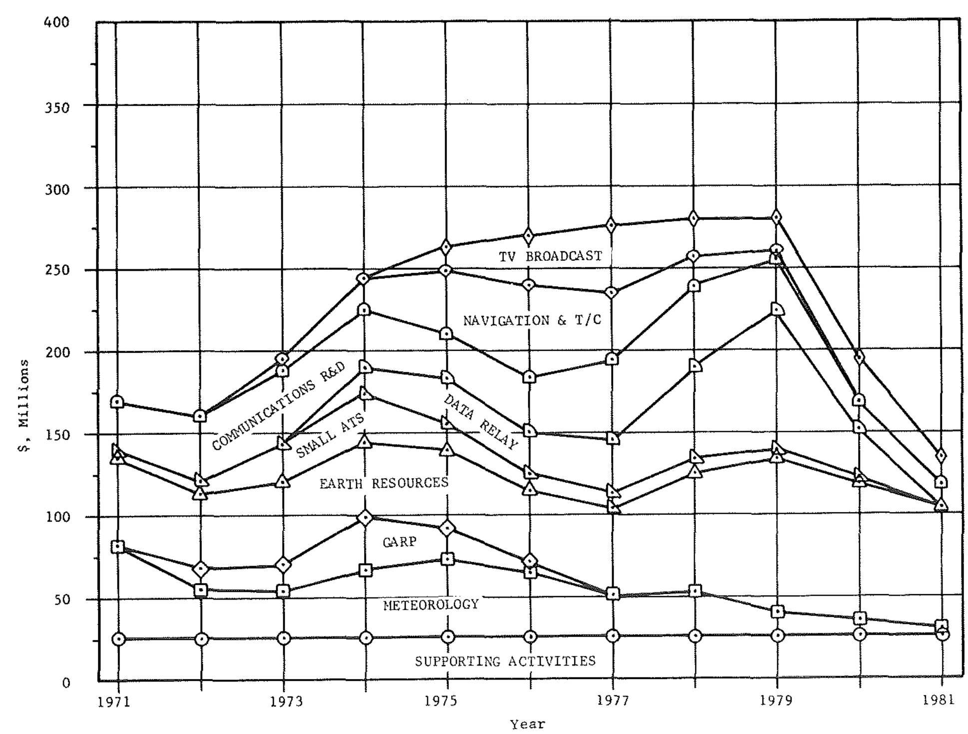

FIGURE VII-9. SA9 FUNDING PLOT

TABLE VII-9. SA9 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
	Meteorological Satellites											
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
NIMBUS(77,78)	TAT(9C)/DELTA	-	-	-	-	-	-	1	1	-	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
METEOROLOGICAL ATS(76)	ATLAS/CENTAUR	-	-	-	-	-	1	-	1	1	-	-
	GARP											
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
	Earth Resources											
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	TAT/DELTA/FW4	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	TAT/DELTA/FW4	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON(MED.-LEVEL)	TAT(9C)/DELTA	-	-	-	-	-	1	1	1	2	2	2
	Small Applications Technology Satellites											
SMALL ATS A-D(73)	SCOUT	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	SCOUT	-	-	1	-	-	-	1	-	1	-	-
GEOS-C(72)	TAT/DELTA/FW4	-	-	1	-	-	-	-	-	-	-	-
SEA-TO-SAT(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
	Data Relay											
DRSS TRIPLE ACCESS(77)	ATLAS/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
DRSS DUAL PURPOSE	ATLAS/CENTAUR/BII	-	-	-	-	-	-	-	-	-	2	-
	Communications R&D											
COMMUNICATIONS ATS F,G(73)	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-
COMMUNICATIONS ATS(77,79)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	1	-	-
COMMUNICATIONS R&D(78,80)	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	1	-
	Navigation and Traffic Control											
NAVIGATION T/C(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	2	-	-	-	-	-
NAVIGATION T/C(77,78)	ATLAS/CENTAUR	-	-	-	-	-	-	1	1	-	-	-
	TV Broadcast											
X-BAND TV TECH(77)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
PROTO-INFO/ETV SAT B	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	1	-
UHF DIRECT TV PROTO-OP	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	-	-	-	-

Model Guidelines and Description: SA10(Alternative VI)

Model SA10 was constructed using the guideline that the funding requirements be near to and lower than the SA projection from Appendix A for the period 1971-1981.

The major characteristics of this model are as follows:

- ATS F,G in 1973 and 1975
- Meteorological ATS in 1976, 1978, 1979
- Medium level ERTS follow-on program
- First 2 data delay satellites in 1977
- 1 Communications satellite per year (1977-1980)
- No Broadcast TV satellites.

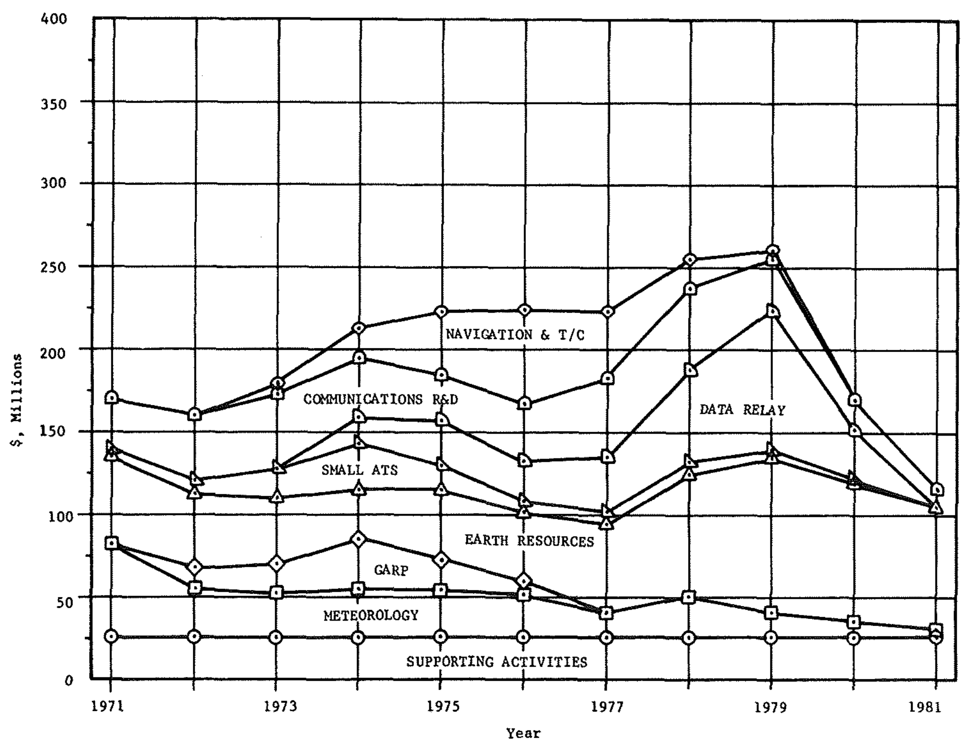

FIGURE VII-10. SA10 FUNDING PLOT

TABLE VII-10. SA10 FLIGHT SCHEDULE

Project	Launch Vehicle	Year										
		71	72	73	74	75	76	77	78	79	80	81
	Meteorological Satellites											
TIROS N(75)	TAT(6C)/DELTA/TE364	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	TAT(9C)/DELTA	-	1	1	-	-	-	-	-	-	-	-
SMS	TAT(9C)/DELTA/TE364	1	1	-	-	-	-	-	-	-	-	-
METEOROLOGICAL ATS(76)	ATLAS/CENTAUR	-	-	-	-	1	-	-	1	1	-	-
	GARP											
GARP EQUATORIAL	TAT/DELTA/FW4	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	TAT(9C)/DELTA/TE364	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	TAT(9C)/DELTA/TE364	-	-	-	1	-	-	-	-	-	-	-
	Earth Resources											
ERTS A,B	TAT/DELTA/FW4	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	TAT/DELTA/FW4	-	-	1	1	-	-	-	-	-	-	-
ERTS FOLLOW-ON(MED.-LEVEL)	TAT/9C)/DELTA	-	-	-	-	-	1	1	1	2	2	2
	Small Applications Technology Satellites											
SMALL ATS A-D(73)	SCOUT	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(75-79)	SCOUT	-	-	-	-	1	-	1	-	1	-	-
GEOS-C(72)	TAT/DELTA/FW4	-	1	-	-	-	-	-	-	-	-	-
SEA-TO-SAT(74-79)	SCOUT	-	-	-	1	-	-	1	-	1	-	-
SAT-TO-SAT(75)	TAT/DELTA/FW4	-	-	-	-	1	-	-	-	-	-	-
DATA COLLECTION(76)	SCOUT	-	-	-	-	-	1	-	-	-	-	-
	Data Relay											
DRSS TRIPLE ACCESS(77)	ATLAS/CENTAUR	-	-	-	-	-	-	2	-	-	-	-
DRSS DUAL PURPOSE	ATLAS/CENTAUR/GBII	-	-	-	-	-	-	-	-	-	2	-
	Communications R&D											
COMMUNICATIONS ATS F,G(73)	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-
COMMUNICATIONS ATS(77,79)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	1	-	-
COMMUNICATIONS R&D(78,80)	TAT(6C)/DELTA/TE364	-	-	-	-	-	-	-	1	-	1	-
	Navigation and Traffic Control											
NAVIGATION T/C(76)	TAT(9C)/DELTA/TE364	-	-	-	-	-	2	-	-	-	-	-
NAVIGATION T/C(77,78)	ATLAS/CENTAUR	-	-	-	-	-	-	1	1	-	-	-

Discussion

SA Models

Figures VII-11 and VII-12 show the funding requirements for the 10 SA mission models presented in the previous section along with funding projections (dashed lines) from Appendix A. Figure VII-11 contains the 4 NASA-based models (SA1-SA4) and Figure VII-12 contains the 6 alternative models (SA5-SA10) developed as part of this study.

As Figure VII-11 indicates, all NASA-based models require very high funding growth rates from FY 1971 to FY 1974 followed by a rapid decline. This decline may have resulted from assuming that the proposed space station and shuttle system would be available in 1976 or 1977. The introduction of such systems might be expected to reduce the number of automated application satellites needed since many such experiments would (or could) probably be incorporated in a space station. However, definition and design of the space station are only in preliminary phases and, thus, it is difficult at this time to draw firm conclusions concerning the eventual impact of such systems.

Current indications are that the NASA budget for the next several years will not be sufficient to support the pace of the programs presented in the STG report to the President.(12) For this reason, it has been assumed here that the space station and shuttle are not likely to be available until after 1980. This basic assumption was used in developing all of the alternative SA models (SA5-SA10).

As indicated in Figure VII-12, all of the alternative models require an increase in annual funding. The funding requirements for these alternative models bracket the SA funding projection from Appendix A. These models are considered to be representative of the range of possible future activities that might be pursued by the OSSA Divisions involved: Earth Observations Programs, and Communications Programs.

The area of space applications is currently receiving growing emphasis in Congress, by the President, and in the public press. This activity area has the largest proposed budget increase for FY 1971 and it appears that, based on present conditions, this growth is likely to continue for the next several years. Such a growth is shown in SA funding projection in Appendix A. However, even assuming that this projection is reasonable, it does not appear possible to pursue space applications activities in the early part of the 1971-1981 period at the pace proposed in the NASA-based models.

Table VII-11 indicates the pace of activity for each activity area by model in terms of first launch date and number of launches. The upper figure in each entry indicates the year of the first launch (after 1970) for that activity in each model. Thus, for example, an entry $\substack{72 \\ 4}$ would indicate that the first launch (after 1970) is in 1972 and that 4 launches are included in the period 1971-1981. Table VII-11 does not indicate the projected schedules for the launches for each activity; however, this information can be obtained by referring to the flight schedules for each individual model presented in the previous section.

A careful study of Table VII-11 shows that most of the variations among the SA models presented are associated with:

SATS

ERTS Follow-on

Communications R&D

Broadcast TV Technology

Broadcast Prototypes

Data Relay.

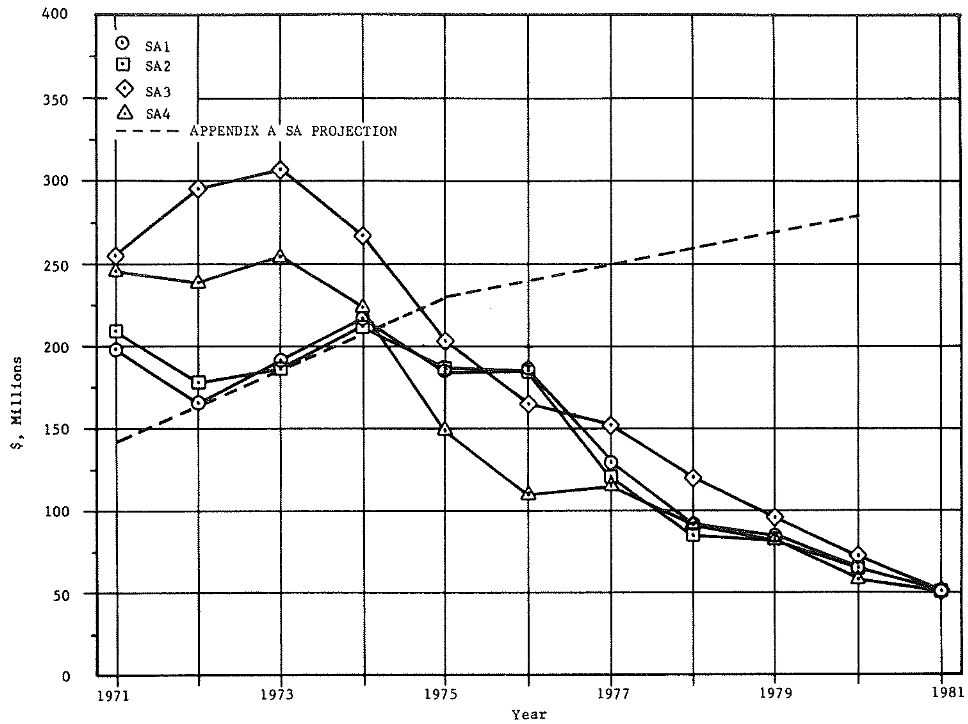

FIGURE VII-11. ESTIMATED FUNDING REQUIRED FOR NASA MODELS SA1-SA4

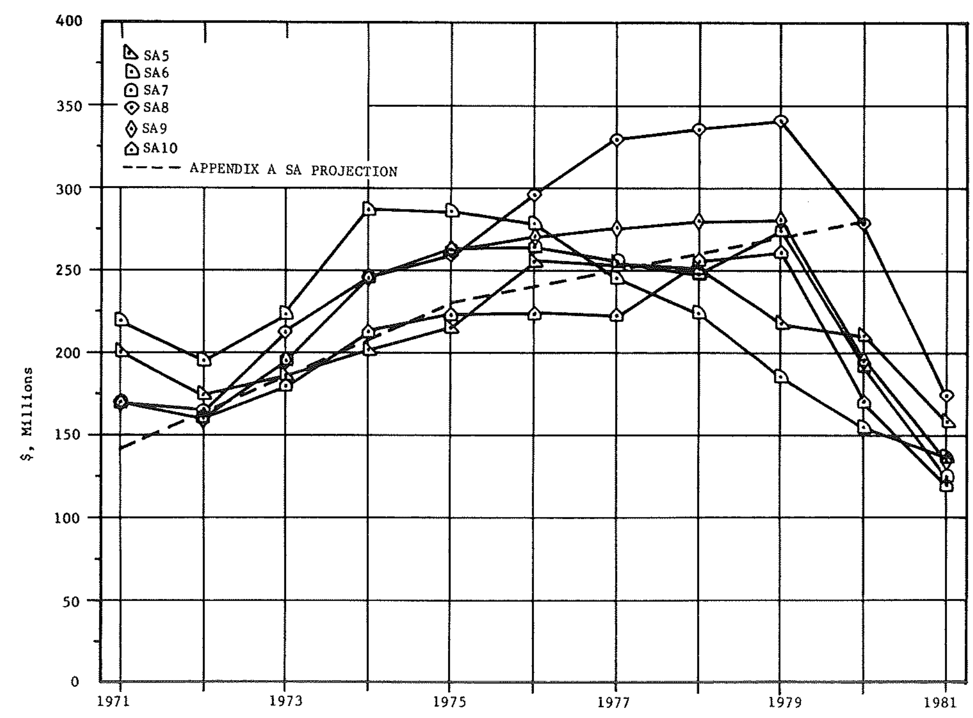

FIGURE VII-12. ESTIMATED FUNDING REQUIRED FOR ALTERNATIVE MODELS SA5-SA10

TABLE VII-11. PROGRAM ACTIVITY BY MODEL

Program Areas	Models									
	SA1	SA2	SA3	SA4	SA5	SA6	SA7	SA8	SA9	SA10
Supporting Activities	• [a]	•	•	•	•	•	•	•	•	•
Sounding Rockets	•	•	•	•	•	•	•	•	•	•
ERS Aircraft	•	•	•	•	•	•	•	•	•	•
TIROS	75 [b] 1	75 1	74 1	75 1	75 1	75 1	75 1	75 1	75 1	75 1
NIMBUS	72 5	72 5	72 6	72 6	72 5	72 5	72 4	72 5	72 4	72 2
SMS	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2
Meteorological ATS	-	-	74 3	-	-	76 3	76 3	75 3	76 3	76 3
GARP	74 4	74 4	74 4	-	74 4	74 4	74 4	74 4	74 4	74 4
ERTS A-F or A-D	72 6	72 6	72 6	72 6	72 6	72 6	72 6	72 6	72 6	72 4
ERTS Follow-on	-	-	-	-	76 12	76 9	76 9	76 12	76 9	76 9
SATS	73 13	71 13	72 15	71 12	71 20	72 18	72 13	72 21	72 13	72 12
Data Relay	78 2	77 2	74 3	74 3	77 2	76 3	77 4	77 4	77 4	77 4
Communications ATS	72 4	72 4	72 4	72 2	72 4	72 2	73 4	73 4	73 4	73 4
Communications R&D	-	-	-	75 2	78 2	75 2	-	78 2	78 2	78 2
Navigation T/C	76 2	76 2	74 2	74 2	76 2	76 4	76 4	76 6	76 4	76 4
Broadcast TV Technology	77 1	77 1	74 3	75 2	77 2	75 2	77 1	77 2	77 1	-
Broadcast TV Prototypes	-	-	76 3	-	78 2	76 2	78 3	78 3	78 3	-
Total	40	40	49	48	64	63	59	75	60	51

(a) A dot (•) mean that a non-space-flight program area is included in the indicated model.
(b) The upper figure of each group indicates the year of first launch (after 1970) and the lower figure indicates the number of launches in the 1971-1981 time period.

The most significant variations involve SATS and ERTS follow-on. This results from having considered a wide range of follow-on activities in both program areas. Both programs are new and the requirements for follow-on satellites depend heavily on results from earlier flights from all applications program areas and on the estimated needs of potential future user organizations. As a result, it is difficult to estimate the future flight program for these areas. The missions included in the alternative SA models shown here are considered representative of the types of follow-on activities that might be pursued.

The other areas involving some variation among the models are associated with the Communications Programs Division. Since this Division is new, its long range plans probably had not been firmly established at the time of the PSG exercises during 1969. Mission plans in these areas also depend heavily upon the needs of the potential future users (i.e., users of the communication systems) and these needs are being revised constantly.

To summarize, current rapid growth in Space Applications makes it difficult to assess the future of these programs since the future plans depend so heavily on results obtained in the next several years and on the rapidly varying projections of user needs. In spite of this difficulty, alternative SA models presented here are considered to reflect a reasonable range of launch vehicle requirements for supporting space applications programs in the 1971-1981 time period.

Launch Vehicle Requirements

Table VII-12 presents launch vehicle requirements by model and year. The family of launch vehicles required to support the SA models presented includes SCOUT, DELTA (ranging from TAT/DELTA to TAT(9C)/DELTA/TE364), ATLAS/CENTAUR, TITAN IIIC and TITAN IIID/CENTAUR. The DELTA has the highest launch rate in each of the models, accounting for 50 to 65% of the launches. The SCOUT has the next highest launch rate, which, on a percentage basis, ranges from 18 to 28%. The TITAN IIIC is assigned to only 2 launches in each of the models: Communications ATS F and G. The use rates of the ATLAS/CENTAUR and TITAN IIID/CENTAUR vary considerably among the models. Both of these vehicles have much higher use rates in second half of the time period (1976-1981) than in the first half (1971-1975). The earliest either vehicle is required is in 1974 and that is only in SA4 (STG Option I), which, because of its funding requirements, is not considered to be realistic. In the alternative models, the earliest dates in which TITAN/CENTAUR and ATLAS/CENTAUR are required range from 1975 to 1977. In SA10, the TITAN IIID/CENTAUR is not required. This results from the absence of Broadcast TV, which is the only SA mission requiring the TITAN IIID/CENTAUR from this model.

In general the launch requirements for the Space Applications program do not appear to require any launch vehicle capability beyond that currently planned.

Summary of the Most Demanding Missions

As noted in the previous section, the projected Space Applications programs do not require launch vehicle capability beyond that currently planned. The most demanding activities are associated with the Broadcast TV missions which involve heavy spacecraft; however, projections indicate that none of these spacecraft would be launched until after 1976.

There are a number of projects which would require the use of the more energetic DELTA vehicles now being considered, i.e. the TAT(9C)/DELTA and TAT(9C)/DELTA/TE364. Both of these vehicles are expected to be available in time for any mission which requires them.

TABLE VII-12. LAUNCH SCHEDULES BY MODEL AND VEHICLE

Model	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81	Total
	SCOUT	-	-	1	4	1	1	2	-	2	-	-	11
	DELTA[a]	1	3	3	6	5	2	1	-	1	-	-	22
SA1	ATLAS/CENTAUR[b]	-	-	-	-	-	-	1	2	-	1	-	4
	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-	1
	TOTAL	1	4	4	11	6	3	5	2	3	1	-	40
	SCOUT	-	-	1	4	1	1	2	-	2	-	-	11
	DELTA	2	4	3	5	4	2	1	-	1	-	-	22
SA2	ATLAS/CENTAUR	-	-	-	-	-	-	3	-	-	1	-	4
	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	-	-	-	-	1
	TOTAL	2	5	4	10	5	3	7	-	3	1	-	40
	SCOUT	-	2	3	2	1	1	1	1	1	1	-	13
	DELTA	1	5	4	11	1	-	1	2	-	-	-	25
SA3	ATLAS/CENTAUR	-	-	-	2	-	1	1	-	-	1	-	5
	TITAN IIIC	-	1	-	1	-	-	1	-	-	-	-	3
	TITAN IIID/CENTAUR	-	-	-	1	1	1	-	2	-	1	-	6
	TOTAL	1	8	7	17	3	3	4	5	1	3	-	52
	SCOUT	-	2	3	2	1	-	1	-	1	-	-	10
	DELTA	2	4	3	4	5	-	1	2	-	-	-	21
SA4	ATLAS/CENTAUR	-	-	-	2	-	-	-	1	-	-	-	3
	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	1	-	-	-	-	1	-	2
	TOTAL	2	7	6	9	7	-	2	3	1	1	-	38
	SCOUT	-	-	2	-	2	2	1	1	1	1	1	11
	DELTA	2	3	3	8	4	4	2	4	3	5	3	41
SA5	ATLAS/CENTAUR	-	-	-	-	-	-	3	-	1	-	-	4
	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	2	-	-	1	4
	TOTAL	2	4	5	9	6	6	7	7	5	6	5	62

(a) In this table, DELTA refers to the following vehicles:

TAT/DELTA
TAT/DELTA/FW4
TAT/DELTA/TE364
TAT(6C)/DELTA/TE364
TAT(9C)/DELTA/TE364.

(b) In this table, ATLAS/CENTAUR also includes ATLAS/CENTAUR/BII.

TABLE VII-12. LAUNCH SCHEDULES BY MODEL AND VEHICLE
(Continued)

Model	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81	Total
SA6	SCOUT	-	-	1	2	3	2	2	1	2	1	2	16
	DELTA	1	5	3	5	5	3	3	2	4	2	2	35
	ATLAS/CENTAUR	-	-	-	-	-	3	1	3	1	-	-	8
	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	1	1	-	1	-	-	1	4
	TOTAL	1	6	4	8	9	9	6	7	7	3	5	65
SA7	SCOUT	-	-	1	4	1	1	2	-	2	-	-	11
	DELTA	1	4	3	6	3	3	2	3	2	2	2	31
	ATLAS/CENTAUR	-	-	-	-	-	1	4	1	1	3	-	10
	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	-	1	1	4
	TOTAL	1	4	5	10	5	5	9	5	5	6	3	58
SA8	SCOUT	-	-	2	3	2	2	2	1	3	1	1	17
	DELTA	1	4	3	6	4	4	2	4	2	5	3	38
	ATLAS/CENTAUR	-	-	-	-	1	-	5	2	1	3	1	13
	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	2	-	1	1	5
	TOTAL	1	4	6	9	8	6	10	9	6	10	6	75
SA9	SCOUT	-	-	1	4	1	1	2	-	2	2	-	13
	DELTA	1	4	3	6	3	3	2	3	2	3	2	32
	ATLAS/CENTAUR	-	-	-	-	-	1	4	2	2	-	-	9
	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	-	1	1	4
	TOTAL	1	4	5	10	5	5	9	6	6	6	3	60
SA10	SCOUT	-	-	1	3	2	-	2	-	2	-	-	10
	DELTA	1	4	3	5	2	3	1	2	2	3	2	28
	ATLAS/CENTAUR	-	-	-	-	-	1	4	2	2	2	-	11
	TITAN IIIC	-	-	1	-	1	-	-	-	-	-	-	2
	TOTAL	1	4	5	8	5	4	7	4	6	5	2	51

References

(1) "Communications and Navigation Program Documentation", prepared by Planning Panel on Communications and Navigation of the Planning Steering Group, May 1, 1969.

(2) "Earth Surveys Program Documentation", prepared by Planning Panel of the Planning Steering Group, April 22, 1969.

(3) Rogers, D. P., "NASA's Developing Strategy of Space Applications", TRW Space Log, Fall, 1968, pp 3-11.

(4) "OSSA Research and Development Program Operating Plan, 69-2", Headquarters, National Aeronautics and Space Administration, Unpublished as a document; material transmitted to NASA Code SP under BMI-NLVP-IL-69-306, December 5, 1969.

(5) McGolrick, J. E., "FY 1971 Budget Data", Memorandum to SV/Advanced Programs and Technology Files, March 16, 1970.

(6) Planning Steering Group (PSG) Prospectus File (1969) (Computer Tape), assembled during 1969 PSG exercise. Available at BMI-NLVP and Goddard Space Flight Center.

(7) "America's Next Decades in Space", A Report for the Space Task Group, prepared by the National Aeronautics and Space Administration, September, 1969.

(8) Wukelic, G. E., and Frazier, N. A., "Selected Space Goals and Objectives and Their Relation to National Goals", prepared by Battelle Memorial Institute, Columbus Laboratories, Columbus, Ohio, for NASA Office of Space Science and Applications, Report No. BMI-NLVP-TR-69-2, July 15, 1969.

(9) "Program Management Report, Level O", NASA Office of Space Science and Applications. Data contained in this document are updated and reviewed monthly.

(10) Nippert, D. A., and Pittenger, J. L., "Trip to NASA Headquarters, December 8, 1969, to Deliver and Discuss Mission Models", Memorandum No. BMI-NLVP-MM-69-64, December 9, 1969.

(11) Nippert, D. A., "Visit to NASA Headquarters to Talk to Mission Planners Concerning Mission Models (11/18/69 and 11/19/69)", Memorandum No. BMI-NLVP-MM-69-59, November 24, 1969.

(12) "The Post-Apollo Space Program--Direction for the Future", A Space Task Group Report to the President, September, 1969.

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CHAPTER VIII. OSSA

Introduction

The Office of Space Science and Applications (OSSA) is the organization to which the four programs (SB, SL, SG, SA) discussed in the preceding chapters belong. The fifth OSSA program division is SV (Launch Vehicle and Propulsion Programs), for whom this study was performed. There is no SV chapter in this report. The programs and activities to be carried out by SV depend on the other four OSSA programs and on the non-OSSA users of its launch vehicles. The requirements of the outside users (non-OSSA) are discussed in Appendix C.

The purpose of this chapter is to combine various OSSA program division models and estimates of outside user requirements. The resulting combined estimates represent a range of possible requirements for OSSA launch vehicles for the period 1971 through 1981. In order to present such a spectrum of estimated launch vehicle requirements, 10 OSSA models were developed and are presented in this chapter. Four of the models are NASA-based models. These models correspond to the 4 NASA-based models presented for each division. The rest of the models presented were developed by selecting various models from the 6 alternative mission models for each division. Obviously, the number of alternative OSSA models presented is a very small set of the total OSSA models that can be created by combining the alternative division models. The total number of possible alternative models is equal to 6^4 or 1,296. To reduce the number of OSSA models to be considered to a reasonable size, OSSA level guidelines were established, and appropriate division models were selected.

One of the guidelines used to select OSSA alternative models was the OSSA funding projection from Appendix A. To establish an estimate of total OSSA funding requirements by year for each model, it is necessary to include all of the appropriate launch vehicle costs. Such costs include the recurring costs associated with purchasing the launch vehicles required and the funding necessary to maintain a continuing economical and reliable launch vehicle program by providing for supporting activities, product improvements, and advanced studies. A discussion of these costs is contained in Appendix D. To obtain estimates of total OSSA launch vehicle procurement costs, it is necessary to include non-OSSA projects for which OSSA would provide the vehicles on a non-reimbursable basis. These non-reimbursable requirements are for OART and "cooperative" international launches for which the vehicle funds are included in the OSSA budget.* Such estimates were included in each model by using the non-reimbursable requirements included in model SV1 from Appendix C. A plot of the associated launch vehicle program costs is presented with each OSSA model.

The launch vehicle program cost determined for each model is added to funding requirements for each of the other 4 OSSA division models to determine the total required OSSA funding. This total OSSA funding is then compared to the OSSA funding estimate from Appendix A. A plot of the total OSSA funding requirements is presented with each model, indicating the portion of funding required for each of the divisions including SV which is shown as launch vehicle procurement. Also shown with each model is a flight schedule, organized by launch vehicle.

In the section entitled "Launch Vehicle Requirements", requirements for non-OSSA users which reimburse OSSA for use of its launch vehicles are added to selected alternative OSSA mission models. That section discusses the effects that such outsider users have on the OSSA family of launch vehicles.

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* A more complete discussion of non-OSSA projects is presented in Appendix C.

OSSA Mission Models, OSSA1 - OSSA10, are presented in this section. Each model is described by its guidelines, characteristics, launch vehicle procurement funding plot and total funding plot (Figures VIII-1 through VIII-20), and flight schedule by launch vehicle (Tables VIII-1 through VIII-10).

The guidelines are presented at the NASA OSSA level in terms of assumed OSSA funding levels and major areas of emphasis. For a discussion of the division guidelines, the reader is referred to the division mission model presentations in Chapters IV-VII. The description of each OSSA model includes a listing of the component division models.

Besides the projects from the 4 OSSA spacecraft divisions (SA, SB, SG, SL), non-OSSA projects which represent requirements for OSSA funding for launch vehicles are included. Again, NASA OART (Office of Advanced Research and Technology) and cooperative international programs projects are in this latter category. Also in each model is one SV project, namely, a test flight for the first TITAN IIID/CENTAUR.

Model Guidelines and Description: OSSA1(Baseline I)

This model was developed directly from the automated projects contained in Programs II and III of the NASA report to the STG.(1)* These programs were built around the following guidelines:

- Space station and shuttle available in 1977
- FY 1971 funding ceiling for NASA of $4 billion
- "Moderate NASA program" after FY 1971.

The following division models are included: SA1, SB3, SG1, and SL3. The non-OSSA launches included in this model are those non-reimbursable requirements from model SV1.

* Numbers in parentheses denote references given at the end of this chapter.

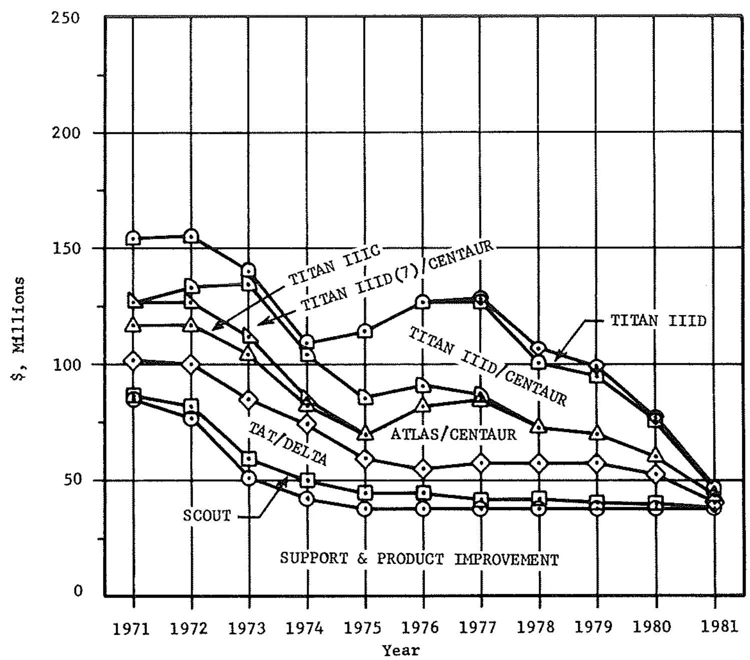

FIGURE VIII-1. OSSA1 LAUNCH VEHICLE FUNDING PLOT

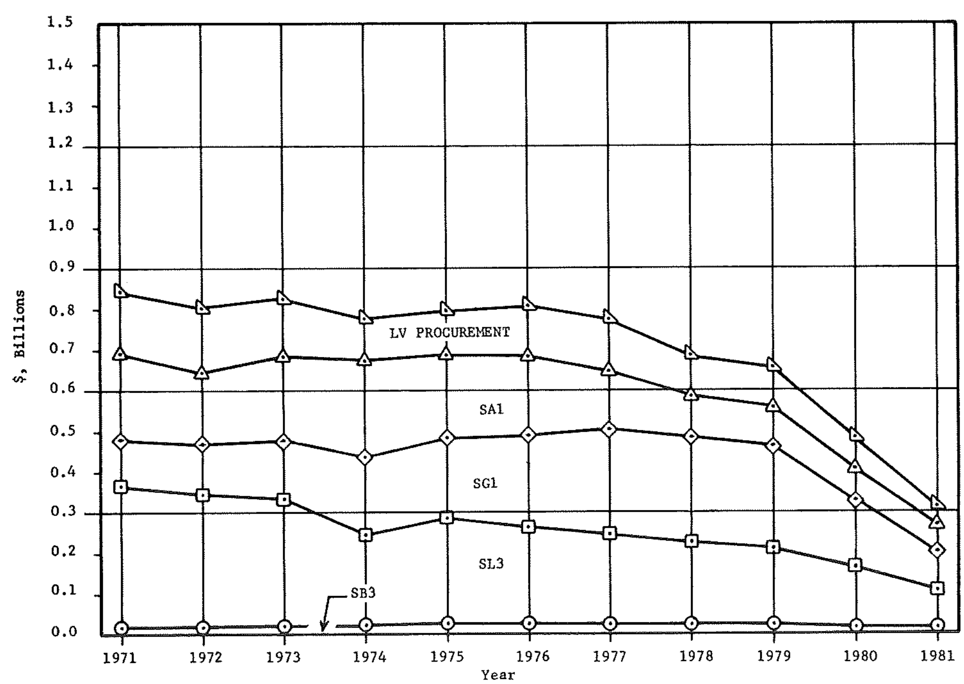

FIGURE VIII-2. OSSA1 TOTAL FUNDING PLOT

TABLE VIII-1. OSSA1 FLIGHT SCHEDULE

Project	Year 71	72	73	74	75	76	77	78	79	80	81
		SCOUT									
OSSA											
BIOEXPLORERS A-F	-	-	1	1	1	1	-	1	-	1	-
SMALL ATS A-D(73)	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	-	-	-	1	-	-	1	-	1	-	-
SEA-TO-SAT(74-79)	-	-	-	1	-	-	1	-	1	-	-
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
SMALL ASTRONOMY SATS A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SSS A-D	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	-	-	-	1	1	1	1	1	1	-	-
SMALL INTERPLANETARY SATELLITE	-	1	1	1	1	1	-	-	-	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
		TAT/DELTA									
OSSA											
BIOPIONEERS A-C	-	-	-	-	1	-	1	-	1	-	-
MARS EXPLORER/ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
MARS EXPLORER/ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G-J	-	-	-	-	1	-	1	-	1	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(74)	-	-	-	1	1	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
GEOS-C(73)	-	-	1	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
NAVIGATION T/C(76)	-	-	-	-	-	2	-	-	-	-	-
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA	-	-	-	1	1	1	1	1	1	1	1
ATMOSPHERE EXPLORERS C,D	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS C,D(72,74)	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J	1	1	-	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP (78,81)	-	-	-	-	-	-	-	2	-	-	1
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-1. OSSA1 FLIGHT SCHEDULE
(Continued)

Project	71	72	73	74	75	76	77	78	79	80	81
						Year					
ATLAS/CENTAUR											
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	-	-	-	-	-	-	-	-	-	-	1
DRSS(78)	-	-	-	-	-	-	-	2	-	-	-
COMMUNICATIONS ATS(77,80)	-	-	-	-	-	-	1	-	-	1	-
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
OAO E-G(77)	-	-	-	-	-	-	1	1	1	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
NON OSSA											
OART	-	-	1	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	-	-	-	1	-	-	-	1	-	-
TITAN IIIC											
COMMUNICATIONS ATS F,G(72)	-	1	-	1	-	-	-	-	-	-	-
TITAN IIID/CENTAUR											
OSSA											
MARS VIKING ORB./SL. A,B(73)	-	-	2	-	-	-	-	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
S-BAND TV TECH(77)	-	-	-	-	-	-	1	-	-	-	-
HEAO(81)	-	-	-	-	-	-	-	-	-	-	1
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
TITAN/CENTAUR TEST FLIGHT(72)	-	1	-	-	-	-	-	-	-	-	-
TITAN IIID(7)/CENTAUR											
OSSA											
MARS VIKING ORB./SL. C,D(75)	-	-	-	-	2	-	-	-	-	-	-
MARS VIKING ORB./SL. E(77)	-	-	-	-	-	-	1	-	-	-	-

Model Guidelines and Description: OSSA2(Baseline II)

This model was developed by modifying OSSA1 (Baseline I) to agree with the plans represented by the OSSA portion of the NASA FY 1971 submission to the Bureau of the Budget. The principal changes made were as follows:

- ERTS C,D were changed to 1972, 1973, from 1974, 1975
- DRSS A,B were changed to 1977 from 1978
- A Jupiter Probe in 1978 was added
- LTM (Large Telescope Mount) was deleted
- HEAO (High Energy Astronomical Observatory) first launch moved to 1974 from 1981
- LST (Large Space Telescope) replaced OAO(E-G).

The following division models are included: SA2, SB4, SG2, and SL4. The non-OSSA launches included in this model are those non-reimbursable requirements from model SV1.

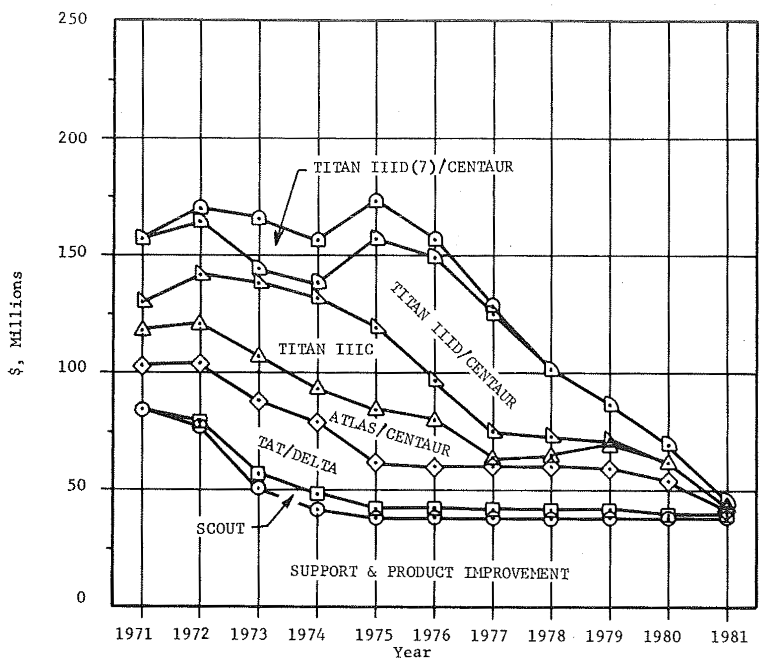

FIGURE VIII-3. OSSA2 LAUNCH VEHICLE FUNDING PLOT

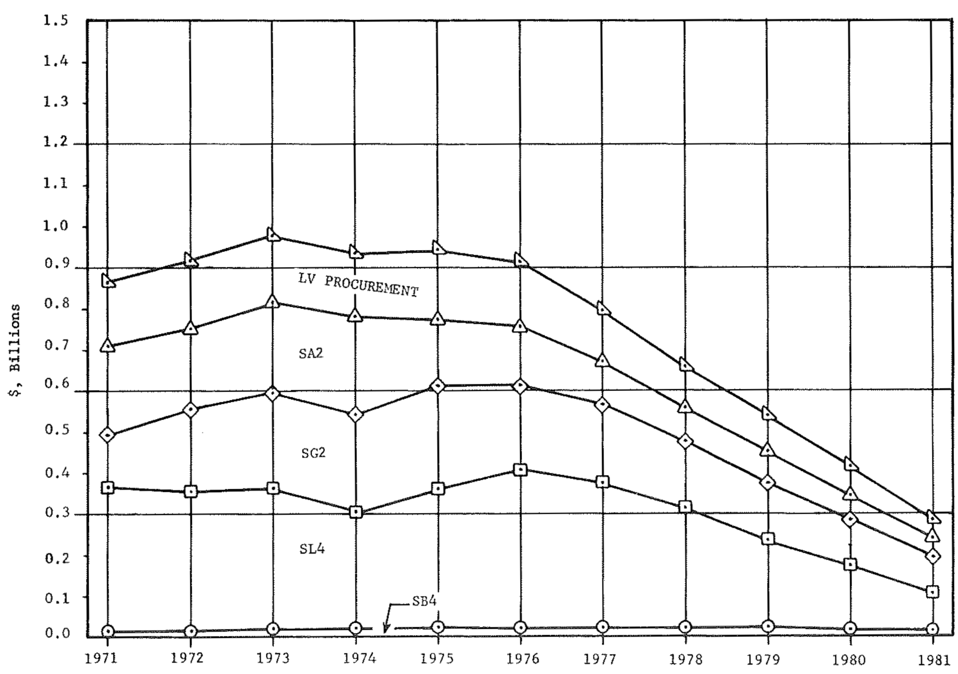

FIGURE VIII-4. OSSA2 TOTAL FUNDING PLOT

TABLE VIII-2. OSSA2 FLIGHT SCHEDULE

Project	Year 71	72	73	74	75	76	77	78	79	80	81
			SCOUT								
OSSA											
BIOEXPLORERS A-H	-	-	-	1	1	1	1	1	1	1	1
SMALL ATS A-D(73)	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	-	-	-	1	-	-	1	-	1	-	-
SEA-TO-SAT(74-79)	-	-	-	1	-	-	1	-	1	-	-
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SSS A-D	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	-	-	-	1	1	1	1	1	1	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
		TAT/DELTA									
OSSA											
BIOEXPLORERS A-C	-	-	-	-	1	-	1	-	1	-	-
MARS EXPLORER/ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
MARS EXPLORER/ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER FLYBY/PROBES(75)	-	-	-	-	2	-	-	-	-	-	-
VENUS EXPLORER ORBITER(76)	-	-	-	-	-	1	-	-	-	-	-
VENUS EXPLORER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G-J	-	-	-	-	1	-	1	-	1	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(72)	-	1	1	-	-	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
GEOS-C(71)	1	-	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
NAVIGATION T/C(74)	-	-	-	2	-	-	-	-	-	-	-
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA	-	-	-	1	1	1	1	1	1	1	1
ATMOSPHERE EXPLORERS C-E(73-75)	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS B-D(71,73,74)	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	-	-	-	-	-	-	-	2	-	-	1
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-2. OSSA2 FLIGHT SCHEDULE
(Continued)

Project	Year										
	71	72	73	74	75	76	77	78	79	80	81
				ATLAS/CENTAUR							
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	-	-	-	-	-	-	-	-	-	-	1
COMET D'ARREST MARINER FLYBY(76)	-	-	-	-	-	1	-	-	-	-	-
DRSS(77)	-	-	-	-	-	-	2	-	-	-	-
COMMUNICATIONS ATS(77,80)	-	-	-	-	-	-	1	-	-	1	-
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	_	1	-	-	-	1	-	-	-	1	-
				TITAN IIIC							
OSSA											
COMMUNICATIONS ATS F,G(72)	-	1	-	1	-	-	-	-	-	-	-
LST A-C(76,77,79)	-	-	-	-	-	1	1	-	1	-	-
HEAO A-C(74)	-	-	-	1	1	1	-	-	-	-	-
GENERAL RELATIVITY(76)	-	-	-	-	-	1	-	-	-	-	-
				TITAN IIID/CENTAUR							
OSSA											
MARS VIKING ORB./SL. A,B(73)	-	-	2	-	-	-	-	-	-	-	-
MARS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER FLYBY/PROBES(78)	-	-	-	-	-	-	-	1	-	-	-
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
S-BAND TV TECH(77)	-	-	-	-	-	-	1	-	-	-	-
HEAO(77)	-	-	-	-	-	-	1	-	-	-	-
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
TITAN/CENTAUR TEST FLIGHT(72)	-	1	-	-	-	-	-	-	-	-	-
				TITAN IIID(7)/CENTAUR							
OSSA											
MARS VIKING ORB./SL. C,D(75)	-	-	-	-	2	-	-	-	-	-	-
MARS VIKING ORB./SL. E(77)	-	-	-	-	-	-	1	-	-	-	-

Model Guidelines and Description: OSSA3(STG Option I)

This model was derived from the automated projects included in Program I of the NASA report to the STG.(1) Program I was the most aggressive of the three programs presented in the report. Program I was built around the following major guidelines:

- 12-man space station and shuttle in 1976
- 50-man space station in 1980
- 12-man geosynchronous space station in 1981
- Planetary Program to support manned Mars landing in 1983
- An active Space Applications program.

