IV. 3

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

April 27, 1962

FUTURE PROJECTS OFFICE

National Aeronautics and Space Administration

NASA

Future Projects Office

April 27, 1962

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

ABSTRACT

The purpose of this brochure is to give interested readers, outside as well as within the agencies of the U.S. Government, information on the mission and activities of the Future Projects Office, George C. Marshall Space Flight Center, National Aeronautics and Space Administration.

This brochure gives a short status report in the area of launch vehicles and space transportation systems with particular emphasis on orbital systems, lunar systems, and planetary systems.

Organizational charts of the Marshall Space Flight Center and of the Future Projects Office, as well as a list of the Office staff members, are included.

In-house and contractor studies sponsored and supervised by the Future Projects Office are listed in summary tables, including funding levels for Fiscal Years 1961 and 1962. A tentative project identification list for Fiscal Years 1963 and 1964 indicates areas of general interest to this organization. Many of the listed studies (if approved) will be performed or supervised jointly with other NASA Centers.

A list of reports resulting from the activities of this Office, and of papers and reports authored by the personnel of Future Projects Office during the past two years, concludes this brochure.

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ILLUSTRATIONS

INTRODUCTION

Almost two years have passed since Dr. Wernher von Braun and his team joined the National Aeronautics and Space Administration as the George C. Marshall Space Flight Center (MSFC). The Future Projects Office (FPO) was created as an element of the Center to coordinate all activities concerning future projects. This seems to be a good time to report on past, present, and future activities in this area.

The George C. Marshall Space Flight Center is responsible for the development and operation of large launch vehicle systems, among others the ATLAS-CENTAUR and the SATURN family. Supporting research and long range planning are also major activities at Marshall. The present organization of the George C. Marshall Space Flight Center is shown in Figure 1, where the Future Projects Office is one of the three technical staff offices reporting directly to the Director of MSFC. Future Projects Office depends on the line Divisions for the in-house support and, to an even greater extent, on the contractors who perform individual study contracts on a competitive basis. The ratio of in-house to contractor effort is approximately one to four. While FPO is concentrating its efforts on studying new launch vehicle and space transportation concepts, the line Divisions are making major in-house and contractual efforts to advance the state of the art for components and subsystems. This activity is coordinated on a Center-wide basis by the Research Projects Division. The ratio of resources spent in the area of launch vehicle and system studies to supporting research, as defined above, is approximately one to three.

The functional organization of the Future Projects Office is shown in Figure 2. Three Project groups are active in vehicle-oriented areas:

Launch Vehicles--conceptual design and development of typical schedules for advanced launch vehicles, such as reusable carrier vehicles and post-NOVA concepts.

Propulsion--surveying the state of the art in advanced propulsion systems, including solid, liquid, nuclear and electrical types.

Astrionics--surveying the state of the art and new developments in electrical and electronic components and subsystems.

Orbital Systems--including logistic supply of orbital space stations, orbital launch operations, maintenance and repair, orbital support equipment.

Lunar Systems--transportation of cargo and personnel to and from the moon, lunar orbital operations, and lunar surface operations, as these activities establish requirements for advanced lunar transportation systems.

Planetary Systems--general mission design, establishment of payload requirements, operational procedures, and interrelationships with launch vehicle system requirements.

Operations and Cost Analysis--a project group working across all vehicles and systems in such areas as reliability, probability of mission success, schedules, costs, and operational procedures.

Program Control--the group responsible for controlling schedules and resources, and reporting procedures.

"Special assistants" in the areas of "launch vehicles" and "space transportation systems" aid the Director of FPO in the coordination of the overall program.

The "senior project engineer" in each area is chiefly responsible for the outside activities, the "project engineer" for the MSFC in-house activities, and the "assistant project engineer" for evaluation and compilation of technical reports and data in support of the technical reporting activities.

One major problem area which constantly faces FPO, is the extreme lead-times. To illustrate this problem, a typical schedule for an advanced launch vehicle, from cradle to grave, is given below:

Request for FY 1964 Study Funds for Conceptual Design	March 1962
Formulation of Detailed Work Statement	May 1963
Receipt for Authorization to Spend Study Funds (FY 1964)	August 1963
Process of Bidding and Source Selection	October 1963
Conceptual Design Study	Nov 1963 to June 1964
Follow-on Preliminary Design Study	July 1964 to Feb 1965
Study Evaluation & Draft of Preliminary Development Plan	May 1965
Approval(or Disapproval) of Project Proposed	July 1965
Hardware Contract Award	November 1965
Begin Development Flight Testing	Mid 1967
Operational Availability	Early 1969
Operational Lifetime	1975 to 1980

Thus, it can readily be seen that under normal circumstances the development of a new vehicle concept, from initiation to program approval, will require more than three years of activity spearheaded by Future Projects Office, and thousands of man-hours for each program. This process also requires a detailed examination of the potential mission requirements for the total operational lifetime of the new launch vehicle. We are faced, therefore, with the almost impossible task of determining the payloads needed in the period 1970 to 1980. Thus, the area of future projects goes much further into the future than most people realize, forcing us to look 12 to 15 years ahead of the present state of the art.

A list of the personnel staffing Future Projects Office follows the functional breakdown for the Office. (See Table I.)

A short summary of the state of the art and development trends in space transportation systems is given as background information on where we are today and where we are going. We can expect an improvement of the state of the art, if expressed in specific transportation cost per unit payload or man round trip, by one order of magnitude every seven years. This will not come automatically; it will require a concentrated effort to select the right concept at the right time. Wrong decisions cost billions of dollars. This is the background against which future activities must be planned and evaluated.

MSFC in-house study activities are listed in Table II. The total effort approximates some 100 to 150 direct engineering man-years and is part of the activities reported under "Advanced Launch Vehicle Technology" in the NASA budget. The distribution of these man-years over the various line Divisions and Offices is shown in Figure 3; this includes supporting research as well as advanced vehicle and systems studies. The planning and design activities for the NOVA launch vehicles, as shown in Figure 4, fall under the jurisdiction of the Future Projects Office also until the configuration is frozen and hardware contracts are assigned.

The general procedure for establishing a study contract on a future project is as follows:

The basic objective of the study is defined by the Director, FPO. The draft of the work statement is developed by the senior project engineer of FPO and finalized with representatives of the line Divisions. After approval by the Director, MSFC, and the cognizant Headquarters project office, a request for quotation is issued to industrial contractors. After selection of the contractor by a source evaluation committee, the progress of the study is closely monitored by the contract's technical supervisor, supported by a supervisory panel. The membership of these panels consists of representatives of the line Divisions, interested Project Offices and, if the study is of general interest, representatives from other NASA Centers, Headquarters and the U.S. Air Force. The technical supervisor reports on technical matters to the Director, Future Projects Office, and on contractual matters to the Chief, Procurement and Contracts Office.

As can be seen from the list of completed contracts, Table III, the large aerospace companies have been primary recipients of the systems study contracts. The chief reasons are the qualifications of their personnel and their long experience in this type of study. It generally takes two things to be a successful bidder in these studies: (1) average or outstanding quality in the proposal, (2) below average or average cost in terms of dollars per direct engineering manhour. Since these studies work both ways--the contractor, as well as the Government, profits from them--it is considered fair to expect reasonable quotations from the contractor on this type of RFQ. While the MSFC originated work statement is the usual procedure, unsolicited proposals do get proper attention, and it is hoped that in exceptional cases such studies can also be funded in the future.

Table IV shows the successful bidders for the FY 1961 series of MSFC/FPO study contracts and an estimate of the expenditures for FY 1962. Active contracts as of April 15, 1962, are listed in Table V, and pending contracts for FY 1962 in Table VI.

The "project identification list" is of a very tentative nature, but does indicate the areas of interest to Future Projects Office for Fiscal Years 1963 and 1964. Many contracts from this group, if approved, will be supervised jointly with other NASA Centers.

This brochure also contains a list of contractor reports on studies and technical reports and papers originating in Future Projects Office.

In reviewing this data, it is hoped that the reader will gain a fair knowledge of the past, present and future activities of the MSFC Future Projects Office. This brochure is designed to overcome one of our gravest problems, communication between individuals and organizations, a problem which sometimes appears to be much greater than any technical problem.

A-V

FUTURE PROJECTS OFFICE

MISSION

To coordinate all Center efforts in the development and evaluation of plans and proposals for advanced systems and future launch vehicle programs.

FUNCTIONS

1. Initiates and/or integrates Center-wide future projects study programs to include, but not limited to, consideration of:

   a. Maximum utilization of hardware currently under development,
   b. Projection of the existing scientific and technical state of the art to assess applicability to future launch vehicle systems,
   c. Program requirements in terms of number of vehicles, cost, rate of production, etc., to meet various mission objectives, and
   d. In-house and contractor capability and funding availability.

2. Prosecutes future project studies and proposals from the point of feasibility determination to the preparation of specifications for hardware development programs.

3. Advises top management on all matter pertaining to future projects including estimates of study efforts necessary to establish feasibility of advanced vehicle concepts, systems and programs.

4. Serves as a focal point for receipt, analysis and preliminary technical evaluation of proposals submitted to the Center. Coordinates any necessary detailed evaluation with other segments of the Center.

5. Prepares, or coordinates the preparation of, future project proposals of the Center, making presentations to NASA Headquarters as required.