The following division models are included: SA3, SB2, SG3, and SL2. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

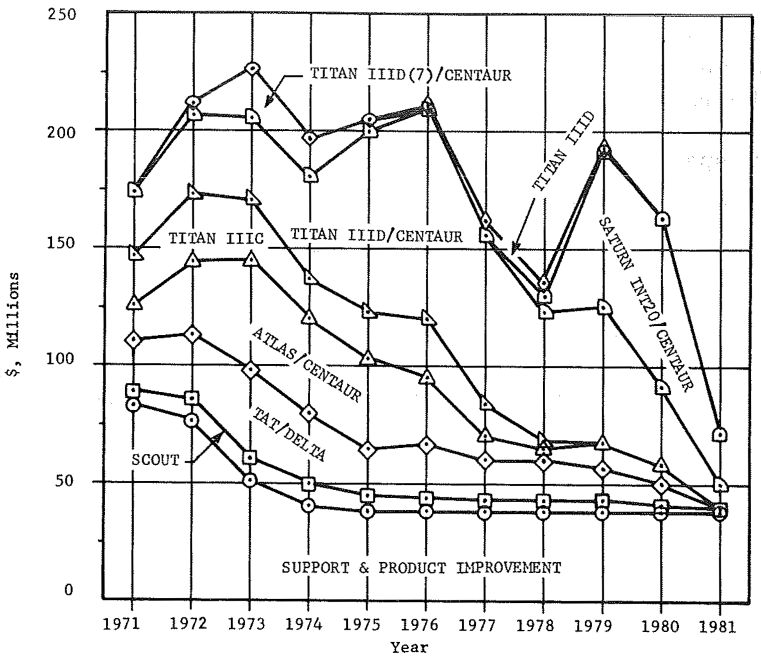

FIGURE VIII-5. OSSA3 LAUNCH VEHICLE FUNDING PLOT

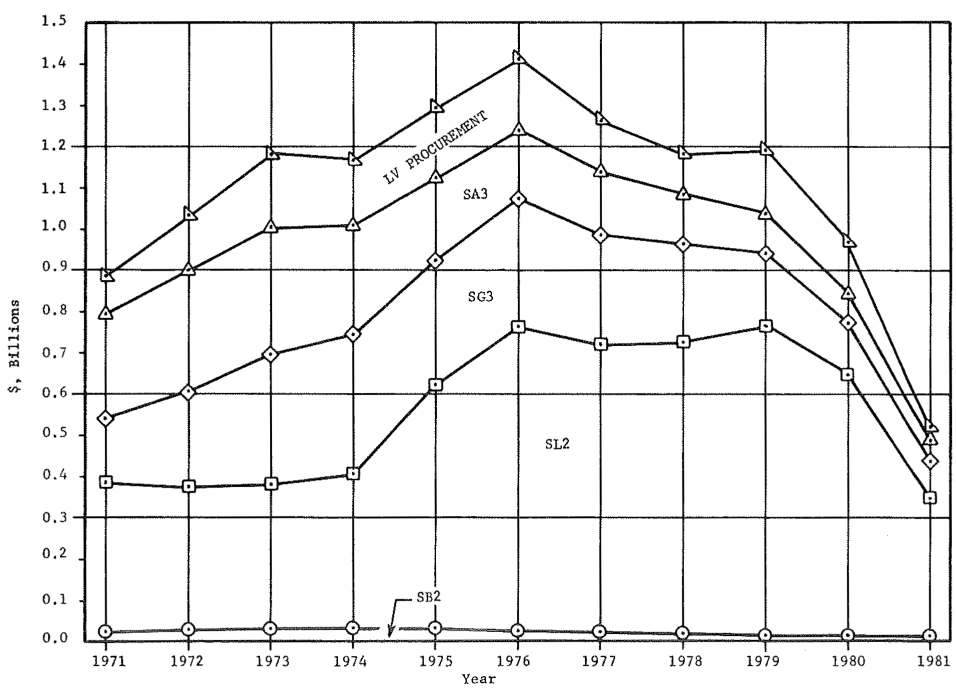

FIGURE VIII-6. OSSA3 TOTAL FUNDING PLOT

TABLE VIII-3. OSSA3 FLIGHT SCHEDULE

Project	Year 71	72	73	74	75	76	77	78	79	80	81
				SCOUT							
OSSA											
BIOEXPLORERS A-N	-	2	2	2	2	1	1	1	1	1	-
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT (HIGH PLAN)	2	1	1	2	1	2	1	2	1	2	1
SSS A-D	1	1	1	-	-	-	-	-	-	-	-
SSS E-F	-	-	-	2	-	-	-	-	-	-	-
SSS G-L	-	-	-	-	1	1	1	1	1	1	-
SMALL INTERPLANETARY SATELLITES	-	1	1	1	1	1	-	-	-	-	-
SEA-TO-SAT(73-80)	-	-	1	-	-	1	-	1	-	1	-
DRAG-FREE SAT(72)	-	1	-	-	-	-	-	-	-	-	-
DRAG-FREE SATS(75-79)	-	-	-	-	1	-	1	-	1	-	-
DATA COLLECTION(74)	-	-	-	1	-	-	-	-	-	-	-
SMALL ATS A-D(72)	-	1	2	1	-	-	-	-	-	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
			TAT/DELTA								
OSSA											
BIOPIONEER A-D(74)	-	-	-	1	1	1	1	-	-	-	-
MARS EXPLORER/ORBITER(75)	-	-	-	-	1	-	-	-	-	-	-
MARS EXPLORER/ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER ORBITER(72)	-	1	-	-	-	-	-	-	-	-	-
VENUS EXPLORER ORBITER(75)	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(76)	-	-	-	-	-	1	-	-	-	-	-
VENUS EXPLORER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73,75)	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA (HIGH PLAN)	-	-	-	1	2	1	2	1	2	1	2
ATMOSPHERE EXPLORERS C,D	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(76,79)	-	-	-	-	-	2	-	-	1	-	-
ISIS C,D(72,74)	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(75)	-	-	-	-	1	-	-	-	-	-	-
CLUSTER(78,80)	-	-	-	-	-	-	-	1	-	1	-
IMP I-J	1	1	-	-	-	-	-	-	-	-	-
IMP KK-LL(74,75)	-	-	-	1	1	-	-	-	-	-	-
IMP M-R	-	-	-	-	-	-	1	1	1	1	-
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBE B,C	-	-	-	-	-	-	1	-	-	1	-
TIROS N(74)	-	-	-	1	-	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G,H	-	-	-	1	1	-	-	-	-	-	-
NIMBUS(77,78)	-	-	-	-	-	-	1	1	-	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(72)	-	1	1	-	-	-	-	-	-	-	-
ERTS E,F(73)	-	-	1	1	-	-	-	-	-	-	-
GEOS-C(72)	-	1	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(74)	-	-	-	1	-	-	-	-	-	-	-
NAVIGATION T/C(74)	-	-	-	2	-	-	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-3. OSSA3 FLIGHT SCHEDULE
(Continued)

Project	Year 71	72	73	74	75	76	77	78	79	80	81
ATLAS/CENTAUR											
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
COMET D'ARREST MARINER FLYBY(76)	-	-	-	-	-	1	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(75)	-	-	-	-	1	-	-	-	-	-	-
ASTEROID EROS MARINER FLYBY(81)	-	-	-	-	-	-	-	-	-	-	1
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
OAO E-G(75)	-	-	-	-	1	1	1	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
METEOROLOGICAL ATS(74)	-	-	-	1	-	1	1	-	-	-	-
DRSS(78-1)	-	-	-	-	-	-	-	1	-	-	-
DRSS TRIPLE ACCESS(74)	-	-	-	2	-	-	-	-	-	-	-
COMMUNICATIONS ATS(77,80)	-	-	-	-	-	-	1	-	-	1	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
TITAN IIIC											
OSSA											
MERCURY/VENUS MARINER FLYBY(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS MARINER FLYBY/PROBES(77)	-	-	-	-	-	-	2	-	-	-	-
HEAO A-C(73)	-	-	1	1	1	-	-	-	-	-	-
COMMUNICATIONS ATS F,G(72)	-	1	-	1	-	-	-	-	-	-	-
TITAN IIID/CENTAUR											
OSSA											
MARS VIKING ORB./SL. A,B(73)	-	-	2	-	-	-	-	-	-	-	-
MARS HIGH DATA ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
MARS SOFT LANDER ROVER(77)	-	-	-	-	-	-	2	-	-	-	-
MARS SOFT LANDER ROVER(79)	-	-	-	-	-	-	-	-	1	-	-
MARS SOFT LANDER ROVER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS MARINER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS MARINER ORBITER(81)	-	-	-	-	-	-	-	-	-	-	2
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
JUPITER FLYBY/PROBES(80)-HIGH	-	-	-	-	-	-	-	-	-	1	-
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
OUT OF ECLIPTIC-PIONEER(75,76)	-	-	-	-	1	1	-	-	-	-	-
HEAO(77)	-	-	-	-	-	-	1	-	-	-	-
S-BAND TV TECH(74)	-	-	-	1	-	-	-	-	-	-	-
X-BAND TV TECH(75)	-	-	-	-	1	-	-	-	-	-	-
PROTO-INSTR TV SAT	-	-	-	-	-	1	-	-	-	-	-
UHF TV TECH(78)	-	-	-	-	-	-	-	1	-	-	-
PROTO-ETV SAT B	-	-	-	-	-	-	-	-	-	1	-
TITAN/CENTAUR TEST FLIGHT(72)	-	1	-	-	-	-	-	-	-	-	-

TABLE VIII-3. OSSA3 FLIGHT SCHEDULE
(Continued)

Project	71	72	73	74	75	76	77	78	79	80	81
					Year						
TITAN IIID(7)/CENTAUR											
OSSA											
MARS VIKING ORB./SL. C,D(75)	-	-	-	-	2	-	-	-	-	-	-
TITAN IIID											
OSSA											
LTM A	-	-	-	-	-	-	-	-	1	-	-
SATURN INT20/CENTAUR											
OSSA											
SATURN MARINER ORBITER/ PROBES(81)-HIGH	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: OSSA4(PSG-LOW)

This model was developed by combining the PSG-LOW models from each of the OSSA divisions. It is believed that the various PSG-LOW division models were developed independently. As a result, when combined, the model does not represent an OSSA program that was considered as part of the PSG or OSSA planning activities.

The characteristics of the model are as follows:

- A very active Planetary program
- An active early Space Applications program (1971-1975)
- A low level late Space Applications program (1976-1981)
- A moderate Physics and Astronomy early program (1971-1975)
- A low level Physics and Astronomy late program (1976-1981)
- A moderate Bioscience program.

The division models included are as follows: SA4, SB1, SG4, and SL1. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

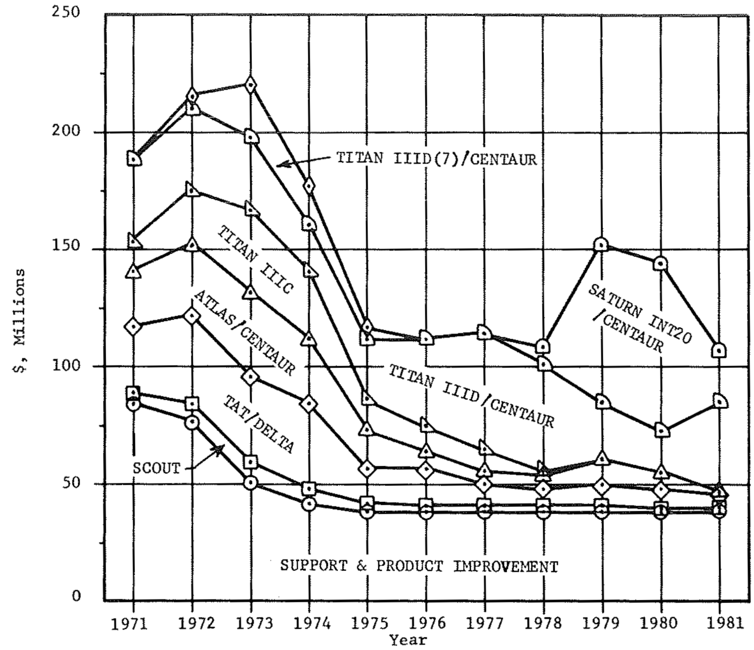

FIGURE VIII-7. OSSA4 LAUNCH VEHICLE FUNDING PLOT

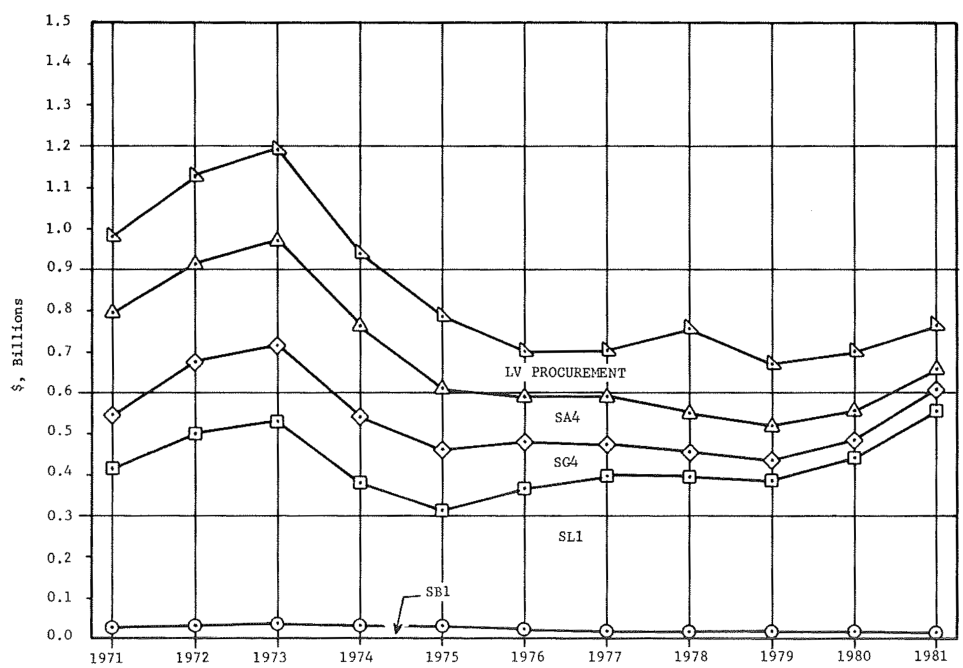

FIGURE VIII-8. OSSA4 TOTAL FUNDING PLOT

TABLE VIII-4. OSSA4 FLIGHT SCHEDULE

Project	71	72	73	74	75	76	77	78	79	80	81
					Year						
SCOUT											
OSSA											
BIOEXPLORER A-O(I)	-	2	2	2	2	1	1	1	1	1	1
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
SSS E-F	-	-	-	2	-	-	-	-	-	-	-
SEA-TO-SAT(73)	-	-	1	-	-	-	-	-	-	-	-
DRAG-FREE SAT (72)	-	1	-	-	-	-	-	-	-	-	-
DRAG-FREE SATS(75-79)	-	-	-	-	1	-	1	-	1	-	-
DATA COLLECTION(74)	-	-	-	1	-	-	-	-	-	-	-
SMALL ATS A-D(72)	-	1	2	1	-	-	-	-	-	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
TAT/DELTA											
OSSA											
BIOPIONEER A-D(73)	-	-	1	1	1	1	-	-	-	-	-
MARS EXPLORER/ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
MARS EXPLORER/ORBITER(73)	-	-	1	-	-	-	-	-	-	-	-
MARS EXPLORER/ORBITER(75)	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(72)	-	1	-	-	-	-	-	-	-	-	-
VENUS EXPLORER ORBITER(73)	-	-	1	-	-	-	-	-	-	-	-
VENUS EXPLORER ORBITER(75)	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(83)					(Launch in 1983)						
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(77)	-	-	-	-	-	-	1	1	-	-	-
RADIO ASTRONOMY EXPLORERS C,D	-	-	-	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS C-E(73-75)	-	-	1	1	1	-	-	-	-	-	-
ISIS B,C(71,73)	1	-	1	-	-	-	-	-	-	-	-
CLUSTER(75)	-	-	-	-	1	-	-	-	-	-	-
GYROSCOPE PRECESSION-PRECURSOR	-	-	1	-	-	-	-	-	-	-	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(74,75)	-	-	-	1	1	-	-	-	-	-	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G,H	-	-	-	1	1	-	-	-	-	-	-
NIMBUS(77,78)	-	-	-	-	-	-	1	1	-	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(72)	-	1	1	-	-	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
GEOS-C(71)	1	-	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78)	-	-	-	-	-	-	-	1	-	-	-
NAVIGATION T/C(74)	-	-	-	2	-	-	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-4. OSSA4 FLIGHT SCHEDULE
(Continued)

Project	Year										
	71	72	73	74	75	76	77	78	79	80	81
ATLAS/CENTAUR											
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
COMET D'ARREST MARINER FLYBY(76)	-	-	-	-	-	1	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(75)	-	-	-	-	1	-	-	-	-	-	-
COMET HALLEY MARINER FLYBY(85)					(Launch in 1985)						
ASTEROID EROS MARINER FLYBY(81)	-	-	-	-	-	-	-	-	-	-	1
OAO C	1	-	-	-	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
DATA RELAY - NEAR EARTH	-	-	-	-	-	-	-	1	-	-	-
DRSS TRIPLE ACCESS(74)	-	-	-	2	-	-	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
TITAN IIIC											
OSSA											
MERCURY/VENUS MARINER FLYBY(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS MARINER FLYBY/PROBES(75)	-	-	-	-	2	-	-	-	-	-	-
HEAO A-C(74)	-	-	-	1	1	1	-	-	-	-	-
COMMUNICATIONS ATS F,G(72)	-	1	-	1	-	-	-	-	-	-	-
TITAN IIID/CENTAUR											
MARS VIKING ORB./SL. A,B(73)	-	-	2	-	-	-	-	-	-	-	-
MARS HIGH DATA ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
MARS HIGH DATA ORBITER(84)					(Launch in 1984)						
MARS SOFT LANDER/ROVER(84)					(Launch in 1984)						
MERCURY SOLAR ELECTRIC ORBITER(82)		-	-	-	-	-	-	-	-	-	-
VENUS MARINER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS MARINER ORBITER/ROUGH LANDER(83)					(Launch in 1983)						
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER MARINER FLYBY/SOLAR ESCAPE(74)	-	-	-	1	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
JUPITER FLYBY/PROBES(80)-LOW	-	-	-	-	-	-	-	-	-	1	-
JUPITER FLYBY/PROBES(84)					(Launch in 1984)						
JUPITER-SATURN-PLUTO MARINER FLYBY(77)-LOW	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)-LOW	-	-	-	-	-	-	-	-	2	-	-
COMET KOPFF MARINER RENDEZVOUS(83)					(Launch in 1983)						
HEAO(77)	-	-	-	-	-	-	1	-	-	-	-
S-BAND TV TECH(75)	-	-	-	-	1	-	-	-	-	-	-
UHF TV TECH(80)	-	-	-	-	-	-	-	-	-	1	-
TITAN/CENTAUR TEST FLIGHT(72)	-	1	-	-	-	-	-	-	-	-	-
TITAN IIID(7)/CENTAUR											
OSSA											
MARS VIKING ORB./SL. C,D(75)	-	-	-	-	2	-	-	-	-	-	-
SATURN INT20/CENTAUR											
OSSA											
SATURN MARINER ORBITER/PROBE A(81)	-	-	-	-	-	-	-	-	-	-	1

Model Guidelines and Description: OSSA5(Alternative I)

This model was created by combining the models from each division for which the funding requirements were the closest to the division funding projections from Appendix A. The major characteristics of the model are as follows:

- A moderate-to-active Bioscience program
- Jupiter Orbiter in 1978
- Mercury/Venus Flyby in 1978
- No Grand Tours
- No follow-on Viking
- Mars Soft Lander/Rover in 1981
- LST (Large Space Telescopes) -- 3 launches, first in 1976
- HEAO (High Energy Astronomical Observatory) -- 2 launches - 1977 and 1981
- Moderate Space Applications program.

The division models included are as follows: SA5, SB10, SG5, and SL7. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

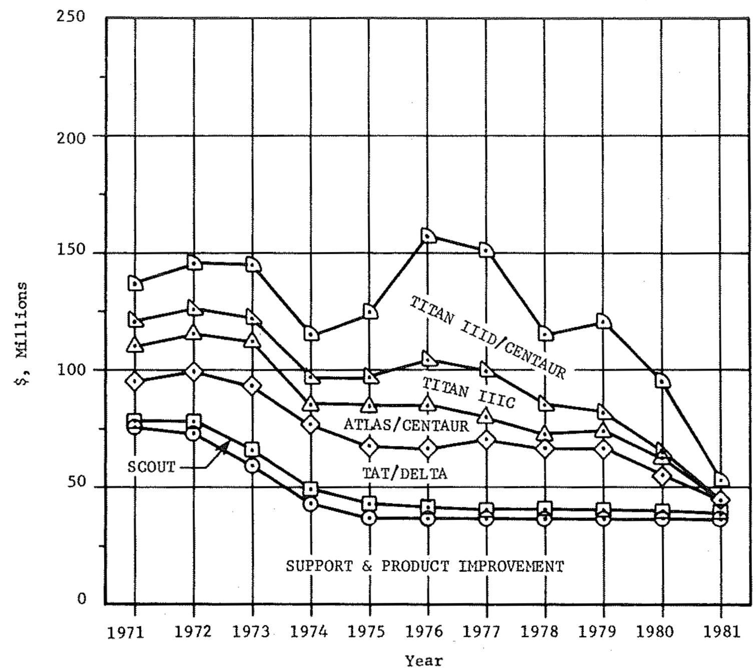

FIGURE VIII-9. OSSA5 LAUNCH VEHICLE FUNDING PLOT

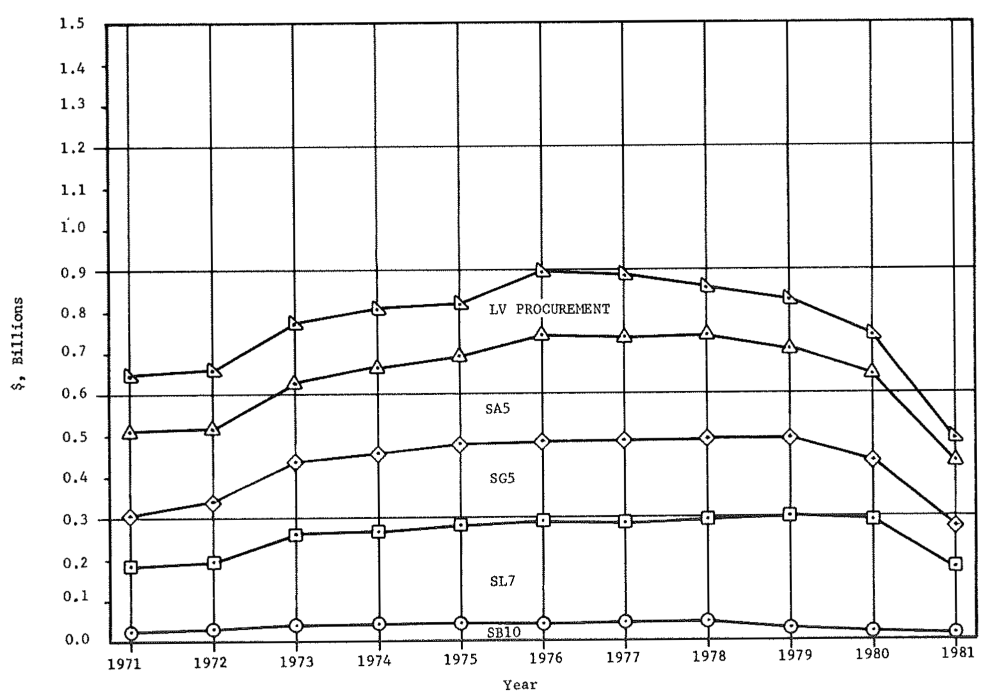

FIGURE VIII-10. OSSA5 TOTAL FUNDING PLOT

TABLE VIII-5. OSSA5 FLIGHT SCHEDULE

Project	Year 71	72	73	74	75	76	77	78	79	80	81
			SCOUT								
OSSA											
BIOEXPLORERS A-N	-	2	2	2	2	1	1	1	1	1	-
SMALL ATS SCOUT	-	-	2	2	2	1	1	1	1	1	1
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
SMALL ASTRONOMY SATS A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SSS A-D	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	-	-	-	1	1	1	1	1	1	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
			TAT/DELTA								
OSSA											
BIOPIONEER A-D(74)	-	-	-	1	1	1	1	-	-	-	-
BIOSATELLITES (IMPROVED) A-J	-	-	-	-	-	2	2	2	2	2	-
VENUS EXPLORER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G-J	-	-	-	-	1	-	1	-	1	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1[1]	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON	-	-	-	-	-	1	1	2	2	3	3
SMALL ATS DELTA	-	-	-	-	-	1	-	1	-	1	-
GEOS-C(71)	1	-	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78,80)	-	-	-	-	-	-	-	1	-	1	-
NAVIGATION T/C(76)	-	-	-	-	-	2	-	-	-	-	-
OSO A-H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA	-	-	-	1	1	1	1	1	1	1	1
ATMOSPHERE EXPLORERS C,D	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS C,D(72,74)	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	-	-	-	-	-	-	-	2	-	-	1
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-5. OSSA5 FLIGHT SCHEDULE
(Continued)

Project	Year										
	71	72	73	74	75	76	77	78	79	80	81
ATLAS/CENTAUR											
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	-	-	-	-	-	-	-	-	-	-	1
DRSS(77)	-	-	-	-	-	-	2	-	-	-	-
COMMUNICATIONS ATS(77,79)	-	-	-	-	-	-	1	-	1	-	-
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
TITAN IIIC											
OSSA											
MERCURY/VENUS MARINER FLYBY(78)	-	-	-	-	-	-	-	1	-	-	-
COMMUNICATIONS ATS F,G(72)	-	1	-	1	-	-	-	-	-	-	-
LST A-C(76,78,80)	-	-	-	-	-	1	-	1	-	1	-
TITAN IIID/CENTAUR											
OSSA											
MARS VIKING ORB./SL. A,B(75)	-	-	-	-	2	-	-	-	-	-	-
MARS SOFT LANDER/ROVER(81)	-	-	-	-	-	-	-	-	-	-	1
MARS HIGH DATA RATE ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA RATE ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
VENUS HIGH DATA RATE ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
X-BAND TV TECH(77)	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	-	-	-	-	-	-	-	1	-	-	-
UHF DIRECT TV PROTO-OP	-	-	-	-	-	-	-	-	-	-	1
UHF TV TECH(78)	-	-	-	-	-	-	-	1	-	-	-
HEAO(81)	-	-	-	-	-	-	-	-	-	-	1
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
TITAN/CENTAUR TEST FLIGHT(73)	-	-	1	-	-	-	-	-	-	-	-

Model Guidelines and Description: OSSA6(Alternative II)

Model OSSA6 was created by finding the combination of division models with combined funding closest to the OSSA total funding projection less the launch vehicle procurement funding projection from Appendix A. This selection criterion resulted in an OSSA mission model with the following characteristics:

- Moderate Bioscience Program
- A Grand Tour in 1979 (Jupiter-Uranus-Neptune)
- Viking 1975, no follow-on
- LST (Large Space Telescopes) -- 3 launches, first in 1976
- HEAO (High Energy Astronomical Observatory) -- 2 launches - 1977 and 1981
- Moderate Space Applications program.

The division models included are as follows: SA5, SB7, SG5, and SL9. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

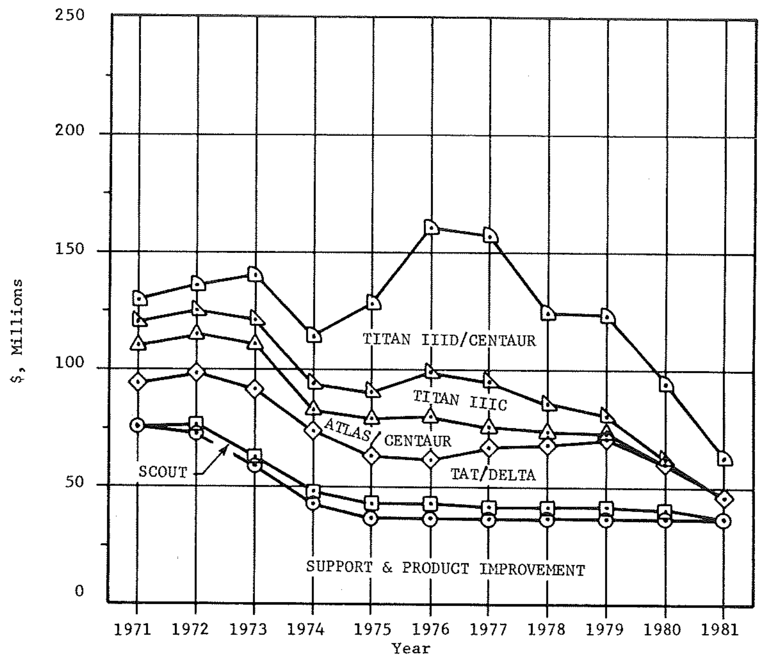

FIGURE VIII-11. OSSA6 LAUNCH VEHICLE FUNDING PLOT

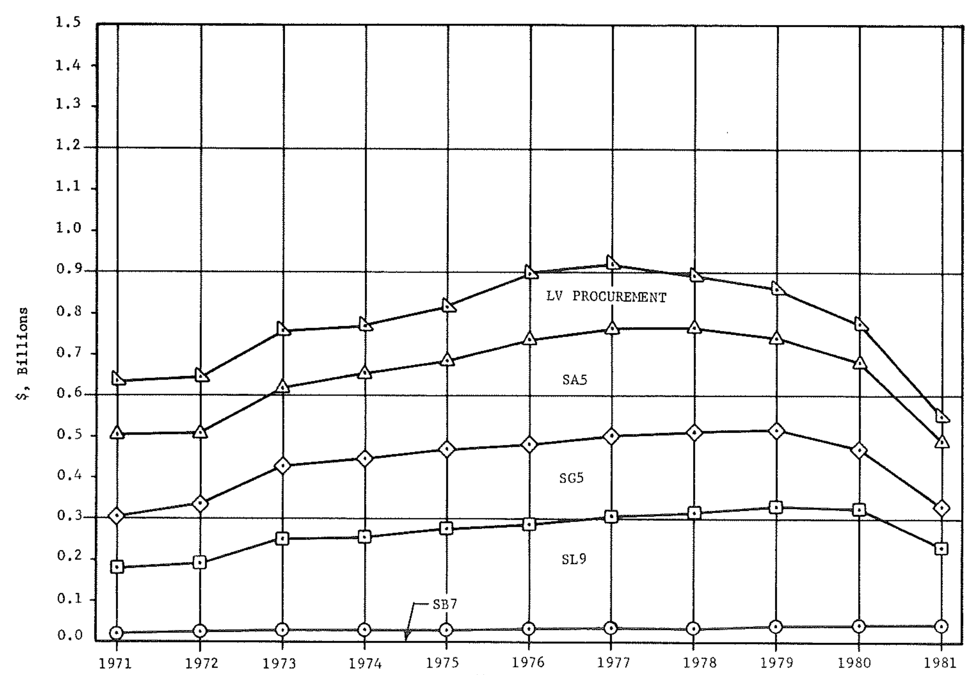

FIGURE VIII-12. OSSA6 TOTAL FUNDING PLOT

TABLE VIII-6. OSSA6 FLIGHT SCHEDULE

Project	Year										
	71	72	73	74	75	76	77	78	79	80	81
SCOUT											
OSSA											
BIOEXPLORER A-O(II)	-	1	1	1	1	2	2	2	2	2	1
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SSS A-D	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	-	-	-	1	1	1	1	1	1	-	-
SMALL ATS SCOUT	-	-	2	2	2	1	1	1	1	1	1
DRAG-FREE SATS(74-79)	-	-	-	1	-	-	1	-	1	-	-
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
TAT/DELTA											
OSSA											
BIOPIONEER A-D(74)	-	-	-	1	1	1	1	-	-	-	-
BIOSATELLITES (IMPROVED) A-C	-	-	-	-	-	-	-	-	-	1	1
MARS EXPLORER/ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
VENUS EXPLORER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA	-	-	-	1	1	1	1	1	1	1	1
ATMOSPHERE EXPLORERS C,D	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS C,D(72,74)	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	-	-	-	-	-	-	-	1	-	-	1
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G-J	-	-	-	-	1	-	1	-	1	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON	-	-	-	-	-	1	1	2	2	3	3
SMALL ATS DELTA	-	-	-	-	-	1	-	1	-	1	-
GEOS-C(71)	1	-	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78,80)	-	-	-	-	-	-	-	1	-	1	-
NAVIGATION T/C(76)	-	-	-	-	-	2	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-6. OSSA6 FLIGHT SCHEDULE
(Continued)

Project	Year 71	72	73	74	75	76	77	78	79	80	81
			ATLAS/CENTAUR								
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
DRSS(77)	-	-	-	-	-	-	2	-	-	-	-
COMMUNICATIONS ATS(77,79)	-	-	-	-	-	-	1	-	1	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
			TITAN IIIC								
OSSA											
MERCURY/VENUS MARINER FLYBY(78)	-	-	-	-	-	-	-	1	-	-	-
LST A-C(76,78,80)	-	-	-	-	-	1	-	1	-	1	-
COMMUNICATIONS ATS F,G(72)	-	1	-	1	-	-	-	-	-	-	-
			TITAN IIID/CENTAUR								
OSSA											
MARS VIKING ORB./SL A,B(75)	-	-	-	-	2	-	-	-	-	-	-
MARS HIGH DATA ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
JUPITER FLYBY/PROBES(83)						(Launch in 1983)					
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
HEAO(77)	-	-	-	-	-	-	1	-	-	-	-
HEAO(81)	-	-	-	-	-	-	-	-	-	-	1
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
X-BAND TV TECH(77)	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	-	-	-	-	-	-	-	1	-	-	-
UHF DIRECT TV PROTO-OP	-	-	-	-	-	-	-	-	-	-	1
UHF TV TECH(78)	-	-	-	-	-	-	-	1	-	-	-
TITAN/CENTAUR TEST FLIGHT(73)	-	-	1	-	-	-	-	-	-	-	-

Model Guidelines and Description: OSSA7 (Alternative III)

This model has the lowest funding requirements of any of the OSSA models considered in this study. It was created by combining the alternative division models with the lowest funding requirements.

This model has the following major characteristics:

- No Bioscience flight program
- A single pair of Vikings launched in 1977
- One Grand Tour-1979 (Jupiter-Uranus-Neptune)
- No Large Space Telescopes (LST)
- 3 automated physics and chemistry labs, first in 1976
- HEAO (High Energy Astronomical Observatories) -- 4 launch programs, first in 1977
- A stretched-out Space Applications program
- No Broadcast TV satellites.

The division models included are as follows: SA10, SB8, SG9, and SL5. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

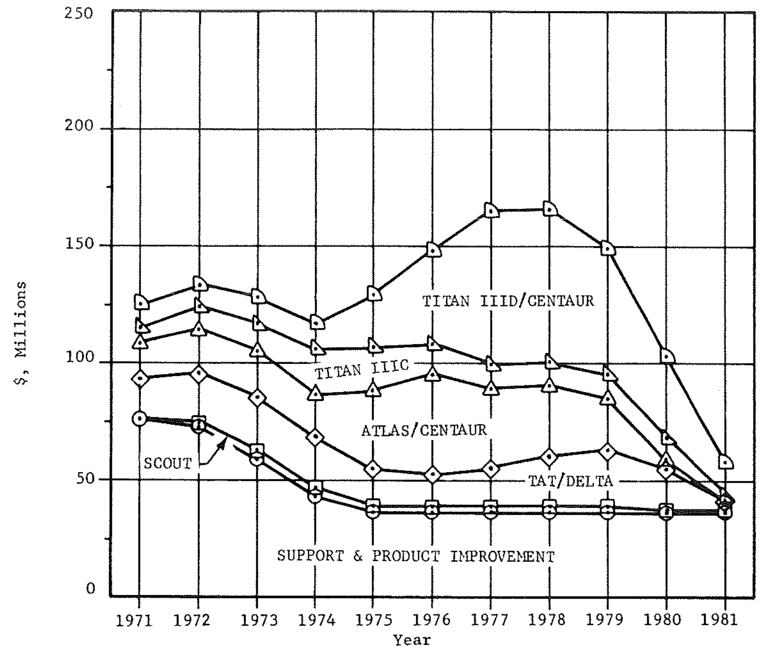

FIGURE VIII-13. OSSA7 LAUNCH VEHICLE FUNDING PLOT

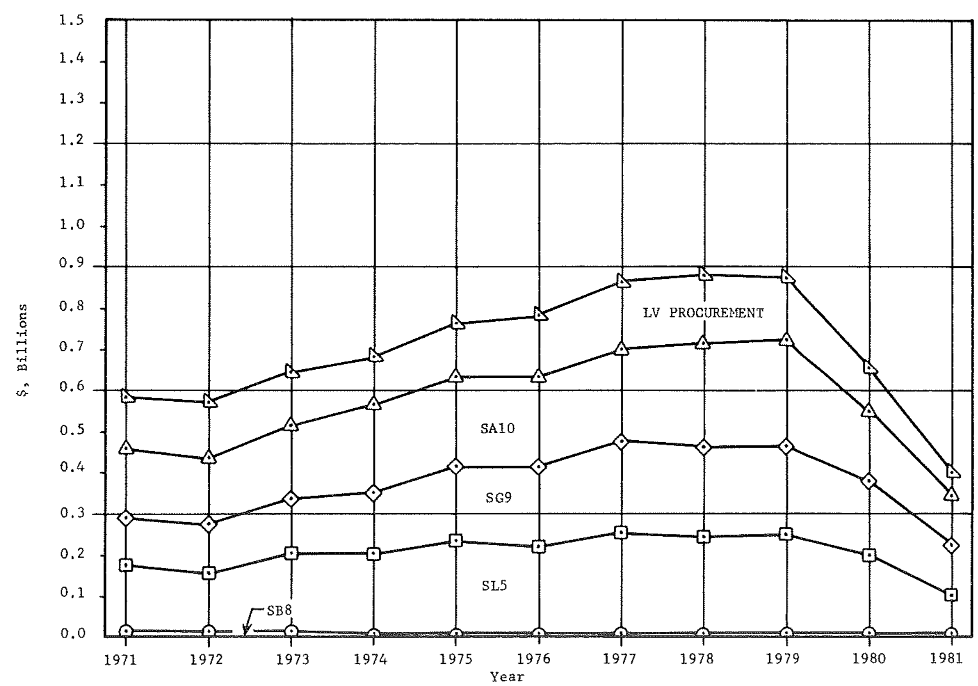

FIGURE VIII-14. OSSA7 TOTAL FUNDING PLOT

TABLE VIII-7. OSSA7 FLIGHT SCHEDULE

Project	Year										
	71	72	73	74	75	76	77	78	79	80	81
SCOUT											
OSSA											
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SMALL ATS A-D(73)	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(75-79)	-	-	-	-	1	-	1	-	1	-	-
SEA-TO-SAT(74-79)	-	-	-	1	-	-	1	-	1	-	-
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL	1	1	2	1	1	2	1	1	2	1	1
TAT/DELTA											
OSSA											
MARS EXPLORER/ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
MARS EXPLORER/ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(75)	-	-	-	-	1	-	-	-	-	-	-
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA(LOW PLAN)	-	-	-	1	-	1	-	1	-	1	-
ATMOSPHERE EXPLORERS C-E(73-75)	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS B-D(71,73,74)	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	-	-	-	-	-	-	-	2	-	-	1
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBES B,C	-	-	-	-	-	-	1	-	-	1	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	-	-	1	1	-	-	-	-	-	-	-
ERTS FOLLOW-ON (MED.-LEVEL)	-	-	-	-	-	1	1	1	2	2	2
GEOS-C(72)	-	1	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78,80)	-	-	-	-	-	-	-	1	-	1	-
NAVIGATION T/C(76)	-	-	-	-	-	2	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-7. OSSA7 FLIGHT SCHEDULE
(Continued)

Project	Year 71	72	73	74	75	76	77	78	79	80	81
ATLAS/CENTAUR											
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
PHYSICS AND CHEMISTRY LAB-AUTOMATED	-	-	-	-	-	1	-	1	-	1	-
METEOROLOGICAL ATS(76)	-	-	-	-	-	1	-	1	1	-	-
DRSS TRIPLE ACCESS(77)	-	-	-	-	-	-	2	-	-	-	-
DRSS DUAL PURPOSE	-	-	-	-	-	-	-	-	-	2	-
COMMUNICATIONS ATS(77,79)	-	-	-	-	-	-	1	-	1	-	-
NAVIGATION T/C(77,78)	-	-	-	-	-	-	1	1	-	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
TITAN IIIC											
OSSA											
HEAO A-C(77-81)	-	-	-	-	-	-	1	-	1	-	1
GENERAL RELATIVITY(76)	-	-	-	-	-	1	-	-	-	-	-
COMMUNICATIONS ATS F,G(73)	-	-	1	-	1	-	-	-	-	-	-
TITAN IIID/CENTAUR											
OSSA											
MARS VIKING ORB./SL. A,B(77)	-	-	-	-	-	-	2	-	-	-	-
MARS HIGH DATA RATE ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
MARS HIGH DATA RATE ORBITER(75)	-	-	-	-	1	-	-	-	-	-	-
VENUS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
HEAO(82)					(Launch in 1982)						
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
SOLAR PROBE TO 0.05 a.u.	-	-	-	-	-	-	-	-	-	1	-
SOLAR PROBE-CLOSE IN PRECURSOR	-	-	-	-	-	-	-	-	1	-	-
RELATIVITY REDSHIFT-SOLAR PROBE	-	-	-	-	-	-	-	1	-	-	-
RELATIVITY REDSHIFT-DEEP SPACE	-	-	-	-	-	-	-	-	-	1	-
TITAN EXPLORERS	-	-	-	-	-	-	-	-	1	-	1
TITAN/CENTAUR TEST FLIGHT(73)	-	-	1	-	-	-	-	-	-	-	-

Model Guidelines and Description: OSSA8(Alternative IV)

The guidelines used in developing this model were intended to emphasize Space Applications, support a moderate Planetary program, and include models from Bioscience and Physics and Astronomy such that the total funding required at the OSSA level would be close to the OSSA funding projection from Appendix A.

The major characteristics of this model are as follows:

- A Space Application program increasing rapidly in the period 1972-1975
- 2 Viking launches in 1975 and 1 launch in 1977
- A Grand Tour in 1979 (Jupiter-Uranus-Neptune)
- No Bioscience flight program
- No Large Space Telescopes (LST)
- A 4-launch HEAO (High Energy Astronomical Observatory) program, first in 1977.