6. Maintains an inventory of the technological capability of private industry and institutions in the area of future concepts and development.

Figure 1. GEORGE C. MARSHALL SPACE FLIGHT CENTER

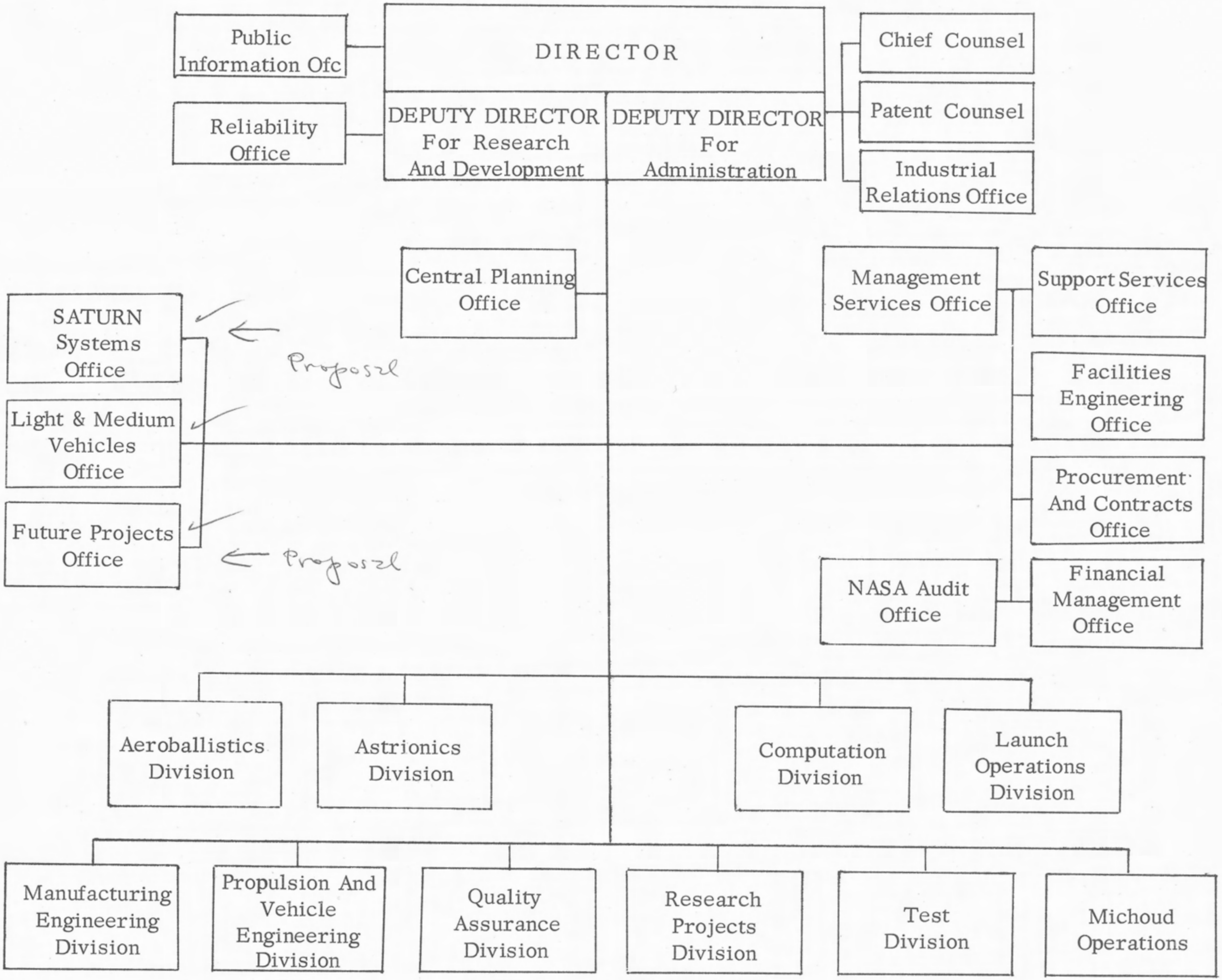


Figure 2. FUTURE PROJECTS OFFICE

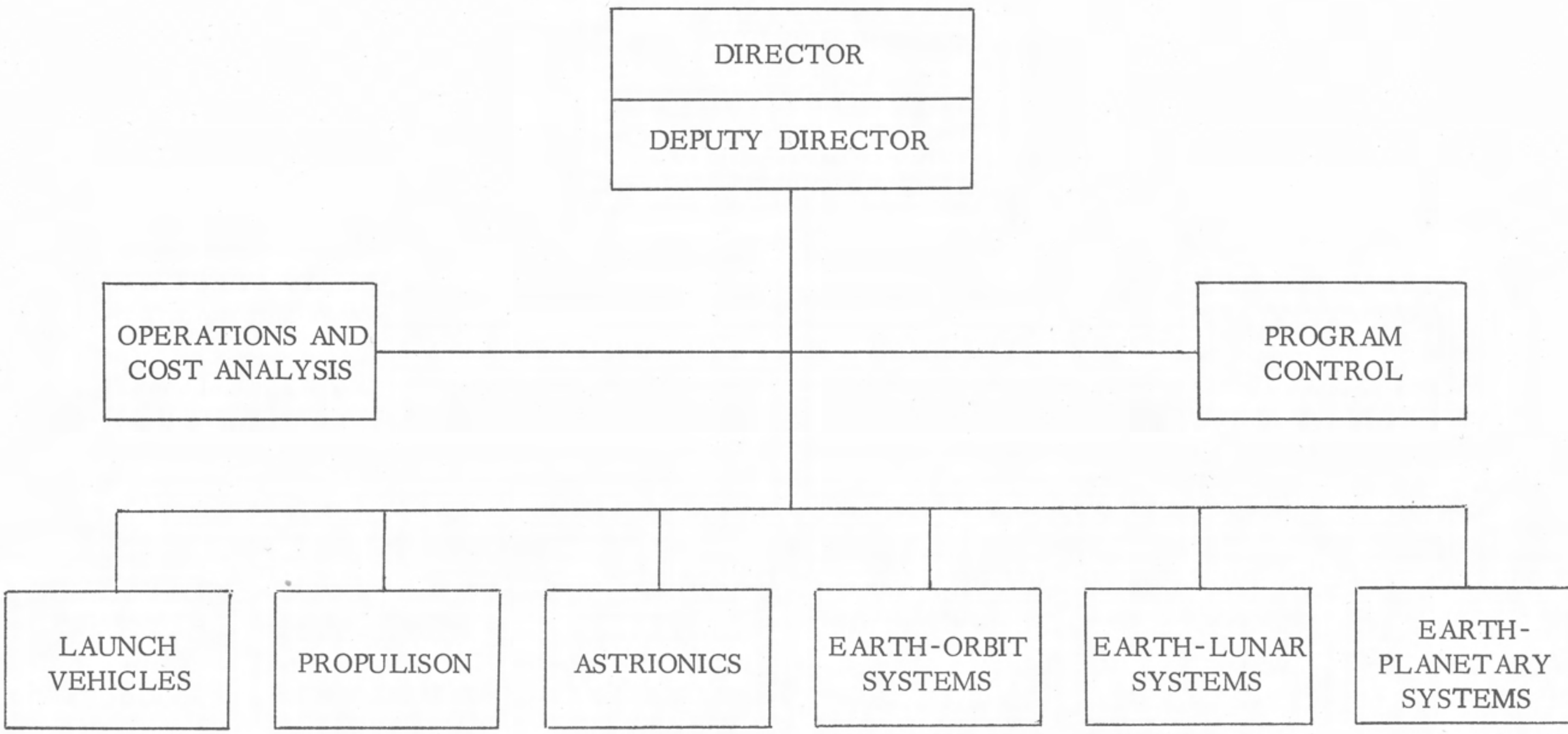


TABLE I

FUTURE PROJECTS OFFICE
PERSONNEL

OFFICE OF DIRECTOR	
Director:	
Mr. H.H. Koelle	876-4714
Deputy Director:	
Mr. F.L. Williams	876-1503
Special Assistant for Vehicles:	
Mr. J.L. Sanders	876-8852
Special Assistant for Systems:	
Mr. H.O. Ruppe	876-1406
Administrative Assistant:	
Mrs. Rose Mottar	876-1503
Technical Editor:	
Miss Helen Neisler	876-1406
Secretary:	
Mrs. Doris Needham	876-4714
OPERATIONS AND COST ANALYSIS	
Senior Project Engineer:	
Mr. W.G. Huber	876-8977
Project Engineer:	
Mr. C.H. Rutland	876-8977
Assistant Project Engineer:	
Mr. Robert Davies	876-8852
Secretary:	
Mrs. Dean West	876-8977
PROGRAM CONTROL	
Senior Project Engineer:	
Vacancy	
Assistant Project Engineer:	
Mr. R.L. Moak	876-8977
Secretary:	
Vacancy	
LAUNCH VEHICLES:	
Senior Project Engineer:	
Mr. L.T. Spears	876-8851
Project Engineer:	
Vacancy	
Assistant Project Engineer:	
Mr. J.W. Morris, Jr.	876-8851
Secretary:	
Miss Eleanor Abernathy	876-8851