The division models included are as follows: SA9, SB8, SG9, and SL8. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

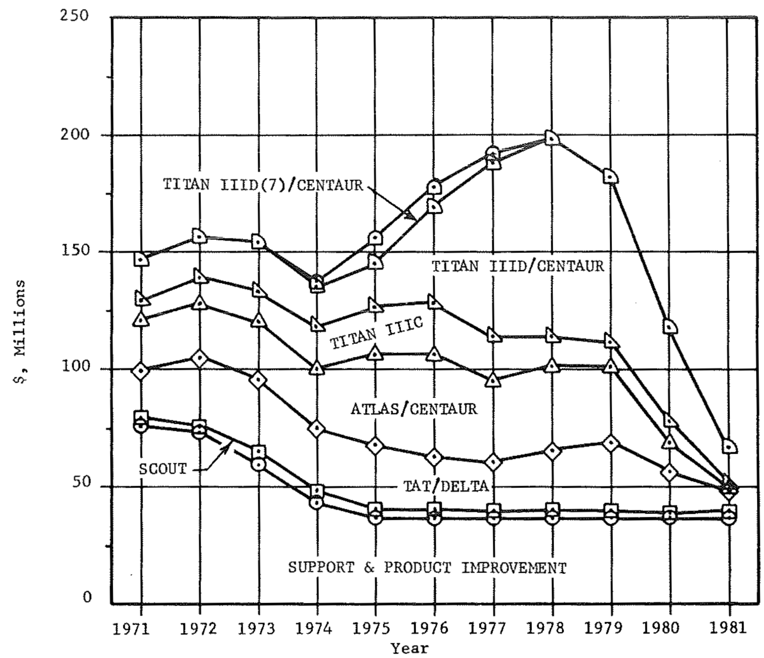

FIGURE VIII-15. OSSA8 LAUNCH VEHICLE FUNDING PLOT

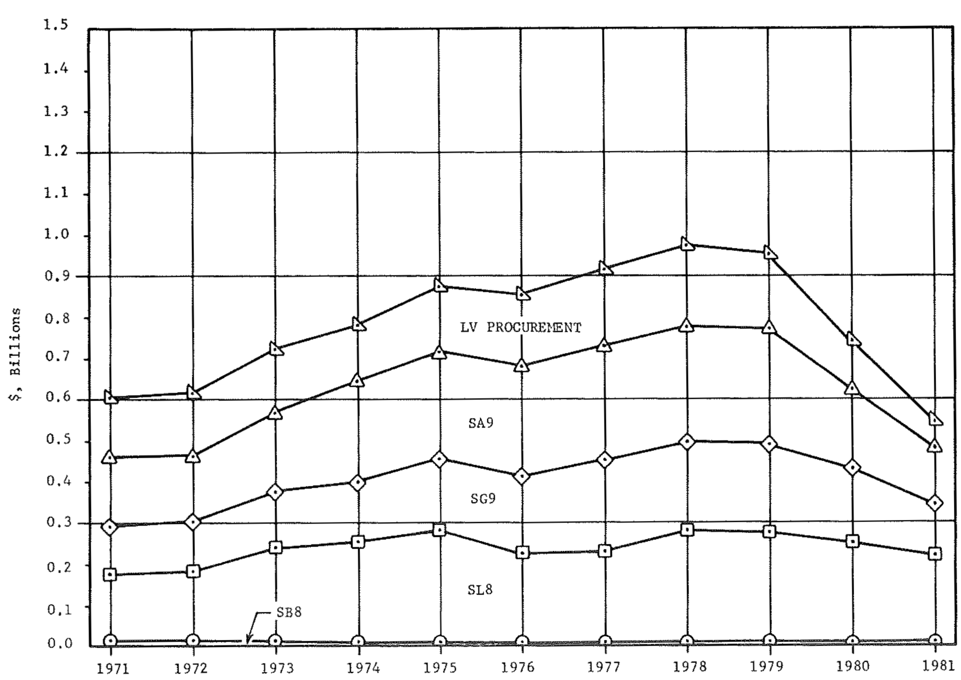

FIGURE VIII-16. OSSA8 TOTAL FUNDING PLOT

TABLE VIII-8. OSSA8 FLIGHT SCHEDULE

Project	Year 71	72	73	74	75	76	77	78	79	80	81
			SCOUT								
OSSA											
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SMALL ATS A-D(73)	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	-	-	-	1	-	-	1	-	1	-	-
SEA-TO-SAT(74-79)	-	-	-	1	-	-	1	-	1	-	-
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
			TAT/DELTA								
OSSA											
MARS EXPLORER/ORBITER(79)	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(76)	-	-	-	-	-	1	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
VENUS EXPLORER ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA(LOW PLAN)	-	-	-	1	-	1	-	1	-	1	-
ATMOSPHERE EXPLORERS C-E(73-75)	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS F,G	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS B-D(71,73,74)	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	-	-	-	-	-	-	-	2	-	-	1
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBE B,C	-	-	-	-	-	-	1	-	-	1	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS(77,78)	-	-	-	-	-	-	1	1	-	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON (MED.-LEVEL)	-	-	-	-	-	1	1	1	2	2	2
GEOS-C(72)	-	1	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78,80)	-	-	-	-	-	-	-	1	-	1	-
NAVIGATION T/C(76)	-	-	-	-	-	2	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-8. OSSA8 FLIGHT SCHEDULE
(Continued)

Project	Year 71	72	73	74	75	76	77	78	79	80	81
					ATLAS/CENTAUR						
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER	-	1	-	-	-	-	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	-	-	-	-	-	-	-	-	-	-	1
OAO C	1	-	-	-	-	-	-	-	-	-	-
OSO D	-	-	-	1	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
PHYSICS AND CHEMISTRY LAB-AUTOMATED	-	-	-	-	-	1	-	1	-	1	-
METEOROLOGICAL ATS(76)	-	-	-	-	-	1	-	1	1	-	-
DRSS TRIPLE ACCESS(77)	-	-	-	-	-	-	2	-	-	-	-
DRSS DUAL PURPOSE	-	-	-	-	-	-	-	-	-	2	-
COMMUNICATIONS ATS(77,79)	-	-	-	-	-	-	1	-	1	-	-
NAVIGATION T/C(77,78)	-	-	-	-	-	-	1	1	-	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
					TITAN IIIC						
OSSA											
MERCURY/VENUS MARINER FLYBY(78)	-	-	-	-	-	-	-	1	-	-	-
HEAO A-C(77-81)	-	-	-	-	-	-	1	-	1	-	1
GENERAL RELATIVITY(76)	-	-	-	-	-	1	-	-	-	-	-
COMMUNICATIONS ATS F,G(73)	-	-	1	-	1	-	-	-	-	-	-
					TITAN IIID/CENTAUR						
OSSA											
MARS VIKING ORB./SL. A,B(75)	-	-	-	-	2	-	-	-	-	-	-
MARS SOFT LANDER/ROVER(84)					(Launch in 1984)						
MARS HIGH DATA RATE ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
HEAO(82)					(Launch in 1982)						
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
SOLAR PROBE TO 0.05 a.u.	-	-	-	-	-	-	-	-	-	1	-
SOLAR PROBE-CLOSE IN PRECURSOR	-	-	-	-	-	-	-	-	1	-	-
RELATIVITY REDSHIFT-SOLAR PROBE	-	-	-	-	-	-	-	1	-	-	-
RELATIVITY REDSHIFT-DEEP SPACE	-	-	-	-	-	-	-	-	-	1	-
TITAN EXPLORERS	-	-	-	-	-	-	-	-	1	-	1
X-BAND TV TECH(77)	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	-	-	-	-	-	-	-	1	-	-	-
PROTO-INFO/ETV SAT B	-	-	-	-	-	-	-	-	-	1	-
UHF DIRECT TV PROTO-OP	-	-	-	-	-	-	-	-	-	-	1
TITAN/CENTAUR TEST FLIGHT(73)	-	-	1	-	-	-	-	-	-	-	-
					TITAN IIID(7)/CENTAUR						
OSSA											
MARS VIKING ORB./SL. C(77)	-	-	-	-	-	-	1	-	-	-	-

Model Guidelines and Description: OSSA9(Alternative V)

For this model, the primary guideline was for inclusion of the most aggressive of the alternative Planetary models. The nominal models (those with funding requirements closest to the Appendix A projections) from SA and SG were added along with the Bioscience low program.

The major characteristics of this model are as follows:

- Two pairs of Vikings in 1977 and 1979
- Both Grand Tours, 1977 and 1979
- Moderate Space Applications program
- Moderate Space Physics and Astronomy program
- No Bioscience flight program.

The division models included are as follows: SA5, SB8, SG5, and SL10. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

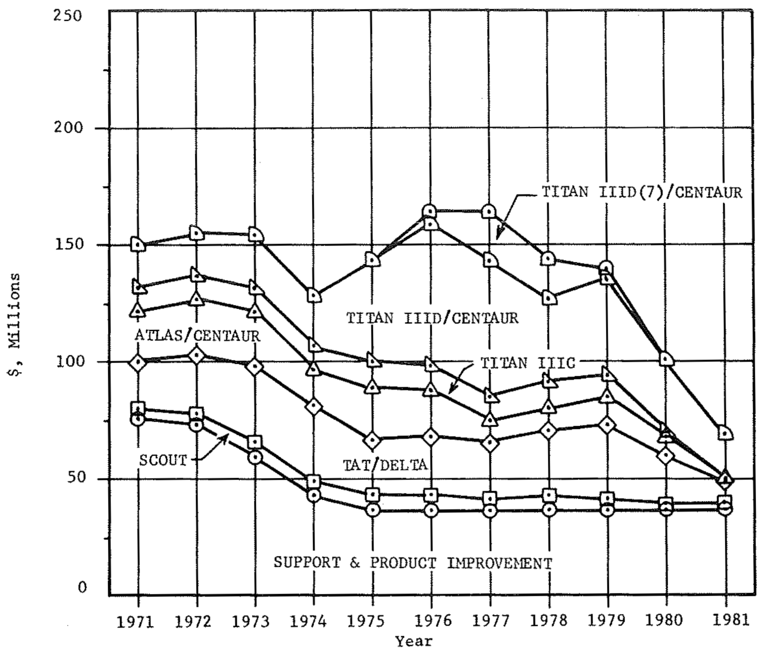

FIGURE VIII-17. OSSA9 LAUNCH VEHICLE FUNDING PLOT

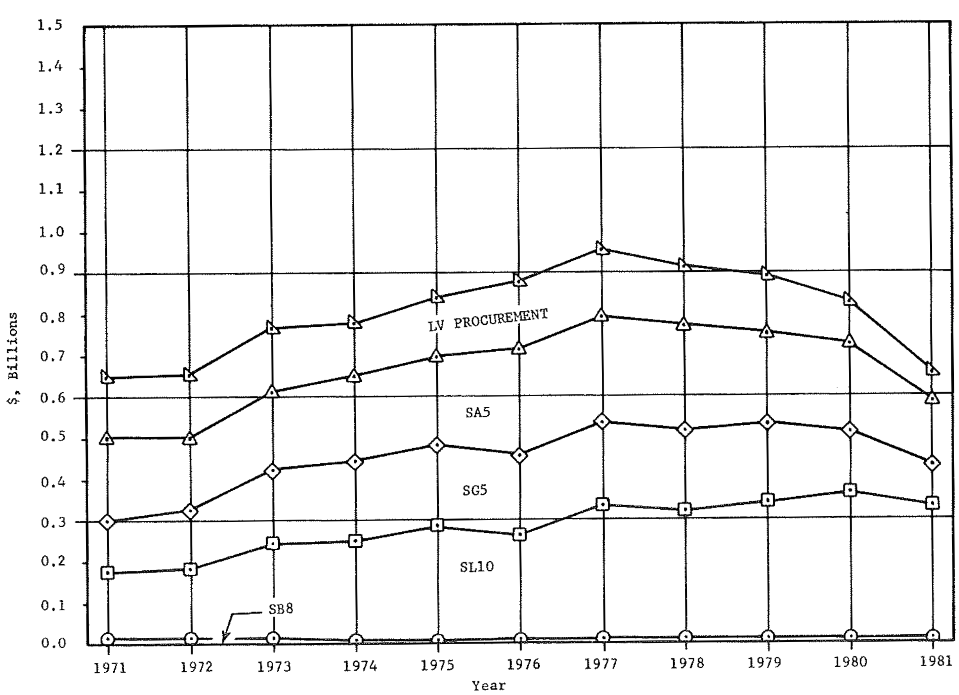

FIGURE VIII-18. OSSA9 TOTAL FUNDING PLOT

TABLE VIII-9. OSSA9 FLIGHT SCHEDULE

Year	71	72	73	74	75	76	77	78	79	80	81
						SCOUT					
OSSA											
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SSS A-D	1	1	1	-	-	-	-	-	-	-	-
SSS E-J	-	-	-	1	1	1	1	1	1	-	-
SMALL ATS SCOUT	-	-	2	2	2	1	1	1	1	1	1
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
DRAG-FREE SATS(74-79)	-	-	-	1	-	-	1	-	1	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
						TAT/DELTA					
OSSA											
MARS EXPLORER/ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS EXPLORER/ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
VENUS EXPLORER ORBITER(75)	-	-	-	-	1	-	-	-	-	-	-
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-75)	-	-	1	1	1	-	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA	-	-	-	1	1	1	1	1	1	1	1
ATMOSPHERE EXPLORERS C,D	1	1	-	-	-	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS C,D(72,74)	-	1	-	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	-	-	-	-	-	-	-	2	-	-	1
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS G-J	-	-	-	-	1	-	1	-	1	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON	-	-	-	-	-	1	1	2	2	3	3
SMALL ATS DELTA	-	-	-	-	-	1	-	1	-	1	-
GEOS-C(71)	1	-	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78,80)	-	-	-	-	-	-	-	1	-	1	-
NAVIGATION T/C(76)	-	-	-	-	-	2	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-9. OSSA9 FLIGHT SCHEDULE
(Continued)

Project	Year 71	72	73	74	75	76	77	78	79	80	81
			ATLAS/CENTAUR								
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
ASTEROID BELT SOLAR ELECTRIC FLY-THROUGH(81)	-	-	-	-	-	-	-	-	-	-	1
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
DRSS(77)	-	-	-	-	-	-	2	-	-	-	-
COMMUNICATIONS ATS(77,79)	-	-	-	-	-	-	1	-	1	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
			TITAN IIIC								
OSSA											
LST A-C(76,78,80)	-	-	-	-	-	1	-	1	-	1	-
COMMUNICATIONS ATS F,G(72)	-	1	-	1	-	-	-	-	-	-	-
			TITAN IIID/CENTAUR								
OSSA											
MARS VIKING ORB./SL. A,B(75)	-	-	-	-	2	-	-	-	-	-	-
MARS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
MARS SOFT LANDER/ROVER(84)						(Launch in 1984)					
VENUS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER FLYBY/PROBES(83)						(Launch in 1983)					
JUPITER-SATURN-PLUTO MARINER FLYBY(77)	-	-	-	-	-	-	2	-	-	-	-
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
HEAO(81)	-	-	-	-	-	-	-	-	-	-	1
HEAO(77)	-	-	-	-	-	-	1	-	-	-	-
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
X-BAND TV TECH(77)	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	-	-	-	-	-	-	-	1	-	-	-
UHF DIRECT TV PROTO-OP	-	-	-	-	-	-	-	-	-	-	1
UHF TV TECH(78)	-	-	-	-	-	-	-	1	-	-	-
TITAN/CENTAUR TEST FLIGHT(73)	-	-	1	-	-	-	-	-	-	-	-
			TITAN IIID(7)/CENTAUR								
OSSA											
MARS VIKING ORB./SL. C,D(79)	-	-	-	-	-	-	-	-	2	-	-

Model Guidelines and Description: OSSA10(Alternative VI)

The principal guideline used in creating OSSA10 involved having a total OSSA funding requirement which averaged 10% higher than the OSSA funding projection from Appendix A.

This model has the following major characteristics:

- A Space Applications program with rapid growth in the period 1972-1975
- A pair of Vikings in 1975
- Grand Tour in 1979
- LST (Large Space Telescopes) -- 3 launch programs, first in 1976
- HEAO (High Energy Astronomical Observatories) -- 4 launches, first in 1977
- A moderate Bioscience flight program.

The division models included are as follows: SA9, SB6, SG8, and SL9. The non-OSSA launches included are those non-reimbursable requirements from model SV1.

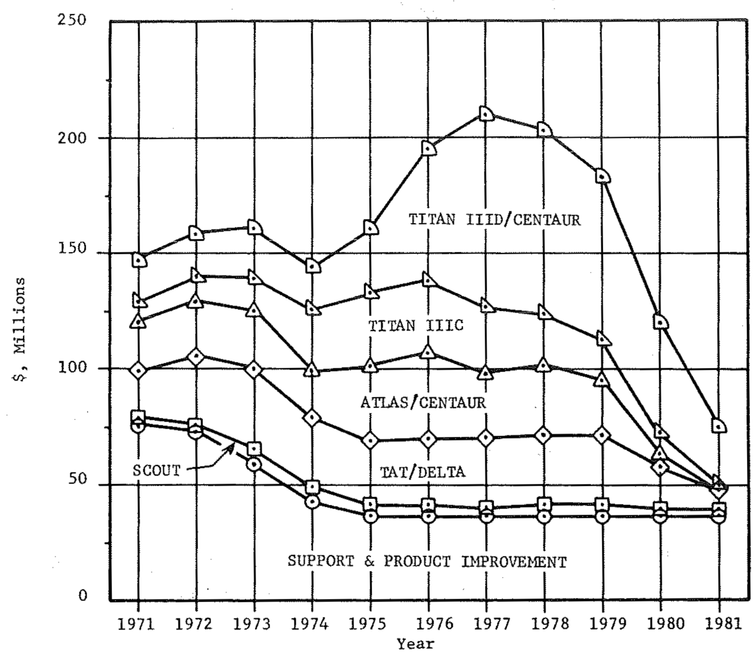

FIGURE VIII-19. OSSA10 LAUNCH VEHICLE FUNDING PLOT

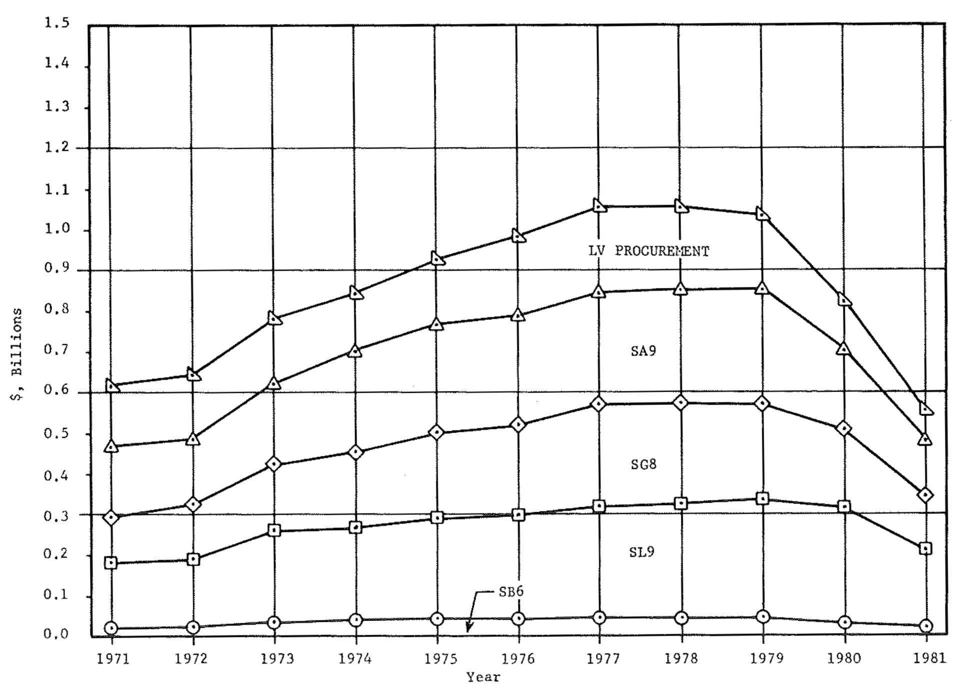

FIGURE VIII-20. OSSA10 TOTAL FUNDING PLOT

TABLE VIII-10. OSSA10 FLIGHT SCHEDULE

Project	Year 71	72	73	74	75	76	77	78	79	80	81
SCOUT											
OSSA											
BIOEXPLORERS A-H	-	-	-	1	1	1	1	1	1	1	1
SMALL ASTRONOMY SATELLITES A,B	1	-	-	-	-	-	-	-	-	-	-
ASTRONOMY EXPLORERS-SCOUT	-	-	1	1	1	1	1	1	1	1	1
SMALL ATS A-D(73)	-	-	1	2	1	-	-	-	-	-	-
DRAG-FREE SATS(74-79)	-	-	-	1	-	-	1	-	1	-	-
SEA-TO-SAT(74-79)	-	-	-	1	-	-	1	-	1	-	-
DATA COLLECTION(76)	-	-	-	-	-	1	-	-	-	-	-
NON OSSA											
OART	2	1	-	-	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	1	1	2	1	1
TAT/DELTA											
OSSA											
BIOPIONEERS A-C	-	-	-	-	1	-	1	-	1	-	-
BIOSATELLITE(IMPROVED) A-H	-	-	-	1	1	1	1	1	1	1	1
MARS EXPLORER/ORBITER(79)	-	-	-	-	-	-	-	-	1	-	-
VENUS EXPLORER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
VENUS EXPLORER ORBITER(80)	-	-	-	-	-	-	-	-	-	1	-
OSO H	1	-	-	-	-	-	-	-	-	-	-
OSO I-K(73-76)	-	-	1	1	-	1	-	-	-	-	-
OSO L,M(79)	-	-	-	-	-	-	-	-	1	1	-
ASTRONOMY EXPLORERS-DELTA (LOW PLAN)	-	-	-	1	-	1	-	1	-	1	-
ATMOSPHERE EXPLORERS F,G	-	-	-	-	-	-	1	-	1	-	-
ATMOSPHERE EXPLORERS C-E(73-75)	-	-	1	1	1	-	-	-	-	-	-
ATMOSPHERE EXPLORERS(81)	-	-	-	-	-	-	-	-	-	-	2
ISIS B-D(71,73,74)	1	-	1	1	-	-	-	-	-	-	-
CLUSTER(77,80)	-	-	-	-	-	-	1	-	-	1	-
IMP I-J(72,73)	-	1	1	-	-	-	-	-	-	-	-
IMP KK-LL(75,76)	-	-	-	-	1	1	-	-	-	-	-
IMP(78,81)	-	-	-	-	-	-	-	2	-	-	1
SPACE WEATHER PROBE A	-	-	-	-	1	-	-	-	-	-	-
SPACE WEATHER PROBES B,C	-	-	-	-	-	-	1	-	-	1	-
TIROS N(75)	-	-	-	-	1	-	-	-	-	-	-
NIMBUS E,F	-	1	1	-	-	-	-	-	-	-	-
NIMBUS(77,78)	-	-	-	-	-	-	1	1	-	-	-
SMS	1	1	-	-	-	-	-	-	-	-	-
GARP EQUATORIAL	-	-	-	1	-	-	-	-	-	-	-
GARP GEOSTATIONARY	-	-	-	2	-	-	-	-	-	-	-
GARP POLAR ORBITER	-	-	-	1	-	-	-	-	-	-	-
ERTS A,B	-	1	1	-	-	-	-	-	-	-	-
ERTS C,D(73)	-	-	1	1	-	-	-	-	-	-	-
ERTS E,F(74)	-	-	-	1	1	-	-	-	-	-	-
ERTS FOLLOW-ON(MED.-LEVEL)	-	-	-	-	-	1	1	1	2	2	2
GEOS-C(72)	-	1	-	-	-	-	-	-	-	-	-
SAT-TO-SAT(75)	-	-	-	-	1	-	-	-	-	-	-
COMMUNICATIONS R&D(78,80)	-	-	-	-	-	-	-	1	-	1	-
NAVIGATION T/C(76)	-	-	-	-	-	2	-	-	-	-	-
NON OSSA											
OART	-	-	-	1	1	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	1	1	2	1	1	2	2	1	1	2	1

TABLE VIII-10. OSSA10 FLIGHT SCHEDULE (Continued)

Project	Year 71	72	73	74	75	76	77	78	79	80	81
ATLAS/CENTAUR											
OSSA											
MARS MARINER(71)	2	-	-	-	-	-	-	-	-	-	-
MERCURY/VENUS MARINER FLYBY(73)	-	-	1	-	-	-	-	-	-	-	-
JUPITER PIONEER F	-	1	-	-	-	-	-	-	-	-	-
OAO C	1	-	-	-	-	-	-	-	-	-	-
OAO D	-	-	-	1	-	-	-	-	-	-	-
HELIOS	-	-	-	1	1	-	-	-	-	-	-
METEOROLOGICAL ATS(76)	-	-	-	-	-	1	-	1	1	-	-
DRSS TRIPLE ACCESS(77)	-	-	-	-	-	-	2	-	-	-	-
DRSS DUAL PURPOSE	-	-	-	-	-	-	-	-	-	2	-
COMMUNICATIONS ATS(77,79)	-	-	-	-	-	-	1	-	1	-	-
NAVIGATION T/C(77,78)	-	-	-	-	-	-	1	1	-	-	-
NON OSSA											
OART	-	-	-	1	-	-	-	-	-	-	-
INTERNATIONAL PROGRAMS	-	1	-	-	-	1	-	-	-	1	-
TITAN IIIC											
OSSA											
MERCURY/VENUS FLYBY(78)	-	-	-	-	-	-	-	1	-	-	-
LST A-C(76,78,80)	-	-	-	-	-	1	-	1	-	1	-
HEAO A-C(77-81)	-	-	-	-	-	-	1	-	1	-	1
GENERAL RELATIVITY(76)	-	-	-	-	-	1	-	-	-	-	-
COMMUNICATIONS ATS F,G(73)	-	-	1	-	1	-	-	-	-	-	-
TITAN IIID/CENTAUR											
OSSA											
MARS VIKING ORB./SL. A,B(75)	-	-	-	-	2	-	-	-	-	-	-
MARS HIGH DATA ORBITER(77)	-	-	-	-	-	-	1	-	-	-	-
MARS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
VENUS HIGH DATA ORBITER(81)	-	-	-	-	-	-	-	-	-	-	1
JUPITER PIONEER G	-	-	1	-	-	-	-	-	-	-	-
JUPITER MARINER ORBITER(78)	-	-	-	-	-	-	-	1	-	-	-
JUPITER FLYBY/PROBES(83)	(Launch in 1983)										
JUPITER-URANUS-NEPTUNE MARINER FLYBY(79)	-	-	-	-	-	-	-	-	2	-	-
HEAO(82)	(Launch in 1982)										
OUT OF ECLIPTIC-PIONEER(78,79)	-	-	-	-	-	-	-	1	1	-	-
SOLAR PROBE TO 0.05 a.u.	-	-	-	-	-	-	-	-	-	1	-
SOLAR PROBE-CLOSE IN PRECURSOR	-	-	-	-	-	-	-	-	1	-	-
RELATIVITY REDSHIFT-SOLAR PROBE	-	-	-	-	-	-	-	1	-	-	-
RELATIVITY REDSHIFT-DEEP SPACE	-	-	-	-	-	-	-	-	-	1	-
TITAN EXPLORERS	-	-	-	-	-	-	-	-	1	-	1
X-BAND TV TECH(77)	-	-	-	-	-	-	1	-	-	-	-
PROTO-INFO/ETV SAT A	-	-	-	-	-	-	-	1	-	-	-
PROTO-INFO/ETV SAT B	-	-	-	-	-	-	-	-	-	1	-
UHF DIRECT TV PROTO-OP	-	-	-	-	-	-	-	-	-	-	1
TITAN/CENTAUR TEST FLIGHT(73)	-	-	1	-	-	-	-	-	-	-	-

Discussion

OSSA Models

Figures VIII-21 and VIII-22 show the funding requirements for the 10 OSSA mission models presented in the previous section along with funding projections (dashed lines) from Appendix A. Figure VIII-21 presents the 4 NASA-based models (OSSA1-OSSA4) and Figure VIII-22 presents the 6 alternative models (OSSA5-OSSA10) developed as part of this study.

As Figure VIII-21 indicates, for 1971-1974, all of the NASA-based models have funding requirements which are considerably higher than the Appendix A OSSA projection. The funding requirements drop below the projection for the remainder of the period for 3 of the 4 models. The fourth NASA-based model, OSSA3(STG Option I), involves a very aggressive automated Planetary program. The decline in funding which appears in OSSA1 and OSSA2 may have resulted from assuming that the proposed space station and shuttle systems would be available in 1977. The introduction of these systems could be expected to reduce the number of automated satellites launched since many scientific experiments probably would be incorporated in a space station. The only program where basic spacecraft designs might not change if a space station were available would be the Planetary program. However, definition and design of the space station are only in preliminary phases, and, thus, it is difficult at this time to draw conclusions concerning the eventual impact of such systems.

Model OSSA4, which shows a decline in funding requirements after FY 1973, is a combination of the PSG-LOW division models, which may have been developed using different and independent guidelines. For all divisions except SL, the PSG-LOW division models included very few new starts after 1974 and appear to be short term models.

Since the FY 1971 NASA budget submitted to Congress is considerably lower than the amount needed to support any of the STG options[(2)], it has been assumed here that the space station and shuttle are not likely to be available for OSSA missions until after 1980. This basic assumption was used in developing all of the alternative OSSA models (OSSA5-OSSA10). In other words, these alternative models assume that the approach to performing OSSA-type missions is not likely to change radically prior to the 1980s.[(3)]

As indicated in Figure VIII-22, the alternative models approximate and bracket the OSSA funding projection from Appendix A. As mentioned earlier in this chapter, these models represent only a small subset of the 1296 alternative OSSA models which could be derived from the alternative OSSA division models developed in this study. However, it is felt that the alternative models presented represent a reasonable range of possible future activities that might be pursued by NASA OSSA. Table VIII-11 summarizes the alternative division models selected for inclusion in each alternative OSSA model.

Table VIII-12 indicates, for each model, the year (after 1970) of the first launch for each mission series and the number of launches involved. The table does not indicate the projected launch schedules for each activity, but this information can be obtained by referring either to the flight schedules presented in the previous section of this chapter or the appropriate OSSA program division flight schedules in Chapters IV-VII. Except for the planetary programs, most of the division activity areas appear in each of the 10 OSSA models. However, the number of launches and first launch date vary from model to model.

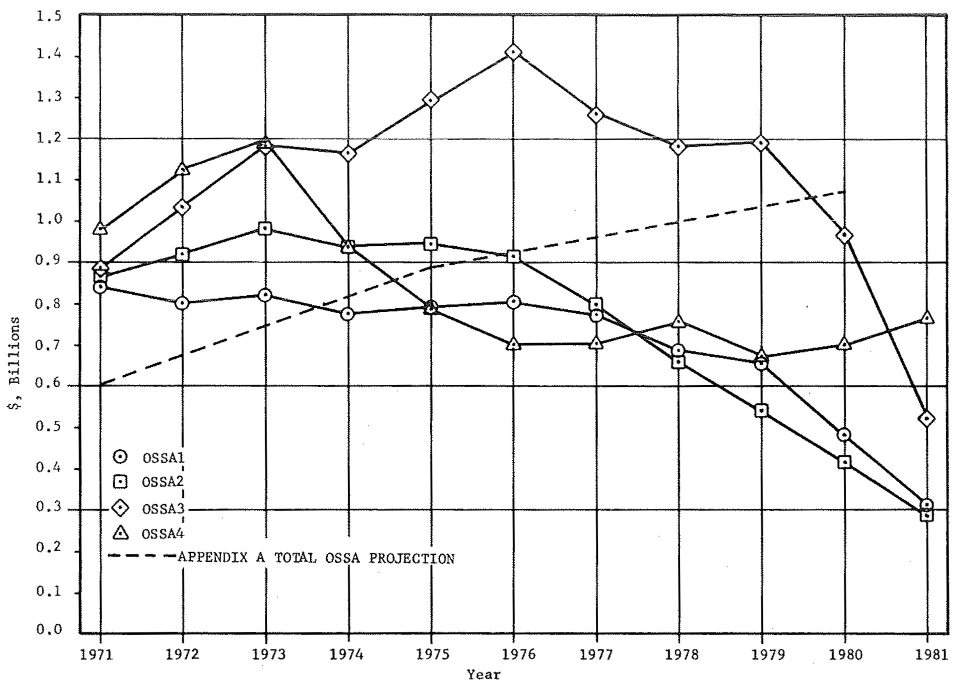

FIGURE VIII-21. ESTIMATED TOTAL OSSA FUNDING FOR NASA-MODELS OSSA1-OSSA4

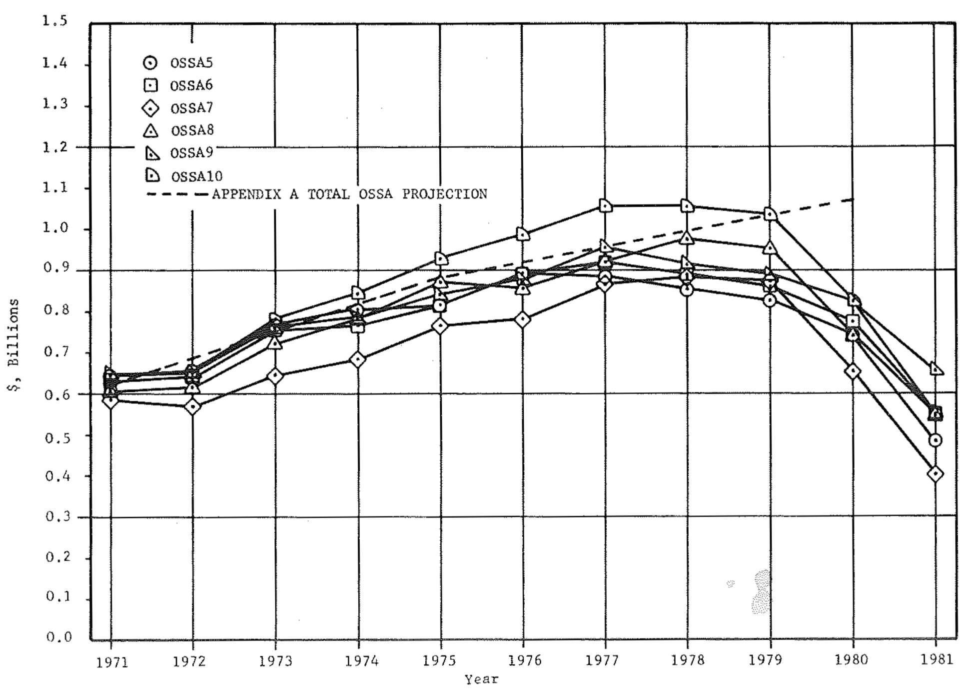

FIGURE VIII-22. ESTIMATED TOTAL OSSA FUNDING FOR NASA-MODELS OSSA5-OSSA10

TABLE VIII-11. ALTERNATIVE DIVISION MODELS INCLUDED IN THE ALTERNATIVE OSSA MODELS

Alternative Division Models	Alternative OSSA Models					
	OSSA5	OSSA6	OSSA7	OSSA8	OSSA9	OSSA10
SA5	●	●			●	
SA6						
SA7						
SA8						
SA9				●		●
SA10			●			
SB5						
SB6						●
SB7		●				
SB8			●	●	●	
SB9						
SB10	●					
SG5	●	●			●	
SG6						
SG7						
SG8						●
SG9			●	●		
SG10						
SL5			●			
SL6						
SL7	●					
SL8				●		
SL9		●				●
SL10					●	

TABLE VIII-12. PROGRAM ACTIVITY BY MODEL

Program Areas	Models OSSA1	OSSA2	OSSA3	OSSA4	OSSA5	OSSA6	OSSA7	OSSA8	OSSA9	OSSA10
Biopioneers	75 3(a)	75 3	74 4	73 4	74 4	74 4	-	-	-	75 3
Bioexplorers	73 6	74 8	72 13	72 14	72 13	72 14	-	-	-	74 8
Biosatellites (Improved)	-	-	-	-	76 10	80 2	-	-	-	74 8
Advanced Biosatellites	-	-	-	-	-	-	-	-	-	-
Mars Mariner Orbiters	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2
Mars Viking Orbiter/Soft Landers	73 5	73 5	73 4	73 4	75 2	75 2	77 2	75 3	75 4	75 2
Mars Soft Lander/Rovers	-	-	77 4	(84 1)(b)	81 1	-	-	(84 1)	(84 1)	-
Mars High Data Rate Orbiters	81 1	81 1	77 2	79 2(c)	77 2	77 2	75 2	81 1	81 1	77 2
Mars Explorer Orbiters	79 2	77 3	75 3	73 4	-	79 1	79 2	79 1	77 2	79 1
Mercury/Venus Flybys	73 1	73 1	73 2	73 2	73 2	73 2	73 1	73 2	73 1	73 2
Mercury Solar Electric Orbiter	-	-	-	(82 1)	-	-	-	-	-	-
Venus Mariner Orbiter	-	-	78 3	78 1	-	-	-	-	-	-
Venus Mariner Flyby/Probes	-	-	77 2	75 2	-	-	-	-	-	-
Venus Explorer Flyby/Probes	-	75 2	-	-	-	-	-	-	-	-
Venus Orbiter/Rough Landers	-	-	-	(83 4)	-	-	-	-	-	-
Venus High Data Rate Orbiters	-	-	-	-	81 1	81 1	81 1	-	81 1	81 1
Venus Explorer Orbiters	78 3	76 4	72 4	72 5(d)	78 1	78 2	75 2	76 3	75 2	78 2
Jupiter Pioneers F&G	72 2	72 2	72 2	72 2	72 2	72 2	72 2	72 2	72 2	72 2
Jupiter Mariner Orbiters	-	-	78 1	78 1	78 1	78 1	-	80 1	-	78 1
Jupiter Flyby/Probes	-	78 1	80 1	80 2(c)	-	(83 1)	-	-	(83 1)	(83 1)
Jupiter Mariner-Class Flyby/Solar Escape	-	-	-	74 1	-	-	-	-	-	-
Grand Tour Mission	77 4	77 4	77 4	77 4	-	79 2	79 2	79 2	77 4	79 2
Saturn Mariner Orbiter/Probes	-	-	81 1	81 1	-	-	-	-	-	-

(a) The upper figure of each group indicates the year of the first launch (after 1970) and the lower figure indicates the number of launches included.
(b) ( ) indicate funding is included to support a launch even though the launch is outside of the time period under consideration (1971-1981).
(c) Second launch is in 1984.
(d) Fifth launch is in 1983.

TABLE VIII-12. PROGRAM ACTIVITY BY MODEL
(Continued)

Program Areas	Models									
	OSSA1	OSSA2	OSSA3	OSSA4	OSSA5	OSSA6	OSSA7	OSSA8	OSSA9	OSSA10
Asteroid Belt Solar Electric Fly-Through	81 1	81 1	75 1	75 1	81 1	-	-	81 1	81 1	-
Asteroid Eros Mariner Flyby	-	-	81 1	81 1	-	-	-	-	-	-
Comet D'Arrest Mariner Flyby	-	76 1	76 1	-	-	-	-	-	-	-
Comet Kopff Mariner Rendezvous	-	-	-	(83 1)	-	-	-	-	-	-
Comet Halley Mariner Flyby	-	-	-	(85 1)	-	-	-	-	-	-
Orbiting Astronomical Observatories	71 5	71 2	71 5	71 1	71 2	71 2	71 2	71 2	71 2	71 2
Large Space Telescopes	-	76 3	-	-	76 3	76 3	-	-	76 3	76 3
Large Telescope Mounts	80 1	-	79 1	-	-	-	-	-	-	-
Orbiting Solar Observatories	71 6	71 6	71 6	71 6	71 6	71 6	71 6	71 6	71 6	71 6
High Energy Astronomical Observatories	81 1	74 4	73 4	74 4	77 2	77 2	77 3	77 3	77 2	77 3
Small Astronomy Satellites	71 18	71 18	71 29	71 3	71 18	71 18	71 14	71 14	71 18	71 14
Atmosphere Explorers	71 4	73 7	71 5	73 3	71 4	71 4	73 7	73 7	71 4	73 7
Small Scientific Satellites	71 9	71 9	71 11	74 2	71 9	71 9	-	-	71 9	-
Interplanetary Monitoring Platforms	71 7	72 7	71 10	72 4	72 7	72 7	72 7	72 7	72 7	72 7
International Satellites for Ionospheric Studies	72 2	73 2	72 2	71 2	72 2	72 2	71 3	71 3	72 2	71 3
Clusters	77 2	77 2	75 3	75 1	77 2	77 2	77 2	77 2	77 2	77 2
Solar Probes	72 7	74 2	72 7	74 2	74 2	74 2	74 4	74 4	74 2	74 4
Space Weather Probes	75 1	75 1	75 3	-	75 1	75 1	75 3	75 3	75 1	75 3
Out of Ecliptic	78 2	78 2	75 2	-	78 2	78 2	78 2	78 2	78 2	78 2
Relativity	-	76 1	-	73 1	-	-	76 3	76 3	-	76 3
Titan Explorers	-	-	-	-	-	-	79 2	79 2	-	79 2
Automated Physics and Chemistry Laboratory	-	-	-	-	-	-	76 3	76 3	-	-

TABLE VIII-12. PROGRAM ACTIVITY BY MODEL
(Continued)

Program Areas	Models OSSA1	OSSA2	OSSA3	OSSA4	OSSA5	OSSA6	OSSA7	OSSA8	OSSA9	OSSA10
TIROS	75 1	75 1	74 1	75 1	75 1	75 1	75 1	75 1	75 1	75 1
NIMBUS	72 5	72 5	72 6	72 6	72 5	72 5	72 2	72 4	72 5	72 4
SMS	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2	71 2
Meteorological ATS	-	-	74 3	-	-	-	76 3	76 3	-	76 3
GARP	74 4	74 4	74 4	-	74 4	74 4	74 4	74 4	74 4	74 4
ERTS A-F or A-D	72 6	72 6	72 6	72 6	72 6	72 6	72 4	72 6	72 6	72 6
SATS	-	-	-	-	76 12	76 12	76 9	76 9	76 12	76 9
Data Relay	73 13	71 13	72 15	71 12	71 20	71 20	72 12	72 13	71 20	72 13
Communications ATS	72 4	72 4	72 4	72 2	72 4	72 4	73 4	73 4	72 4	73 4
Communications R&D	-	-	-	75 2	78 2	78 2	78 2	78 2	78 2	78 2
Navigation T/C	76 2	76 2	74 2	74 2	76 2	76 2	76 4	76 4	76 2	76 4
Broadcast TV Technology	77 1	77 1	74 3	75 2	77 2	77 2	-	77 1	77 2	77 1
Broadcast TV Prototypes	-	-	76 3	-	78 2	78 2	-	78 3	78 2	78 3

Examination of Table VIII-12 indicates that there are generally fewer new programs started in the early years in the alternative models (OSSA5-OSSA10) than in the NASA-based models (OSSA1-OSSA4). Thus, in general, the required launch vehicle program in the early years (1971-1974) for these alternative OSSA models is less demanding than for the NASA-based models.

Launch Vehicle Procurement Funding

Figures VIII-23 and VIII-24 present the OSSA launch vehicle funding required to support each of the 10 OSSA mission models. Funding is shown in Figure VIII-23 for the NASA-based models (OSSA1-OSSA4) and in Figure VIII-24 for the alternative models (OSSA5-OSSA10). A comparison of Figure VIII-22 (estimated funding required for alternative OSSA models OSSA5-OSSA10) with Figure VIII-24 (launch vehicle funding for the same OSSA models) indicates that there is greater variation (on a percentage basis) in the launch vehicle procurement funding which is primarily a result of differences in requirements for the larger and more expensive vehicles, such as TITAN IIID/CENTAUR, ATLAS/CENTAUR, and TITAN IIIC. The largest variations in procurement funding occur in the later part of the time period considered. Funding for the various models tend to be similar in the earlier part of the time period since most programs that have early launches are on-going programs or were proposed FY 1971 new starts. Thus, estimates for the first part of the period are subject to less variation.

The plots of launch vehicle funding requirements for all alternative models have a "dip" in 1974. This results from a significant decrease in the projected annual support and product improvement costs following completion of the Centaur improvement and the TITAN/CENTAUR integration programs.

Table VIII-13 shows launch procurement funding as a percent of total estimated OSSA funding requirements by year for the 6 alternative models.

TABLE VIII-13. LAUNCH VEHICLE PROCUREMENT FUNDING AS A PERCENTAGE OF TOTAL OSSA FUNDING -- ALTERNATIVE MODELS (OSSA5-OSSA10)

Model	Year 71	72	73	74	75	76	77	78	79	80	81	Average
OSSA5	21	22	19	18	15	17	17	13	15	13	11	16.4
OSSA6	20	20	19	15	16	18	17	14	14	12	11	16.0
OSSA7	21	23	20	17	17	19	19	19	17	16	14	18.4
OSSA8	24	25	21	18	18	21	21	20	19	16	12	19.5
OSSA9	23	24	21	17	17	20	20	19	18	15	14	17.4
OSSA10	24	24	21	17	17	20	20	19	18	15	14	19.0

As can be seen from this table, the variation in percentage of total OSSA funding required for launch vehicle procurement is from 10 to 25%. However, the average by model tends to be between 16 and 19%. All percentages higher than 21 occur before 1974 and are a result of the funding required in the first 3 years (1971-1973) for Centaur improvement and TITAN/CENTAUR integration.

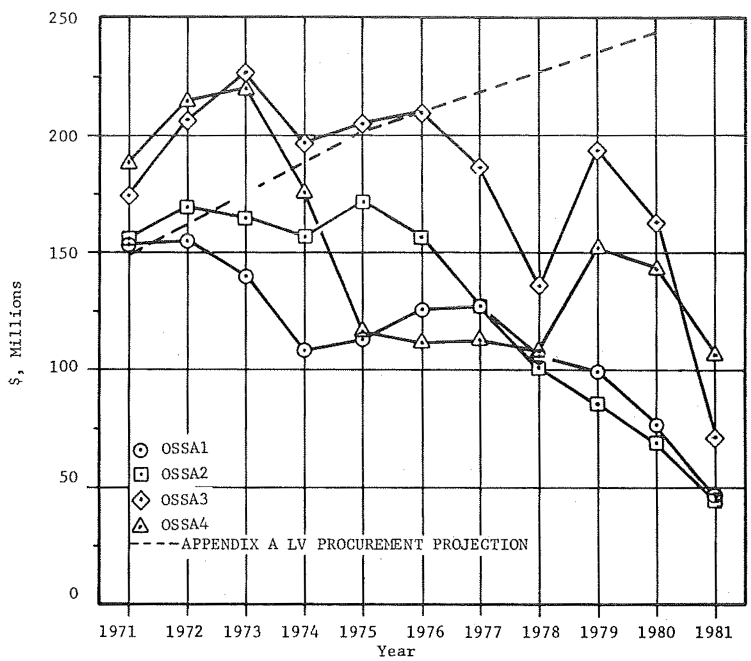

FIGURE VIII-23. ESTIMATED LAUNCH VEHICLE FUNDING FOR NASA-MODELS OSSA1-OSSA4

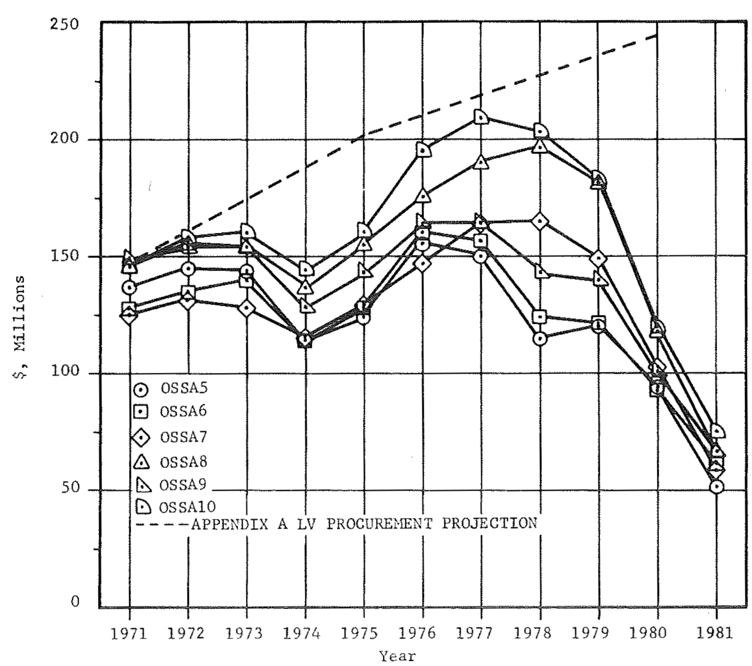

FIGURE VIII-24. ESTIMATED LAUNCH VEHICLE FUNDING FOR NASA-MODELS OSSA5-OSSA10

The costs for developing and testing the TITAN IIID(7)/CENTAUR and the SATURN INT20/CENTAUR have not been included here. In the models which indicate that either vehicle is required, associated launch vehicle development funds will have to be considered. Such funds were not included here because it is considered possible that either or both development programs could be cost-shared with OMSF or the DOD. The funds that would have to be added, if OSSA has to fund the developments are likely to be in the $40-80 million range for the TITAN IIID(7)/CENTAUR and in the $30-40 million range for the SATURN INT20/CENTAUR. These funds would probably be spread over a period of 3 to 5 years.(4)

OSSA Funded Launch Vehicle Requirements

As noted previously, the mission models (OSSA1-OSSA10) include only those projects for which OSSA would be expected to fund the launches. For these missions the OSSA funding requirements can be estimated and the corresponding launch vehicle costs calculated.

Table VIII-14 presents launch vehicle requirements by OSSA mission model and year. The family of launch vehicles required to support the OSSA models presented are SCOUT, DELTA [ranging from TAT/DELTA to TAT(9C)/DELTA/TE364], ATLAS/CENTAUR, TITAN IIIC, TITAN IIID/CENTAUR, TITAN IIID(7)/CENTAUR, TITAN IIID, and SATURN INT20/CENTAUR; however, the SATURN INT20/CENTAUR is included only in the most aggressive planetary models which are considered to have a low probability of implementation in view of budget constraints.

The DELTA has the highest launch rate in each of the models, accounting for 39 to 50% of the launches. In the alternative models, the DELTA percentage varies from 47 to 50. SCOUT has the next highest use rate, accounting for 21 to 33% of the launches. The vehicles involving the Centaur stage, those with Atlas and Titan [including TITAN IIID and TITAN IIID(7)] boosters, have third highest use rate.

Launch Vehicle Requirements

Table VIII-15 compares the OSSA launch vehicle requirements among the models (OSSA1-OSSA10) by year. The figures presented in the table are for OSSA funded vehicles only. In order to obtain a complete picture of the total future needs for OSSA launch vehicles, it is necessary to examine the projected requirements for all outside (non-OSSA) users of the vehicles. A discussion of such projections is presented in Appendix C. As noted previously, mission models OSSA1-OSSA10 contained only part of the outside user requirements--in particular, those requirements for which OSSA might be expected to have to budget for the launch vehicles. In Appendix C, these are referred to as non-reimbursable requirements.

Table VIII-16 contains estimates of the reimbursable requirements presented in Appendix C. Table VIII-17 presents estimates of total OSSA launch vehicle requirements which were obtained by combining reimbursable estimates from selected SV models with selected alternative OSSA models. The combinations presented were selected in order to provide a range of estimates for total launch vehicle requirements. Thus, the combination of OSSA6 and SV5(reimbursables) represents a nominal estimate; OSSA7 and SV5(reimbursables) combine to yield a low estimate; and OSSA10 and SV4(reimbursables) combined yield a high estimate.

TABLE VIII-14. LAUNCH SCHEDULES BY MODEL AND VEHICLE[(a)]

Model	Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81	Total
OSSA1	SCOUT	5	4	7	9	6	7	5	4	6	3	2	58
	TAT/DELTA[(b)]	5	7	6	11	12	6	6	5	6	6	7	77
	ATLAS/CENTAUR[(c)]	3	2	1	3	1	1	2	3	1	2	1	20
	TITAN IIIC	-	1	-	1	-	-	-	-	-	-	-	2
	TITAN IIID/CENTAUR[(d)]	-	1	3	-	-	-	3	1	3	-	2	13
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	1	-	-	-	-	3
	TITAN IIID	-	-	-	-	-	-	-	-	-	1	-	1
	TOTAL	13	15	17	24	21	14	17	13	16	12	12	174
OSSA2	SCOUT	5	3	5	8	5	6	6	4	7	3	3	55
	TAT/DELTA	5	6	9	13	13	6	8	5	7	6	7	85
	ATLAS/CENTAUR	3	2	1	3	1	2	3	-	-	2	1	18
	TITAN IIIC	-	1	-	2	1	3	1	-	1	-	-	9
	TITAN IIID/CENTAUR	-	1	3	-	-	-	4	2	3	-	1	14
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	1	-	-	-	-	3
	TOTAL	13	13	18	26	22	17	23	11	17	11	12	184
OSSA3	SCOUT	7	9	10	10	7	8	5	6	6	6	2	76
	TAT/DELTA	5	10	7	17	12	7	9	6	6	7	4	90
	ATLAS/CENTAUR	3	2	1	6	3	4	3	1	-	2	1	26
	TITAN IIIC	-	1	1	2	1	-	2	1	-	-	-	8
	TITAN IIID/CENTAUR	-	1	3	1	2	2	6	4	3	2	4	28
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-	2
	TITAN IIID	-	-	-	-	-	-	-	-	1	-	-	1
	SATURN INT20/CENTAUR	-	-	-	-	-	-	-	-	-	-	1	1
	TOTAL	15	23	23	36	27	21	25	18	16	17	12	232
OSSA4	SCOUT	4	6	7	7	4	3	3	2	4	2	2	44
	TAT/DELTA	5	7	13	11	15	3	5	4	1	3	2	69
	ATLAS/CENTAUR	3	2	1	4	2	2	-	1	-	1	1	17
	TITAN IIIC	-	1	-	2	1	1	-	1	-	-	-	6
	TITAN IIID/CENTAUR	-	1	3	1	3	-	3	2	3	2	-	18
	TITAN IIID(7)/CENTAUR	-	-	-	-	2	-	-	-	-	-	-	2
	SATURN INT20/CENTAUR	-	-	-	-	-	-	-	-	-	-	1	1
	TOTAL	12	17	24	25	27	9	11	10	8	8	6	157
OSSA5	SCOUT	5	5	8	7	7	7	5	5	6	4	3	62
	TAT/DELTA	5	7	7	12	11	11	9	11	8	12	8	101
	ATLAS/CENTAUR	3	2	1	3	1	1	3	-	1	1	1	17
	TITAN IIIC	-	1	-	1	-	1	-	2	-	1	-	6
	TITAN IIID/CENTAUR	-	-	1	-	2	-	2	4	2	-	4	15
	TOTAL	13	15	17	23	21	20	19	22	17	18	16	201

(a) Does not include reimbursable launches.
(b) In this table TAT/DELTA refers to the following vehicles:
TAT/DELTA, TAT/DELTA/FW4, TAT/DELTA/TE364, TAT(6C)/DELTA/TE364, and TAT(9C)/DELTA/TE364.
(c) Includes ATLAS/CENTAUR, and ATLAS/CENTAUR/BII.
(d) Includes both TITAN IIID/CENTAUR and TITAN IIID/CENTAUR/BII.

TABLE VIII-14. LAUNCH SCHEDULES BY MODEL AND VEHICLE
(Continued)

Model	Vehicle	71	72	73	74	75	76	77	78	79	80	81	Title
		Year											
OSSA6	SCOUT	5	4	7	7	6	8	7	6	8	5	4	67
	TAT/DELTA	5	7	7	12	11	9	7	9	7	12	9	95
	ATLAS/CENTAUR	3	2	1	3	1	1	3	-	1	1	-	16
	TITAN IIIC	-	1	-	1	-	1	-	2	-	1	-	6
	TITAN IIID/CENTAUR	-	-	2	-	2	-	2	4	3	-	4	17
	TOTAL	13	14	17	23	20	19	19	21	19	19	17	201
OSSA7	SCOUT	4	2	4	5	5	3	4	2	5	2	2	38
	TAT/DELTA	4	6	9	11	8	8	6	6	6	10	7	81
	ATLAS/CENTAUR	3	2	1	3	1	3	4	3	2	4	-	26
	TITAN IIIC	-	-	1	-	1	1	1	-	1	-	1	6
	TITAN IIID/CENTAUR	-	-	2	-	1	-	2	2	5	2	3	17
	TOTAL	11	10	17	19	16	15	17	13	19	18	13	168
OSSA8	SCOUT	4	2	4	6	3	4	4	2	5	2	2	38
	TAT/DELTA	4	6	9	12	8	9	7	7	6	10	7	85
	ATLAS/CENTAUR	3	2	1	3	1	3	4	3	2	4	1	27
	TITAN IIIC	-	-	1	-	1	1	1	1	1	-	1	7
	TITAN IIID/CENTAUR	-	-	2	-	2	-	1	3	5	4	3	20
	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	1	-	-	-	-	1
	TOTAL	11	10	17	21	15	17	18	16	19	20	14	178
OSSA9	SCOUT	5	3	6	6	5	6	5	4	6	3	3	52
	TAT/DELTA	5	7	7	11	11	8	7	8	7	11	8	90
	ATLAS/CENTAUR	3	2	1	3	1	1	3	-	1	1	1	17
	TITAN IIIC	-	1	-	1	-	1	-	1	-	1	-	5
	TITAN IIID/CENTAUR	-	-	2	-	2	-	4	3	3	-	4	18
	TITAN IIID(7)/CENTAUR	-	-	-	-	-	-	-	-	2	-	-	2
	TOTAL	13	13	16	21	19	16	19	16	19	16	16	184
OSSA10	SCOUT	4	2	4	7	4	5	5	3	6	3	3	46
	TAT/DELTA	4	6	9	13	10	9	9	9	8	11	7	95
	ATLAS/CENTAUR	3	2	1	3	1	2	4	2	2	3	-	23
	TITAN IIIC	-	-	1	-	1	2	1	2	1	1	1	10
	TITAN IIID/CENTAUR	-	-	2	-	2	-	2	4	5	3	4	22
	TOTAL	11	10	17	23	18	18	21	20	22	21	15	196

TABLE VIII-15. LAUNCH SCHEDULES BY VEHICLE AND MODEL[(a)]

Launch Vehicle	Model	Year 71	72	73	74	75	76	77	78	79	80	81	Total
SCOUT	OSSA1	5	4	7	9	6	7	5	4	6	3	2	58
	OSSA2	5	3	5	8	5	6	6	4	7	3	3	55
	OSSA3	7	9	10	10	7	8	5	6	6	6	2	76
	OSSA4	4	6	7	7	4	3	3	2	4	2	2	44
	OSSA5	5	5	8	7	7	7	5	5	6	4	3	62
	OSSA6	5	4	7	7	6	8	7	6	8	5	4	67
	OSSA7	4	2	4	5	5	3	4	2	5	2	2	38
	OSSA8	4	2	4	6	3	4	4	2	5	2	2	38
	OSSA9	5	3	6	6	5	6	5	4	6	3	3	52
	OSSA10	4	2	4	7	4	5	5	3	6	3	3	46
TAT/DELTA[(b)]	OSSA1	5	7	6	11	12	6	6	5	6	6	7	77
	OSSA2	5	6	9	13	13	6	8	5	7	6	7	85
	OSSA3	5	10	7	17	12	7	9	6	6	7	4	90
	OSSA4	5	7	13	11	15	3	5	4	1	3	2	69
	OSSA5	5	7	7	12	11	11	9	11	8	12	8	101
	OSSA6	5	7	7	12	11	9	7	9	7	12	9	95
	OSSA7	4	6	9	11	8	8	6	6	6	10	7	81
	OSSA8	4	6	9	12	8	9	7	7	6	10	7	85
	OSSA9	5	7	7	11	11	8	7	8	7	11	8	90
	OSSA10	4	6	9	13	10	9	9	9	8	11	7	95
ATLAS/CENTAUR[(c)]	OSSA1	3	2	1	3	1	1	2	3	1	2	1	20
	OSSA2	3	2	1	3	1	2	3	-	-	2	1	18
	OSSA3	3	2	1	6	3	4	3	1	-	2	1	26
	OSSA4	3	2	1	4	2	2	-	1	-	1	1	17
	OSSA5	3	2	1	3	1	1	3	-	1	1	1	17
	OSSA6	3	2	1	3	1	1	3	-	1	1	-	16
	OSSA7	3	2	1	3	1	3	4	3	2	4	-	26
	OSSA8	3	2	1	3	1	3	4	3	2	4	1	27
	OSSA9	3	2	1	3	1	1	3	-	1	1	1	17
	OSSA10	3	2	1	3	1	2	4	2	2	3	-	23
TITAN IIIC	OSSA1	-	1	-	1	-	-	-	-	-	-	-	2
	OSSA2	-	1	-	2	1	3	1	-	1	-	-	9
	OSSA3	-	1	1	2	1	-	2	1	-	-	-	8
	OSSA4	-	1	-	2	1	1	-	1	-	-	-	6
	OSSA5	-	1	-	1	-	1	-	2	-	1	-	6
	OSSA6	-	1	-	1	-	1	-	2	-	1	-	6
	OSSA7	-	-	1	-	1	1	1	-	1	-	1	6
	OSSA8	-	-	1	-	1	1	1	1	1	-	1	7
	OSSA9	-	1	-	1	-	1	-	1	-	1	-	5
	OSSA10	-	-	1	-	1	2	1	2	1	1	1	10

(a) Does not include reimbursable launches.
(b) In this table TAT/DELTA refers to the following vehicles: TAT/DELTA, TAT/DELTA/FW4, TAT/DELTA/TE364, TAT(6C)/DELTA/TE364, and TAT(9C)/DELTA/TE364.
(c) Includes ATLAS/CENTAUR, and ATLAS/CENTAUR/BII.

TABLE VIII-15. LAUNCH SCHEDULES BY VEHICLE AND MODEL
(Continued)

Launch Vehicle	Model	Year											Total
		71	72	73	74	75	76	77	78	79	80	81	
	OSSA1	-	1	3	-	-	-	3	1	3	-	2	13
	OSSA2	-	1	3	-	-	-	4	2	3	-	1	14
	OSSA3	-	1	3	1	2	2	6	4	3	2	4	28
	OSSA4	-	1	3	1	3	-	3	2	3	2	-	18
TITAN IIID/CENTAUR[(d)]	OSSA5	-	-	1	-	2	-	2	4	2	-	4	15
	OSSA6	-	-	2	-	2	-	2	4	3	-	4	17
	OSSA7	-	-	2	-	1	-	2	2	5	2	3	17
	OSSA8	-	-	2	-	2	-	1	3	5	4	3	20
	OSSA9	-	-	2	-	2	-	4	3	3	-	4	18
	OSSA10	-	-	2	-	2	-	2	4	5	3	4	22
	OSSA1	-	-	-	-	2	-	1	-	-	-	-	3
	OSSA2	-	-	-	-	2	-	1	-	-	-	-	3
	OSSA3	-	-	-	-	2	-	-	-	-	-	-	2
	OSSA4	-	-	-	-	2	-	-	-	-	-	-	2
TITAN IIID(7)/CENTAUR	OSSA5	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA6	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA7	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA8	-	-	-	-	-	-	1	-	-	-	-	1
	OSSA9	-	-	-	-	-	-	-	-	2	-	-	2
	OSSA10	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA1	-	-	-	-	-	-	-	-	-	1	-	1
	OSSA2	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA3	-	-	-	-	-	-	-	-	1	-	-	1
	OSSA4	-	-	-	-	-	-	-	-	-	-	-	0
TITAN IIID	OSSA5	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA6	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA7	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA8	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA9	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA10	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA1	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA2	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA3	-	-	-	-	-	-	-	-	-	-	1	1
	OSSA4	-	-	-	-	-	-	-	-	-	-	1	1
SATURN INT20/CENTAUR	OSSA5	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA6	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA7	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA8	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA9	-	-	-	-	-	-	-	-	-	-	-	0
	OSSA10	-	-	-	-	-	-	-	-	-	-	-	0

(d) Includes both TITAN IIID/CENTAUR and TITAN IIID/CENTAUR/BII.

TABLE VIII-16. ESTIMATES OF REIMBURSABLE OUTSIDE USER LAUNCH VEHICLE REQUIREMENTS

Launch Vehicle	Model	Year											Total
		71	72	73	74	75	76	77	78	79	80	81	
	SV1	4	4	3	4	4	3	4	4	3	4	4	41
	SV2	4	3	3	3	4	2	4	3	3	3	4	36
SCOUT	SV3	5	2	3	3	3	3	3	3	3	2	4	34
	SV4	4	4	4	4	4	4	4	4	4	4	4	44
	SV5	4	3	3	3	4	2	4	3	3	3	4	36
	SV1	4	5	7	6	7	5	7	7	8	7	5	68
	SV2	4	5	7	6	7	5	7	7	8	5	7	68
TAT/DELTA	SV3	4	4	7	5	6	6	6	6	8	5	5	62
	SV4	7	7	10	5	9	8	7	7	9	3	9	81
	SV5	4	4	5	6	5	6	5	6	7	5	5	58
	SV1	2	3	3	1	2	-	-	3	2	1	1	18
	SV2	2	2	2	2	2	-	-	3	2	1	1	17
ATLAS/CENTAUR	SV3	2	2	2	2	2	-	1	2	2	1	1	17
	SV4	2	2	3	4	4	3	2	1	4	2	1	28
	SV5	2	2	2	2	2	-	1	2	2	1	1	17
	SV1	-	-	-	-	-	-	1	1	1	1	1	5
	SV2	-	-	-	-	-	-	1	1	1	1	1	5
TITAN IIID/CENTAUR	SV3	-	-	-	-	-	-	1	1	1	1	1	5
	SV4	-	-	-	-	-	-	-	1	2	1	1	5
	SV5	-	-	-	-	-	-	1	1	1	1	1	5

TABLE VIII-17. SELECTED ESTIMATES OF TOTAL OSSA LAUNCH VEHICLE REQUIREMENTS

Launch Vehicle	Source of Estimates: OSSA Model	Source of Estimates: SV Model (a)	Model Class (b)	Year 71	72	73	74	75	76	77	78	79	80	81	Total
SCOUT	OSSA6	SV5	N	9	7	10	10	10	10	11	9	11	8	8	103
	OSSA7	SV5	L	8	5	7	8	9	5	8	5	8	5	6	74
	OSSA10	SV5	H	8	6	8	11	8	9	9	7	10	7	7	90
TAT/DELTA (c)	OSSA6	SV5	N	9	11	12	18	16	15	12	15	14	17	14	153
	OSSA7	SV5	L	8	10	14	17	13	14	11	12	13	15	12	139
	OSSA10	SV4	H	11	13	19	18	19	17	16	17	17	14	16	177
ATLAS/CENTAUR (d)	OSSA6	SV5	N	5	4	3	5	3	1	4	2	3	2	1	33
	OSSA7	SV5	L	5	4	3	5	3	3	5	5	5	5	1	44
	OSSA10	SV4	H	5	4	4	7	5	5	6	3	6	5	1	51
TITAN IIIC	OSSA6	- (e)	N	-	1	-	1	-	1	-	2	-	1	-	6
	OSSA7	-	L	-	-	1	-	1	-	1	1	1	-	1	6
	OSSA10	-	H	-	-	1	-	1	2	1	2	1	1	1	10
TITAN IIID/CENTAUR (f)	OSSA6	SV5	N	-	-	2	-	2	-	3	5	4	1	5	22
	OSSA7	SV5	L	-	-	2	-	1	-	3	3	6	3	4	22
	OSSA10	SV4	H	-	-	2	-	2	-	2	5	7	4	5	27
TOTAL REQUIREMENTS	OSSA6	SV5	N	23	23	27	34	31	27	30	33	32	29	28	317
	OSSA7	SV5	L	21	19	27	30	27	22	28	26	33	28	24	285
	OSSA10	SV4	H	24	23	34	36	35	33	34	34	41	31	30	355

(a) Only reimbursable launches were used from the indicated SV models. Each of the OSSA models includes the non-reimbursable launches from SV1.

(b) The following designators are used to specify model class: N-Nominal, L-Low and H-High.

(c) In this table TAT/DELTA refers to the following vehicles: TAT/DELTA, TAT/DELTA/FW4, TAT/DELTA/TE364, TAT(6C)/DELTA/TE364, and TAT(9C)/DELTA/TE364.

(d) Includes ATLAS/CENTAUR, and ATLAS/CENTAUR/BII.

(e) Outside users would probably purchase TITAN IIIC from the U. S. Air Force rather than OSSA.

(f) Includes both TITAN IIID/CENTAUR and TITAN IIID/CENTAUR/BII.

The terms nominal, low and high refer to the total estimated launch activity in each model, and do not necessarily hold true for one particular vehicle. Thus, for example, in Table VIII-17 the combination of low models involves 11 more ATLAS/CENTAUR launches than does the nominal combination. Table VIII-17 also indicates that the greatest variations in estimated requirements for launches among the low, nominal, and high model combinations occur for the smaller vehicles, SCOUT and DELTA. These vehicles account for 75 to 80% of the total launches. In particular SCOUT percentages range from 25 to 32% and the DELTA percentages from 48 to 50%. These percentages are very similar to the percentages associated with the alternative OSSA models. This indicates that the outside users' proportion of requirements by vehicles are very similar to those of OSSA.

References

(1) "America's Next Decades in Space", A Report for the Space Task Group prepared by the National Aeronautics and Space Administration, September, 1969.

(2) "The Post-Apollo Space Program - Direction for the Future", A Space Task Group Report to the President, September, 1969.

(3) McGolrick, J. E., "Space Shuttle", Memorandum to SV Director, Launch Vehicle and Propulsion Programs, National Aeronautics and Space Administration, December 2, 1969.

(4) Nippert, D. A., "Development Costs for the Titan IIID(7)/Centaur and the Saturn INT20/Centaur", Battelle Memorial Institute, Columbus, Ohio, Report No. BMI-NLVP-ICM-70-72, April 24, 1970.

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APPENDIX A

PROJECTIONS AND ANALYSIS OF OSSA FUNDING

Introduction

This appendix is based on material from BMI-NLVP-ICM-69-140, "Quantification of Task 1 - Projections and Analysis of OSSA Funding", by L. L. Lederman and M. L. Windus[(1)*]. The following major sections define the three basic topics covered in this analysis:

A-I A quantification of the Reference 2 projections for each of the Federal Functional Fields[(2)]

A-II A quantification of the Reference 2 NASA program areas projections[(2)]

A-III An attempt to project OSSA funding levels by division.

Each section includes information about the methodology and strategy employed in the projections. The remaining paragraphs of this introductory section contain background notes and geopolitical and economic assumptions underlying the projections given in the three major sections.

Background Notes

Projections made in this study are single point projections for 1975 and 1980. Three factors should be kept in mind when looking at such projections:

(1) For projections related to Federal Functional Fields and NASA program areas (A-I and A-II above), a ±10% deviation might be visualized around each projected value as the reasonable range within which the actual values have a higher probability of occurring than any other possible projection. Projections at lesser aggregate levels can be expected to be somewhat less accurate.

(2) All dollar figures are expressed in current dollars; that is, dollars for whatever year they appear rather than in constant (deflated) dollars for some year, such as 1970. Thus, inflation is included in the growth rates and "real" growth will be something less than the rates shown.

(3) The projections of R&D growth for the next 10 years are likely to cause some concern because they do not take inflation factors into account. There is good reason to believe that past inflation in R&D costs has been around 6% per year[(3)**], although reliable R&D inflation factors have not been precisely measured.

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* Superscript numbers denote references given at the end of this appendix.
** The breakdown by periods [in Reference (3)] in annual increases in technical-man-year costs was 7% for 1950-1955; 8% for 1956-1960; and 4% for 1961-1965.

While it is probably correct to assume that inflation in R&D costs will absorb much of the future growth rate and that not many more man-hours of input will be purchasable at the likely higher funding, two other factors should be considered. The first relates to the appropriateness of applying past inflation factors to the future; that is, it may not be reasonable to assume that inflation factors will remain constant. There are good practical and theoretical reasons to believe that as growth rates slow down, so do inflation rates. If one assumes that R&D inflation factors will decrease to the level of general inflation as R&D growth rates fall to the level of the general growth rates, then R&D inflation could be closer to 3% per year for the 1968-1980 period. This could mean that the difference between 3% and the rates of change in R&D funding shown would be available for increases in manpower or other inputs. The second factor to be considered is that statistical estimates of R&D inflation factors have very little to do with changes in the productivity or quality of output. Obviously, it is possible to achieve higher or lower levels in the productivity or quality of output (despite the difficulties in measurement) from a given R&D dollar input over time. This is a point that R&D organizations will have to be increasingly concerned with as growth rates remain low.

The following few broad basic assumptions underlie the projections at the macro-level which provided the totals to which the more micro-projections reported here must aggregate (100% principle):

Geopolitical Assumptions

- Vietnam settlement 1973-1975, 500,000 man reduction in U. S. forces 1970-1973
- Continuation of cold war between USA and USSR
- Russia remaining as the number one threat, with Red China a rapidly growing threat
- Continued Communist harrassment in Asia
- More political wars in Africa and South America
- U. S. role in worldwide hostilities will shift from military intervention to diplomatic reconciliation.

Economic Assumptions

- National economic average annual growth -- 3.7% per year in real dollars plus up to 2.0% per year inflation
- Average unemployment rate 4%
- No major depression
- 1975 and 1980 (projected years) normal years with possibility of minor recessionary/inflationary factors exceeding assumptions in other years
- Population growth varying between Census Bureau's "C" Projection of 2.8 children/woman and "B" Projection of 3.1 children/woman.[(4)]

A-I. Projection of Functional Fields to 1975 and 1980

Table A-1 shows projections of functional field totals to 1975 and 1980 for total outlays and for R&D, and Table A-2 shows projected changes. The total outlay figures were projected as a part of some other work done at Battelle. They are based on a number of different methods, primarily:

(1) Linear extrapolation of program or expenditure trends

(2) Expenditures if "needs" were met or "goals" fulfilled, scaled down to match likely resources

(3) Expenditures based on demographic changes.

As with most projections, these should not be taken as anything approaching absolute certainty. The political decision-making process is not a predictable, quantitative variable.

The R&D expenditure levels were projected using figures gathered for the previous report to NASA[2], with 1969 data revised and 1970 data added based upon the FY 1970 Budget. Projections were, for most fields, based on the average annual growth rates over the last decade modified by the lower growth rates of the last few years. There is general agreement that the high early 1960 growth rates for Government R&D will not return because of the maturing of Government R&D, the high absolute dollar amounts involved, and some degree of skepticism. This is why overall rates for the whole decade were modified (and thus lowered) by the last few years for projection purposes.

Specifically the average yearly percent growth or decline in percent of total R&D was calculated for the entire 1961-1970 period and used to project to 1980. The average yearly percent growth or decline in percent of total R&D was also calculated for the most recent, 1967-1970, period and projected. Then an average of the 1961-1970 projection and the recent 1967-1970 projection was taken. This results in the 1967-1970 time period being weighted more heavily.

For 8 of the 12 functional fields involving R&D, this strategy was used to project percent of total to 1980. In the four other R&D fields, it was decided that other projection techniques should be used, viz:

- Commerce, Transportation, and Communications - The growth rate for the entire 1961-1970 period only was used because the growth rate for the 1967-1970 period was unusually high and caused the average of the two to appear unattainable.

- Space - Because Space was a relatively new field of R&D activity in 1961, the 1961-1970 change rate is very high and continuation of such a growth rate would be unrealistic, as recent events have demonstrated. On the other hand, the recent 1967-1970 period has shown such sharp decreases that a continuation of this would make Space R&D unrealistically low. Therefore, to get a 1980 likely percent of total, the present (1970) percent of total and the percent of total arrived at by using the 1967-1970 rate of change in percent of total were averaged.

- Housing & Community Development - The 1967-1970 growth rate alone was used because there was no reported R&D in 1961 and therefore no calculable growth rate for the entire period.

TABLE A-1. FUNCTIONAL FIELD PROJECTIONS TO 1975 AND 1980, TOTAL OUTLAYS AND R&D(a)

Functional Fields	Outlays						R&D						R&D as a % of Outlays		
	$ Billions			% of Subtotal			$ Billions			% of Subtotal					
	1970	1975	1980	1970	1975	1980	1970	1975	1980	1970	1975	1980	1970	1975	1980
National Security	80.3	60.6	70.4	44.1	27.6	25.3	8.65	9.87	11.58	54.2	52.1	47.9	10.8(b)	16.3	16.4
Welfare	39.5	66.6	85.6	21.7	30.3	30.8	0.06	0.12	0.27	0.3	0.6	1.1	0.1	0.2	0.3
Health	14.6	23.7	34.2	8.1	10.8	12.3	1.25	1.99	3.25	7.8	10.5	13.4	8.5	8.4	9.5
Commerce, Transportation and Communications	8.9	12.4	16.2	4.9	5.6	5.8	0.46	0.82	1.52	2.9	4.3	6.3	5.1	6.6	9.4
Education & Knowledge	6.5	13.8	21.1	3.6	6.3	7.6	1.17	1.50	1.99	7.3	7.9	8.2	18.0	10.9	9.5
Veterans	5.4	6.3	6.6	3.0	2.9	2.4	--	--	--	--	--	--	--	--	--
Agriculture	5.2	6.8	6.3	2.8	3.1	2.3	0.24	0.31	0.40	1.5	1.6	1.7	4.6	4.5	6.4
Labor & Manpower	5.1	6.4	7.3	2.8	2.9	2.6	0.03	0.08	0.17	0.2	0.4	0.7	0.7	1.2	2.4
International Relations	3.8	5.4	6.5	2.1	2.5	2.3	0.02	0.03	0.05	0.1	0.2	0.2	0.5	0.6	0.8
National Resources & Environment	3.4	4.6	6.0	1.9	2.1	2.2	0.78	0.96	1.22	4.9	5.1	5.0	23.0	21.1	20.2
Space	3.3	3.7	3.8	1.8	1.7	1.4	3.26	3.11	3.22	20.4	16.4	13.3	98.5	84.2	84.3
General Government	3.3	5.0	6.7	1.8	2.3	2.4	0.02	0.06	0.20	0.1	0.3	0.8	0.6	1.3	2.9
Housing & Community Development	2.7	4.7	7.3	1.5	2.1	2.6	0.04	0.11	0.32	0.2	0.6	1.3	1.5	2.4	4.3
Subtotal	181.9	219.9	278.0	100.0	100.0	100.0	15.96	18.95	24.19	100.0	100.0	100.0	8.8	8.6	8.7
Bloc Grants or Revenue Sharing	--	10.0	18.0												
Interest	16.0	17.5	18.0												
Special Allowances	3.2	--	--												
Undist. Adjustment	-5.7	-6.6	-8.0												
Total	195.3	240.8	306.0												

(a) While single dollar figures are shown, a ±10% range should be visualized as being the range within which the actual figure is more likely to fall than any other projected value. The figures shown may not add to totals shown due to rounding: Calculations are based on unrounded numbers.

(b) For example, National Security R&D as a % of outlays for 1970 was computed as follows:

$$10.8\% = \frac{8.65[\text{R\&D (1970)}]}{80.3[\text{Outlays (1970)}]} \times 100$$

TABLE A-2. SUMMARY OF PROJECTED CHANGES BY FUNCTION, OUTLAYS, AND R&D, 1970 to 1980

Functional Field	Outlays: 1970 to 1980 Change: $ Billions	Outlays: 1970 to 1980 Change: % of Total	Outlays: Average Annual % Change in Outlays	R&D: 1970 to 1980 Change: $ Billions	R&D: 1970 to 1980 Change: % of Total	R&D: Average Annual % Change in R&D	1980 Minus 1970 "R&D as a % of Outlays"
National Security	- 9.9	-18.8	- 1.3	2.93	- 6.3	+ 3.0	+ 5.6
Welfare	46.1	+ 9.1	+ 8.0	0.21	+ 0.8	+16.9	+ 0.2
Health	19.6	+ 4.2	+ 8.8	2.01	+ 5.7	+10.1	+ 1.0
Education & Knowledge	14.6	+ 4.0	+12.5	0.83	+ 0.9	+ 5.5	- 8.5
Commerce, Transportation and Communications	7.3	+ 0.9	+ 6.2	1.07	+ 3.4	+12.8	+ 4.3
Veterans	1.2	- 0.6	+ 2.0	--	--	--	--
Agriculture	1.1	- 0.5	+ 2.0	0.16	+ 0.2	+ 5.4	+ 1.8
International Relations	2.7	+ 0.2	+ 5.6	0.03	+ 0.1	+10.3	+ 0.3
National Resources & Environment	2.7	+ 0.3	+ 6.0	0.44	+ 0.1	+ 4.6	- 2.8
Space	0.5	- 0.4	+ 1.4	-0.04	- 7.1	- 0.1	-14.2
General Government	3.4	+ 0.6	+ 7.4	0.18	+ 0.7	+25.3	+ 2.3
Housing & Community Development	4.6	+ 1.1	+10.5	0.28	+ 1.1	+23.1	+ 2.8
Labor & Manpower	2.2	- 0.2	+ 3.7	0.14	+ 0.5	+17.8	+ 1.7
Total Change for all Functional Fields	96.1		+ 4.3	8.23		4.2	- 0.1

- General Government - Research in connection with General Government (law enforcement exclusively at this time) is a new field of activity. As a result, growth rates are unusually high and are not expected to continue. Thus, what otherwise would have been unrealistically high continued growth rates were reduced somewhat.

The percents of total obtained from these projection strategies resulted in a total of 105%, which was then normalized to 100%.

To arrive at estimates of total Government R&D dollar expenditures in 1975 and 1980 (to which these percentages might be applied), the 1970 expenditures were projected at the rate of 3.5% to 1975 and at 5% from 1975 to 1980. The 3.5% is the average of the rate from 1961-1970 (6.9%) and from 1967-1970 (0.1%). It was felt that the stringent restrictions of the last few years would not continue to result in such low growth rates but would modify the higher rate of the 1960 decade until 1975. After that (1975-1980), R&D was projected at 5% increase per year. Neither of these rates of growth is as high as R&D growth rates in earlier years. This reflects the judgment that such growth rates (i.e., 10 to 15% per year) would not resume and, because R&D was maturing in its relationship to the economy, would not, in the future, grow at rates so far in excess of the growth of the GNP.

The reader should note the figures at the bottom of the outlay figures on Table A-1, which show deductions made from Government outlay totals before percentages for the functional field subtotals were determined.* The deductions shown for 1970 were explained in Reference (2) as being outlays which could not be related to individual functional fields. A new item has been deducted from 1975 and 1980 outlays: bloc grants or revenue sharing. These are projected amounts of Federal outlays in the form of a transfer payment that will go directly to states or local governments to be used at the discretion of the receiving governments. They will not be administered by Executive Branch agencies as are present categorical grants, and will not be designated as to functional field of expenditure. Because they will be expended by state or local governments, however, these grants will be in the areas which are of primary concern to this level of government such as health, education, and welfare. This bloc of outlays is larger in amount in the 1980 projections than 9 of the 13 functional fields.

General Comments on Federal R&D

A few of the most important points to note about Government R&D during the next decade are as follows:

(1) Although total Federal R&D was projected to grow at 4.2% per year for 1970-1980, the two largest functions (National Security and Space), which make up three-fourths of the total, are projected to grow at rates below this, with Space having a small negative rate. The result of this is that many other smaller fields grow at well above the averages for R&D as a whole.

(2) In relative shares (percent of total) among the 12 functional fields involving R&D, National Security and Space will decrease and other fields will increase. This will in no way endanger the number one position of National Security, but Space may drop from second to third, slightly behind Health. Commerce, Transportation and Communications is likely to move ahead of Natural Resources and Environment.

* It is these functional field subtotals that are referred to when the phrase "percent of total Government outlays" is used.

The changes in percent of total indicate some movement away from the preponderance of R&D funds on military/space/atomic energy to more R&D funds for social problems. In particular, the two top fields in 1970 -- National Security and Space -- will decrease from 75% of total to 61% of total. Substantial increases will come in the social problem areas of Health, and Commerce, Transportation and Communications. This trend has recently been combined with Congressional questioning of many aspects of the defense establishment (Vietnam, cost overruns, charges of mismanagement), a rather new occurrence in the Congress and in the country at large, and one which may add to the trend of less military R&D relative to other areas. (In an unprecedented action, the Senate Armed Services Committee authorized a 12.7% reduction in DOD R&D. The Committee cut $1 billion out of the $8.3 billion requested authorization for FY 1970.)

(3) The recent questioning of military expenditures and military R&D was preceded, however, by a growing skepticism and criticism of Federally funded R&D in general. This has appeared following a decade of strong growth in R&D funding, so that R&D is now a fairly large proportion of the annual "controllable" expenditures. This makes it more visible and more susceptible to cuts in a period of budgetary pressure from both the military/Vietnam costs and for domestic programs. In addition, pressure is growing for action programs rather than "more studies".

(4) Another significant challenge to military R&D is coming from the student generation, which is questioning the role of military R&D in the universities and colleges, as well as the role of the universities and colleges more generally in our society. Students have caused many academic institutions to review their associations with the Government, especially with respect to the military, and it is likely that, over the next decade, academic institutions may move away from DOD-supported R&D and seek greater support from other sources.

(5) Discussion has once again arisen concerning some kind of reorganization of Federal scientific activities. Many different schemes have been suggested, most of which would leave Defense and Space R&D in their present locations but would consolidate nonmission-oriented Federal R&D around a strengthened NSF.

(6) The position of Space R&D has been difficult to predict because of the guiding force (up to this point) behind its growth -- the Russian challenge. It was assumed, in making the 1980 projection, that the reduction of funding in the last few years will not continue but that no new spectacular goal will emerge, despite the moon landing, to push NASA to significantly higher expenditure levels. However, because of the strong elements of international prestige and competition involved in the rationale for the space program, this field might once again serve as a vehicle for building our international prestige, especially if the Vietnam experience causes us to question the usefulness of potential military involvements.

A-II. Basis for Projecting NASA Program Areas

Projections for program areas within NASA follow. The basis for projecting R&D for the 13 functional fields has been described in the functional field material (Section A-I). As with most projections of this sort, confidence in the projections is greater at the more aggregate level (functional field) and less at the more detailed level (program area). For this reason, the program areas were projected to 1980 within the projected total for the respective functional fields rather than with respect to total Government R&D or to agency totals. This means that the Space Applications Program Area projection is a projection of the future (1980) percentage of the Space functional field.* Applving the projected 1980 Space Applications percentage of the Space functional field to the already arrived at total 1980 dollar projection for the Space functional field results in the projected 1980 Space Applications dollars.

The following points reflect the strategy used to project the individual program areas within the respective functional fields:

(1) The trend in percent for the program area within the functional field from FY 1967-1970 was used as the basis for projecting the likely 1980 percent. While Reference (2) presents data that go back to 1961, only the 1967-1970 period was used because the early period involves the start up of the space program and, as a result, the later period is a better indicator of relationships between space program areas.

(2) Where there was not a clear trend in percent for the program area within the functional field total in the 1967-1970 period, the average of the percent of total for the 4 years was used for 1980. Where the past 4 years shows an upward trend, the projection of the 1980 percent of total functional field continues the upward trend. Where the trend in the past 4 years shows a decrease in percent of total, this was continued to project the 1980 percent of total.

(3) Where special circumstances are known to exist (e.g., for Space Applications, Supporting Operations and Aircraft Technology) judgments were exercised in allowing these circumstances to affect the projections, as spelled out in the text.

(4) While the material shows absolute percent and dollar projections to 1980, the reader should think in terms of ±10% of these values as being representative of the range of the most probable projection.

Figures A-1 and A-2 summarize graphically the projections which are presented in the following subsections.

Manned Space Flight

This program area is 72.8% of the Space functional field total in 1970. The percent had dropped each year of the 1967-1970 period, and it was estimated that there would be a further drop to 69.7% in 1975 and 1980. This results in 1975 dollar outlays of $2,578 million and 1980 outlays of $2,662 million, based on the Space functional field total previously discussed. When added to all NASA program area dollars (from various functional fields), Manned Space Flight dollars for 1975 and 1980 are 57.3% of the NASA total for 1975 and 53.3% for 1980. The average annual growth rate for dollars between 1970 and 1980 that results from this projection is 1.0%.

	1967	1968	1969	1970	1975	1980
$ Millions	3,649	3,097	2,757	2,413	2,578	2,662
% of Space Functional Field	78.3	77.2	76.0	72.8	69.7	69.7
% of NASA	67.3	65.5	64.9	61.1	57.3	53.3

* The space functional field includes the program areas of Manned Space Flight, Space Technology, Space Applications and Supporting Operations. Other NASA program areas that appear in other functional fields are Space Sciences (in Education & Knowledge), and Aircraft Technology (in Commerce, Transportation and Communications).

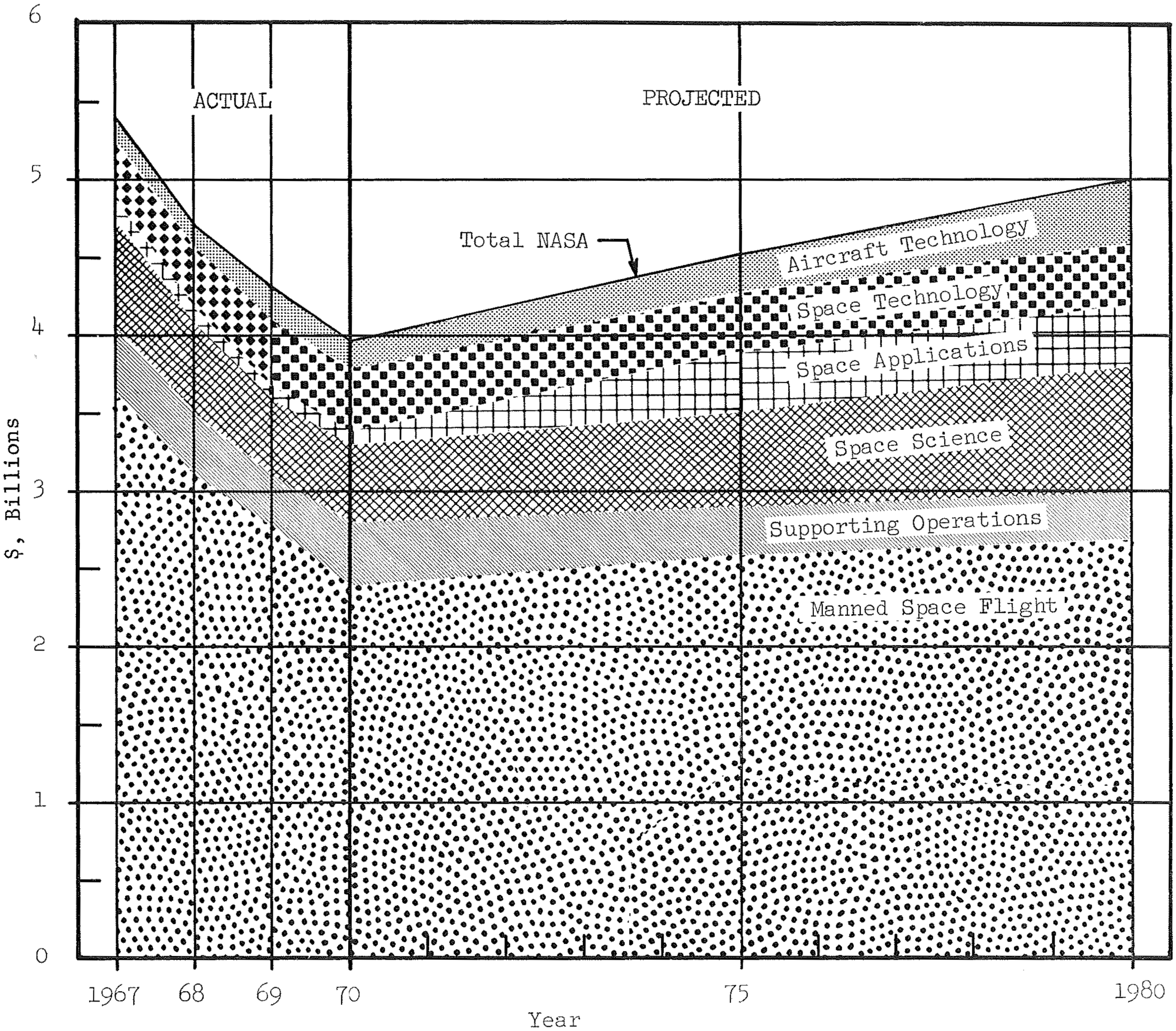

FIGURE A-1. COMPOSITE FUNDING GRAPH OF PROJECTED NASA PROGRAM AREAS

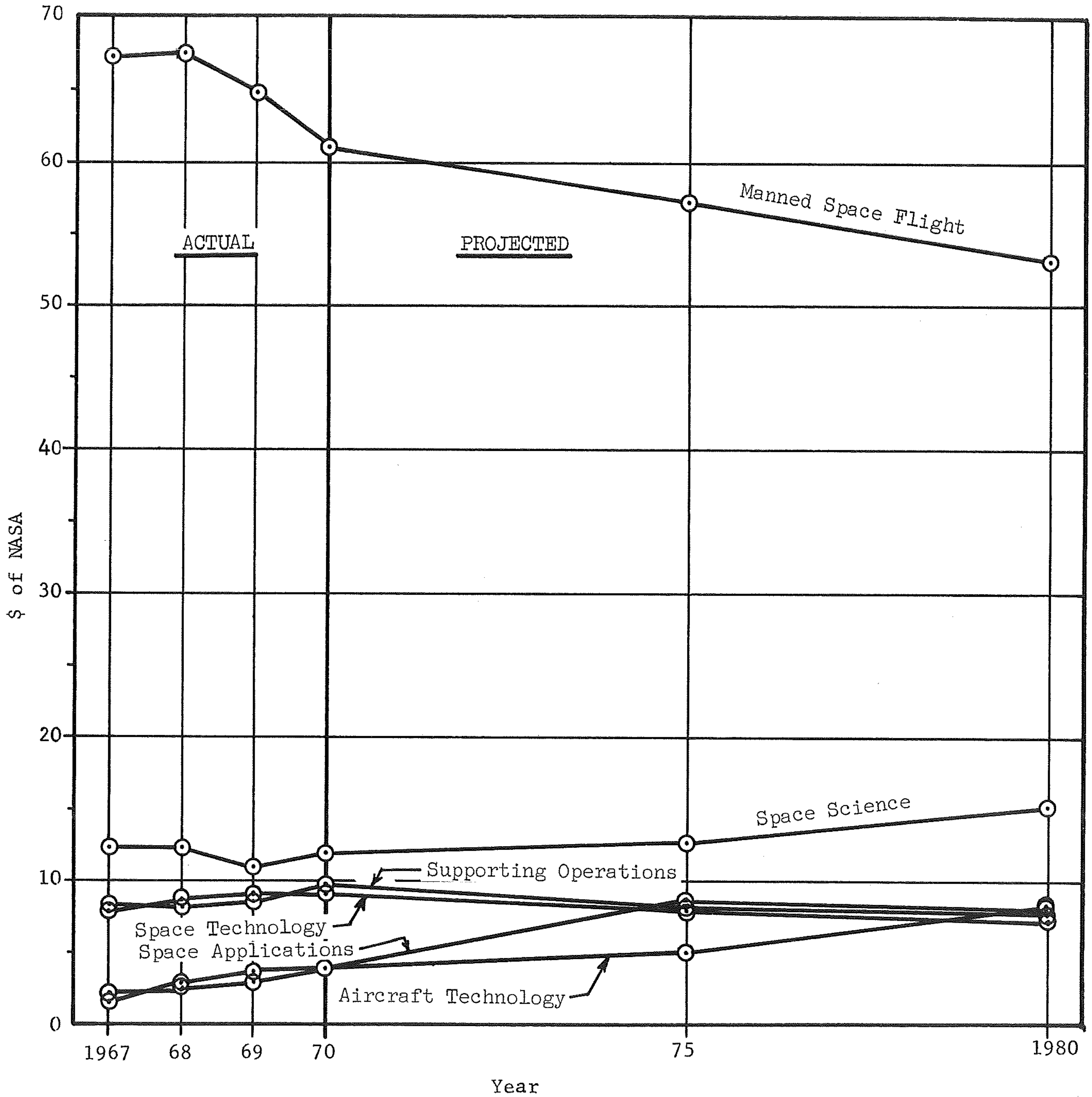

FIGURE A-2. PROGRAM AREAS AS A PERCENT OF TOTAL NASA BUDGET

Space Technology

Space Technology is 10.8% of the Space functional field in 1970. The percent of total varied only slightly within the 1967-1970 period, and thus the percent used as a 1975 and 1980 projection is the average of these years -- 10.1%. This results in 1975 dollars of $374 million and 1980 of $386 million. When combined with all NASA (not just Space functional field) program areas, Space Technology is 8.3% of NASA in 1975 and 7.7% in 1980. The average annual 1970-1980 growth rate that results from this projection is 0.8%.