PROPULSION
Senior Project Engineer:
Vacancy
Project Engineer:
Vacancy
Assistant Project Engineer:
Vacancy
Secretary:
Miss Eleanor Abernathy 876-8851

ASTRIONICS
Senior Project Engineer:
Vacancy
Project Engineer:
Mr. C.L. Greer 876-8851
Assistant Project Engineer:
Vacancy
Secretary:
Mrs. Joyce Lewey 876-1406

ORBITAL SYSTEMS
Senior Project Engineer:
Mr. J.W. Carter 876-1406
Project Engineer:
Mr. L.H. Ball 876-1406
Project Engineer:
Dr. John Hilchey 876-1406
Secretary:
Mrs. Joyce Lewey 876-1406

LUNAR SYSTEMS
Senior Project Engineer:
Vacancy
Project Engineer:
Mr. C.C. Cvitan 876-8851
Assistant Project Engineer:
Vacancy
Secretary:
Vacancy

PLANETARY SYSTEMS
Senior Project Engineer (Acting):
Mr. V. Gradecak 876-8852
Project Engineer:
Vacancy
Assistant Project Engineer:
Mr. Jerry Smith 876-8852

Thrust Payload

Atlas 360,000 = 4,000 } 2 Meg.
Nova 12,000,000 400,000

SUMMARY REPORT

STATE OF THE ART AND DEVELOPMENT TRENDS IN SPACE TRANSPORTATION

A. Introduction

One of the key elements, if not the determining factor of our progress in the national space flight program, is the availability and capability of launch vehicles. Therefore, let us take a brief look at where we are today and where we are going.

Approval of the SATURN C-5 launch vehicle configuration and the decision to move ahead as rapidly as resources permit with a NOVA size vehicle, have set a definite pattern for what to expect in the area of ground launch vehicles during the next 10 years. This decade will find us concerned with quickly increasing the payload capability of launch vehicles and, thereby, our national mission capabilities. This approach is dictated by competition with the USSR for an early accomplishment of primary space flight objectives and appears to be a sound one for this decade. The question of economy, consequently, must rank second in priority.

What, then, can we expect to accomplish during this decade? We should have an operational capability for 10-ton orbital payloads (C-1) by 1964, which will increase to 100 tons (C-5) by 1967, and 200 tons (NOVA) by 1969-1970. This is an increase by two orders of magnitude over today's capabilities. 2 tons Atlas The first research and development flights for these vehicles will begin approximately two years prior to these dates. Each of these vehicles is a two-stage, expendable rocket to low earth orbit, and a three-stage to escape velocity. In escape missions these vehicles will carry about 40 percent of their orbital payload when chemical stages are used, and approximately 75 percent if nuclear stages are employed. After 10 research and development flights, one can hope for two successful missions out of three attempts, with an increase to about three out of four after two operational years, and four out of five in the fourth operational year.

These vehicle sizes, payload capabilities and projected mission reliabilities will produce a specific transportation cost approaching 150 $/lb for direct operating cost (vehicle procurement, propellants, ground transportation, and launch operations) for transporting cargo from the earth surface to low earth orbits near the end of this decade. Ten times as much will be paid for each pound of cargo delivered to the moon, as long as chemical systems are used exclusively. There is little hope that the economy of earth-to-orbit transportation systems can be improved by introducing a nuclear upper stage during this decade. However, a nuclear third stage should make it possible to reach a specific transportation cost of about 600 $/lb for cargo transportation to the moon in the late Sixties.

Translating this state of the art into "round-trip tickets" for passenger transport, we must face a 300, 000 $/trip fare for earth-to-orbit flights and a 10 million $/trip fare for a lunar round trip around 1970. Obviously, we have a long way to go before we can speak of commercial space flight.

Then, what are we looking for? We would like to see, one of these years, earth-to-orbit trips as convenient and cheap as a trip to Europe, and a flight to the moon no more expensive than a trip around our own planet today. Then and only then will we be able to speak of commercial space travel in the true sense.

Translating this into figures, and using present air traffic fatality rates, we must average more than 49 successful flights out of 50 from earth to orbit and return, when we use a space vehicle carrying 50 passengers to orbit in one flight. We must also reduce the specific transportation cost to less than 5 $/lb of useful payload to make this economically attractive. For lunar flights with comparable fatality rates, approximately 24 out of 25 must be successful with 10 passengers per flight. The specific payload cost for such a trip to the moon must be reduced to less than 25 $/lb to even discuss commercial flights. Unfortunately, we do not have a workable concept for realizing this state of the art and, therefore, it may be 1980 or later before we can expect to open the first commercial space line to earth orbit and to the moon. The only hope for an earlier date is the possibility of a breakthrough.