	1967	1968	1969	1970	1975	1980
$ Millions	440	410	381	358	374	386
% of Space Functional Field	9.4	10.2	10.5	10.8	10.1	10.1
% of NASA	8.1	8.7	9.0	9.1	8.3	7.7

Space Applications

Space Applications is 4.5% of the Space functional field in 1970. This percentage of total and the actual dollars have been rising during the 1968-1970 period at an increasing rate and is expected to continue to rise significantly during the next decade. It has been estimated at 10.5% for 1975 and 1980. This means dollar outlays of $388 million in 1975 and $401 million in 1980 or an average annual 1970-1980 growth of 10.4%. When combined with all NASA program areas, Space Applications is 8.6% of NASA in 1975 and 8.0% in 1980.

	1967	1968	1969	1970	1975	1980
$ Millions	122	116	127	149	388	401
% of Space Functional Field	2.6	2.9	3.5	4.5	10.5	10.5
% of NASA	2.2	2.5	3.0	3.8	8.6	8.0

Supporting Operations

Supporting Operations in 1970 is 11.9% of the Space functional field. Although the percent of total has been rising in the last few years, this is not expected to continue because of completion of major investment in R&D and facilities and progress in satisfying requirements at lower cost. The estimated percent of total for 1975 and 1980 is 9.7%. This results in dollar outlays of $358 million for 1975 and $370 million for 1980, or a negative average annual growth rate between 1970 and 1980 of -0.6%. When combined with all NASA program areas, Supporting Operations is 8.0% of NASA in 1975 and 7.4% in 1980.

	1967	1968	1969	1970	1975	1980
$ Millions	452	390	364	393	358	370
% of Space Functional Field	9.7	9.7	10.0	11.9	9.7	9.7
% of NASA	8.3	8.3	8.6	9.9	8.0	7.4

Space Sciences

The NASA program area of Space Sciences is classified as part of the functional field of Education & Knowledge. In 1970 it is 40.7% of R&D in that functional field. It has been decreasing as a percent of the Education & Knowledge R&D in the 1967-1970 period. The projection for 1975 and 1980 is 38.3%. This means dollar outlays of $576 million in 1975 and $763 million in 1980, a faster dollar rise than previously discussed NASA program areas because the Education & Knowledge functional field R&D is expected to grow as a whole faster than the Space functional field. The average annual growth rate for Space Sciences from 1970 to 1980 that results from this projection is 4.8%. When this program area is added in with other NASA program areas, the percent of NASA total is 12.8% in 1975 and 15.3% in 1980.

	1967	1968	1969	1970	1975	1980
$ Millions	674	584	470	479	576	763
% of Education & Knowledge Functional Field R&D	55.0	48.4	42.1	40.7	38.3	38.3
% of NASA	12.4	12.4	11.1	12.1	12.8	15.3

Aircraft Technology

The NASA program area of Aircraft Technology is classified as part of the Commerce, Transportation and Communications functional field. In 1970 it is 33.3% of that functional field's R&D. Because of drops in percent of total during the last 2 years, and the probable difficulty of increasing this program area within NASA too much when other areas are not growing strongly, the 1975 and 1980 percent of total R&D of the Commerce, Transportation, and Communications functional field has been decreased to 27.3%. This results, nonetheless, in 1975 dollar outlays of $226 million and 1980 dollar outlays of $416 million because R&D in the functional field of Commerce, Transportation and Communications is expected to grow rapidly. This means a 10.1% average annual growth rate for Aircraft Technology. When combined with all of NASA, the percent of total is 5.0% in 1975 and 8.3% in 1980.

	1967	1968	1969	1970	1975	1980
$ Millions	89	128	152	159	226	416
% of Commerce, Transportation, & Communications functional field R&D	38.2	42.2	38.4	33.3	27.3	27.3
% of NASA	1.6	2.7	3.6	4.0	5.0	8.3

Total NASA

The above program areas make up NASA. The foregoing data show total outlays for 1967 to 1970 and projections to 1975 and 1980. The NASA total is a combination of (1) the Space functional field as projected in Section A-I (and then projected by program area within the Space functional field), (2) the Space Science program area from Education & Knowledge, and (3) the Aircraft Technology program area from Commerce, Transportation, and Communications. The resulting NASA projections are $4,500 million for 1975 and $4,998 million for 1980, or an average annual 1970 to 1980 growth of 2.4%. As a percent of total Federal outlays, NASA decreased from 3.6% in 1967 to 2.2% in 1970. The projections slow the rate of decrease and result in 2.0% in 1975 and 1.8% in 1980.

	1967	1968	1969	1970	1975	1980
$ Millions	5,426	4,725	4,251	3,951	4,500	4,998
NASA as a % of Total Federal Outlays	3.6	2.8	2.5	2.2	2.0	1.8

A-III. Projections of OSSA Divisions to 1975 and 1980

This section presents funding projections for OSSA by division for 1975 and 1980. Data for past OSSA costs by division were obtained from OSSA POP Summaries(5) of accrued costs. Differences between these data and the totals of the areas of Scientific Investigation in Space and Space Applications are detailed in the text. The major conceptual difference between the POP summaries and the NASA program area figures in Section A-II is that the NASA program area figures of Section A-II include construction of facilities (C of F) and research and program management (RPM) at NASA centers, items which are not included in the OSSA data.

The techniques utilized in projecting total functional fields (Section A-I) are not as meaningful when the problem of projecting divisions within program areas is attacked. Thus, while it is reasonable to project functional fields and program areas utilizing a strategy based upon past trends and geopolitical information, such a strategy is not nearly as useful for divisions within program areas. While geopolitics may play a major role in the funding of divisions within program areas, it is generally, for these divisions, intraagency politics rather than Congressional and Executive department politics which control allocations. It is difficult to assimilate knowledge concerning the intra-NASA political situation which may, along with divisional technical capabilities, be a crucial element in formulating strategies for projecting future divisional funding. The people directly involved in agency planning and program development are best suited to analyze the crucial intraagency political setting and technical capability. Nevertheless, it was thought that an attempt to apply the conventional statistical techniques (utilized in Sections A-I and A-II) to the problem would at least yield useful projected values that could be considered by appropriate NASA personnel and modified for possible use in extended planning exercises.

As a result, the projections shown in this section must be viewed only as a starting point for future discussion. There can be no high degree of confidence in their validity and certainly the statement that they have a higher probability of occurring within ±10% than any other possible projections, as was made with regard to Section A-I and A-II projections, no longer holds. These are quantitative statistical projections only and are made without the benefit of an examination of qualitative and policy information that is essential for making projections with a reasonable degree of confidence.

The basis for making these statistical projections is an examination of the trends in the OSSA Budget divided into five divisions as reported in NASA POP Summaries for OSSA. The costs shown are accrued costs. Thus, they are expenditures plus bills received at the end of the fiscal year but not yet paid.

Data prior to 1967 were not utilized because, as explained in Section A-II and in BMI-NLVP-TR-69-1(2), the most recent years were believed to be the best guide to the near-term future and also because trends for earlier years were erratic, as would be expected in relatively new agencies and relatively new program areas.

In Table A-3, the OSSA total of the divisional data is less than the total of the Scientific Investigations in Space and the Space Applications program areas taken from Section A-II. This difference is shown in Table A-3. Although the two program areas of Scientific Investigations in Space and Space Applications have a close correspondence to the OSSA office, the data are not comparable for a number of reasons. The OSSA data by division are taken from OSSA R&D contract accrued costs.(5) The historical budget summaries (based on the President's Budget) used in Section A-II show the total NASA R&D budget by program area. The major differences between these sources of data are Construction of Facilities (C of F) expenditures and expenditures for R&D in NASA Centers and program management (RPM), which are not included in the OSSA accrued costs, but are included in the President's Budget. Finally, there is some difference that is probably due to bills received but not yet paid at the end of a fiscal year. Bills received are included in OSSA accrued costs in the year received; they are included in the budget expenditures when paid. Because of these differences, figures supplied in the OSSA POP Summaries are not comparable to the data used in the historical summary tables which were used in Section A-II, even though the same identifying terminology (e.g., Space Applications) is used. Figures by OSSA division are available only in the OSSA POP, and therefore the OSSA POP data were used as the basis for the following projections:

(1) Physics and Astronomy Division (SG). This division is 19.1% of the total Scientific Investigations in Space and Space Applications programs areas in 1970. The percent of total between 1967 and 1970 has varied up and down within a narrow range. Therefore, the 1975 and 1980 percent of total was estimated at the average of the 1967-1970 period or 20% of total. This results in projected dollar outlays in 1975 of $193 million and in 1980 of $233 million. The average annual growth rate between 1970 and 1980 that results from this projection is 6.9%.

(2) Lunar and Planetary Division (including Viking) (SL). This division is 27.1% of total in 1970. The 1967-1970 trend has been erratic. The 1975 and 1980 percent of total is estimated at 23% which is the average of the 1967-1970 percents of total. This results in projected dollar outlays in 1975 of $222 million and in 1980 of $268 million. The average annual growth rate between 1970 and 1980 that results from this projection is 4.7%.

(3) Biosciences Division (SB). This division is 3.8% of the total in 1970. While the 1967-1970 trend is downward, indications are that the percent of total is about to level off. Based on this, the estimate for this division is 4% of total for 1975 and 1980. This results in projected dollar outlays in 1975 of $39 million and in 1980 of $47 million. The average annual growth rate between 1970 and 1980 that results from this projection is 7.0%.

(4) Space Applications (SA).* This division is 19.3% of the total Scientific Investigations in Space and Space Applications program areas in 1970. The 1967 to 1970 data show an increasing trend in priority and a future increase to 24% of total in 1975 and 1980 has been estimated. This results in projected dollar outlays in 1975 of $231 million and in 1980 of $279 million. The average annual growth rate between 1970 and 1980 that results from this projection is 8.7%.

(5) Launch Vehicle Procurement (SV Procurement). This division is 21.5% of total in 1970 and the 1967-1970 variation is within narrow limits. As a result, the 1975 and 1980 percent of total was projected at the average of the 1967 through 1970 percent of total or 21%. This results in projected dollar outlays in 1975 of $202 million and in 1980 of $244 million. The average annual growth rate between 1970 and 1980 that results from this projection is 6.1%.

* This Division has been split into two divisions: Communications(SC) and Earth Observations(SR). They have been considered jointly as Space Applications in order to apply historical data.

TABLE A-3. OSSA COST BY DIVISIONS FOR 1967-1970 AND PROJECTIONS TO 1975 AND 1980 ON A COST ACCRUAL BASIS(a)

	$ Millions						% of Total Scientific Investigations in Space and Space Applications				Projected % of Total for 1975	Average Annual Growth Rate %
	1967	1968	1969	1970	1975	1980	1967	1968	1969	1970	1980	1970-1980
Lunar and Planetary Exploration(SL)	211	158	84	170	222	268	26.5	22.6	14.1	27.1	23.0	+4.7
Space Applications(SA) (Communications, Earth Observations)	83	94	92	121	231	279	10.4	13.5	15.4	19.3	24.0	+8.7
Physics and Astronomy(SG)	143	156	128	120	193	233	18.0	22.3	21.5	19.1	20.0	+6.9
Bioscience (SB)	41	43	36	24	39	47	5.2	6.1	6.0	3.8	4.0	+7.0
Launch Vehicles (SV Procurement)	171	147	116	135	202	244	21.5	21.0	19.4	21.5	21.0	+6.1
Other	--	10	1	2	--	--	--	1.4	.1	.3	--	--
OSSA	649	608	457	572	887	1071	81.6	86.9	76.5	91.0	92.0	+6.5
Total Scientific Investigations in Space and Space Applications	796	700	597	628	964	1164	100.0	100.0	100.0	100.0	100.0	+6.4
Difference between two Totals Above	147	92	140	56	77	93	18.4	13.1	23.5	9.0	8.0	
Itemization of Difference:												
• C of F	14	8	6	4								
• RPM for Scientific Investigations in Space	79	77	75	78								
• RPM for Space Applications	19	23	20	21								
• Difference Between OSSA Costs Accrued for R&D shown above and final R&D expenditures for Scientific Investigations and Space Applications	-4	-16	39	-48								
• SV (Development)	39	--	--	--								

(a) The figures shown may not add to the totals shown due to rounding; calculations are based on unrounded numbers.

(6) The sum of the above results is an OSSA 1975 and 1980 projected total (on the basis of the OSSA accrued costs) that is 92% of the total for the Scientific Investigations in Space and Space Applications program areas. This results in projected dollar outlays in 1975 of $887 million and in 1980 of $1,071 million. The average annual growth rate between 1970 and 1980 that results from this projection is 6.5%.

(7) Unallocated -- the difference between the OSSA total [on a cost accrual basis Item (6) above] and the total of the Scientific Investigations in Space and Space Applications program areas from The Budget [on an expenditure basis Item (8) below] is an amount that cannot be allocated to the various divisions, although it is clearly spent to pursue division responsibilities. This amount was 9.0% of the total of the two program areas in 1970 and has been estimated at 8% for 1975 and 1980. This results in projected dollar outlays in 1975 of $77 million and in 1980 of $93 million. The average annual growth rate between 1970 and 1980 that results from this projection is 5.1%.

(8) Total Scientific Investigations in Space and Space Applications program areas from the U. S. Budget. Total Expenditures for Scientific Investigations in Space and Space Applications program areas is $628 million in the President's FY 1970 Budget. The addition of the above projections results in an increase to $964 million in 1975 and $1,164 million in 1980. The average annual growth rate for the total of these two program areas between 1970 and 1980 that results from this projection is 6.4%.

The projections, based on data shown in Table A-3, are shown graphically in Figures A-3 and A-4.

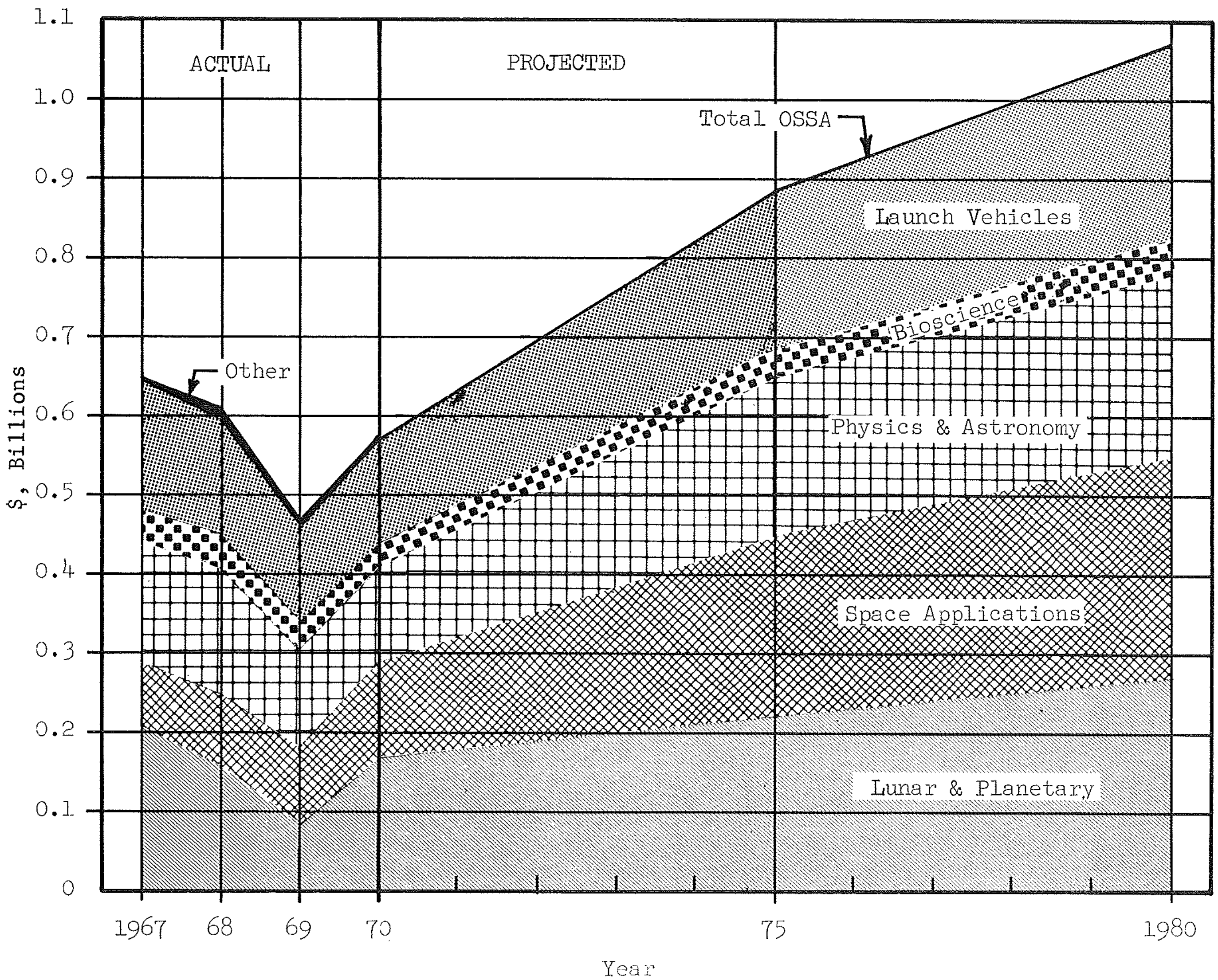

FIGURE A-3. COMPOSITE FUNDING GRAPH OF PROJECTED NASA OSSA DIVISIONS

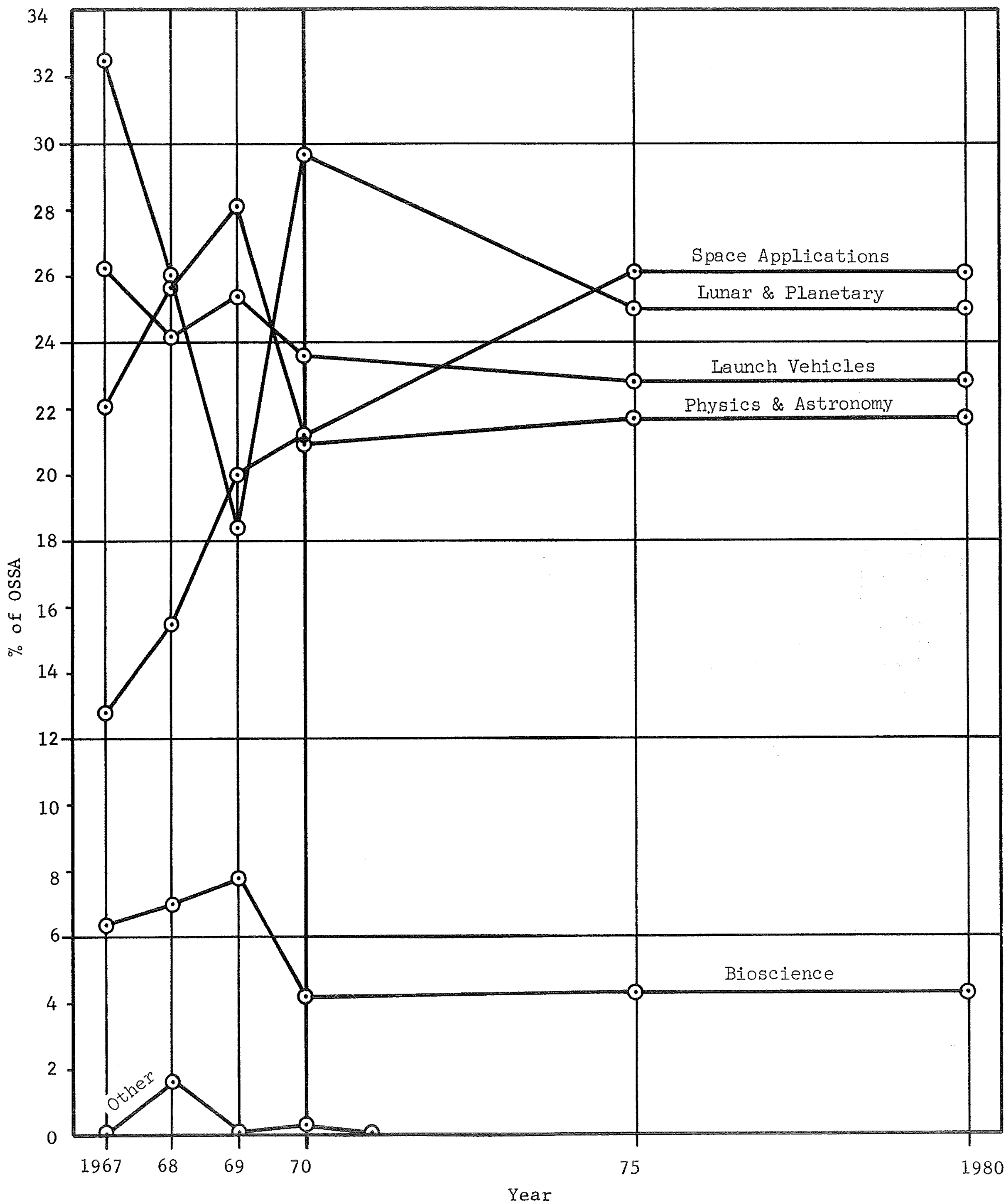

FIGURE A-4. OSSA DIVISIONS AS A PERCENT OF TOTAL OSSA

REFERENCES

(1) Lederman, L. L., and Windus, M. L., "Quantification of Task 1 Projections and Analysis of OSSA Funding", BMI-NLVP-ICM-69-140, Columbus Laboratories, Battelle Memorial Institute, November 5, 1969.

(2) Lederman, L. L., and Windus, M. L., "An Analysis of the Allocation of Federal Budget Resources as an Indicator of National Goals and Priorities", Report No. BMI-NLVP-TR-69-1, Battelle Memorial Institute, Columbus Laboratories, February 10, 1969.

(3) Milton, Helen S., "Cost-of-Research Index, 1920-1965", Operations Research, November - December 1966, pp 977-991.

(4) "Population Estimates", Series P-25 No. 388, U. S. Bureau of the Census, March 14, 1968.

(5) "POP Cost Accrual Data", NASA (SV) Memorandum, March 16, 1970.

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APPENDIX B

PROSPECTUS COMPUTER PROGRAM

Introduction

The Prospectus Program is a computer program that has been used in the NASA OSSA Prospectus Exercise. The OSSA Prospectus Exercise is a long-range planning activity designed to coordinate OSSA automated space program projections. The term "Prospectus" is used to imply proposed nonrigid plans representing current OSSA thinking on its future space program. It is important to realize that any plans created by the OSSA Prospectus Exercise do not imply commitment on the part of NASA management.

In the early phases of the Prospectus Exercise, the work was carried out manually by the program planners. Much of this work work was tedious, routine, poorly documented, and required a massive effort to summarize. As a result, only a few variations on a few basic plans could be examined. This situation prompted the creation of a Prospectus computer program.* The program was developed in 1967 for Launch Vehicles and Propulsion Programs in OSSA. The Prospectus program relieved the planners of many routine tasks and allowed them to focus attention on their primary responsibility -- planning. It also allowed considerations of a broader spectrum of space program variations. Although the program was originally developed for OSSA, the general planning concepts are compatible with other organizational planning processes. In this Appendix, however, the discussion of the Prospectus program concentrates on its use in the OSSA Prospectus Exercise for which the program was originally developed.

Utility of the Prospectus Program

The Prospectus Program provides a formalized planning technique that can be used at various organizational levels for planning in OSSA (or NASA). The program performs repetitious and routine tasks that can be handled more accurately and efficiently by the computer. The speed provided by the computerized system allows the exercise to be cycled many times to find better mission plans that meet specified objectives and satisfy existing constraints. One of the greatest virtues that may be derived from the Prospectus program is forced documentation of all planning activities in the process of creating mission plans.

Inputs to Prospectus Program

A general flow chart of the Prospectus computer program is presented in Figure B-1. The user input for the program can be divided into five parts described below: projects, launch vehicle data, Summary Is, Summary IIs, and Summary IIIs.

Projects

The projects in the Prospectus Exercise comprise the heart of the planning process. Projects are a collection of pertinent data describing space-related activities (such as a space launch, supporting research and technology, launch vehicle development program, etc.**) that require expenditure of available resources. Each project is uniquely

* In the following the Prospectus computer program will be referred to as the "Prospectus Program" or "the program".

** For examples of the different kinds of projects that may exist, the reader is referred to the project index (Table B-1).

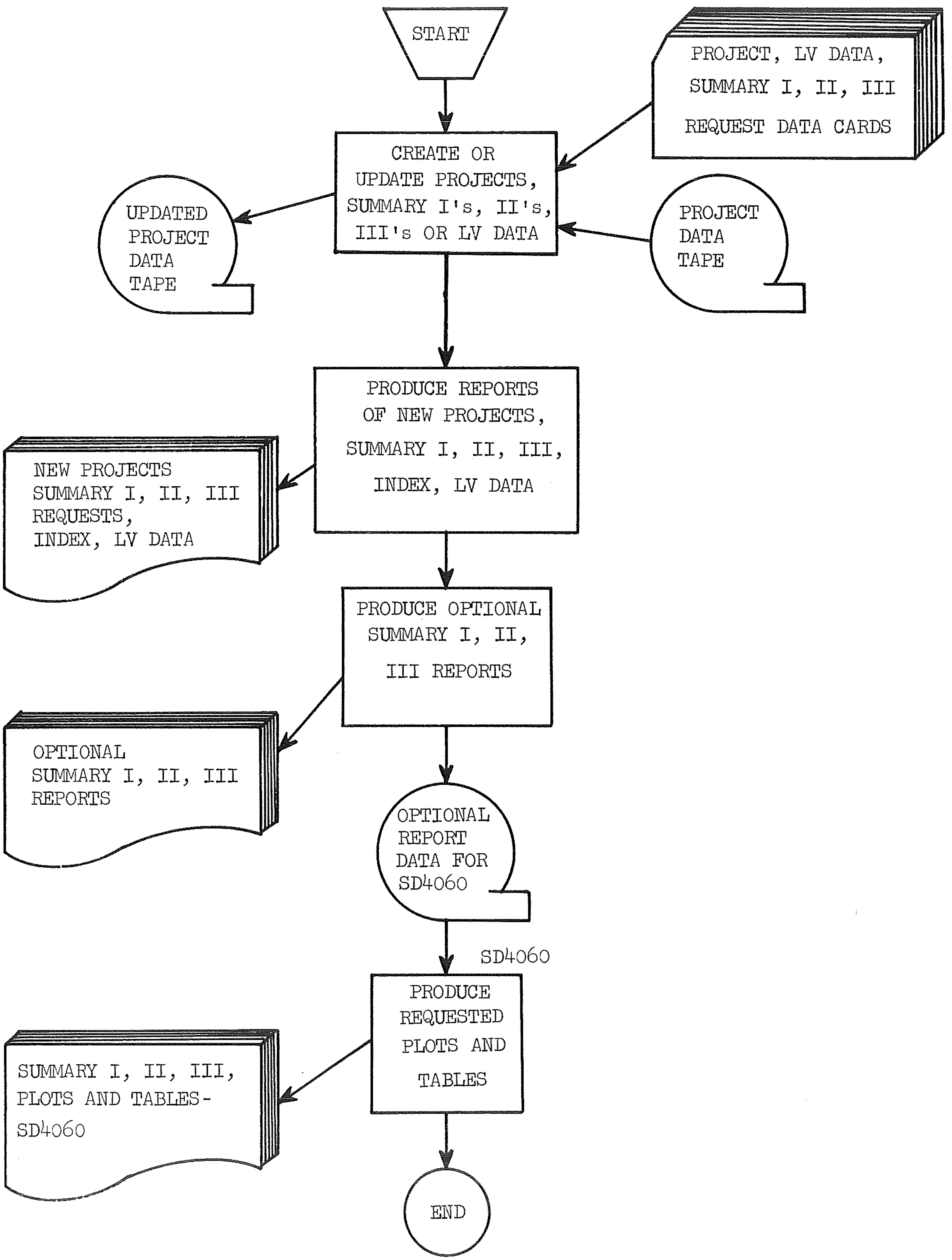

FIGURE B-1. PROSPECTUS PROGRAM FLOW CHART identified by an assigned project identification code (project ID). The program accepts any new projects in the form of punched computer cards that are created upon completion of a project data worksheet (Figure B-2) by the project planners in each OSSA division. Project funding and flight schedules are important constituents of the project data. The project funding consists of two parts:

(1) Approved Program Operating Plan (POP) funding. The POP is an OSSA biannual planning document giving a 5-year cost spread of all projects which have been approved by the Bureau of the Budget (BOB) to receive future funds.

(2) Total funding (TF). Provides an estimate of the total funding required for completion of the project.

A flight schedule indicates the years in which a space launch (or launches) will (or is expected to) occur. The launches are classified in one of the following three categories:

(1) Approved. The launch has been approved by the BOB to receive funds for development of hardware.

(2) Planned. The project has approved funds for planning but not for hardware construction.

(3) Proposed. No funds have been allocated to the project.

Launch Vehicle Data

Each new project that includes a space launch is assigned an appropriate launch vehicle (LV) by the Launch Vehicle and Propulsion Programs (SV). Certain LV cost data are input for each launch vehicle used by the program. Providing the LV cost data independently of the projects allows LV planners to assign different LV combinations to the projects with a minimum of effort. These LV input data (Figure B-3) include LV identification, cost spread/flight, and sustaining engineering and maintenance costs.

The remaining input data (Summary Is, IIs, and IIIs) provide planning reports summarized from the requested projects and appropriate LV data. Therefore, to have an effective planning program, it is essential that the project and LV cost data be as complete and accurate as possible.

Summary Is

The next step, as indicated in Figure B-1 flowchart, is the creation of Summary Is. A Summary I is a collection of projects which form a plan for one of the OSSA divisions. The projects to be included in a given Summary I are requested by completing a Summary I planning request sheet (Figure B-4). The number of different Summary I requests possible depends upon the existing number of projects and is theoretically limited by the laws of mathematical combinations, but is realistically limited by computer memory.

A Summary I can be used to integrate different projects into groups and composite projects. A group may contain all projects with similar characteristics such as the Orbiting Solar Observatories (OSO) or Application Technology Satellites (ATS). The different projects in any given group will appear as a separate line item in tables such as flight schedules but will appear as one line in the funding plot. A composite project combines all the individual projects requested on a Summary I request sheet and is treated as a single project in the flight schedules and funding plots.

* The OSSA organization comprises six Program divisions as follows: Space Biology (SB), Space Physics and Astronomy (SG), Space Lunar and Planetary Exploration (SL), Space Launch Vehicles (SV), Communications (SC) and Earth Observations (SR).

PROJECT DATA
(TENTATIVE WORK SHEET)

01 Project ID: Prefix ___ Project No. ___ Date: M___ D___ Y___
Modification of Project: ___ ___
(If modification of another project, enter that Project ID above and only fill out area of sheet for which modification differs. Enter zero in fields where information is to be deleted.)
Project Names -
Full: ___
02 Short: ___
Planner: ___ Extension No. ___
Is this a "manned" project? (Circle One) 1. Yes 2. No.

Project Type: (Circle One)
1. Primary S/C 4. SR&T
2. Secondary S/C 5. Other+
3. Experiment(s)

Project Funding Source: (Circle One)
1. OSSA 4. OTDA
2. OMSF 5. Mixed NASA+
3. OART 6. Other+

Candidate Management Center (s): (Mark "M" for Center considered in manpower estimates and "C" for up to 6 other Centers.)

03 ___ KSC ___ MSC ___ MSFC ___ GSFC ___ JPL ___ WS
___ ARC ___ ERC ___ FRC ___ LaRC ___ LeRC ___ HQ

	YEAR	FLIGHT SCHEDULE X	FLIGHT SCHEDULE #	FLIGHT SCHEDULE *	FUNDING (In Millions) APPROVED POP	FUNDING (In Millions) TOTAL	MANPOWER (In Man-Years) NASA DIRECT	MANPOWER (In Man-Years) NASA INDIRECT	MANPOWER (In Man-Years) CON-TRACT	YEAR
04	69									69
05	70									70
06	71									71
07	72									72
08	73									73
09	74									74
10	75									75
11	76									76
12	77									77
13	78									78
14	79									79
15	80									80
16	81									81
17	82									82
18	83									83
19	84									84
20	85									85
21	86									86
22	87									87
23	88									88

X Approved # Planned * Proposed
+ Please explain in Remarks Section on last page.

SPACECRAFT (In this section give information for a single spacecraft.)

A. Propulsion System Capabilities
Fill in the appropriate number for type of propulsion.
(1. Liquid 2. Solid 3. Electric 4. Other+)

	Purpose of Propulsion System	ΔV (ft/sec)	Type	Number of Restarts	Nominal Weight (lbs)
24					
25					
26					
27					
28					

29 B. Weights (lbs)

	Nominal	Lower Limit	Upper Limit
Basic S/C with Support System			
Experiments(s)			
Propulsion System(s)			
Contingencies			
Other+			
Total			

30 C. Linear Dimensions (Including All Items in B)

	Nominal	Lower Limit	Upper Limit
Height, inches			
Maximum Diameter, inches			

Please note any unusual characteristics under Remarks.

D. Spin

	Nominal	Lower Limit	Upper Limit
Required rpm			
Acceptable rpm (if not, enter zero)			

E. Guidance (Circle One)
1. Optical
2. Radio
3. Radio Inertial
4. Combined Optical/Radio/Inertial
5. Other+

+ Please explain in Remarks Section on last page.

MISSION PARAMETERS

A. Earth Orbital

31 Indicate Final Orbital Elements	Nominal	Lower Limit	Upper Limit
Perigee, n. mi.			
Apogee, n. mi.			
Inclination, deg.			
Longitude, if Synchronous			

B. Flybys/Swingbys

		Target-Planet/Body	Miss Distance, n. mi.	Trip Time, days
32	(1)			
	(2)			
33	(3)			
	(4)			

C. Probes

	Nominal	Lower Limit	Upper Limit
34 Distance, a.u.			
Inclination to Ecliptic, deg.			
Trip Time, days			

D. Orbiters Target-Planet/Body
35 ___

	Nominal	Lower Limit	Upper Limit
36 Periapsis, planetary radii			
Apoapsis, planetary radii			
Inclination, deg.			
Trip Time, days			

E. Landers/Atmospheric Probes
Target-Planet/Body
37 ___
Weight, lbs ___ Trip Time, days ___

F. Earth Return
Return to Earth Planned? (Circle One) 1. Yes 2. No
If Yes: Total Trip Time, days ___
Method (Circle One)
1. Ballistic 2. Swingby 3. S/C Propulsion

+ Please explain in Remarks Section on last page.

FIGURE B-2. PROJECT DATA SHEET

LAUNCH INFORMATION

38 A. Velocity Requirements

	Nominal	Lower Limit	Upper Limit
V_C from Launch Vehicle, ft/sec	9 ____	15 ____	21 ____

B. Multiplexed Spacecraft

Number of Spacecraft from this project per launch 27 ____

Host Project ID 33 ____ 39 ____

Spacecraft from other projects to be multiplexed (For Host project only)

	Project ID	# of S/C	Total Weight (lbs)
39	45 ___ 51 ____	57 ____	63 ____
	9 ___ 15 ____	21 ____	27 ____
	33 ___ 39 ____	45 ____	51 ____
	57 ___ 63 ____	69 ____	75 ____

C. Weights (lbs) (In the case of multiplexed spacecraft, fill in this section only if this project is the Host project.)

40	Nominal	Lower Limit	Upper Limit
Total Spacecraft including all secondary spacecraft	9 ____		
Multiplexing Hardware	15 ____		
Other+	21 ____		
Total	27 ____	33 ____	39 ____
Adapter	45 ____		
Shroud	51 ____		

D. Acceptable Opportunity Width, days 57 ____

41 A. Assignment

Code Number 9 ____ Name 15 ____ 21 ____ 27 ____

Assigned by (initials) 33 ____ Date: M 39 ____ D 45 ____ Y 51 ____

B. Performance Capability

Maximum Weight, lbs:

At Nominal V_C 57 ____

At Upper V_C 63 ____

Maximum V_C, ft/sec

At Nominal Weight 69 ____

At Upper Weight 75 ____

42 C. Launch Site (Circle One)

9
1. ETR
2. WTR
3. Wallops Island
4. San Marcos
5. Other+

D. Funding Source (Circle One)

15
1. OSSA
2. OMSF
3. OART
4. OTDA
5. Mixed NASA+
6. Other+

+ Please explain in Remarks Section on last page.

SPACE TECHNOLOGY NEEDS
(Check one Status for each Area)

1 = Not Applicable; 2 = Currently Available; 3 = Available with Growth; 4 = Special Emphasis (Incl. Critical+); 5 = Not Yet Determined

	SPACE TECHNOLOGY AREA		1	2	3	4	5
43	Launch Vehicles and Operation	9					
	Operational Technology	15					
	Operating Life	21					
	Reliability	27					
	Flight Dynamics and Operations	33					
	Chemical Primary Propulsion Systems	39					
	Nuclear Primary Propulsion Systems	45					
	Electric Primary Propulsion Systems	51					
	Chemical Secondary Propulsion Systems	57					
	Nuclear Secondary Propulsion Systems	63					
	Electric Secondary Propulsion Systems	69					
	Chemical Space Power Systems	75					
44	Solar Space Power Systems	9					
	Nuclear Space Power Systems	15					
	Guidance, Navigation and Controls	21					
	Rendezvous and Docking Controls	27					
	Stationkeeping, Attitude and Pointing Controls	33					
	System Monitoring and Environmental Controls	39					
	Instrumentation On-Board Data Handling and Processing	45					
	Communications	51					
	Tracking and Data Acquisition	57					
	Ground Data Handling and Processing	63					
	Earth Atmosphere Entry and Landing Systems	69					
	Lunar and Planetary Entry, Landing and Take-off Systems	75					
45	Aerothermodynamics and Loads	9					
	Material and Structures	15					
	Environmental Factors	21					
	Life Support and Protection Systems	27					
	Man-Machine Integration	33					
	Mobile Life Support, Protection and Work Systems	39					
	Human and Performance	45					

+ Please explain in Remarks Section on last page.

(From the list below select the Primary Purpose and Secondary Uses of this mission and fill in the following blanks with the appropriate numbers.)

MISSION OBJECTIVES

46 Primary Purpose 9 ____ (SECONDARY USES) 15 ____ 21 ____ 27 ____ 33 ____ 39 ____ 45 ____ 51 ____ 57 ____ 63 ____ 69 ____ 75 ____

Space Oriented Scientific Disciplines

Astronomy
- 1-Solar
- 2-Stellar
- 3-Binary Stars
- 4-Galactic Structure & Interstellar Matter
- 5-Galaxies & Intergalactic Space
- 6-Celestial Mechanics
- 7-Relativity
- 8-Astronomy Technology
- 9-Other+

Ionospheres & Radio Physics
- 17-Radio Physics
- 18-Terrestrial Ionosphere
- 19-Interplanetary Ionization
- 20-Solar Ionization
- 21-Lunar Ionization
- 22-Planetary Ionospheres & Atmospheres
- 23-Other+

Solar Physics
- 33-Solar Activity
- 34-Solar Magnetism
- 35-Atmospheric Inhomogeneities & Turbulence
- 36-The Flare Phenomenon
- 37-Other+

Interdisciplinary, Multi-disciplinary, & Support Programs
- 38-International Cooperation Program
- 39-Launch Vehicle & Propulsion Program
- 40-Manned Space Flight Capability
- 41-Advanced Technology Demonstration
- 42-Other+

Bioscience
- 10-Origin & Nature of Living Systems
- 11-Biological Exploration of the Planets & Moon
- 12-Planetary Quarantine & Spacecraft Sterilization
- 13-Effects of Space Environment on Organisms
- 14-Behavioral Biology
- 15-Biogenerative Life Support System
- 16-Other+

Planetology
- 24-Mars
- 25-Venus
- 26-Major Planets
- 27-Comets & Asteroids
- 28-Mercury & Interplanetary Dust
- 29-Lunar Geological Exploration
- 30-Lunar Geophysical Exploration
- 31-Lunar Geochemical Exploration
- 32-Other+

Application of Space Technology
- 43-Communications
- 44-Earth Resources
- 45-Geodesy
- 46-Meteorology
- 47-Navigation & Traffic Control
- 48-Space Application Techniques
- 49-Other+

REMARKS

47
48
49
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51
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53
54
55
56

+ Please explain in Remarks Section on last page.

FIGURE B-2. PROJECT DATA SHEET
(Continued)

LAUNCH VEHICLE INFORMATION

(TENTATIVE WORK SHEET)

Recurring and Annual Support Costs (In Millions)

	Launch Vehicle Number	Launch Vehicle Name	Annual Support Cost	5 Year Cost Spread					LV Group Number
				Year of Launch	-1	-2	-3	-4	
62									
	9	15 21 27	33	39	45	51	57	63	69
	9	15 21 27	33	39	45	51	57	63	69
	9	15 21 27	33	39	45	51	57	63	69
	9	15 21 27	33	39	45	51	57	63	69
	9	15 21 27	33	39	45	51	57	63	69
	9	15 21 27	33	39	45	51	57	63	69

FIGURE B-3. LAUNCH VEHICLE INFORMATION WORKSHEET

SUMMARY I PLANNING REQUEST

Rev. A

63 Request ID ____ (5)   Standard Prefix* __ (9)

Planner ____ (15, 21, 27)   Ext. No.: ____ (33)   Date: M ___ (39) D ___ (45) Y ___ (51)+

Type of Request (Circle One)(57) 1. New or Modification Request 2. Rerun of stored request+

Should this request be stored? (Circle One)(63) 1. Yes 2. No

Modification of Summary I ID ____ (69)

(If this Summary I is a modification of another Summary I for which a request sheet has been filled out, enter that Request ID above and only fill out the remaining area of the sheet for which this modification differs.)

INSTRUCTIONS

Within their respective sections, list groups, composite projects, and projects in the order desired for printing and plotting. The first group listed will be the first printed and plotted. Composite projects and projects likewise will be displayed in the order listed, within the framework of the outline shown below. On funding plots, groups will be plotted as one item, but on tables such as flight schedules, the breakout shown below will be followed.

1. Groups
   a. Composite Projects
   b. Projects
2. Ungrouped Composite Projects
3. Ungrouped Projects

This standard display order is set when a Summary I Planning Request first enters the system. Any additional items entered through the modification process will fall at the end of their respective section. If this standard display order is not desired, an optional display order may be specified on the last page of this form.

GROUPS

64

Group No. (9)	Group Name (15, 21, 27, 33, 39)

+ Remainder of sheet need not be filled out. *See third page for explanation.

COMPOSITE PROJECTS I

65

Composite Project Number (9)	Composite Project Name (15, 21, 27, 33, 39)	Group Number (45)

PROJECTS REQUESTED

All prefixes which are the same as the Standard Prefix on page 1 may be omitted on this page. If this is a new request, fill in Project ID's in order desired. If this is a modification, fill in one line per change--NEW for an addition, OLD for a deletion, or both for a replacement.

66

MODIFICATION CHANGES											
OLD				NEW							
	PREFIX (9)	Project Number (15)	Composite Project No. (CPXX) or Group No. (GXX) (21)		PREFIX (27)	Project Number (33)	Composite Project No. (CPXX) or Group No. (GXX) (39)		PREFIX (45)	Project Number (51)	Composite Project No. (CPXX) or Group No. (GXX) (57)
1				34				67			
2				35				68			
3				36				69			
4				37				70			
5				38				71			
6				39				72			
7				40				73			
8				41				74			
9				42				75			
10				43				76			
11				44				77			
12				45				78			
13				46				79			
14				47				80			
15				48				81			
16				49				82			
17				50				83			
18				51				84			
19				52				85			
20				53				86			
21				54				87			
22				55				88			
23				56				89			
24				57				90			
25				58				91			
26				59				92			
27				60				93			
28				61				94			
29				62				95			
30				63				96			
31				64				97			
32				65				98			
33				66				99			

OUTPUT OPTIONS

67 Headers: (1) ____ (9, 15, 21, 27, 33, 39)

(2) ____ (45, 51, 57, 63, 69)

68 (3) ____ (9, 15, 21, 27, 33, 39)

"Major" Project Funding Source: (Circle One)(45)

1. OSSA 3. OART 5. Mixed NASA 7. All Sources
2. OMSF 4. OTDA 6. Other

(Only those requested projects with the funding source circled above will be included in funding totals and plots. Those with different funding sources will be shown separately on flight and funding reports, but will not contribute to any totals. If number "7" is circled, all requested projects will be included in all reports regardless of their individual funding source.)

Circle Reports Desired:

1. Flight Schedule with Short Project Name (51)
2. Flight Schedule with Full Project Name (63)
3. Plot of Funding (Group/Composite Project/Project) (69)
4. Plot of Funding (Group/Composite Project/Project) and LV Funding (75)
5. Five Year Reports which Include: (57)
   Approved 5 Year Flights
   5 Year New Start Flights
   POP 5 Year Funding Plot
   5 Year New Start Funding Plot

Individual Project summaries are available if desired. They will include the name, ID, and assigned launch vehicle of each project requested and any or all of the following information. (Circle each that is desired.)

69 1. Flight Schedule (9)
2. POP Funding (21)
3. Project Funding (33)
4. 5 Year New Start Funding (15)
5. Launch Vehicle Funding (27)
6. Total (Project and LV) Funding (39)

Manpower Displays? (Circle One)(45) 1. Yes 2. No

OPTIONAL DISPLAY

If an optional display order is desired for both flight schedules and funding plots, list in the order desired, the number of each Group, ungrouped Composite Project, or ungrouped Project to be displayed and an associated identifier G, CP, or P, respectively.

		G, CP, or P	Group or Composite Project Number or Project ID		G, CP, or P	Group or Composite Project Number or Project ID		G, CP, or P	Group or Composite Project Number or Project ID
71	1.	(9)	(15)	11.	(21)	(27)	21.	(33)	(39)
72	2.			12.			22.		
73	3.			13.			23.		
74	4.			14.			24.		
75	5.			15.			25.		
76	6.			16.			26.		
77	7.			17.			27.		
78	8.			18.			28.		
79	9.			19.			29.		
80	10.			20.			30.		