While we are waiting for this breakthrough, however, we will improve the state of the art beyond our present SATURN and NOVA vehicle concepts, and, around 1970, we can expect to improve the specific transportation cost for orbital and lunar trips by, perhaps, a factor of five. This can be expected to be within the state of the art in the years 1970 to 1980. This is what we think we can do and what we consider to be "future projects" for the coming years.

B. Earth-to-Orbit Transportation Systems

The key to economical earth-to-orbit transportation seems to be the reusable vehicle. Eventually we must abandon the concept of expendable vehicles which is only a very good shortcut to a rapid increase of payload capabilities. We must design a vehicle that can be reused at least 100 times. For passenger comfort, it is preferred that this vehicle not exceed more than 2 g's in a standard ascent or descent trajectory. That means we must accept a concept similar to the rocket airplane or aerospace plane. We should also try to approach the operational concept of jet liners to make space travel attractive and acceptable to the average passenger. It appears feasible to develop two-stage rocket airplanes for earth-to-orbit traffic. A vehicle in the C-5 class, for example, using the same basic propulsion system, would offer a payload capability of 100,000 to 150,000 pounds. The weight of the recovery gear results in a payload reduction of approximately 100,000 pounds as compared to the present expendable C-5 with a 200,000 to 250,000 pound payload capability.

Later we might find ways and means to take advantage of the oxygen in the air, resulting in a single stage earth-to-orbit aerospace plane. However, the approach seems to limit the size of the vehicle and appears to be attractive only if it does not require too complex an engine system. The present launch operations concept should also be reviewed to see if there is a way to reduce the initial high risk of vertical takeoff for personnel-carrying vehicles and, at the same time, reduce the tremendous cost of vertical checkout and launch facilities. There is no conclusive evidence, at this time, that horizontal takeoff, with some assistance on the ground, is not feasible. Admittedly, it puts some of the burden on the flying hardware, but it could be that improved propulsion systems may make this acceptable.

We cannot hope to introduce space flight to the general public unless we find an operational mode and operational cost acceptable to the "high-income taxpayer." If we are successful in developing a single or two stage chemical rocket aerospace plane and learn to fly it 100 times or more before it is worn out, we should be able to achieve a specific transportation cost to earth orbit of about 20 $/lb or less. It is also obvious that the trend toward the reusable vehicle concept does favor the liquid rocket systems rather than the solid propellant engines. While the solid system might offer an alternate method to gain large payloads fast, it does not seem competitive with the reusable liquid vehicle in the long run. This is obvious when one considers the fact that solid propellants cost one dollar/lb, and liquid propellants two to five cents/lb or, for high energy liquids, up to 25 cents/lb. Propellant costs become a dominant factor for vehicles with high reusability rates.

C. Lunar Transportation Systems

It is obvious that orbital operations will play a major role in future space applications and systems. The term, orbital operations, includes such activities as: rendezvous, docking, refueling, maintenance and repair, checkout, personnel and cargo transfer, orbital launch operations, orbital assembly and construction, operation of space stations, etc. These techniques will be developed in this decade. The GEMINI and APOLLO programs will make use of orbital operations. It is likely that one or more space stations will also operate in earth orbit during this decade. Thus, it is concluded that orbital operations is a thing to come and to stay; not only earth orbital operations, but also lunar and planetary orbital operations.

The same basic concept of reusable vehicles appears to be feasible and attractive for advanced lunar transportation systems. Such systems would make use of a chemical reusable rocket aerospace plane to orbit, a reusable nuclear ferry from earth orbit to lunar orbit and back, and a local chemical (single stage) lunar shuttle carrying cargo and personnel between the lunar orbit and the lunar surface. The nuclear ferry vehicle would be refueled in earth orbit and the lunar shuttle in lunar orbit. Preliminary investigations show that lunar round-trip costs can be reduced to about $3 million per man using such a system. If and when we learn to manufacture propellants on the surface of the moon, this system can be further improved--possibly to a point when one round trip costs less than $1 million per person. The alternate method for developing an economic earth-lunar transportation system is the all-nuclear rocket. However, we must find a way which offers specific impulses considerably better than the 800 to 1000 seconds which is now being discussed and is in the early development stage. It is very hard to say when we might be able to do this; this might be the breakthrough mentioned earlier in this discussion. It is quite likely, therefore, that we will proceed with the development of an all-reusable three phase earth-lunar transportation system unless, of course, we find a better way of doing it. The first portion of such a system would be a reusable chemical rocket aerospace plane from the earth surface to orbit and return.

Up to this point in the development of space systems, it has been quite difficult to sell the idea of reusable vehicles because it can be easily shown that (1) these systems are fairly expensive to develop, and (2) this development will take several years. Thus, reusable systems will be acceptable only if it can be shown that there will be a real market for space travel. Recent studies indicate that space flight can become cheap enough to lay the foundation for the development of a large market. From the economic viewpoint, it is probable that, if enough requirements develop, this market will increase rapidly during the Seventies. Thus, chances are good that the next space vehicles, following the present family of expendable launch vehicles, will be reusable.