FIGURE B-4. SUMMARY I REQUEST FORM

Summary IIs

A Prospectus coordinator assembles the desired Summary Is from each division into OSSA plans. Each plan is a group of Summary Is which constitutes a Summary II. The appropriate Summary Is are requested by completing a Summary II request form (Figure B-5).

Summary IIIs

Summary III requests are then developed from Summary IIs by NASA management, thus providing an overall NASA plan. In order to have a NASA-wide Summary III it would be necessary for the other directorates of NASA (OART, OMSF, OTDA) to participate in the Prospectus Exercise and produce the necessary project data, Summary Is, and Summary IIs. A Summary III request sheet is illustrated in Figure B-6.

Prospectus Program Output

The computer program reads the project data, LV cost data, Summary Is, Summary IIs, and Summary IIIs from punched cards. A magnetic tape containing all previously created projects, LV cost data, and certain Summary Is is also used as input to the program (explained later). Any new projects or LV cost data are compiled into records and stored on the magnetic tape. It is also possible to update any projects or LV data already existing on the input tape. In this manner, a current file containing all projects and LV cost data created by the planner is maintained. Thus, if the LV cost data are considered correct, they need only be entered once at the beginning of the planning process. It is also possible to request that any Summary I be stored on the tape file. This storage capability is not provided for Summary IIs and IIIs. The advantage of storing Summary Is is that a Summary II request can be made without including the punch card decks for each of the Summary Is that are included in the Summary II. The Summary Is, LV cost data, or projects may be used and/or modified an indefinite number of times.

Certain reports are provided for the planner in the output listing each time the Prospectus Program is run. These reports are as follows:

(1) A printout (Figure B-7) of each new or modified project entered into the project file

(2) An up-to-date index of all projects by project name (Table B-1) and by project ID (similar to Table B-1 except sorted by project identification)

(3) A listing of each new or modified Summary I request (Figure B-8), Summary II request (Figure B-9), and/or Summary III request (Figure B-10)

(4) Standard LV cost summary (Table B-2) as it appears on the data tape.

The remaining reports which the Prospectus program provides are optional and are requested by the planner via the Summary I, Summary II, and Summary III request sheets. The reports are created either by the computer printer or a Stromberg Datagraphics SD-4060*, depending upon the report. The SD-4060 is used to produce visual plots of cost data and flight schedules for the program planners.

---

* The Stromberg Datagraphics SD-4060 is a hardware unit that provides visual displays (graphs, pictures, tables, etc.) of data from a magnetic tape created by a digital computer. An SD-4020, which is a predecessor of the SD-4060, may be used in place of a SD-4060.

SUMMARY II PLANNING REQUEST
(SUMMARY I DETAIL) (TENTATIVE WORK SHEET)

Rev. A

81 Request ID: ______

Planner: ______ Ext. No. ______ Date: M___ D___ Y___

82 Headers: (1) ______

(2) ______

83 (3) ______

"Major" Project Funding Source: (Circle One)

1. OSSA
2. OMSF
3. OART
4. OTDA
5. Mixed NASA
6. Other
7. All Sources

Fill in ID number of SE&M Cost to be used. ______

(Only those requested projects with the funding source circled above will be included in funding totals and plots. Those with different funding sources will be shown separately on flight and funding reports, but will not contribute to any totals. If number "7" is circled, all requested projects will be included in all reports regardless of their individual funding source.)

SUMMARY I's REQUESTED

List below the Request ID's for the Summary I groupings to be included in this Summary II Report. They will be printed and plotted in the order listed.

84
1 ______ 6 ______
2 ______ 7 ______
3 ______ 8 ______
4 ______ 9 ______
5 ______ 10 ______

REPORTS DESIRED

85 Circle Reports Desired:

1. Plot of Summary I Funding (with separate LV funding)
2. Plot of Summary I Funding (with LV funding included in its respective Summary I total)
3. Plot of Manned Funding
4. Funding Table by Project Type within each Summary I
5. Consolidated Flight Schedule
6. LV Procurement Funding Plot
7. Detailed LV Flight and Procurement Funding Schedule
8. Plot of POP Five Year Funding
9. Plot of First 5 Years "New Start" Funding
10. Manpower Displays

FIGURE B-5. SUMMARY II REQUEST FORM

SUMMARY III PLANNING REQUEST
(SUMMARY II DETAIL) (TENTATIVE WORK SHEET)

Rev. A

87 Request ID: ______

Planner: ______ Ext. No. ______ Date: M___ D___ Y___

88 Headers: (1) ______

(2) ______

89 (3) ______

SUMMARY II's REQUESTED

List below the Request ID's for the Summary II groupings to be included in this Summary III Report. They will be printed and plotted in the order listed.

90
1 ______ 6 ______
2 ______ 7 ______
3 ______ 8 ______
4 ______ 9 ______
5 ______ 10 ______

REPORTS DESIRED

91 Circle Reports Desired:

1. Plot of Summary II Funding (with separate LV funding)
2. Plot of Summary II Funding (with LV funding included in its respective Summary II total)
3. Plot of Manned Funding
4. Funding Table by Project Type within each Summary II
5. Consolidated Flight Schedule
6. LV Procurement Funding Plot
7. Detailed LV Flight and Procurement Funding Schedule
8. Plot of POP Five Year Funding
9. Plot of First 5 Years "New Start" Funding
10. Manpower Displays

FIGURE B-6. SUMMARY III REQUEST FORM

AT 1043 PROJECT NAME HIGH ENERGY ASTRON OBS AB+C PROJECT DATA UNMANNED 4/22/70
SHORT PROJECT NAME HEAD AB+C PLANNER BMI=NLVP EXTENSION NO. 20147 MODIFICATION OF PROJECT AT 1043
PROJECT TYPE=PRIMARY S/C PROJECT FUNDING SOURCE=OSSA

	FLIGHTS			FUNDING (MILLIONS)		MANPOWER NASA		CON-	
YEAR	X	+	*	POP	TOTAL	DIR	ID	TRACT	
69	0	0	0	0.00	0.0	0	0	6	69
70	0	0	0	0.00	0.0	0	0	0	70
71	0	0	0	0.00	0.0	0	0	0	71
72	0	0	0	4.00	4.0	0	0	0	72
73	0	0	0	45.50	45.5	0	0	0	73
74	0	0	0	47.00	47.0	0	0	0	74
75	0	1	0	44.00	44.0	0	0	0	75
76	0	1	0	40.00	40.0	0	0	0	76
77	0	1	0	[illegible].00	14.0	0	0	0	77
78	0	0	0	0.00	5.0	0	0	0	78
79	0	0	0	0.00	3.0	0	0	0	79
80	0	0	0	0.00	0.0	0	0	0	80
81	0	0	0	0.00	0.0	0	0	0	81
82	0	0	0	0.00	0.0	0	0	0	82
83	0	0	0	0.00	0.0	0	0	0	83
84	0	0	0	0.00	0.0	0	0	0	84
85	0	0	0	0.00	0.0	0	0	0	85
86	0	0	0	0.00	0.0	0	0	0	86
87	0	0	0	0.00	0.0	0	0	0	87
88	0	0	0	0.00	0.0	0	0	0	88
TOT	0	3	0	190	202	0	0	6	TOT

CANDIDATE MANAGEMENT CENTER(S)
CENTER USED IN MANPOWER ESTIMATE: MSFC
OTHER CANDIDATE CENTERS

MISSION PARAMETERS

A. EARTH ORBITAL — NOMINAL / LOWER / UPPER
PERIGEE, NM 200 180 250
APOGEE, NM 200 180 250
INCLINATION, DEG 28.5 0.0 28.5
LONGITUDE IF SYNCHRONOUS 0 0 0

B. FLYBYS/SWINGBYS — TARGET / MISS DISTANCE(NM) / TRIP TIME (DAYS)
0 0
0 0
0 0
0 0

E. LANDERS/ATMOSPHERIC PROBES
TARGET=PLANET/BODY
WEIGHT,LBS. 0
TRIP TIME,DAYS 0

C. PROBES — NOMINAL / LOWER / UPPER
DISTANCE,AU 0.0 0.0 0.0
INCLIN. TO ECLIP.,DEG 0 0 0
TRIP TIME,DAYS 0 0 0

D. PLANETARY/ORBITAL
TARGET=PLANET/BODY — NOMINAL / LOWER / UPPER
PERIAPSIS,P.R. 0 0 0
APOAPSIS,P.R. 0 0 0
INCLIN., DEG. 0.0 0.0 0.0
TRIP TIME,DAYS 0 0 0

F. EARTH RETURN
NO RETURN TO EARTH

SPACECRAFT

A. PROPULSION SYSTEM V FT/SEC TYPE RESTARTS NOM. WT.
0 0 0
0 0 0
0 0
0 0 0
0 0 0

B. WEIGHTS — NOMINAL / LOWER LIM / UPPER LIM
S/C WITH SUPPORT SYSTEM 7000
EXPERIMENTS 13600
PROPULSION SYSTEM(S) 0
CONTINGENCIES 3000
OTHER 0
TOTAL 23600 0 0

C. LINEAR DIMENSIONS (INCHES)
HEIGHT 360 0 0
MAXIMUM DIAMETER 100 0 0

D. SPIN
REQUIRED RPM 1 0 0
ACCEPTABLE RPM 0

E. GUIDANCE=OPTICAL
AT 1043

LAUNCH INFORMATION

A. VELOCITY REQUIREMENTS — NOMINAL / LOWER LIM / UPPER LIM
VC FROM LAUNCH VEHICLE, FT/SEC 25200 0 0

B. MULTIPLEXED SPACECRAFT
NUMBER OF S/C PER LAUNCH= 0
HOST PROJECT ID 0
SPACECRAFT FROM PROJECTS TO BE MULTIPLEXED
PROJECT ID NO. OF S/C WEIGHT PROJECT ID NO. OF S/C WEIGHT
0 0 0 0 0 0
0 0 0 0 0 0

C. WEIGHTS(LBS) — NOMINAL / LOWER LIM / UPPER LIM
TOTAL SPACECRAFT 23600
MULTIPLEXING HARDWARE 0
OTHER 0
TOTAL 23600 0 0
ADAPTER 0
SHROUD 0

D. ACCEPTABLE OPPORTUNITY WIDTH, DAYS 0

LAUNCH VEHICLE

A. ASSIGNMENT
NUMBER 176 NAME TITAN IIIC ASSIGNED BY JEM 5/14/69

B. PERFORMANCE CAPABILITY
PAYLOAD PAD-LBS
AT NOMINAL VC= 6400
AT UPPER VC = 0
VC PAD-FT/SEC
AT NOMINAL WEIGHT= 0
AT UPPER WEIGHT = 0

C. LAUNCH SITE=ETR
D. FUNDING SOURCE=OSSA VEHICLE COST 62.2

SPACE TECHNOLOGY NEEDS

CURRENTLY AVAILABLE

LAUNCH VEHICLES AND OPERATION
OPERATING LIFE
FLIGHT DYNAMICS AND OPERATIONS
SOLAR SPACE POWER SYSTEMS
STATION KEEPING, ATTITUDE AND POINTING CONTROLS
INSTRUMENTATION ON-BOARD DATA HANDLING AND PROCESSING
MATERIAL AND STRUCTURES
OPERATIONAL TECHNOLOGY
RELIABILITY
CHEMICAL PRIMARY PROPULSION SYSTEMS
GUIDANCE, NAVIGATION AND CONTROLS
SYSTEM MONITORING AND ENVIRONMENTAL CONTROLS
COMMUNICATIONS
ENVIRONMENTAL FACTORS

NOT YET DETERMINED

TRACKING AND DATA ACQUISITION
GROUND DATA HANDLING AND PROCESSING

AT1043 PROJECT NAME - HIGH ENERGY ASTRON OBS AB+C 4/22/70

REMARKS

PRIMARY PURPOSE OF THESE TWO FLIGHTS IS TO CONDUCT AN ALL-SKY SURVEY IN COSMIC RAY X-RAY AND GAMMA RAY ENERGIES IN THE RANGE OF 10000 EV AND 10 (15TH) EV

AT1042 + AT2000 FUNDING = POP 69-2

MISSION OBJECTIVES

PRIMARY PURPOSE -
OTHER

SECONDARY USES -
STELLAR
BINARY STARS
GALACTIC STRUCTURE +INTERSTELLAR MATTER
GALAXIES + INTERGALACTIC SPACE

FIGURE B-7. EXAMPLE OF A PROJECT LISTING

TABLE B-1. PROJECT INDEX

PROJECT INDEX BY PROJECT NAME FOR TAPE 48 5 PROSPECTUS

PH	2502		LS	2004	ADV BIOSAT ABCD	SB	2001	ADV BIOSAT ABCD	SB	2003	ADV BIOSAT ABCD
SB	2004	ADV BIOSAT ABCD	SP	2313	ADV COS RAY PHYS	SA	1521	ADV SYNCH MET SA	SA	1522	ADV SYNCH MET SA
SA	1524	ADV SYNCH MET SA	SA	1523	ADV SYNCH MET 76	PH	3003	AE CD+E	SP	2107	AE E-I
PH	3004	AE F+G	SB	1501	AEB SUBSAT	NN	9	AERO/MAR SAT.	SG	8804	AIRPL + BALLOON
AS	2060	AIR-C141	AS	1060	AIR-990	SB	1500	AP EXT BIO EXP	EP	2060	AST BELT SE FT75
IP	11	AST BELT SE FT75	EP	6160	AST EROS FB 81	IP	138	AST EROS FB 81	AT	10	ASTR EXPL DELTA
AT	6009	ASTR EXPL DELTA	AT	8	ASTR EXPL DELTA	AT	7	ASTR EXPL DELTA	AT	9	ASTR EXPL DELTA
AT	12	ASTR EXPL SCOUT	AT	6012	ASTR EXPL SCOUT	AT	13	ASTR EXPL SCOUT	AT	14	ASTR EXPL SCOUT
PH	3002	ATMOS EXPLOR 81	PH	8002	ATMOS EXPLORERS	PH	3001	ATMOSPHERE EXPL	EA	1204	ATS F+G(73)
NC	1206	ATSG MW TR EX AB	SB	1400	BIO A	SB	1420	BIO C	SB	1440	BIO D
SB	1460	BIO E	SB	1480	BIO F	LS	1300	BIOEXPL PH CD	SB	1200	BIOEXPL PH CD
SB	1201	BIOEXPL PH CD	LS	1200	BIOEXPLORER	LS	1201	BIOEXPLORER	LS	1202	BIOEXPLORER
LS	1	BIOEXPLORERS	LS	1100	BIOPION PH CD	LS	1101	BIOPION PH CD	LS	1302	BIOPION PH CD
SB	1100	BIOPION PH CD	SB	1101	BIOPION PH CD	LS	1303	BIOPIONEERS A-C	SB	1304	BIOSATS(IMP)
LS	1063	BIOSAT(IMP) RCV	SB	1063	BIOSAT(IMP) RCV	LS	3	BIOSAT(IMP)PH CD	LS	1061	BIOSAT(IMP)PH CD
SB	1060	BIOSAT(IMP)PH CD	SB	1061	BIOSAT(IMP)PH CD	SB	1062	BIOSAT(IMP)PH CD	SB	1064	BIOSAT(IMP)PH CD
SB	1065	BIOSAT(IMP)PH CD	SB	1066	BIOSAT(IMP)PH CD	SB	1067	BIOSAT(IMP)PH CD	SB	1068	BIOSAT(IMP)PH CD
SB	1306	BIOSAT(IMP)PH CD	SB	8801	BIOSCIENCE SR+T	LS	1203	BIOS(1-3)	SB	8803	BIOS. SR+T
NC	301	BROADCASTING	NC	311	BROADCASTING	EA	311	BROADCASTING	NN	5	CANADIAN DOM SAT
LV	2020	CENT/SIVR INTEGR	PH	2105	CLUSTER	PH	8105	CLUSTER	SP	2105	CLUSTER
SP	2101	CLUSTER PHASE AB	SP	2102	CLUSTER PHASE CD	EP	2050	CO D ARREST F 76	EP	6140	CO KOPFF REND 83
EA	1202	COM ATS H + J	EA	1203	COM ATS H + J	EP	6310	COM HAL RE(NE)84	EP	6150	COM HALLEY FB 85
ES	1202	COMM ATS	NC	200	COMM R+D	NC	210	COMM R+D	NC	300	COMM R+D
NC	310	COMM R+D	EA	2212	COMMUNICATION SA	EA	25	COMM. CONTR. ADM	EA	8801	COMM. SR+T
NC	8801	COMM. + NAV. SRT	EA	1201	COM. ATS	SG	8806	CONTRACT ADMIN.	EA	8	COOP APPL SATS
AS	1050	COOP A+B	SG	8805	COOP PROGRAMS	SP	2109	COOPERATIVES	SP	1103	COOPS PHASE CD
NC	2501	DATA COLL PH AB	NC	2511	DATA COLL PH CD	NC	102	DATA COLLECTION	NC	201	DATA COLLECTION
NC	303	DATA COLLECTION	EA	201	DATA COLLECTION	NC	100	DATA REL SAT A-D	NC	302	DATA REL-NEAR EA
AT	2201	DELTA EXPL ASTR	ES	202	DFS A-C	ES	1413	DFS-A	NN	19	DOD - A/C
NN	54	DOD - A/C	NN	18	DOD - DELTA	NN	17	DOD - SCOUTS	NN	53	DOD - SCOUTS
EA	202	DRAG-FREE SATS(7	EA	1213	DRSS 78 (1)	EA	1302	DRSS A+B	EA	1214	DRSS DUAL ACC
EA	1216	DRSS DUAL PURPOS	EA	1215	DRSS TRIPLE ACCE	EA	1303	DRSS 78	EA	8803	EA CONTRACT ADM.
EA	8802	EARTH OBS. SR+T	NN	13	EARTH RES. SRVEY	SP	2310	ENV RES CLUST-BD	SP	2110	ENV RES CLUS-ACE
SA	8804	ERS AIRCRAFT	EA	3001	ERTS A+B	EA	1612	ERTS A+B	ES	1601	ERTS C+D PH A+B
ES	201	ERTS C+D PH C+D	ES	1611	ERTS C+D PH C+D	EA	16	ERTS C+D PH C+D	ES	2601	ERTS C+D (72)
EA	1614	ERTS C+D(73)	EA	2601	ERTS C+D(74)	EA	2602	ERTS C+D(74)	EA	1610	ERTS E+F(73)
EA	1611	ERTS E+F(74)	EA	1613	ERTS FOLLOW-ON	EA	1615	ERTS FOLLOW-ON M	NN	11	ESSA LOW ORBIT
NN	12	ESSA LOW ORBIT	NN	14	ESSA SYNCH	NN	15	ESSA SYNCH	AS	1070	EXP
SB	1600	EXP DEF/SUPPORT	ES	2609	EXPT DATA SYST	NN	8	FAA(ATC)	ES	1102	GARP EQUATOR PHB
ES	2112	GARP EQUATORIAL	ES	1103	GARP GEO PH B	ES	2113	GARP GEOSTATIONA	ES	2104	GARP POL ORB B
ES	2114	GARP POLAR ORBIT	PH	1302	GEN RELATIVITY	ES	1412	GEOS-C	EA	10	GEOS-C
EA	1010	GEOS-C 72	EA	1412	GEOS-C (71)	SP	2308	GRAVITY WAVES	SP	2312	GYRO PRECESSION
SP	1301	GYRO PRECURSOR	AT	1043	HEAD AB+C	AT	1045	HEAD AB+C	AS	1040	HEAD AB+C
AT	1042	HEAD AB+C	AS	2040	HEAD E+F	AS	1041	HEAD (ABC)	AT	1040	HEAD-AB
AT	1044	HEAO A B C	SP	1303	HEAVY EXPLORER	PH	5	HELIOS	AT	9000	HEOA D
AT	9001	HEOS D	AT	1041	HI ENERGY AST OB	LV	6010	HI ENERGY KICK	NC	2236	HI-PR UHF TV SAT
PH	9001	IMP H-J	PH	9003	IMP H-J	PH	1101	IMP KK LL	SP	1101	IMP KK LL
PH	9002	IMP LATE 70 S	SP	2111	IMP M-Q	PH	6009	IMP M-R	SP	2106	IMP M-T
LV	6000	IMPR CENT H-F	NN	7	INDIA DOM. TV	NN	47	INT A/C (INT)	NN	51	INT A/C (INT)
NN	61	INT DELTA 40 PCT	NN	60	INT SCOUT 40 PCT	NN	2	INTELSAT III	NN	3	INTELSAT IV

```
                                      SUMMARY I PLANNING REQUEST
REQUEST ID-SG05  LOW PLAN             PHYSICS AND ASTRONOMY PROGRAMS   SCALED DOWN  BASELINE 1              4/17/70
STANDARD PREFIX-     PLANNER-HMI-NLVP        EXT. NO.-    0     STORED                     PROJECTS
MODIFICATION OF REQUEST ID-SG05   MAJOR PROJECT FUNDING SOURCE-USSA       PROJECT  CP GROUP    PROJECT   CP GROUP
                                                                              ID     NO. NO.      ID      NO. NO.
           GROUPS                                   COMPOSITE PROJECTS     1 SG 8801      1  51
NO.             NAME                                              GROUP    2 SG 8802      1  51
 1   SUPPORTING ACTIVITIES               NO.             NAME      NO.     3 SG 8806      1  53
 2   ORBITING ASTRONOMICAL OSS.+LST                                        4 SG 8804      1  54
 3   LARGE TELESCOPE MOUNT                                                 5 SG 8805      1  55
 4   ORBITING SOLAR OBSERVATORIES                                          6 SG 8803      1  56
 5   HIGH ENGERY ASTRONOMICAL OBS.                                         7 AT    1      2  57
 6   SMALL ASTRONOMY SATELLITES                                            8 AT 1001      2  58
 7   VARIOUS SMALL PHYSICS SATS                                            9 AT 1005      2  59
 8   INTERPLANETARY MONITORING PLAT                                       10 AT    2      4  60
 9   INTERPLANETARY + SOLAR PROBES                                        11 AT    3      4  61
                                                                          12 AT 2080      4  62
                                                                          13 AT 1041      5  63
                                                                          14 AT 2502      6  64
                                                                          15 AT   14      6  65
                                                                          16 AT   10      6  66
                                                                          17 PH 3001      7  67
                                                                          18 PH 3002      7  68
                                                                          19 PH    1      7  69
                                                                          20 PH 2112      7  70
                                                                          21 PH 9003      8  71
                                                                          22 PH 1101      8  72
                                                                          23 PH 9002      8  73
        REPORTS DESIRED                                                   24 PH 2103      7  74
FLIGHT SCHEDULE WITH SHORT PROJECT NAME                                   25 PH 2105      7  75
FLIGHT SCHEDULE WITH FULL PROJECT NAME                                    26 PH    5      9  76
PLOT OF FUNDING (G/CP/P)                                                  27 PH 1502      9  77
PLOT OF FUNDING (G/CP/P) + LV FUNDING                                     28 PH 2501      9  78
FIVE YEAR REPORTS                                                         29 AT 9000      5  79
     INDIVIDUAL PROJECT SUMMARIES                                         30                 80
FLIGHT SCHEDULE                                                           31                 81
POP FUNDING                                                               32                 82
PROJECT FUNDING                                                           33                 83
5 YEAR NEW START FUNDING                                                  34                 84
LAUNCH VEHICLE FUNDING                                                    35                 85
TOTAL (PROJECT AND LV) FUNDING                                            36                 86
                                                                          37                 87
        OPTIONAL DISPLAY ORDER                                            38                 88
   G=GROUP CP=COMPOSITE PROJECT P=PROJECT                                 39                 89
      NUMBER           NUMBER          NUMBER                             40                 90
      OR ID            OR ID           OR ID                              41                 91
 1             11             21                                          42                 92
 2             12             22                                          43                 93
 3             13             23                                          44                 94
 4             14             24                                          45                 95
 5             15             25                                          46                 96
 6             16             26                                          47                 97
 7             17             27                                          48                 98
 8             18             28                                          49                 99
 9             19             29                                          50
10             20             30
REQUEST ID-SG05
```

FIGURE B-8. EXAMPLE OF A COMPUTER OUTPUT SUMMARY I LISTING

```
                                   REQUEST ID  OS-3

PLANNER   BMI-NLVP                 EXT. NO.      0         DATE  M   3  D  31  Y  70

HEADERS     STG OPTION I
         OSSA TOTAL PROGRAM 71-81

MAJOR PROJECT FUNDING SOURCE  OSSA
ID NUMBER OF SE+M COST      0

SUMMARY I REQUESTED.
         SBS1    SLS1    SG03    SA04

THE FOLLOWING REPORTS ARE REQUESTED.
PLOT OF SUMMARY I FUNDING (WITH SEPARATE LV FUNDING)
FUNDING TABLE BY PROJECT TYPE WITHIN EACH SUMMARY I.
CONSOLIDATED FLIGHT SCHEDULE.
LV PROCUREMENT FUNDING PLOT.
DETAILED LV FLIGHT AND PROCUREMENT FUNDING SCHEDULE.
```

FIGURE B-9. EXAMPLE OF COMPUTER OUTPUT SUMMARY II LISTING

```
                              REQUEST ID  SUM3

PLANNER  NASA                   EXT. NO.  12345        DATE  M   4  D  29  Y  70

HEADERS
         ALTERNATIVE NASA MISSION MODEL
          2

SUMMARY II REQUESTED.
         OSA2    OART    OMSF    OTDA

THE FOLLOWING REPORTS ARE REQUESTED.

PLOT OF SUMMARY II FUNDING(WITH SEPARATE LV FUNDING)

PLOT OF SUMMARY II FUNDING (WITH LV FUNDING INCLUDED IN ITS RESPECTIVE SUMMARY II TOTAL)

PLOT OF MANNED FUNDING.

FUNDING TABLE BY PROJECT TYPE WITHIN EACH SUMMARY II

CONSOLIDATED FLIGHT SCHEDULE.

LV PROCUREMENT FUNDING PLOT.

DETAILED LV FLIGHT AND PROCUREMENT FUNDING SCHEDULE.

PLOT OF POP FIVE YEAR FUNDING.

PLOT OF FIRST 5 YEARS NEW START FUNDING.
```

FIGURE B-10. EXAMPLE OF COMPUTER OUTPUT SUMMARY III LISTING

TABLE B-2. LAUNCH VEHICLE COST SUMMARY

LAUNCH VEHICLE INFORMATION

RECURRING AND ANNUAL SUPPORT COSTS (IN MILLIONS)

LAUNCH VEHICLE NUMBER	LAUNCH VEHICLE NAME	ANNUAL SUPPORT COST	YEAR OF LAUNCH	5 YEAR COST SPREAD -1	-2	-3	-4	TOTAL COST	LV GROUP NO.
1	SCOUT	0.0	.5	.6	0.0	0.0	0.0	1.1	1
2	TAT/AGENA	0.0	.4	5.0	1.1	0.0	0.0	6.6	2
3	TAT/DELTA/FW-4	0.0	.4	1.5	1.0	0.0	0.0	2.9	3
4	TAT/DELTA/TE364	0.0	.4	1.6	1.0	0.0	0.0	3.0	3
6	TIIIX/AGENA	0.0	.7	5.1	2.8	.5	0.0	9.2	5
11	SIB/SIVB	0.0	35.5	49.3	14.1	0.0	0.0	98.9	6
13	SATURN V	0.0	56.5	105.5	59.5	1.6	4.3	227.4	7
28	260/SIVB	0.0	7.5	15.1	7.5	0.0	0.0	30.2	20
42	SCOUT(5-STAGE)	0.0	1.4	.6	0.0	0.0	0.0	2.0	1
56	SIC/SIVB	0.0	37.1	70.9	48.7	2.1	0.0	158.8	23
82	TIIIX(7S)/T.S.	0.0	2.4	9.7	9.7	2.4	0.0	24.3	0
134	SLV3C/CENTAUR	0.0	1.5	6.1	4.8	0.0	0.0	12.4	9
143	TIIIX(5S)/C	0.0	2.1	7.5	8.7	1.5	0.0	19.8	25
146	TIIIX(5S)/AGENA	0.0	1.5	8.6	6.1	1.3	0.0	17.5	12
148	TIIIX/CENTAUR	0.0	1.1	4.7	5.4	.5	0.0	11.7	13
149	SIB/SIVB/CENTAUR	0.0	37.2	52.8	17.6	0.0	0.0	107.6	22
176	TITAN IIIC	0.0	2.1	8.3	8.3	2.1	0.0	20.7	10
184	SLV3X/CENTAUR	0.0	1.2	7.7	4.4	0.0	0.0	13.3	9
185	TIIIX(7S)/C	0.0	2.7	8.2	10.8	2.7	0.0	24.4	32
238	SLV3C/C/GBII	0.0	1.6	6.6	4.9	0.0	0.0	13.1	9
239	SLV3X/C/GBII	0.0	1.5	8.1	4.4	0.0	0.0	14.0	9
241	TITAN IIIC/GBII	0.0	2.3	8.7	8.3	2.1	0.0	21.4	10
256	SLV3A/BII	0.0	.9	3.6	1.6	0.0	0.0	6.1	34
263	TIIIX(5S)/C/GBII	0.0	2.3	7.8	8.7	1.5	0.0	20.3	25
264	TIIIX(7S)/C/GBII	0.0	2.9	11.1	10.6	2.7	0.0	27.3	32
267	TAT9C/DELTA/T364	0.0	.4	1.9	1.0	0.0	0.0	3.3	3
269	TAT6C/DELTA/T364	0.0	.4	1.8	1.0	0.0	0.0	3.2	3
284	260/SIVB/CENTAUR	0.0	13.0	13.0	13.0	0.0	0.0	38.9	19
286	SIC/SIVB/CENTAUR	0.0	22.1	70.6	67.5	7.3	0.0	167.5	37
287	SATURN V/CENTAUR	0.0	45.8	124.9	113.1	6.8	0.0	290.6	21
310	SCOUT(44A)	0.0	1.3	.6	0.0	0.0	0.0	1.9	1
311	SCOUT-44A-5STAGE	0.0	1.4	.6	0.0	0.0	0.0	2.0	1
312	TAT6C/DELT/GT364	0.0	1.4	3.1	.9	0.0	0.0	5.3	3
313	TAT9C/DELT/GT364	0.0	.4	3.8	1.0	0.0	0.0	5.2	3
268	TAT6C/DELT(2STG)	0.0	.4	1.7	1.0	0.0	0.0	3.1	3
45	TAT3C/DELT(2STG)	0.0	.4	1.5	1.0	0.0	0.0	2.9	3
266	TAT9C/DELT(2STG)	0.0	.4	1.8	1.0	0.0	0.0	3.2	3
382	TITANIIID(7)	0.0	1.8	7.2	7.2	1.8	0.0	17.9	8
383	TITANIIID	0.0	1.3	5.3	5.3	1.3	0.0	13.2	36

TABLE B-2. LAUNCH VEHICLE COST SUMMARY
(Continued)

LAUNCH VEHICLE INFORMATION

LAUNCH VEHICLE GROUPS

LV GROUP NO.	LAUNCH VEHICLE GROUP NAME
1	SCOUT
2	TAT/AGENA
3	TAT/DELTA
4	ATLAS/AGENA
5	TITAN IIIX/AGENA
6	SATURN IB
7	SATURN V
8	TITAN IIIX(1207)
9	ATLAS/CENTAUR
10	TITAN IIIC
11	TITAN IIIX(1207)/AGENA
12	TITAN IIIX(1205)/AGENA
13	TITAN IIIX/CENTAUR
14	SATURN IB/CENTAUR
15	260(1.2)/SIVB
16	260(1.2)/SIVB/CENTAUR
17	HYDROGEN-FLORINE(3-STAGE)
18	TAT/HOSS
19	260(3.7)/SIVB/CENTAUR
20	260(3.7)/SIVB
21	SATURN V/CENTAUR
22	SATURN IB (1207)/CENTAUR
23	SATURN INT20
24	260(3.7)/260(1.2)/SIVB/CENTAUR
25	TITAN IIID/C
26	260(3.7)/SIVB/CENTAUR/KICK
27	TITAN IIIX(1207)/CENTAUR/KICK
28	SATURN V/CENTAUR/KICK
29	SATURN INT20/CENTAUR/KICK
30	ATLAS/CENTAUR/KICK
31	SATURN INT20/CENTAUR
32	TITAN IIID(7)/C
33	THOR
34	ATLAS
35	SATURN V - NUCLEAR SIVB
36	TITANIIID
37	SATURN INT20/C

20 YEAR SE+M COST(IN MILLIONS)/

NO.	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1965	1986	1987	1988
1	4.4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2	55.5	62.9	83.9	77.2	51.2	41.9	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
3	56.0	63.0	75.6	73.0	59.4	42.9	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0

Summary I Reports

The Summary I reports that can be requested by the planner are listed below:

(1) Flight schedule with short project name (Table B-3). The short project name is specified on the project data sheet in Figure B-2.

(2) Flight schedule with long project name. (Similar to Table B-3 except that the long project name as assigned on the project data sheet is used in place of the short project name.)

(3) Plot of funding for group/composite project/project (Figure B-11)*. A funding table (Table B-4), giving the plotted data, is also provided in a computer listing.

(4) Plot of funding for group/composite project/project and launch vehicle.* (Similar to Figure B-11 but with LV funding included.) A table similar to Table B-4 is also provided in a computer listing.

(5) Five-year Reports*

a. Approved 5-year flights (Table B-5)

b. Five-year new start flights (Similar to Table B-5 except that only nonapproved flights are shown)

c. Program Operating Plan (POP) 5-year funding plot (Figure B-12)

d. Five-year new start funding plot (Similar to Figure B-12 except that only new start money for the first 5-years shown).

(6) Individual project summaries* (Table B-6) which include name, ID, and assigned launch vehicle plus any of the following:

a. Flight schedule

b. POP funding

c. Project funding

d. 5-year new start funding

e. Launch vehicle funding

f. Total (project + LV) funding.

Summary II and Summary III Reports

Summary II and Summary III optional reports are identical. The available Summary II (III) reports are as follows:

(1) Composite funding plot of Summary Is (IIs)*, with LV funding shown separately (Figure B-13)

(2) Composite funding plot of Summary Is (IIs)*, with LV funding included in its respective Summary I (II) (similar to Figure B-13)

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* SD-4060 output.

TABLE B-3. FLIGHT SCHEDULE WITH SHORT PROJECT NAME

PAGE 1 SUMMARY I SG05
FLIGHT SCHEDULE
LOW PLAN

PHYSICS AND ASTRONOMY PROGRAMS

SCALED DOWN BASELINE I

APRIL 29, 1970

PROJECT	VEHICLE	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
ORBITING ASTRONOMICAL OSS.+LST																					
OAO - C	SLV3C/CENTAUR		X	X																	
OAO-D	SLV3C/CENTAUR						+														
LST A,B,C	TITAN IIIC								*		*		*								
ORBITING SOLAR OBSERVATORIES																					
OSO A-H	TAT3C/DELT(2STG)			X																	
OSO I-K	TAT3C/DELT(2STG)					+	+	+													
OSO L+M	TAT/DELTA/FW-4											*	*								
HIGH ENGERY ASTRONOMICAL OBS.																					
HI ENERGY AST OB	T111X(5S)/C													*							
HEOA D	T111X(5S)/C									*											
SMALL ASTRONOMY SATELLITES																					
SAS A+B	SCOUT		X	X																	
ASTR EXPL SCOUT	SCOUT					*	*	*	*	*	*	*	*	*	*	*	*				
ASTR EXPL DELTA	TAT/DELTA/FW-4		*				*	*	*	*	*	*	*	*							
VARIOUS SMALL PHYSICS SATS																					
ATMOSPHERE EXPL	TAT/DELTA/FW-4			+	+																
ATMOS EXPLOR 81	TAT/DELTA/FW-4													**							
SSS A-D	SCOUT		*	*	*	*															
SSS E-J	SCOUT						*	*	*	*	*	*									
ISIS (B-C-D)	TAT/DELTA/FW-4		+		+		*														
CLUSTER	TAT/DELTA/TE364									*			*								
INTERPLANETARY MONITORING PLAT																					
IMP H-J	TAT9C/DELTA/T364		X		X	X															
IMP KK LL	TAT9C/DELTA/T364							*	*												
IMP LATE 70 S	TAT9C/DELTA/T364										**			*							
INTERPLANETARY + SOLAR PROBES																					
HELIOS	SLV3C/CENTAUR						+	+													
SWP	TAT6C/DELTA/T364							+													
OUT ECLIP-PIO CD	T111X(5S)/C										*	*									

FLIGHT STATUS
- X APPROVED
- + PLANNED
- * PROPOSED

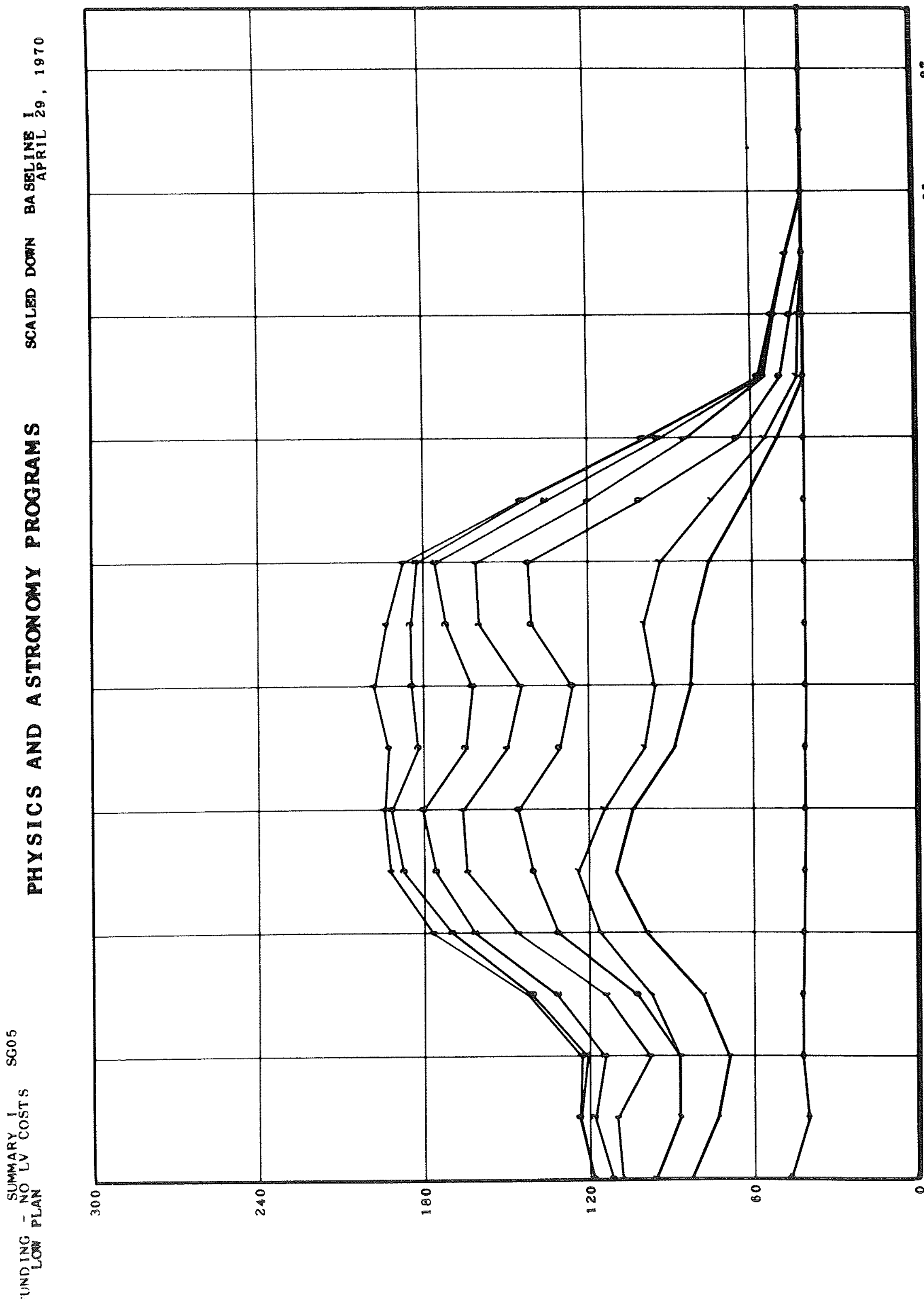

FIGURE B-11. PLOT OF FUNDING (GROUP/COMPOSITE PROJECT/PROJECT - SD-4060 PLOT)

TABLE B-4. FUNDING TABLE FOR FIGURE B-11

LOW PLAN SUMMARY I SG 5 PHYSICS AND ASTRONOMY PROGRAMS SCALED DOWN BASELINE I

FUNDING - NO I V COSTS

DATE 4/29/70

			1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
G	1	SUPPORTING ACTIVITIES																				
			46	40	42	42	41	41	41	41	40	40	40	40	40	40	40	40	40	40	40	40
	CUM=		47	40	42	42	42	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
G	2	ORBITING ASTRONOMICAL OSS.+LST																				
			36	33	27	36	57	68	63	48	42	41	35	22	10	0	0	0	0	0	0	0
	CUM=		83	74	69	79	99	110	104	89	83	82	76	63	51	41	41	41	41	41	41	41
G	3	LARGE TELESCOPE MOUNT																				
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CUM=		83	74	69	79	99	110	104	89	83	82	76	63	51	41	41	41	41	41	41	41
G	4	ORBITING SOLAR OBSERVATORIES																				
			13	13	17	18	16	14	10	10	12	18	17	12	4	2	1	0	0	0	0	0
	CUM=		96	87	87	97	116	124	115	100	96	100	94	75	55	43	42	41	41	41	41	41
G	5	HIGH ENGERY ASTRONOMICAL OBS.																				
			0	0	0	5	15	16	31	31	30	41	48	26	10	6	3	0	0	0	0	0
	CUM=		96	87	87	102	132	140	146	131	126	141	142	101	65	49	45	41	41	41	41	41
G	6	SMALL ASTRONOMY SATELLITES																				
			11	22	11	11	14	24	20	19	19	19	19	19	19	6	6	6	0	0	0	0
	CUM=		108	110	98	114	146	164	166	150	145	160	161	120	84	55	51	47	41	41	41	41
G	7	VARIOUS SMALL PHYSICS SATS																				
			3	8	16	17	15	11	14	15	17	12	14	15	9	0	0	0	0	0	0	0
	CUM=		112	118	115	132	162	176	180	165	162	172	176	136	94	56	52	47	41	41	41	41
G	8	INTERPLANETARY MONITORING PLAT																				
			6	5	6	9	8	11	11	17	22	13	7	8	5	1	0	0	0	0	0	0
	CUM=		118	124	121	141	170	188	192	182	184	185	183	144	100	57	52	47	41	41	41	41
G	9	INTERPLANETARY + SOLAR PROBES																				
			0	0	1	1	6	4	2	10	13	8	5	1	0	0	0	0	0	0	0	0
	CUM=		118	124	123	142	177	192	195	193	198	194	188	145	100	58	52	47	41	41	41	41
TOTAL			118	124	123	142	177	192	194	193	198	193	187	145	100	57	52	46	40	40	40	40

TABLE B-5. APPROVED 5-YEAR FLIGHTS

PAGE 1 SUMMARY 1 SG05
FIVE YEAR FLIGHT SCHEDULE
LOW PLAN

PHYSICS AND ASTRONOMY PROGRAMS

SCALED DOWN BASELINE I

APRIL 29, 1970

PROJECT	VEHICLE	69	70	71	72	73
ORBITING ASTRONOMICAL OSS.+LST						
ORBITING ASTRONOMICAL OBS. A-C	SLV3C/CENTAUR		x	x		
ORBITING ASTRONOMICAL OBS.-D	SLV3C/CENTAUR					
LST A B C (OAO EF+G)	TITAN IIIC					
ORBITING SOLAR OBSERVATORIES						
ORBITING SOLAR OBS. A-H	TAT3C/DELT(2STG)			x		
ORBITING SOLAR OBS. I-K	TAT3C/DELT(2STG)					
ORBITING SOLAR OBS. L+M	TAT/DELTA/FW-4					
HIGH ENGERY ASTRONOMICAL OBS.						
HIGH ENERGY ASTRONOMICAL OBS	TIIIX(5S)/C					
HIGH ENERGY OBS. D	TIIIX(5S)/C					
SMALL ASTRONOMY SATELLITES						
SMALL ASTRONOMY SATS A+B	SCOUT		x	x		
ASTRONOMY EXPLORERS SCOUT	SCOUT					
ASTRONOMY EXPLORERS -DELTA	TAT/DELTA/FW-4					
VARIOUS SMALL PHYSICS SATS						
ATMOSPHERE EXPLORERS C+D	TAT/DELTA/FW-4					
ATMOSPHERE EXPLORERS 81	TAT/DELTA/FW-4					
SSS A-D	SCOUT					
SSS E-J	SCOUT					
ISIS (B-C-D)	TAT/DELTA/FW-4					
CLUSTER	TAT/DELTA/TE364					
INTERPLANETARY MONITORING PLAT						
INTERPLAN. MONITOR PROBES H-J	TAT9C/DELTA/T364		x		x	x
IMP KK LL	TAT9C/DELTA/T364					
INTERPLAN MONITOR PROBES	TAT9C/DELTA/T364					
INTERPLANETARY + SOLAR PROBES						
HELIOS	SLV3C/CENTAUR					
SPACE WEATHER PROBE	TAT6C/DELTA/T364					
OUT OF ECLIP-PIONEER PHASE CD	TIIIX(5S)/C					

FLIGHT STATUS
- x APPROVED
- + PLANNED
- * PROPOSED

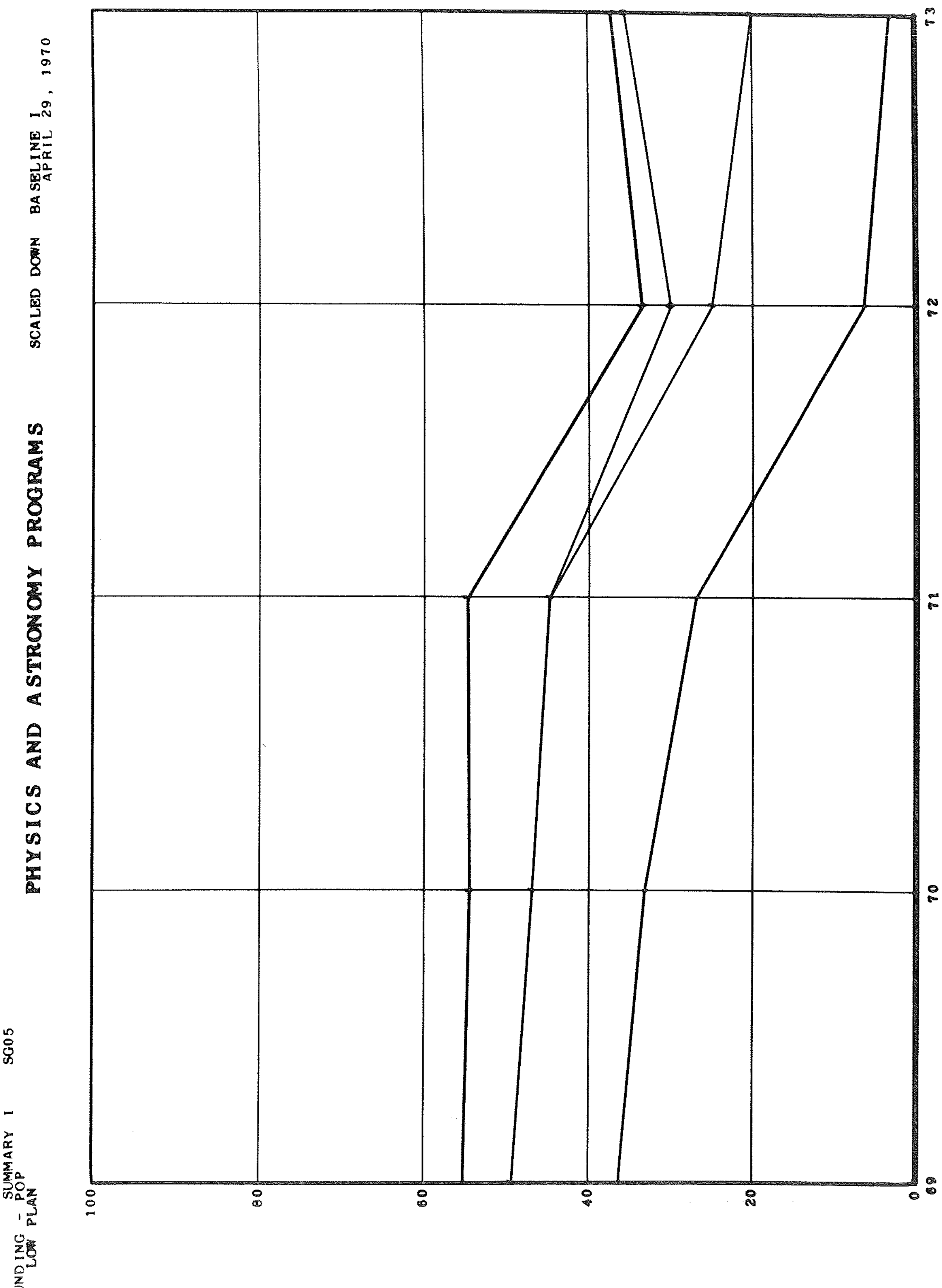

FIGURE B-12. POP 5-YEAR FUNDING PLOT

TABLE B-6. INDIVIDUAL PROJECT SUMMARY

PAGE 1 SUMMARY I SG05
INDIVIDUAL PROJECT SUMMARY
LOW PLAN

PHYSICS AND ASTRONOMY PROGRAMS

SCALED DOWN BASELINE I

INDIVIDUAL PROJECT SUMMARY

APRIL 29, 1970

FS - FLIGHT SCHEDULE CP - COMPOSITE PROJECT FLIGHT SCHEDULE PF - PROJECT FUNDING
PP - POP FUNDING 5Y - 5 YEAR FUNDING LV - LV FUNDING TF - TOTAL PROJECT + LV FUNDING GF - GROUP FUNDING

	1969	PROJECT 1970	1971	1972	1973	1974	1975	1976	1977	SCHEDULE 1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	TOTAL
SUPPORTING ACTIVITIES																					
SG 8801 PHYSICS + ASTRONOMY SR+T																					X + *
FS																					
PP																					0
PF	23.4	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	301
5Y	23.4	14.6	14.6	14.6	14.6																82
TF	23.4	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	301
SG 8802 PHYSICS + ASTRONOMY DATA ANLY																					X + *
FS																					
PP																					0
PF	3.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	60
5Y	3.4	3.0	3.0	3.0	3.0																15
TF	3.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	60
SG 8806 CONTRACT ADMINISTRATION																					X + *
FS																					
PP																					0
PF			1.0	1.2																	14
5Y			1.0	1.2																	5
TF			1.0	1.2																	14
SG 8804 AIRPLANE + BALLOON PROGRAMS																					X + *
FS																					
PP																					0
PF		2.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	73
5Y		2.9	3.9	3.9	3.9																15
TF		2.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	73
SG 8805 COOPERATIVE PROGRAMS																					X + *
FS																					
PP																					0
PF																					3
5Y																					2
TF																					3
SG 8803 SOUNDING ROCKETS																					X + *
FS																					
PP																					0
PF	19.2	18.8	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	378
5Y	19.2	18.8	18.9	18.9	18.9																95
TF	19.2	18.8	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	378
GF	46.9	40.3	42.3	42.4	42.0	41.5	41.3	41.1	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	830
ORBITING ASTRONOMICAL OSS.+LST																					
AT 1 ORBITING ASTRONOMICAL OBS. A-C SLV3C/CENTAUR																					X + *
FS		1	1																		2
PP	36.4	33.3	27.1	6.4	3.2																107
PF	36.4	33.3	27.1	6.4	3.2																107
5Y																					0
LV	10.9	7.6	1.5																		20
TF	47.3	40.9	28.6	6.4	3.2																127
AT 1001 ORBITING ASTRONOMICAL OBS.-D SLV3C/CENTAUR																					X + *
FS						1															1
PP																					0
PF				15.0	18.0	18.0	8.0	3.0	2.0	1.0											65
5Y				15.0	18.0																33
LV				4.8	6.1	1.5															12
TF				19.8	24.1	19.5	8.0	3.0	2.0	1.0											77
AT 1005 LST A B C (OAO EF+G) TITAN IIIC																					X + *
FS								1		1		1									3
PP																					0
PF				15.0	36.0	50.0	55.0	45.0	40.0	40.0	35.0	22.0	10.0								348
5Y				15.0	36.0																51
LV					2.0	8.2	10.3	10.3	10.3	10.3	8.2	2.0									62
TF				15.0	38.0	58.2	65.3	55.3	50.3	50.3	43.2	24.0	10.0								410
GF	36.4	33.3	27.1	36.4	57.2	68.9	63.0	48.0	42.0	41.0	35.0	22.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	520
ORBITING SOLAR OBSERVATORIES																					

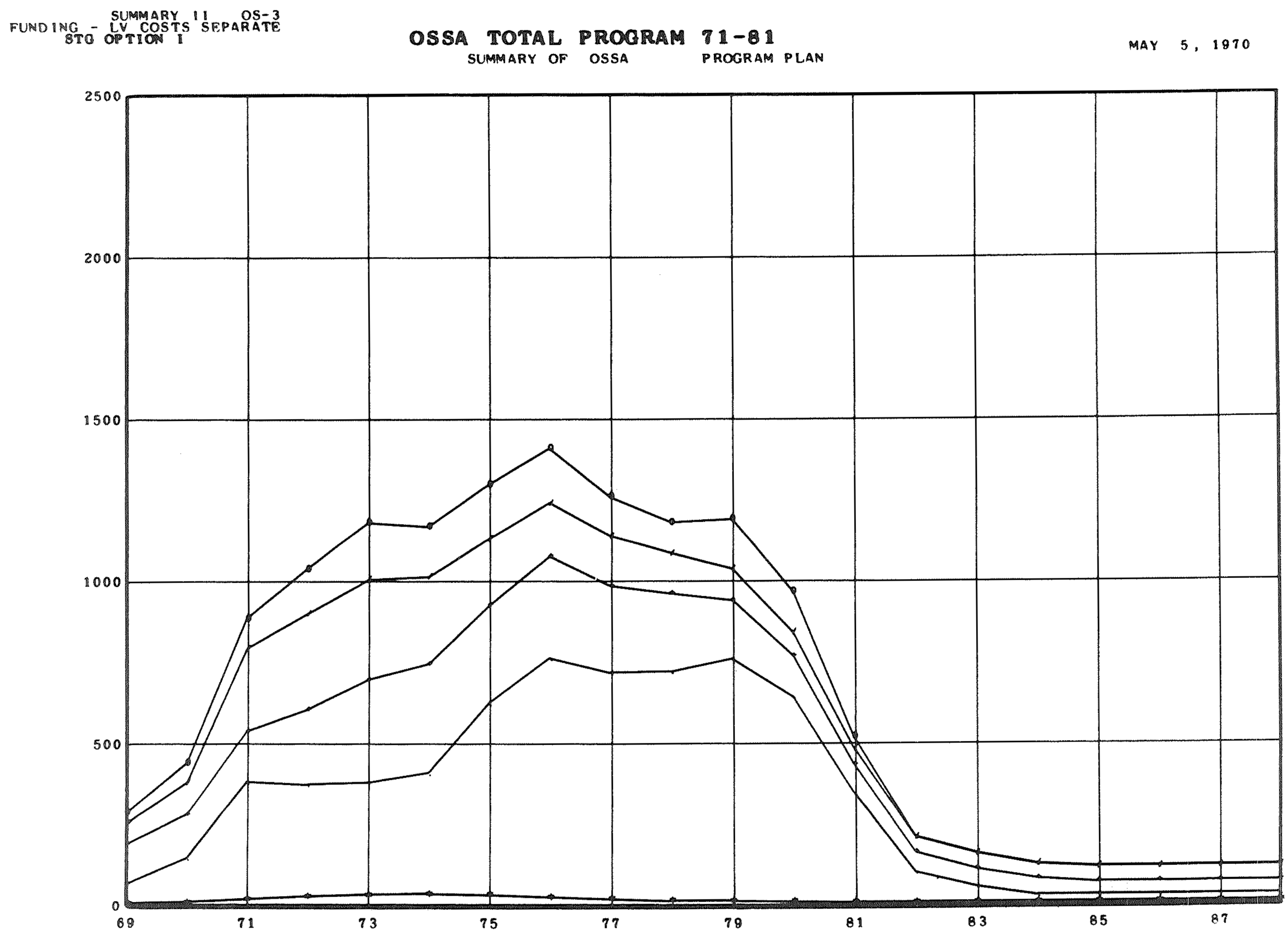

FIGURE B-13. PLOT OF SUMMARY I(II) FUNDING (SEPARATE LV FUNDING)

(3) Composite "manned" funding (similar to Figure B-13 with only "manned" projects plotted)

(4) Funding table by project type for each Summary I (II) included in the Summary II (III) (Table B-7)

(5) Consolidated flight schedule (Table B-8)

(6) LV procurement funding plot* (Figure B-14)

(7) Detailed LV flight and procurement funding schedule* (Table B-9)

(8) Plot of POP 5-year funding* (similar to Figure B-12)

(9) Plot of first 5-year "new start" funding* (similar to Figure B-12 except that only 5-year "new start" funding is included)

(10) Manpower displays* (similar to Figure B-13 except that manpower in man-years is plotted instead of funding).

Any combination of the optional reports in either the Summary Is, IIs, or IIIs may be requested by the program planner.

The Prospectus Exercise

Figure B-15 is a flow chart describing how the Prospectus Exercise is carried out in OSSA. The planning process is initiated by the program planners, who generate projects and Summary Is in each OSSA division office. The project and Summary I data are passed to Launch Vehicle and Propulsion Programs (SV), which checks the project data from the other OSSA divisions, assigns an appropriate launch vehicle to each project having a launch, and generates launch vehicle maintenance and procurement cost data. The Prospectus Coordinator then receives the data, checks the Summary I requests, and generates any desired Summary II requests. [Note: If the Prospectus Exercise were to be used by NASA, the data would then be passed to the overall NASA planning personnel who would select appropriate Summary II plans and generate the desired Summary III requests. As mentioned previously, in order for the Summary III request to be made it would be necessary for all NASA directorates [i.e. (OSSA, OART, OMSF, OTDA) to participate in the Prospectus Exercise.] The data are then entered into the computer along with the computer program to generate the requested reports. The output is returned to the Prospectus coordinator who distributes the reports to the proper OSSA division offices. Each OSSA division reviews and, if satisfied, approves the reports. The approved reports are returned to the Prospectus Coordinator for final checking and approval.

If, at any point in the planning cycle, approval is not given to an element in the plan, new data may be generated or old data rearranged and reprocessed by the Prospectus program. Therefore, the planning process can be a time-consuming, tedious procedure before the Prospectus Exercise completes the cycle of producing an OSSA (or NASA) "approved" Prospectus.

Conclusion

The Prospectus program has been used to assist in NASA OSSA planning since 1967. In 1969, many of the Planning Steering Group (PSG) planning panels also used the program. The project data tape created by the PSG exercise was one of the basic inputs utilized in

* SD-4060 output.

TABLE B-7. FUNDING TABLE BY PROJECT TYPE WITHIN EACH SUMMARY I(II)

PAGE 1 SUMMARY II OS-3
FUNDING BY PROJECT TYPE
STG OPTION I

OSSA TOTAL PROGRAM 71-81

(PROGRAM TOTALS INCLUDE MANNED PROGRAM PARTICIPATION)
(BUT LAUNCH VEHICLES FOR UNMANNED FLIGHTS ONLY)

DOLLARS IN MILLIONS MAY 5, 1970

PROGRAM FISCAL YEAR	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
BIOSCIENCE PROGRAM																				
PRIMARY S/C			8	16	19	26	25	17	12	7	5	4	1							
SECONDARY S/C																				
EXPERIMENT(S)																				
SR+T AND SUPPORT																				
OTHER	10	14	16	16	17	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
PROGRAM TOTAL	10	14	24	32	36	39	38	30	25	20	18	17	14	13	13	13	13	13	13	13
LUNAR AND PLANETARY																				
PRIMARY S/C	35	116	331	311	314	296	474	643	651	666	722	610	314	72	29					
SECONDARY S/C																				
EXPERIMENT(S)																				
SR+T AND SUPPORT																				
OTHER	24	20	30	34	34	77	115	93	45	38	23	20	20	20	20	20	20	20	20	20
PROGRAM TOTAL	59	136	361	345	347	373	589	736	696	704	745	630	334	92	49	20	20	20	20	20
PHYSICS AND ASTRONOMY PROGRAMS																				
PRIMARY S/C	91	105	125	172	227	231	204	202	169	139	111	75	48	29	21	19	19	19	19	19
SECONDARY S/C																				
EXPERIMENT(S)																				
SR+T AND SUPPORT	23	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
OTHER	8	13	17	45	75	90	84	95	84	88	54	35	26	18	18	18	8	8	8	8
PROGRAM TOTAL	123	133	157	231	316	336	302	311	267	241	179	124	88	61	53	51	41	41	41	41
SPACE APPLICATIONS PROGRAMS																				
PRIMARY S/C	27	58	209	249	263	223	159	121	107	76	51	29	7	2	2	2	2	2	2	2
SECONDARY S/C																				
EXPERIMENT(S)																				
SR+T AND SUPPORT	5	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
OTHER	32	37	40	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
PROGRAM TOTAL	64	101	255	294	308	267	203	165	152	121	96	74	51	47	47	47	47	47	47	47
LAUNCH VEHICLE PROCUREMENT	33	60	91	136	176	156	167	170	122	96	155	125	34							
SUMMARY - TOTAL																				
PRIMARY S/C	154	280	673	748	823	776	861	982	939	888	889	718	369	103	52	21	21	21	21	21
SECONDARY S/C																				
EXPERIMENT(S)																				
SR+T AND SUPPORT	29	20	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
OTHER	74	83	102	134	164	218	250	239	180	177	128	106	97	89	89	89	79	79	79	79
LAUNCH VEHICLE PROCUREMENT	33	60	91	136	176	156	167	170	122	96	155	125	34							
PROGRAM TOTAL	290	443	888	1039	1184	1171	1300	1413	1262	1182	1193	970	521	213	163	131	121	121	121	121

TABLE B-8. CONSOLIDATED FLIGHT SCHEDULE

PAGE 1 SUMMARY 11 OS-3
CONSOLIDATED FLIGHT SCHEDULE
STG OPTION I

OSSA TOTAL PROGRAM 71-81

CONSOLIDATED SCHEDULE LAUNCH VEHICLES

MAY 5, 1970

LAUNCH VEHICLE	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	TOTAL LAUNCHES
SCOUT		X**	1X3*	1+6*	2+6*	3+6*	6*	6*	4*	5*	4*	5*	*								62
TAT/DELTA		X+*	2X2+	1X6+ 2*	4+1*	3+ 12*	3+7*	5*	7*	5*	5*	5*	***								76
ATLAS/CENTAUR		X	XXX	X	X	2+3*	++*	+**	+**	*		*	*								23
TITAN IIIC				*	+	+*	+		**	*											8
TITAN IIID/C					XXX	*	**	**	6*	4*	***	**	4*								27
TITAN IIID(7)/C							**														2
TITANIIID											*										1
SATURN INT20/C													*								1
TOTAL LAUNCHES		XXX + ***	6X ++ ***	XX 7+ 9*	4X 7+ 7*	9+ 23*	6+ 18*	+ 15*	+ 21*	16*	13*	13*	10*								200

FLIGHT STATUS
X APPROVED
+ PLANNED
* PROPOSED

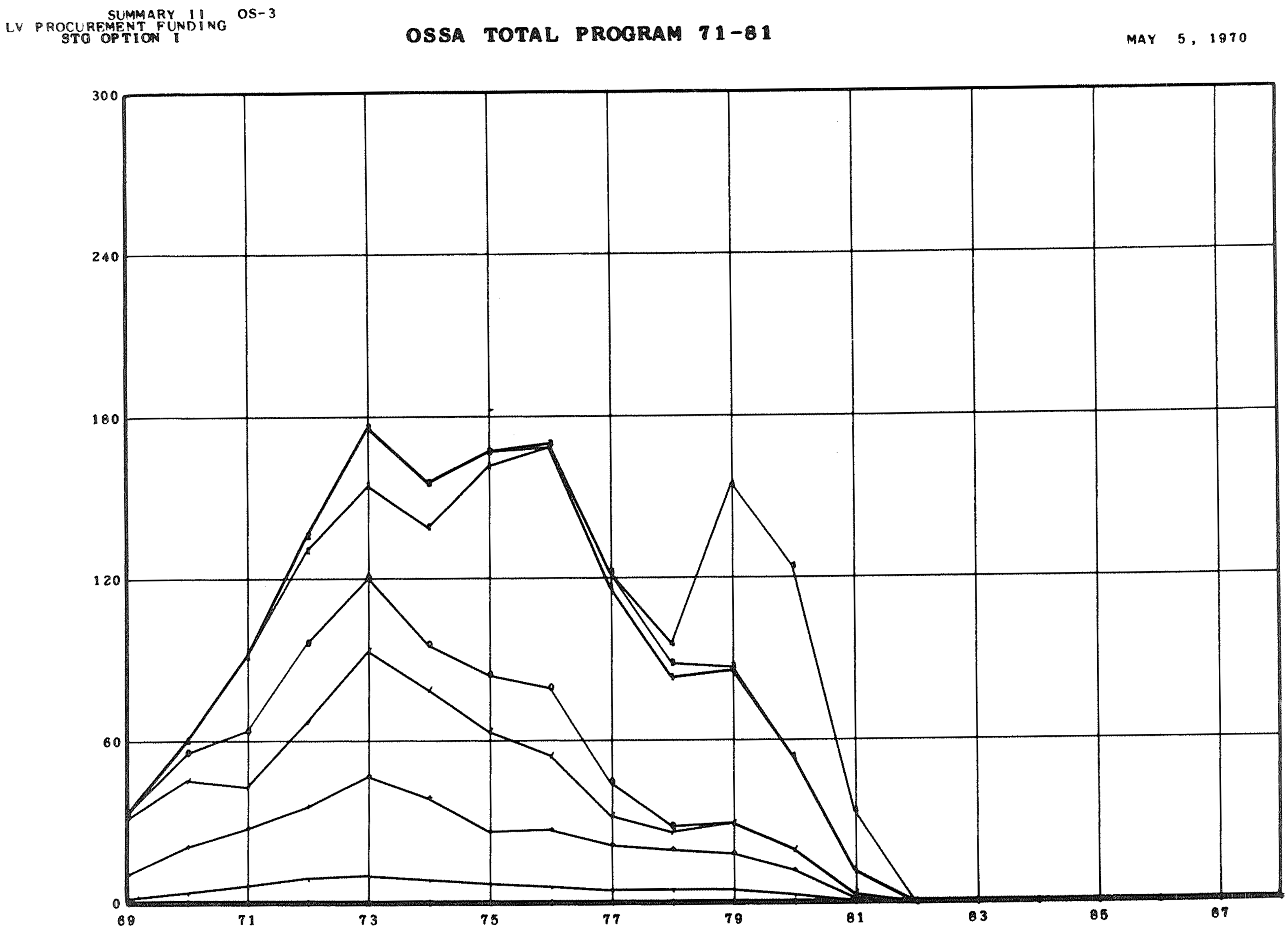

FIGURE B-14. LAUNCH VEHICLE PROCUREMENT FUNDING PLOT

TABLE B-9. DETAILED LAUNCH VEHICLE FLIGHT AND PROCUREMENT FUNDING SCHEDULE

PAGE 1 SUMMARY II OS-3
DETAILED LV SCHEDULE
STG OPTION I

LAUNCH VEHICLE PROCUREMENT
PAGE 1

OSSA TOTAL PROGRAM 71-81
LAUNCH VEHICLE SCHEDULE BY PROJECT OR USER
(INCLUDING TOTAL COSTS BY LAUNCH VEHICLE)
COSTS ARE DOLLARS IN MILLIONS

MAY 5, 1970

	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	TOTAL COST	TOTAL LAUNCHES
SCOUT																						
OSSA MISSIONS																						
BIOEXPLORERS				**	**	**	**	*	*	*	*	*										13
SMALL ASTRONOMY SATS A+B		X	X																			2
ASTRONOMY EXPLORERS SCOUT		*	**	*	*	**	*	**	*	**	*	**	*									17
SSS A-D		*	*	*	*																	4
SSS E-F						++																2
SSS G-L							*	*	*	*	*	*										6
SMALL INTERPLANTARY SATELLITE				*	*	*	*	*														5
SEA-SAT -A,B,C					*			*		*		*										4
DRAG-FREE SAT-A PHASE C + D				*																		1
DRAG FREE SATS A-C							*		*		*											3
DATA COLLECTION PHASE CD						*																1
SMALL ATS A-D PHASE C+D				+	++	+																4
TOTAL LAUNCHES FOR		X	X																			
OSSA MISSIONS				+	++	+++																
		**	***	6*	6*	6*	6*	6*	4*	5*	4*	5*	*									62
TOTAL LAUNCH VEHICLE COST FOR OSSA MISSIONS ONLY	2	4	6	9	10	9	8	6	5	5	5	3	1								73	
TAT/DELTA																						
OSSA MISSIONS																						
BIOPIONEERS						*	*	*	*													4
MARS EXPLORER ORBITERS							*		*				*									3
VENUS EXPLORERS				*			*	*		*												4
ORBITING SOLAR OBS. A-H			X																			1
ORBITING SOLAR OBS. I-K					+	+	+															3
ORBITING SOLAR OBS. L+M											*	*										2
ASTRONOMY EXPLORERS -DELTA		*				*	**	*	**	*	**	*	**									13
ATMOSPHERE EXPLORERS C+D			+	+																		2
ATMOSPHERE EXPLORERS								**			*											3
ISIS (B-C-D)		+		+		*																3
CLUSTER PHASE CD							*															1
CLUSTER										*		*										2
INTERPLAN. MONITOR PROBES H-J		X	X	X																		3
IMP KK LL						+	+															2
IMP M-R									*	*	*	*										4
SPACE WEATHER PROBE							+															1
SPACE WEATHER PROBE- B C									*			*										2
TIROS N PHASE CD						*																1
NIMBUS E+F				+	+																	2

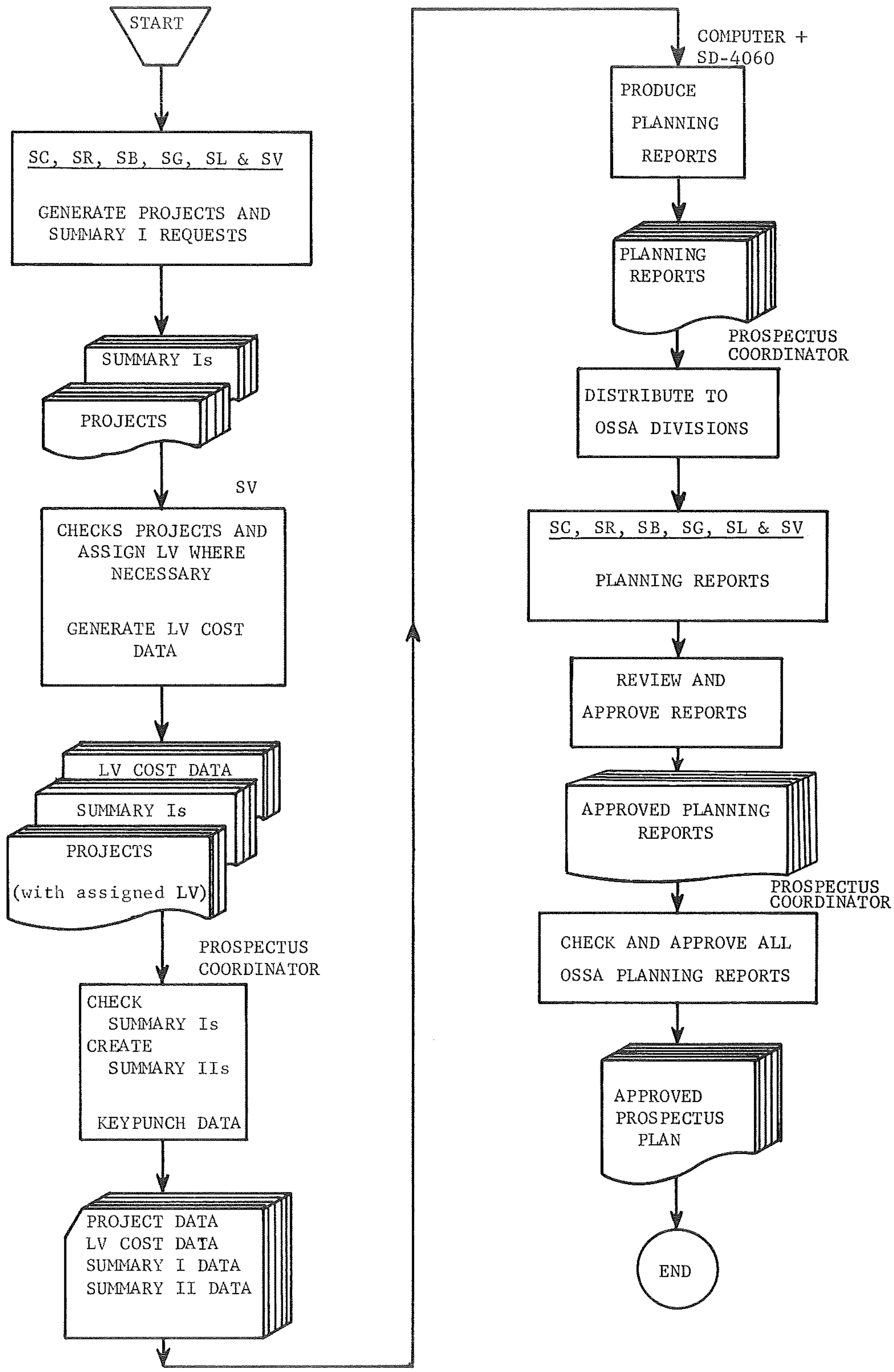

FIGURE B-15. PROSPECTUS EXERCISE FLOW CHART this study. The projects developed by the PSG planners, plus variations of these provided the set of projects from which the mission models discussed in this report were developed.

The program was used extensively in this study to generate various division and OSSA mission models (i.e., Summary Is and Summary IIs, respectively) because of its ability to provide quick and accurate funding plots, flight schedules, and summaries of launch vehicle requirements. It also provided complete documentation of the project data used in the study.

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APPENDIX C. OUTSIDE USERS

LIST OF TABLES

APPENDIX C

OUTSIDE USERS

Introduction

The term "outside users" refers to all users of OSSA launch vehicles (LV) except NASA OSSA. The outside users have been catagorized into five groups*:

- OART (NASA Office of Application and Research Technology)
- DOD (Department of Defense)
- International Programs
- Communications (e.g., Comsat Corporation)
- Earth Observations (e.g., ESSA)

Some launches for outside users are "reimbursable". For example, in the case of launches for other government agencies such as DOD and ESSA, that agency budgets for the costs of launch vehicles and transfers the funds to NASA on an Interdepartmental Purchase Request. Since these funds are included in the budgets of other agencies they do not appear in the NASA budget. Some other flights for outside users are handled differently. In the case of flights for OART and those international flights that are "cooperative" there is no transfer of funds for launch vehicles; the funds are included in the OSSA budget. In the case of Comsat flights and "non-cooperative" international flights, the funds for the launch are provided by the outside user; therefore, the funds do not appear in any government budget. In this report, displays of OSSA budget requirements include estimates of the non-reimbursable funding requirements for "outside user" launches.

When estimating launch vehicle procurement for OSSA, outside user requirements must be considered, since they have a significant effect on LV use rates. In the past, outside users have used DELTA, SCOUT, TAT/AGENA, and ATLAS/CENTAUR type vehicles. The use rate for these vehicles for the years 1965 through 1969 is presented in Table C-1.

Table C-1 indicates that SCOUT and DELTA type vehicles fulfilled the majority of outside user requirements. The DELTA and SCOUT vehicles are expected to continue to have the largest requirements from outside users. The use of ATLAS/CENTAUR and, later in the period, the use of TITAN IIID/CENTAUR is expected to increase.

The documents used to obtain the estimates of outside user requirements represents informed judgements but are not backed up by the depth of information that was available for the programs of the OSSA Divisions (i.e. SA, SB, SG, SL). Therefore, there is a greater uncertainty associated with numbers of outside user flights presented here.

The data was translated from the available documents for DOD, OART, International, Communications, and Earth Observations Programs into a format consistent with other (OSSA) project data (i.e. SA, SB, SG, SL) in this report. Five sets of guidelines were then established to represent a range of possible alternatives for outside users for the 1971-1981 time period. Selections were made from the outside user projects to form five different outside user mission models (SV1-SV5) which were best correlated with the corresponding guidelines. These models are presented later in this Appendix. The projects included in the five models are presented in the next section.

* The specific projects included in each group are presented in the next section.

TABLE C-1. OUTSIDE USER LAUNCH RATES FOR THE PERIOD 1965-1969

LV	Year 65	66	67	68	69
DELTA	1 11[a]	4 44	6 55	5 63	5 45
SCOUT	3 60	9 100	9 100	6 86	2 100
THOR/AGENA	1 100	0 0	0 0	0 0	0 0
ATLAS/CENTAUR	1 20	0 0	0 0	0 0	0 0
TOTALS[b]	6 30	13 46	15 47	11 56	7 39

(a) The upper figure indicates the number of launches for outsider users. The lower figure is the percentage of launches accounted for by outside user out of the total number of launches for the indicated launch vehicle and year.

(b) The percentages in the total data represent that portion of the total number of OSSA launches which were for outside users.

Program Areas[(1-6)]*

This section presents the projects which comprise the outside user models (SV1-SV5) presented later in this Appendix. Spacecraft weights and characteristic velocities (V_C) are given in pounds and feet-per-second, respectively, whenever the data were available. In many instances (e.g., DOD, International), the weight statements and V_C data were not given since many of the missions are not yet sufficiently well defined, and/or because the estimates represent several different missions which require the same launch vehicle. The international flight schedules in this section were divided into two catagories (i.e. reimbursables and non-reimbursables) for each launch vehicle group (i.e., SCOUT, DELTA, ATLAS/CENTAUR) used in international programs. The non-reimbursables involve the costs for about 60%[(7)] of launches for which OSSA provides the launch vehicle.** The remaining 40% of these total launch costs are reimbursed to OSSA by the foreign organization sponsoring the spacecraft.

* Superscripts denote references listed at the end of this appendix.

** As noted in Reference 7, this is a projection of the probable future division between reimbursable and non-reimbursable launch costs for international programs.

	SV1	SV2	SV3	SV4	SV5
DOD-SCOUT	•			•	
DOD-DELTA	•	•	•	•	
DOD-ATLAS/CENTAUR	•			•	
DOD-SCOUT(LOW)		•	•		•
DOD-ATLAS/CENTAUR(LOW)		•	•		•
DOD-DELTA(72-81)					•
OART REENTRY H(72)	•	•	•	•	•

DOD Launches

DOD-SCOUT LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	3	3	3	3	3	3	3	3	3	3	3

DOD-DELTA LV: DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	1	2	1	1	1	1	1	1	1	1

DOD-ATLAS/CENTAUR LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	1	2	-	-	-	-	-	-	-	-

DOD-SCOUT(LOW) LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	3	2	3	2	3	2	3	2	3	2	3

DOD-ATLAS/CENTAUR(LOW) LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	1	1	-	-	-	-	-	-	-

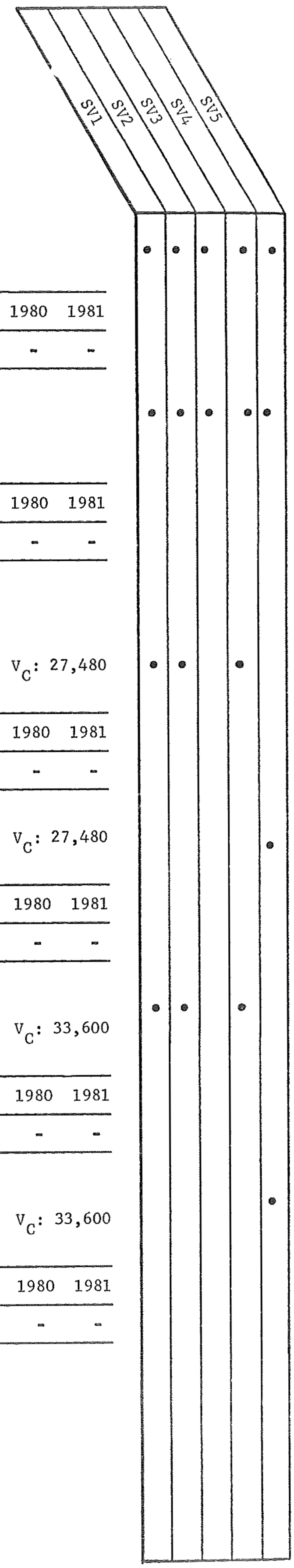
DOD-DELTA(72-81) LV: TAT/DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	1	-	1	-	1	-	1	-	1	1

OART Approved Missions

OART REENTRY H(72) LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	1	-	-	-	-	-	-	-	-	-



OART PLANETARY ATMOSPHERE EXPERIMENTS TEST G(71)
LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	-	-	-	-	-	-	-	-	-	-

OART METEOROID TECHNOLOGY SAT A(71)
LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	-	-	-	-	-	-	-	-	-	-

<u>OART Planned Missions</u>

OART ORBITAL SCANNER(75) LV: TAT/DELTA Wt: 800 V_C: 27,480

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	1	-	-	-	-	-	-

OART ORBITAL SCANNER(76) LV: TAT/DELTA Wt: 800 V_C: 27,480

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	1	-	-	-	-	-

OART OPTICAL COMMUNICATION TECHNOLOGY(74)
LV: ATLAS/CENTAUR Wt: 4,000 V_C: 33,600

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	-	-	-	-	-	-	-

OART OPTICAL COMMUNICATION TECHNOLOGY(75)
LV: ATLAS/CENTAUR Wt: 4,000 V_C: 33,600

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	1	-	-	-	-	-	-

	SV1	SV2	SV3	SV4	SV5
OART RADIO TELESCOPE STRUCTURE TECH., FLIGHT EXP.(74)	•	•		•	
OART RADIO TELESCOPE STRUCTURE TECH. FLIGHT EXP.(77)					•
INTERNTL. PROG.-SCOUT(LOW)			•		
INTERNTL. PROG.-SCOUT(INT)	•	•			•
INTERNTL. PROG.-SCOUT(HIGH)				•	
INTERNTL. PROG.-DELTA(LOW)			•		•

OART RADIO TELESCOPE STRUCTURE TECH., FLIGHT EXP.(74)
LV: TAT/DELTA
Wt: 500-1,000
V_C: for low Earth orbit

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	-	-	-	-	-	-	-

OART RADIO TELESCOPE STRUCTURE TECH. FLIGHT EXP.(77)
LV: TAT/DELTA
Wt: 500-1,000
V_C: for low Earth orbit

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	-	1	-	-	-	-

International Programs(Non-Reimbursable)

INTERNTL. PROG.-SCOUT(LOW)
LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	1	1	-	1	1	1	-	1	1	1

INTERNTL. PROG.-SCOUT(INT)
LV: SCOUT

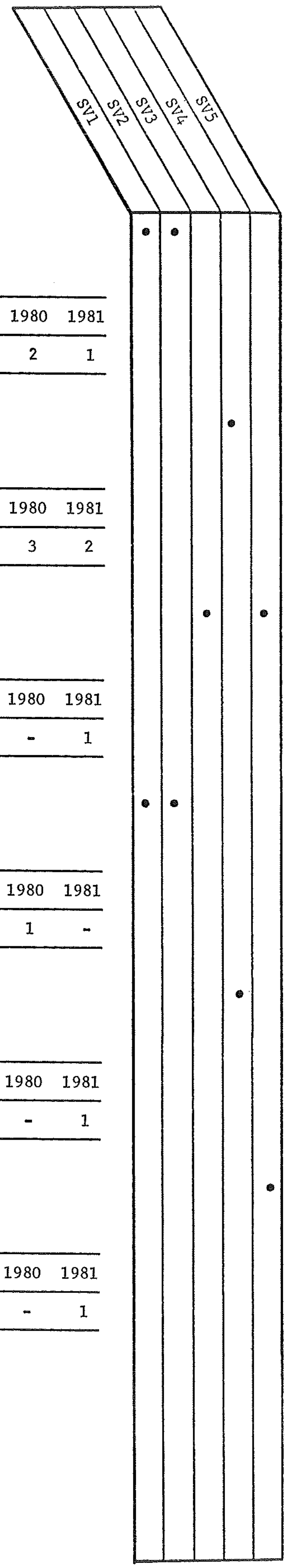
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	1	2	1	1	2	1	1	2	1	1

INTERNTL. PROG.-SCOUT(HIGH)
LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	1	2	1	2	1	2	1	2	1	2

INTERNTL. PROG.-DELTA(LOW)
LV: TAT/DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	1	-	1	1	-	1	1	-	1	1



INTERNTL. PROG.-DELTA(INT)
LV: TAT/DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	1	2	1	1	2	2	1	1	2	1

INTERNTL. PROG.-DELTA(HIGH)
LV: TAT/DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	3	2	2	2	2	3	2	2	3	2

INTERNTL. PROG.-CENTAUR(LOW)
LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	1	-	-	-	-	-	-	-	1

INTERNTL. PROG.-CENTAUR(INT)
LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	1	-	-	-	1	-	-	-	1	-

INTERNTL. PROG.-CENTAUR(HIGH)
LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	1	1	-	-	1	1	1	-	-	1

INTERNTL. PROG.-CENTAUR(74-81)
LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	-	-	-	-	-	-	1

REIM. INTERNTL. PROG.-SCOUT(LOW)
LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	-	-	1	-	1	-	1	-	-	1

REIM. INTERNTL. PROG.-SCOUT(INT)
LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	1	-	1	1	-	1	1	-	1	1

REIM. INTERNTL. PROG.-SCOUT(HIGH)
LV: SCOUT

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	1	1	1	1	1	1	1	1	1	1

REIM. INTERNTL. PROG.-DELTA(LOW)
LV: TAT/DELTA

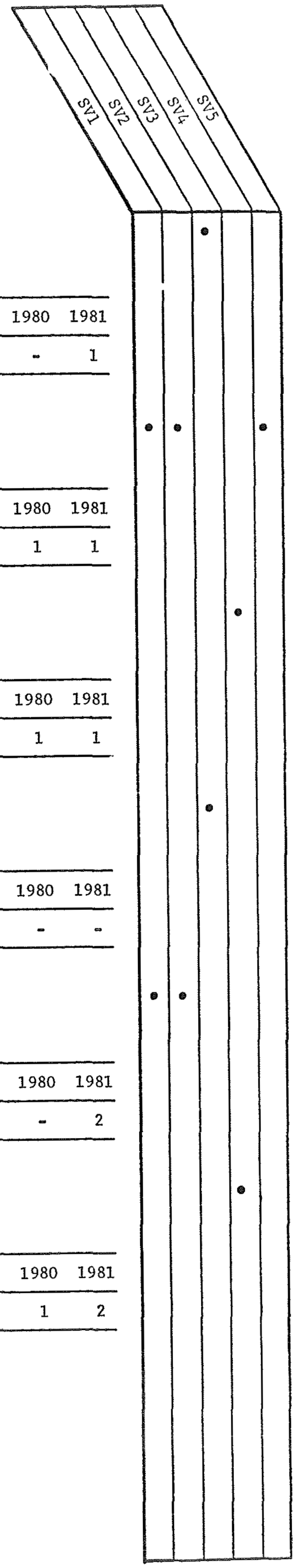
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	-	1	-	-	1	-	-	1	-	-

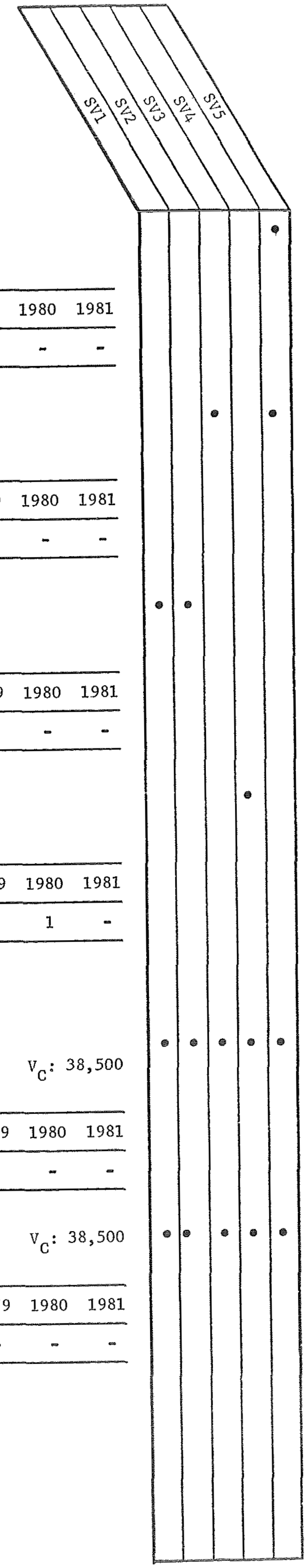
REIM. INTERNTL. PROG.-DELTA(INT)
LV: TAT/DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	1	1	1	1	-	1	1	1	-	2

REIM. INTERNTL. PROG.-DELTA(HIGH)
LV: TAT/DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	1	2	1	2	2	1	1	2	1	2





REIM. INTERNTL. PROG.-DELTA(71-81)
LV: TAT/DELTA

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	-	1	1	-	1	-	-	1	-	-

REIM. INTERNTL. PROG.-CENTAUR(LOW)
LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	-	1	-	-	-	-

REIM. INTERNTL. PROG.-CENTAUR(INT)
LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	-	-	1	-	-	-

REIM. INTERNTL. PROG.-CENTAUR(HIGH)
LV: ATLAS/CENTAUR

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	1	-	-	-	1	1	-

Communications Satellites

U.S. DOMESTIC SATELLITE(73)
LV: TAT/DELTA Wt: 1,000 V_C: 38,500

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	2	1	1	-	-	2	2	-	-

INTELSAT III(71) LV: TAT/DELTA Wt: 640 V_C: 38,500

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	-	-	-	-	-	-	-	-	-	-

	SV1	SV2	SV3	SV4	SV5
INTELSAT IV(71)				•	
INTELSAT IV(71-75)	•	•	•		•
INTELSAT V(78)				•	
INTELSAT V(77-81)	•	•	•		•
CANADIAN DOMESTIC SATS(72)				•	
CANADIAN DOMESTIC SATS(73-81)	•	•	•		•
SOUTH AMERICAN REGIONAL SAT(76)				•	

INTELSAT IV(71) LV: ATLAS/CENTAUR Wt: 2,500 V_C: 38,500

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	1	1	1	1	1	-	-	-	-	-

INTELSAT IV(71-75) LV: ATLAS/CENTAUR Wt: 2,500 V_C: 38,500

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	2	1	1	1	-	-	-	-	-	-

INTELSAT V(78) LV: TITAN IIID/CENTAUR Wt: 5,000 V_C: 38,400

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	-	-	1	2	1	1

INTELSAT V(77-81) LV: TITAN IIID/CENTAUR Wt: 5,000 V_C: 38,400

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	-	1	1	1	1	1

CANADIAN DOMESTIC SATS(72)
LV: TAT/DELTA Wt: 1,000 V_C: 38,400

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	2	1	1	2	1	1	-	-	-	2

CANADIAN DOMESTIC SATS(73-81)
LV: TAT/DELTA Wt: 1,000 V_C: 38,400

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	1	1	1	-	1	-	-	2	1

SOUTH AMERICAN REGIONAL SAT(76)
LV: TAT/DELTA Wt: 1,000 V_C: 38,400

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	1	1	1	-	-	1

SOUTH AMERICAN REGIONAL SAT(76-81)
LV: TAT/DELTA Wt: 1,000 V_C: 38,400

SV1	SV2	SV3	SV4	SV5
•	•	•		•

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	1	1	-	-	1	1

INDIA DOMESTIC TV(74) LV: ATLAS/CENTAUR Wt: 1,000 V_C: 38,400

SV1	SV2	SV3	SV4	SV5
			•	

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	1	-	-	-	1	1	-

INDIA DOMESTIC TV(75,79) LV: ATLAS/CENTAUR Wt: 1,000 V_C: 38,400

SV1	SV2	SV3	SV4	SV5
•	•	•		•

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	1	-	-	-	1	-	-

FAA(ATC)(74) LV: ATLAS/CENTAUR Wt: 1,000 V_C: 38,400

SV1	SV2	SV3	SV4	SV5
			•	

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	1	-	-	1	1	-	-

FAA(ATC)(78-81) LV: ATLAS/CENTAUR Wt: 1,000 V_C: 38,400

SV1	SV2	SV3	SV4	SV5
•	•	•		•

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	-	-	2	1	1	1

AERONAUTICAL/MARITIME SAT.
LV: ATLAS/CENTAUR Wt: 750 V_C: 39,600

SV1	SV2	SV3	SV4	SV5
			•	

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	2	2	-	1	-	1

Earth Observation Programs

ESSA WORLD WEATHER WATCH(76) LV: TAT/DELTA Wt: 1,800 V_C: 27,200

SV1	SV2	SV3	SV4	SV5
			•	

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	2	-	1	1	-	-

ESSA WORLD WEATHER WATCH(76-79) LV: TAT/DELTA Wt: 1,800 V_C: 27,200

SV1	SV2	SV3	SV4	SV5
•	•	•		•

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	1	-	1	1	-	-

ESSA LOW ORBIT(71) LV: TAT/DELTA Wt: 675 V_C: 27,700

SV1	SV2	SV3	SV4	SV5
			•	

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	2	2	2	-	-	-	-	-	-	-	-

ESSA LOW ORBIT(71-74) LV: TAT/DELTA Wt: 675 V_C: 27,700

SV1	SV2	SV3	SV4	SV5
•	•	•		•

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	3	1	1	-	-	-	-	-	-	-

ESSA LOW ORBIT(74) LV: TAT/DELTA Wt: 1,200 V_C: 27,700

SV1	SV2	SV3	SV4	SV5
			•	

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	1	1	1	1	1	1	1

ESSA LOW ORBIT(75-81) LV: TAT/DELTA Wt: 1,200 V_C: 27,700

SV1	SV2	SV3	SV4	SV5
•	•	•		•

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	1	1	1	1	1	1	1

Program	SV1	SV2	SV3	SV4	SV5
ESSA SYNCHRONOUS(71)				•	
ESSA SYNCHRONOUS(74-76)	•	•	•		•
ESSA SYNCHRONOUS(75)				•	
ESSA SYNCHRONOUS(77-79)	•	•	•		•
EARTH RESOURCES SURVEY(75)	•	•	•	•	•

ESSA SYNCHRONOUS(71) LV: TAT/DELTA Wt: 1,000 V_C: 39,600

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	1	1	1	-	-	-	-	-	-	-	-

ESSA SYNCHRONOUS(74-76) LV: TAT/DELTA Wt: 1,000 V_C: 39,600

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	1	1	1	-	-	-	-	-

ESSA SYNCHRONOUS(75) LV: TAT(6C)/DELTA Wt: 1,200 V_C: 39,600

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	1	-	1	-	1	-	1

ESSA SYNCHRONOUS(77-79) LV: TAT(6C)/DELTA Wt: 1,200 V_C: 39,600

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	-	-	1	1	1	-	-

EARTH RESOURCES SURVEY(75)
LV: TAT/DELTA Wt: 2,000 V_C: 26,300

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flights	-	-	-	-	1	-	1	-	1	-	1

SV Mission Models

Introduction

In this section, five mission models (SV1-SV5) for outside user launches are presented. For convenience they have been identified as SV mission models. In NASA OSSA, Code SV is the Launch Vehicle and Propulsion Program Division. For NASA management reporting purposes, SV is in fact designated as the NASA program office for many outside user launches. Each model is described by a set of guidelines and characteristics with a corresponding flight schedule. A discussion of the five models is given in the next section of this chapter.