D. Planetary Transportation Systems

The goal of astronautics can be easily described: namely, exploration and/or utilization of natural or artificial celestial bodies other than Earth. The structure of the universe, however, imposes certain development steps in the process of realizing this broad goal. These steps can be aptly identified by the maximum distance each leads us from home: first, the immediate earth environment; second, the moon; third, the planets--and here our technological knowledge stops us for the time being.

With the means becoming available, we can explore and utilize the solar system. A different technology appears to be required to bring the stars within reach, and subsequently more to open up flight between galaxies.

We live at the beginning of the early planetary phase, and our goal is to put a small expedition on the planets. Of course, there are intermediate steps: to put a man into orbit, to reach the moon--to name some outstanding targets. But we should not mistake the intermediate targets for the ultimate goal.

If we review our present efforts in light of our goal, they fall into place as important steps in the evolution of space flight: The manned satellite is the first cautious step; man on the moon is the important test operation. Parallel to these is the development of various means of nuclear propulsion, of advanced navigation, of novel operational concepts. All are geared to one goal--to open up the solar system for man.

What elements are missing to put man on the planets? Transportation-wise, NOVA plus orbital operations plus nuclear propulsion can perform the task. Environmental protection, life support, power supply, navigation and communication, earth landing systems, and the systems supporting the planetary operations must, also, be developed or improved greatly over what is required for the lunar enterprise.

What can be done today toward the development of planetary transportation systems? Certain current hardware programs will contribute; for example, NOVA or RIFT. Besides these long leadtime items, one major element is missing: a long range program which clearly spells out--this is the goal; these are the ways to reach it; this is the way we shall try. To take a major step toward finding the facts to formulate such a long range plan, sufficient information must be available. To generate this is the immediate goal of the interplanetary portion of the FPO study program. In progress, or to be initiated soon, are a study resulting in two-way trajectory computation methods, evaluations and, finally, a manual on this subject; another study on the role of nuclear-electric compared to nuclear-heat-exchanger propulsion systems; and a third on the systems aspects of a proposed "first" interplanetary manned mission, which is possibly "only" a Crocco round trip, but which will signal that the greatest and most decisive period of the planetary phase has begun.

E. Summary

What, then, are the trends? Here is a teletype-style summary: We must find ways to make space transportation faster, more reliable, and more economical.

1. 2 3

communication

good design

production

We can expect to continue along the following lines:

1950 - 1960	10	Decade of Preparation
1961 - 1965	5	First Manned Satellites
1965 - 1970	5	First Large Manned Space Stations
1967 - 1970	3	First Manned Lunar Expedition
1970 - 1975	5	Lunar Base Construction
1970 - 1980	10	First Manned Planetary Exploration

The year, 2000, should find humanity well along the road toward utilizing all the resources of the solar system, and traveling within the solar system should become fairly routine. To put man on the moon, on the planets, or anywhere within the solar system wherever his environment can be controlled: This is the goal. This can be done. More is not feasible now, but nothing less will suffice.

Seattle missed the boat

TABLE II

GEORGE C. MARSHALL SPACE FLIGHT CENTER
IN-HOUSE STUDY ACTIVITIES
IN THE FUTURE PROJECTS AREA

ADVANCED LAUNCH VEHICLE SYSTEMS

1. Operational Analysis
2. Booster Recovery and Reuse
3. NOVA Design Studies
4. SATURN D (Nuclear) Upper Stage Design Studies
5. Post-NOVA Design Studies

ORBITAL OPERATIONS

1. Systems Analysis
2. Rendezvous
3. Docking
4. Refueling
5. Checkout
6. Orbital Launch Operations, Maintenance and Repair
7. Orbital Construction

EARTH-LUNAR TRANSPORTATION SYSTEMS

1. Operational Analysis
2. Lunar Landing Vehicles
3. Lunar Launch Vehicles
4. Lunar Ferry Vehicles
5. Lunar Surface Operations