Model Guidelines and Description: SV1

The guideline for model SV1 was to create an intermediate-level outside user plan. The characteristics of model SV1 are as follows:

- A DOD launch program consisting of 33 Scouts, 11 Deltas, and 3 Atlas Centaurs[1]
- All OART approved and planned flight missions[2] using OSSA launch vehicles are included
- International (Intermediate)[3]

  Scout: An average launch rate of 2 Scouts per year. No impact on the NASA program from foreign launch vehicles

  Delta: Total of 9 scientific and application satellites; also assumes absence of an ELDO vehicle

  Atlas/Centaur: Average of 1 vehicle every 3 years

- Active Communications and Earth Observations programs consisting of 40 and 26 launches respectively.[4]

TABLE C-2. SV1 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
		OSSA Non-Reimbursables										
OART												
OART REENTRY H(72)	SCOUT	-	1	-	-	-	-	-	-	-	-	-
OART PLANETARY ATMOSPHERE EXPERIMENTS TEST G(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART METEOROID TECHNOLOGY SAT A(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART ORBITAL SCANNER(75)	TAT/DELTA	-	-	-	-	1	-	-	-	-	-	-
OART OPTICAL COMMUNICATION		-	-	-								
TECHNOLOGY(74)	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
OART RADIO TELESCOPE STRUCTURAL TECH. FLIGHT EXP(74)	TAT/DELTA	-	-	-	1	-	-	-	-	-	-	-
International Programs												
INTERNTL. PROG.-SCOUT(INT)	SCOUT	1	1	2	1	1	2	1	1	2	1	1
INTERNTL. PROG.-DELTA(INT)	TAT/DELTA	1	1	2	1	1	2	2	1	1	2	1
INTERNTL. PROG.-CENTAUR(INT)	ATLAS/CENTAUR	-	1	-	-	-	1	-	-	-	1	-
		OSSA Reimbursables										
International Programs												
REIM. INTERNTL. PROG.-SCOUT(INT)	SCOUT	1	1	-	1	1	-	1	1	-	1	1
REIM. INTERNTL. PROG.-DELTA(INT)	TAT/DELTA	1	1	1	1	1	-	1	1	1	-	2
REIM. INTERNTL. PROG.-CENTAUR(INT)	ATLAS/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
Communications												
US DOMESTIC SATELLITE(73)	TAT/DELTA	-	-	2	1	1	-	-	2	2	-	-
INTELSAT III(71)	TAT/DELTA	2	-	-	-	-	-	-	-	-	-	-
INTELSAT IV(71-75)	ATLAS/CENTAUR	2	2	1	1	1	-	-	-	-	-	-
INTELSAT V(77-81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1
CANADIAN DOMESTIC SATS(73-81)	TAT/DELTA	-	-	1	1	1	-	1	-	-	2	1
SOUTH AMERICAN REGIONAL SAT(76-81)	TAT/DELTA	-	-	-	-	-	1	1	-	-	1	1
INDIA DOMESTIC TV(75,79)	ATLAS/CENTAUR	-	-	-	-	1	-	-	-	1	-	-
FAA(ATC) (78-81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	2	1	1	1
Earth Observations												
ESSA WORLD WEATHER WATCH(76-79)	TAT/DELTA	-	-	-	-	-	1	-	1	1	-	-
ESSA LOW ORBIT(71-74)	TAT/DELTA	1	3	1	1	-	-	-	-	-	-	-
ESSA LOW ORBIT(75-81)	TAT/DELTA	-	-	-	-	1	1	1	1	1	1	1
ESSA SYNCHRONOUS(74-76)	TAT/DELTA	-	-	-	1	1	1	-	-	-	-	-
ESSA SYNCHRONOUS(77-79)	TAT(6C)/DELTA	-	-	-	-	-	-	1	1	1	-	-
EARTH RESOURCES SURVEY(75)	TAT/DELTA	-	-	-	-	1	-	1	-	1	-	1
DOD												
DOD-SCOUT	SCOUT	3	3	3	3	3	3	3	3	3	3	3
DOD-DELTA	DELTA	-	1	2	1	1	1	1	1	1	1	1
DOD-ATLAS/CENTAUR	ATLAS/CENTAUR	-	1	2	-	-	-	-	-	-	-	-

Model Guidelines and Description: SV2

The guideline for Model SV2 was to present an intermediate level plan similar to SV1 but with decreased emphasis on DOD mission models. The characteristics of this model are as follows:

- A low DOD launch program consisting of 28 Scouts, 11 Deltas, and 2 Atlas/Centaurs(5)
- All OART approved and planned flight missions(2) using OSSA launch vehicles included
- International: (Intermediate)(3)

  Scout: An average launch rate of 2 Scouts per year. No impact on the NASA program from foreign launch vehicles

  Delta: Total of 9 scientific and application satellites every 4 years; also assumes absense of an ELDO vehicle

  Atlas/Centaur: Average of 1 vehicle every 3 years
- Active Communications and Earth Observations programs consisting of 40 and 26 launches respectively.

TABLE C-3. SV2 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
OSSA Non-Reimbursables												
OART												
OART REENTRY H(72)	SCOUT	-	1	-	-	-	-	-	-	-	-	-
OART PLANETARY ATMOSPHERE EXPERIMENTS TEST G(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART METEOROID TECHNOLOGY SAT A(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART ORBITAL SCANNER(75)	TAT/DELTA	-	-	-	-	1	-	-	-	-	-	-
OART OPTICAL COMMUNICATION TECHNOLOGY(74)	SLV3C/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
OART RADIO TESESCOPE STRUCTURAL FLIGHT EXP(74)	TAT/DELTA	-	-	-	1	-	-	-	-	-	-	-
International Programs												
INTERNTL. PROG.-SCOUT(INT)	SCOUT	1	1	2	1	1	2	1	1	2	1	1
INTERNTL. PROG.-DELTA(INT)	TAT/DELTA	1	1	2	1	1	2	2	1	1	2	1
INTERNTL. PROG.-CENTAUR(INT)	ATLAS/CENTAUR	-	1	-	-	-	1	-	-	-	1	-
OSSA Reimbursables												
International Programs												
REIM. INTERNTL. PROG.-SCOUT(INT)	SCOUT	1	1	-	1	1	-	1	1	-	1	1
REIM. INTERNTL. PROG.-DELTA(INT)	TAT/DELTA	1	1	1	1	1	-	1	1	1	-	2
REIM. INTERNTL. PROG.-CENTAUR(INT)	ATLAS/CENTAUR	-	-	-	-	-	-	-	1	-	-	-
Communications												
US DOMESTIC SATELLITE(73)	TAT/DELTA	-	-	2	1	1	-	-	2	2	-	-
INTELSAT III(71)	TAT/DELTA	2	-	-	-	-	-	-	-	-	-	-
INTELSAT IV(71-75)	ATLAS/CENTAUR	2	2	1	1	1	-	-	-	-	-	-
INTELSAT V(77-81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1
CANADIAN DOMESTIC SATS(73-81)	TAT/DELTA	-	-	1	1	1	-	1	-	-	2	1
SOUTH AMERICAN REGIONAL SAT(76-81)	TAT/DELTA	-	-	-	-	-	1	1	-	-	1	1
INDIA DOMESTIC TV(75,79)	ATLAS/CENTAUR	-	-	-	-	1	-	-	-	1	-	-
FAA(ATC)(78-81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	2	1	1	1
Earth Observations												
ESSA WORLD WEATHER WATCH(76-79)	TAT/DELTA	-	-	-	-	-	1	-	1	1	-	-
ESSA LOW ORBIT(71-74)	TAT/DELTA	1	3	1	1	-	-	-	-	-	-	-
ESSA LOW ORBIT(75-81)	TAT/DELTA	-	-	-	-	1	1	1	1	1	1	1
ESSA SYNCHRONOUS(74-76)	TAT/DELTA	-	-	-	1	1	1	-	-	-	-	-
ESSA SYNCHRONOUS(77-79)	TAT(6C)/DELTA	-	-	-	-	-	-	1	1	1	-	-
EARTH RESOURCES SURVEY(75)	TAT/DELTA	-	-	-	-	1	-	1	-	1	-	1
DOD												
DOD-SCOUT(LOW)	SCOUT	3	2	3	2	3	2	3	2	3	2	3
DOD-DELTA	TAT/DELTA	-	1	2	1	1	1	1	1	1	1	1
DOD-ATLAS/CENTAUR(LOW)	ATLAS/CENTAUR	-	-	1	1	-	-	-	-	-	-	-

Model Guidelines and Description: SV3

The guideline for Model SV3 was to create a plan which had a low flight activity as compared to the other plans in this Appendix. The characteristics of this model are as follows:

- A low DOD launch program consisting of 28 Scouts, 11 Deltas, and 2 Atlas/ Centaurs(5)
- All approved OART launches flown and all planned OART missions cancelled
- International (low)(3)

  Scout: Phase-in of the French Diamant, the British Black Arrow, and the Japanese Lambda foreign launch vehicles. Scout launch rate assumed to be 5 launches every 4 years.

  Delta: Demand consists of 1 scientific satellite per year with the addition of 8 overseas applications satellites for the period 1971-81. Of these launches, it is further assumed that 8 will be provided by ELDO's Europa vehicle.

  Atlas/Centaur: Assumed launch rate of 1 vehicle every 4th year.

- Active Communications and Earth Orbservations programs consisting of 40 and 26 launches respectively.(4)

TABLE C-4. SV3 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
OSSA Non-Reimbursables												
OART												
OART REENTRY H(72)	SCOUT	-	1	-	-	-	-	-	-	-	-	-
OART PLANETARY ATMOSPHERE EXPERIMENTS TEST G(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART METEOROID TECHNOLOGY SAT A(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
International Program												
INTERNTL. PROG.-SCOUT(LOW)	SCOUT	-	1	1	-	1	1	1	-	1	1	1
INTERNTL. PROG.-DELTA(LOW)	TAT/DELTA	-	1	-	1	1	-	1	1	-	1	1
INTERNTL. PROG.-CENTAUR(LOW)	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	1
OSSA Reimbursables												
International Programs												
REIM. INTERNTL. PROG.-SCOUT(LOW)	SCOUT	2	-	-	1	-	1	-	1	-	-	1
REIM. INTERNTL. PROG.-DELTA(LOW)	TAT/DELTA	1	-	1	-	-	1	-	-	1	-	-
REIM. INTERNTL. PROG.-CENTAUR(LOW)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
Communications												
US DOMESTIC SATELLITE(73)	TAT/DELTA	-	-	2	1	1	-	-	2	2	-	-
INTELSAT III(71)	TAT/DELTA	2	-	-	-	-	-	-	-	-	-	-
INTELSAT IV(71-75)	ATLAS/CENTAUR	2	2	1	1	1	-	-	-	-	-	-
INTELSAT V(77-81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1
CANADIAN DOMESTIC SATS(73-81)	TAT/DELTA	-	-	1	1	1	-	1	-	-	2	1
SOUTH AMERICAN REGIONAL SAT(76-81)	TAT/DELTA	-	-	-	-	-	1	1	-	-	1	1
INDIA DOMESTIC TV(75,79)	ATLAS/CENTAUR	-	-	-	-	1	-	-	-	1	-	-
FAA(ATC)(78-81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	2	1	1	1
Earth Observations												
ESSA WORLD WEATHER WATCH(76-79)	TAT/DELTA	-	-	-	-	-	1	-	1	1	-	-
ESSA LOW ORBIT(71-74)	TAT/DELTA	1	3	1	1	-	-	-	-	-	-	-
ESSA LOW ORBIT(75-81)	TAT/DELTA	-	-	-	-	1	1	1	1	1	1	1
ESSA SYNCHRONOUS(74-76)	TAT/DELTA	-	-	-	1	1	1	-	-	-	-	-
ESSA SYNCHRONOUS(77-79)	TAT(6C)/DELTA	-	-	-	-	-	-	1	1	1	-	-
EARTH RESOURCES SURVEY(75)	TAT/DELTA	-	-	-	-	1	-	1	-	1	-	1
DOD												
DOD-SCOUT(LOW)	SCOUT	3	2	3	2	3	2	3	2	3	2	3
DOD-DELTA	TAT/DELTA	-	1	2	1	1	1	1	1	1	1	1
DOD-ATLAS/CENTAUR(LOW)	ATLAS/CENTAUR	-	-	1	1	-	-	-	-	-	-	-

Model Guidelines and Descriptions: SV4

The guideline for Model SV4 was to present an aggressive outside user plan by using the highest launch rate estimates given in the available documents. The principal characteristics of this program are as follows:

- A DOD launch program consisting of 33 Scouts, 11 Deltas and 3 Atlas/Centaurs[1]
- All OART approved and planned flight missions[2] using OSSA launch vehicles are included
- International (High)[3]

  Scout: Average launch rate of 5 satellites every 2 years with no competition from foreign launch vehicles

  Delta: Assumed launch of 15 scientific satellites and 22 applications satellites during the 1971-1981 time period with no competition from an ELDO launch vehicle

  Atlas/Centaur: Average launch rate of 1 vehicle per year for heavier applications satellites

- Aggressive Communications and Earth Observations programs consisting of 50[6] and 29[2] launches respectively.

TABLE C-5. SV4 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
OSSA Non-Reimbursables												
OART												
OART REENTRY H(72)	SCOUT	-	1	-	-	-	-	-	-	-	-	-
OART PLANETARY ATMOSPHERE EXPERIMENTS TEST G(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART METEOROID TECHNOLOGY SAT A(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART ORBITAL SCANNER(75)	TAT/DELTA	-	-	-	-	1	-	-	-	-	-	-
OART OPTICAL COMMUNICATION TECHNOLOGY(74)	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	-
OART RADIO TELESCOPE STRUCTURE TECH. FLIGHT EXP.	TAT/DELTA	-	-	-	1	-	-	-	-	-	-	-
International Programs												
INTERNTL. PROG.-SCOUT(HIGH)	SCOUT	2	1	2	1	2	1	2	1	2	1	2
INTERNTL. PROG.-DELTA(HIGH)	TAT/DELTA	2	3	2	2	2	2	3	2	2	3	2
INTERNTL. PROG.-CENTAUR(HIGH)	ATLAS/CENTAUR	1	1	1	-	-	1	1	1	-	-	1
OSSA Reimbursables												
International Programs												
REIM. INTERNTL. PROG.-SCOUT(HIGH)	SCOUT	1	1	1	1	1	1	1	1	1	1	1
REIM. INTERNTL. PROG.-DELTA(HIGH)	TAT/DELTA	2	1	2	1	2	2	1	1	2	1	2
REIM. INTERNTL. PROG.-CENTAUR(HIGH)	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	1	1	-
Communications												
US DOMESTIC SATELLITE(73)	TAT/DELTA	-	-	2	1	1	-	-	2	2	-	-
INTELSAT III(71)	TAT/DELTA	2	-	-	-	-	-	-	-	-	-	-
INTELSAT IV(71)	ATLAS/CENTAUR	2	1	1	1	1	1	-	-	-	-	-
INTELSAT V(78)	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	2	1	1
CANADIAN DOMESTIC SATS(72)	TAT/DELTA	-	2	1	1	2	1	1	-	-	-	2
SOUTH AMERICAN REGIONAL SAT(76)	TAT/DELTA	-	-	-	-	-	1	1	1	-	-	1
INDIA DOMESTIC TV(74)	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	1	1	-
FAA(ATC)(74)	ATLAS/CENTAUR	-	-	-	1	1	-	-	1	1	-	-
AERONAUTICAL/MARITIME SAT.	ATLAS/CENTAUR	-	-	-	-	-	2	2	-	1	-	1
Earth Observations												
ESSA WORLD WEATHER WATCH(76)	TAT/DELTA	-	-	-	-	-	2	-	1	1	-	-
ESSA LOW ORBIT(71)	TAT/DELTA	2	2	2	-	-	-	-	-	-	-	-
ESSA LOW ORBIT(74)	TAT/DELTA	-	-	-	1	1	1	1	1	1	1	1
ESSA SYNCHRONOUS(71)	TAT/DELTA	1	1	1	-	-	-	-	-	-	-	-
ESSA SYNCHRONOUS(75)	TAT(6C)/DELTA	-	-	-	-	1	-	1	-	1	-	1
EARTH RESOURCES SURVEY(75)	TAT/DELTA	-	-	-	-	1	-	1	-	1	-	1
DOD												
DOD-SCOUT	SCOUT	3	3	3	3	3	3	3	3	3	3	3
DOD-DELTA	TAT/DELTA	-	1	2	1	1	1	1	1	1	1	1
DOD-ATLAS/CENTAUR	ATLAS/CENTAUR	-	1	2	-	-	-	-	-	-	-	-

Model Guidelines and Description: SV5

Outsider user model SV5 presents an intermediate level model consisting primarily of the data presented in Reference 4. The guideline for this model was to develop a plan using data that were considered the most recent estimates in the areas of Communications, Earth Observations, International Delta and Centaur programs, and DOD-OART Delta programs.

The principal features in this model are as follows:

- A DOD launch program consisting of 28 Scouts[5], 2 Atlas/Centaurs[5], and 6 Deltas[4]
- All OART approved missions with the updated OART planned missions, as presented in Reference 4, included
- International

  Scout: An average launch rate of 2 Scout vehicles per year with little impact on the NASA programs from foreign launch vehicles[3]

  Delta: Twelve launches spread over the 11 year period[4]

  Atlas/Centaur: Three launches spread over the 11 year period[4]

- Active Communications and Earth Observations programs consisting of 40 and 26 launches respectively.

TABLE C-6. SV5 FLIGHT SCHEDULE

Project	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81
OSSA Non-Reimbursables												
OART												
OART REENTRY H(72)	SCOUT	-	1	-	-	-	-	-	-	-	-	-
OART PLANETARY ATMOSPHERE EXPERIMENTS TEST G(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART METEOROID TECHNOLOGY SAT A(71)	SCOUT	1	-	-	-	-	-	-	-	-	-	-
OART RADIO TELESCOPE STRUCTURE TECH. FLIGHT EXP.(77)	TAT/DELTA	-	-	-	-	-	-	1	-	-	-	-
OART ORBITAL SCANNER(76)	TAT/DELTA	-	-	-	-	-	1	-	-	-	-	-
OART OPTICAL COMMUNICATION TECHNOLOGY(75)	ATLAS/CENTAUR	-	-	-	-	1	-	-	-	-	-	-
International Programs												
REIM. INTERNTL. PROG.-SCOUT(INT)	SCOUT	1	1	2	1	1	2	1	1	2	1	1
REIM. INTERNTL. PROG.-DELTA(LOW)	TAT/DELTA	-	1	-	1	1	-	1	1	-	1	1
REIM. INTERNTL. PROG.-CENTAUR(LOW)	ATLAS/CENTAUR	-	-	-	1	-	-	-	-	-	-	1
OSSA Reimbursables												
International Programs												
REIM. INTERNTL. PROG.-SCOUT(INT)	SCOUT	1	1	-	1	1	-	1	1	-	1	1
REIM. INTERNTL. PROG.-DELTA(71-81)	TAT/DELTA	1	-	1	1	-	1	-	-	1	-	-
REIM. INTERNTL. PROG.-CENTAUR(LOW)	ATLAS/CENTAUR	-	-	-	-	-	-	1	-	-	-	-
Communications												
US DOMESTIC SATELLITE(73)	TAT/DELTA	-	-	2	1	1	-	-	2	2	-	-
INTELSAT III(71)	TAT/DELTA	2	-	-	-	-	-	-	-	-	-	-
INTELSAT IV(71-75)	ATLAS/CENTAUR	2	2	1	1	1	-	-	-	-	-	-
INTELSAT V(77-81)	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1
CANADIAN DOMESTIC SATS(73-81)	TAT/DELTA	-	-	1	1	1	-	1	-	-	2	1
SOUTH AMERICAN REGIONAL SAT(76-81)	TAT/DELTA	-	-	-	-	-	1	1	-	-	1	1
INDIA DOMESTIC TV(75,79)	ATLAS/CENTAUR	-	-	-	-	1	-	-	-	1	-	-
FAA(ATC)(78-81)	ATLAS/CENTAUR	-	-	-	-	-	-	-	2	1	1	1
Earth Observations												
ESSA WORLD WEATHER WATCH(76-79)	TAT/DELTA	-	-	-	-	-	1	-	1	1	-	-
ESSA LOW ORBIT(71-74)	TAT/DELTA	1	3	1	1	-	-	-	-	-	-	-
ESSA LOW ORBIT(75-81)	TAT/DELTA	-	-	-	-	1	1	1	1	1	1	1
ESSA SYNCHRONOUS(74-76)	TAT/DELTA	-	-	-	1	1	1	-	-	-	-	-
ESSA SYNCHRONOUS(77-79)	TAT(6C)/DELTA	-	-	-	-	-	-	1	1	1	-	-
EARTH RESOURCES SURVEY(75)	TAT/DELTA	-	-	-	-	1	-	1	-	1	-	1
DOD												
DOD-SCOUT(LOW)	SCOUT	3	2	3	2	3	2	3	2	3	2	3
DOD-DELTA(72-81)	TAT/DELTA	-	1	-	1	-	1	-	1	-	1	1
DOD-ATLAS/CENTAUR(LOW)	ATLAS/CENTAUR	-	-	1	1	-	-	-	-	-	-	-

Discussion

SV Models

The five outside user models (SV1-SV5) presented in this study provide a range of possible launch rate activities that might be pursued by outside users during the 1971-1981 time period. Models SV1 through SV4 represent moderate, moderately low, low, and aggressive models, respectively. Model SV5 represents the most recent data[4] received for outside users. Each model is divided into "OSSA non-reimbursables" and "OSSA reimbursables." Included in the non-reimbursable projects are all OART missions and approximately 60% of the international program missions. The remaining missions are assumed to be reimbursable projects.

Table C-7 presents the program activities for each model. The data for each program represent the first year of launch after 1970 and the total number of launches in the time span 1971-1981. The table indicates that the flight activity for outside users may be quite high for the 1971-1981 period.

Launch Vehicle Requirements

Table C-8 presents the launch vehicle requirements by year for each outside user model SV1-SV5. The launch vehicles required to support any SV model are SCOUT, TAT/DELTA, ATLAS/CENTAUR, and TITAN IIID/CENTAUR. The DELTA, which accounts for 44 to 52% of the launch vehicles, has the highest use rate in all five outside user models. SCOUT has the next highest use rate and accounts for 30 to 38% of the launch vehicles. The ATLAS/CENTAUR vehicle ranks third and accounts for 14 to 16% of the launch vehicles. The TITAN IIID/CENTAUR vehicle has a constant use rate of 5 vehicles in each model.

Table C-9 presents the total use rate of each vehicle in each model for the five outside users (i.e., DOD, OART, International, Communications, and Earth Observations). Careful inspection of the table reveals that the primary users of each vehicle are as follows:

Vehicle	Primary Outside Users(In Descending Order)
SCOUT	DOD and International
DELTA	Earth Observations, International, Communications, and DOD
ATLAS/CENTAUR	Communications
TITAN IIID/CENTAUR	Communications

Table C-9 also reveals the primary vehicles that each outside user relies upon. These data can be summarized as follows:

Outside User	LV Primary Relied Upon(In Descending Order)
DOD	SCOUT - DELTA
OART	SCOUT - DELTA
INTERNATIONAL	DELTA - SCOUT-ATLAS
COMMUNICATIONS	DELTA - ATLAS/CENTAUR - TITAN IIID/CENTAUR
EARTH OBSERVATIONS	DELTA

TABLE C-7. OUTSIDE USER PROGRAM ACTIVITY BY MODEL

Program Areas	Models SV1	SV2	SV3	SV4	SV5
DOD-SCOUT	71 33[a]	71 28	71 28	71 33	71 28
DOD-DELTA	72 11	72 11	72 11	72 11	72 6
DOD-ATLAS/CENTAUR	72 3	73 2	73 2	72 3	73 2
OART(APPROVED LAUNCHES)	71 3	71 3	71 3	71 3	71 3
OART(PLANNED LAUNCHES)	74 3	74 3	-	74 3	71 3
INTERNTL. PROG.-SCOUT	71 22	71 22	71 14	71 28	71 22
INTERNTL. PROG.-DELTA	71 25	71 25	71 11	71 42	71 12
INTERNTL. PROG.-CENTAUR	71 4	71 4	72 3	71 11	74 3
US DOMESTIC SATELLITES	73 8	73 8	73 8	73 8	73 8
INTELSATS	71 14	71 14	71 14	71 14	71 14
CANADIAN DOMESTIC SATELLITES	73 7	73 7	73 7	72 10	73 7
SOUTH AMERICAN REGIONAL SATELLITES	76 4	76 4	76 4	76 4	76 4
INDIA DOMESTIC TV SATELLITES	75 2	75 2	75 2	74 4	74 2
FAA(ATC) SATELLITES	78 5	78 5	78 5	74 4	78 5
AERONAUTICAL/MARITIME SATELLITES	-	-	-	76 6	-
ESSA WORLD WEATHER WATCH SATELLITES	76 3	76 3	76 3	76 4	76 3
ESSA LOW ORBIT SATELLITES	71 13	71 13	71 13	71 14	71 13
ESSA SYNCHRONOUS SATELLITES	74 6	74 6	74 6	71 7	74 6
EARTH RESOURCES SURVEY	75 4	75 4	75 4	75 4	75 4

(a) The top number represents the first year of launch, and the bottom number indicates the total number of launches in the 1971-1981 period.

TABLE C-8. OUTSIDE USER LAUNCH SCHEDULES BY MODEL AND VEHICLE

Model	Launch Vehicle	Year 71	72	73	74	75	76	77	78	79	80	81	Total
					OSSA Non-Reimbursables								
	SCOUT	3	2	2	1	1	2	1	1	2	1	1	17
	DELTA	1	1	2	2	2	2	2	1	1	2	1	17
	ATLAS/CENTAUR	-	1	-	1	-	1	-	-	-	1	-	4
	TOTAL	4	4	4	4	3	5	3	2	3	4	2	38
SV1					OSSA Reimbursables								
	SCOUT	4	4	3	4	4	3	4	4	3	4	4	41
	DELTA	4	5	7	6	7	5	7	7	8	7	5	68
	ATLAS/CENTAUR	2	3	3	1	2	-	-	3	2	1	1	18
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1	5
	TOTAL	10	12	13	11	13	8	12	15	14	13	11	132
					OSSA Non-Reimbursables								
	SCOUT	3	2	2	1	1	2	1	1	2	1	1	17
	TAT/DELTA	1	1	2	2	2	2	2	1	1	2	1	17
	ATLAS/CENTAUR	-	1	-	1	-	1	-	-	-	1	-	4
	TOTAL	4	4	4	4	3	5	3	2	3	4	2	38
SV2					OSSA Reimbursables								
	SCOUT	4	3	3	3	4	2	4	3	3	3	4	36
	TAT/DELTA	4	5	7	6	7	5	7	7	8	5	7	68
	ATLAS/CENTAUR	2	2	2	2	2	-	-	3	2	1	1	17
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1	5
	TOTAL	10	10	12	11	13	7	12	14	14	10	13	126
					OSSA Non-Reimbursables								
	SCOUT	2	2	1	-	1	1	1	-	1	1	1	11
	DELTA	-	1	-	1	1	-	1	1	-	1	1	7
	ATLAS/CENTAUR	-	-	1	-	-	-	-	-	-	-	1	2
	TOTAL	2	3	2	1	2	1	2	1	1	2	3	20
SV3					OSSA Reimbursables								
	SCOUT	5	2	3	3	3	3	3	3	3	2	4	34
	DELTA	4	4	7	5	6	6	6	6	8	5	5	62
	ATLAS/CENTAUR	2	2	2	2	2	-	1	2	2	1	1	17
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1	5
	TOTAL	11	8	12	10	11	9	11	12	14	9	11	118

TABLE C-8. OUTSIDE USER LAUNCH SCHEDULES BY MODEL AND VEHICLE (Continued)

Model	Launch Vehicle	71	72	73	74	75	76	77	78	79	80	81	Total
							Year						
					OSSA Non-Reimbursables								
	SCOUT	4	2	2	1	2	1	2	1	2	1	2	20
	TAT/DELTA	2	3	2	3	3	2	3	2	2	3	2	27
	ATLAS/CENTAUR	1	1	1	1	-	1	1	1	-	-	1	8
	TOTAL	7	6	5	5	5	4	6	4	4	4	5	55
SV4					OSSA Reimbursables								
	SCOUT	4	4	4	4	4	4	4	4	4	4	4	44
	TAT/DELTA	7	7	10	5	9	8	7	7	9	3	9	81
	ATLAS/CENTAUR	2	2	3	4	4	3	2	1	4	2	1	28
	TITAN IIID/CENTAUR	-	-	-	-	-	-	-	1	2	1	1	5
	TOTAL	13	13	17	13	17	15	13	13	19	10	15	158
					OSSA Non-Reimbursables								
	SCOUT	3	2	2	1	1	2	1	1	2	1	1	17
	DELTA	-	1	-	1	1	1	2	1	-	1	1	9
	ATLAS/CENTAUR	-	-	-	1	1	-	-	-	-	-	1	3
	TOTAL	3	3	2	3	3	3	3	2	2	2	3	29
SV5					OSSA Reimbursables								
	SCOUT	4	3	3	3	4	2	4	3	3	3	4	36
	DELTA	4	4	5	6	5	6	5	6	7	5	5	58
	ATLAS/CENTAUR	2	2	2	2	2	-	1	2	2	1	1	17
	TITAN IIID/CENTAUR	-	-	-	-	-	-	1	1	1	1	1	5
	TOTAL	10	9	10	11	11	8	11	12	13	10	11	116

TABLE C-9. TOTAL USE BY VEHICLE FOR EACH OUTSIDE USER

Model	Project	Scout	Delta	Atlas/Centaur	Titan IIID/Centaur
	DOD	33	11	3	--
	OART	3	2	1	--
SV1	INTERNTL.	22	25	4	--
	COMMUNICATIONS	--	21	14	5
	EARTH OBSERVATIONS	--	26	--	--
	DOD	28	11	2	--
	OART	3	2	1	--
SV2	INTERNTL.	22	25	4	--
	COMMUNICATIONS	--	21	14	5
	EARTH OBSERVATIONS	--	26	--	--
	DOD	28	11	2	--
	OART	3	--	--	--
SV3	INTERNTL.	14	11	3	--
	COMMUNICATIONS	--	21	14	5
	EARTH OBSERVATIONS	--	26	--	--
	DOD	33	11	3	--
	OART	3	2	1	--
SV4	INTERNTL.	28	42	11	--
	COMMUNICATIONS	--	24	21	5
	EARTH OBSERVATIONS	--	29	--	--
	DOD	28	6	2	--
	OART	3	2	1	--
SV5	INTERNTL.	22	12	3	--
	COMMUNICATIONS	--	21	14	5
	EARTH OBSERVATIONS	--	26	--	--

The comparison of outside user and OSSA LV use rates are discussed in Chapter VIII. The launch rates in models SV1-SV5 and Chapter VIII indicate that outside user demands can be expected to have a significant effect upon launch rates for the period considered.

Summary of Most Demanding Missions

The largest launch vehicle required in any model is the TITAN IIID/CENTAUR. Although this vehicle is not currently operational, its availability should pose no problems since the earliest projected launch date is 1977. The only other launch vehicle which may be needed and is not operational at the present time is the TAT(9C)/DELTA. This vehicle is expected to be available in time to satisfy any outsider user's needs.

Table C-10 lists the proposed outside user projects with the most demanding launch vehicle requirements. One or the other of the projects requiring TITAN/CENTAUR appears in all five models.

TABLE C-10. OUTSIDE USER PROJECTS HAVING MOST DEMANDING LV REQUIREMENTS

Project	Vehicle	Weight, lb	V_C, ft/sec	First Launch
INTELSAT V(77-81)	TITAN IIID/CENTAUR	5,000	38,400	1977
INTELSAT V(78)	TITAN IIID/CENTAUR	5,000	38,400	1978

References

(1) "Forecast of DOD Requirements for NASA Launch Vehicle Support", Memorandum to Files from SV/Advanced Programs Manager, National Aeronautics and Space Administration, November 19, 1969.

(2) "20 Year Forecast of OSSA Supported Space Flight Projects", Memorandum to S/Associate Administrator for Space Science and Applications from R/Acting Associate Administrator for Advanced Research and Technology, National Aeronautics and Space Administration, October 31, 1969.

(3) "Twenty-Year Forecast of International Programs", Memorandum to SF/Director, Advanced Program, and SV/Director, Launch Vehicles and Propulsion, from I/Deputy Assistant Administrator for International Affairs, National Aeronautics and Space Administration, September 16, 1969.

(4) "Mission Model and FY 1972 New Program Data", SV/Memorandum to Files, National Aeronautics and Space Administration, April 14, 1970.

(5) Pittenger, J. L., "Telecons, 3/31/70, concerning DOD Launch Vehicle Requirements ...", BMI-NLVP-ICM-70-65, Battelle Memorial Institute, Columbus Laboratories, April 17, 1970.

(6) Pittenger, J. L., "Letter regarding data on use of non-OSSA launches for Earth Observations and Communications Missions", to J. E. McGolrick, BMI-NLVP-IL-70-75, Battelle Memorial Institute, Columbus Laboratories, March 26, 1970.

(7) Pittenger, J. L., "Telecon With J. E. McGolrick Regarding Funding Sources for International Program LV Support on April 21, 1970", BMI-NLVP-ICM-70-73, Battelle Memorial Institute, Columbus Laboratories, April 21, 1970.

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APPENDIX D

LAUNCH VEHICLE DESCRIPTIONS AND COST SUMMARY

Table D-1 presents a summary of launch vehicle nomenclature used in this report along with the corresponding stage make-up and recurring cost for each vehicle. Launch vehicle support and product improvement costs are discussed in the last section of this Appendix.

Configurations

The Scout vehicle is made up of four solid propellant stages: Algol, Castor, Antares, and FW4. A fifth stage, the BE3, is used when required. Both the FW4 and BE3 upper stages are spin stabilized. In this report SCOUT is used to refer to both the 4-stage and 5-stage versions.

Delta vehicles are based on the Long Tank Thrust Augmented Thor (DSV2L) booster (designated TAT in this study). Thrust augmentation is provided currently by a set of three Castor II solid motor strap-ons. Versions using 6 or 9 Castor strap-ons are planned. In this report these are called TAT(6C) and TAT(9C), respectively. The Delta (DSV-3E-3) liquid propellant second stage and the FW4 or TE364 third stage are used with the TAT booster. Both the FW4 and the TE364 are spin-stabilized solid rocket motor stages. The TE364 is now available with 1440 lb of propellant and loadings of up to about 2300 lb are planned.

The TAT/Agena used the Long Tank Thor augmented with three Castor II strap-ons as the booster with the Agena liquid propellant second stage. This vehicle is being phased out of the inventory of launch vehicles for NASA missions.

The Atlas/Centaur utilizes the SLV3C booster and the Centaur cryogenic second stage. The Burner II (BII), a 3-axis stabilized top stage using the TE364 solid motor (again with propellant loading from 1440 to about 2300 lb) may be used with Centaur.

The Titan family of launch vehicles is based on a 2-stage liquid propellant core vehicle. Solid motor strap-ons, 120 in. in diameter, are used as zero-stages. A pair of 5-segment or 7-segment motors can be strapped-on to the core. The Titan IIID and Titan IIIC use the 5-segment strap-ons. The Titan IIID(7) would use the 7-segment strap-ons. Transtage is currently used as an upper stage on the Titan IIIC and integration of the Centaur upper stage to the Titan IIID is to be accomplished by 1973 or 1974. Vehicles using 7-segment strap-ons will also have a stretched version of the first core stage.

Saturn family production is being phased out. However, the SIC/SIVB (Int-20) version, proposed as an intermediate-size vehicle using a modified SIC stage and eliminating the SII from the Saturn V, has been used in this study*. Centaur is proposed as an upper stage for use with this vehicle.

* An SIC/SII (Int-21) configuration has also been proposed and may replace the SIC/SIVB as a favored intermediate Saturn vehicle because it eases the problems of integration with proposed thermal-nuclear stages.

TABLE D-1. LAUNCH VEHICLE CONFIGURATION AND RECURRING COST SUMMARY

	STRAP-ONS			BOOSTER STAGES										UPPER STAGES								LAUNCH VEHICLE RECURRING COST, $, MILLIONS						
	SOLID			SOLID					LIQUID					LIQUID				SOLID							COST SPREAD BY YEAR PRIOR TO LAUNCH ($, MILLIONS)			
	3 CASTORS	6 CASTORS	9 CASTORS	5-SEG. 120 IN.	7-SEG. 120 IN.	ALGOL II OR III	CASTOR II	ANTARES II	LONG-TANK THOR	ATLAS (SLV3C)	STD. TITAN CORE	STR. TITAN CORE	SIC	SIVB	AGENA	DELTA (DSV3E)	CENTAUR	TRANSTAGE-STD	FW4	BE3	BURNER II	TE364(a)	HARDWARE	SUPPORT (b)	TOTAL (c)	0	-1	-2	-3
SCOUT						•	•	•											•				1.1	0	1.1	.5	.6	-	-
TAT/AGENA	•								•						•								4.8	1.7	6 6	.4	5.0	1.1	-
TAT/DELTA	•								•							•							2.8	0	2.8	.4	1.5	1.0	-
TAT/DELTA/FW4	•								•							•			•				2.9	0	2.9	.4	1.5	1.0	-
TAT/DELTA/TE364	•								•							•						•	3.0	0	3.0	.4	1.6	1.0	-
TAT(6C)/DELTA		•							•							•							3.1	0	3.1	.4	1.7	1.0	-
TAT(6C)/DELTA/TE364		•							•							•						•	3.2	0	3.2	.4	1.8	1.0	-
TAT(9C)/DELTA			•						•							•							3.3	0	3.3	.4	1.8	1.0	-
TAT(9C)/DELTA/TE364			•						•							•						•	3.4	0	3.4	.4	1.9	1.0	-
ATLAS/CENTAUR										•							•						10.1	2.3	12.4	1.5	6.1	4.8	-
ATLAS/CENTAUR/BII										•							•				•		10.7	2.5	13.2	1.6	6.6	4.9	-
TITAN IIIB/CENTAUR											•						•						10.3	1.5	11.8	1.1	4.7	5.4	.5
TITAN IIIC				•							•							•					12.9	7.8	20.7	2.1	8.3	8.3	2.1
TITAN IIID				•							•												8.2	5.0	13.2	1.3	5.3	5.3	1.3
TITAN IIID/CENTAUR				•							•						•						14.8	5.0	19.8	2.1	7.5	8.7	1.5
TITAN IIID/CENTAUR/BII				•							•						•				•		15.3	5.1	20.4	2.3	7.8	8.7	1.5
TITAN IIID(7)/CENTAUR					•							•					•						16.6	7.8	24.4	2.7	8.2	10.8	2.7
SIC/SIVB/CENTAUR													•	•			•						79.7	85.6	165.3	22.1	68.2	67.7	7.3

Notes:

(a) TE364 may have 1440 to 2300 lb propellant loading as required.
(b) Annual Support Cost for on-going OSSA Programs: SCOUT, DELTA Vehicles and the CENTAUR stage, are not included in this table.
These annual costs are contained in the Budget Projections shown in Tables D-2 and D-3 of this Appendix.
(c) Totals may differ from sum of items due to rounding.

Recurring Costs

The recurring costs shown in Table D-1 were derived from the 1969 Economic Data Document[(1)]*. The cost totals and cost spreading functions used are considered to be satisfactory for advance planning purposes, but should not be used in detailed cost analyses.

Vehicle costs are sensitive to launch and production rate schedules. The data shown in Table D-1 are based on rates considered to be typical for the range of mission models contained in this report. Two categories of launch vehicle cost are shown in Table D-1: (1) Hardware and (2) Support.

"Hardware" costs include costs necessary to produce finished vehicle stages ready for delivery to the launch site, and for final vehicle assembly, checkout and launch. Specifically included are production of airframe, liquid engines, solid motors, guidance, payload adapter, shroud, mission-peculiar hardware (typical), certification, checkout, and vehicle integration.

Support costs are non-hardware-associated costs that are necessary to maintain continuity in the launch vehicle program and to provide launch services. Specifically included are transportation, launch propellants, sustaining engineering, launch operations, and maintenance of launch capability. Some of these costs are incurred on a unit basis. Others are incurred on an annual basis, and must be prorated on the basis of annual launch rate to obtain unit support costs.

Annual costs for on-going OSSA programs--Scout, Delta vehicles, and Centaur--are included in budget projections presented in the following section of this Appendix. These annual costs have not been included in the Unit Support Costs shown in Table D-1.

Support and Product Improvement Costs

Program support and product improvement projects are maintained to contribute to the continuing operation of an economical and reliable launch vehicle program. The costs associated with these items are referred to as support and product improvement costs. In this study, two different sets of support and product improvement costs were used. The first set, shown in Table D-2, was derived from the NASA FY 1971 submission to the Bureau of the Budget[(2)]. This set of costs was used in connection with the four NASA-based OSSA models presented in Chapter VIII. The second set of support and product improvement costs, shown in Table D-3, was derived from data which are the result of programmatic decisions made in conjunction with the FY 1971 NASA budget that was submitted to Congress.[(3-5)] This set of costs was used with all of the alternative OSSA models presented in Chapter VIII.

* Superscripts refer to references at the end of this Appendix.

TABLE D-2. SUPPORT AND PRODUCT IMPROVEMENT COSTS USED WITH OSSA NASA-BASED MODELS

Launch Vehicle Program	71	72	73	74	75	76	77	78	79	80	81
Titan/Centaur Integration	15.1	18.2	.8	-	-	-	-	-	-	-	-
Scout	9.8	9.1	8.2	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Delta	20.8	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Centaur	34.2	28.9	21.2	12.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0
SR&T, Advanced Studies	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Total	83.9	77.2	51.2	41.9	38.0	38.0	38.0	38.0	38.0	38.0	38.0

TABLE D-3. SUPPORT AND PRODUCT IMPROVEMENT COSTS USED WITH THE ALTERNATIVE OSSA MODELS

Launch Vehicle Program	71	72	73	74	75	76	77	78	79	80	81
Titan/Centaur Integration	10.2	15.0	10.0	2.0	-	-	-	-	-	-	-
Scout	9.8	9.1	8.2	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Delta	20.8	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Centaur	31.8	28.9	21.2	12.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0
SR&T, Advanced Studies	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Total	75.6	73.0	59.4	42.9	37.0	37.0	37.0	37.0	37.0	37.0	37.0

References

(1) "Economic Data Document, 1969", Launch Vehicle and Propulsion Programs, NASA Office of Space Science and Applications, October 28, 1969.

(2) McGolrick, J. E., "FY 1971 Budget Estimates", Memorandum to NASA SV/Advanced Programs and Technology Files, January 16, 1970.

(3) "Program Management Report, Level 0", NASA Office of Space Science and Applications, February, 1970.

(4) Naugle, J. E., "Titan Centaur Programmatic Guidelines for POP 70-1", NASA OSSA Memorandum to Lewis Research Center, Attention: Mr. Bruce T. Lundin, January 14, 1970.

(5) Naugle, J. E., "Statement Before the Committee on Science and Astronautics - House of Representatives", Launch Vehicle and Propulsion Programs, NASA-OSSA Statement unavailable.