EARTH-PLANETARY TRANSPORTATION SYSTEMS

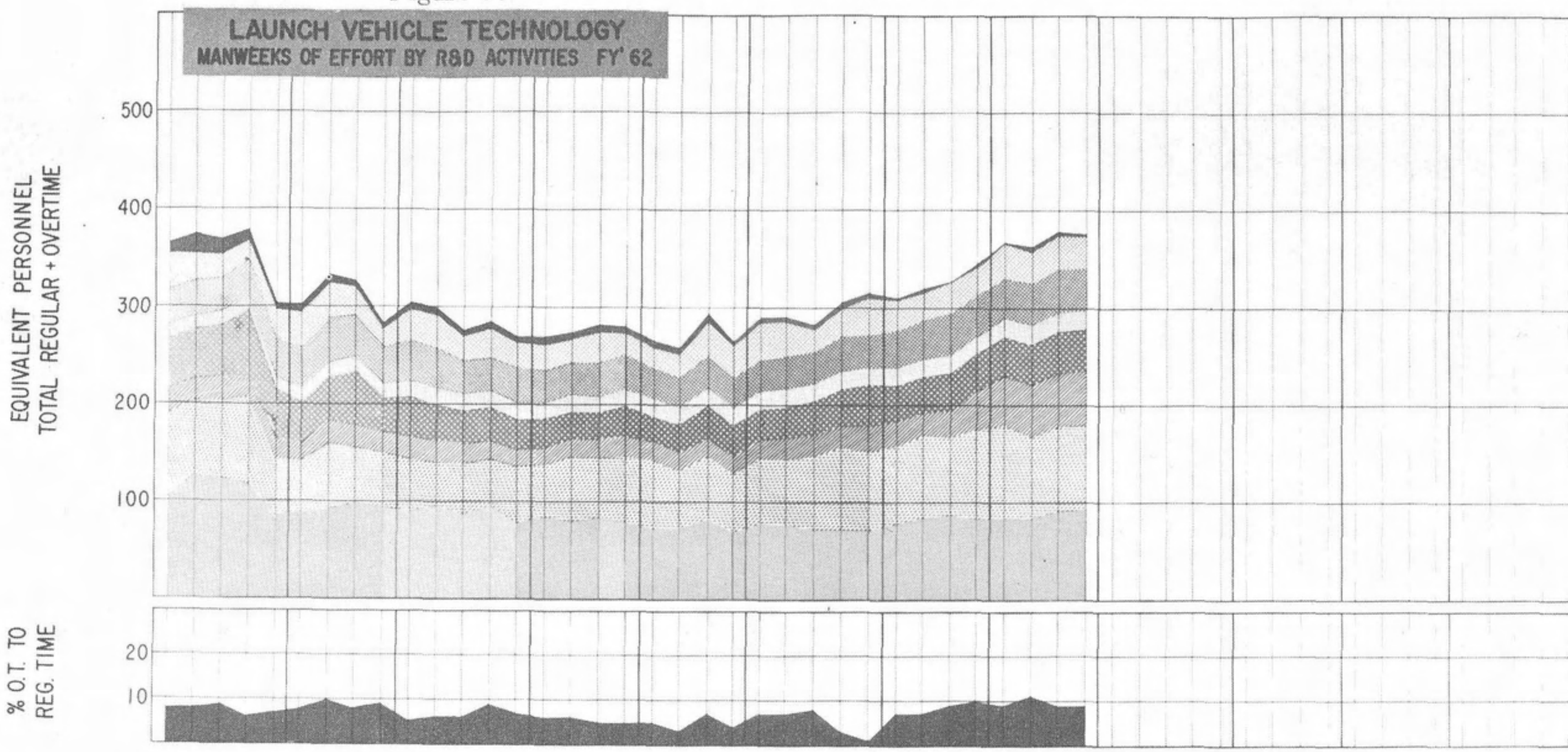
1. Mission Design
2. Operations Analysis
3. Orbital Launch Vehicles
4. Interplanetary Transport Vehicles
5. Planetary Landing and Launch Vehicles
6. Planetary Orbital Operations

OPERATIONS AND COST ANALYSIS

1. Operations Analysis of Advanced Launch Vehicle Systems
2. Systems Analysis of Orbital Operations
3. Operations Analysis of Earth-Lunar Transportation Systems
4. Operations Analysis of Earth-Planetary Transportation Systems

IN-HOUSE

Figure 3.



	JUL					AUG				SEP				
	1	8	15	22	29	5	12	19	26	2	9	16	23	30
P&VE	103	127	123	117	86	89	91	99	94	90	95	87	95	78
MFG. ENG. DIV.	87	76	80	90	58	52	69	56	56	54	46	52	49	58
RPD	23	23	26	18	21	18	24	24	22	23	22	20	18	17
AERO	55	52	53	71	49	43	44	55	34	40	36	34	35	32
FUT. PROJ.	14	13	14	13	13	14	15	15	16	17	18	18	17	17
ASTRIONICS	36	36	33	34	40	43	46	42	38	42	41	34	34	36
COMP	36	28	24	24	31	36	34	29	18	31	34	26	30	25
OTHER	12	20	17	12	5	6	8	6	6	7	6	6	8	7
TOTAL	366	375	370	379	303	301	331	326	284	304	298	277	286	270
% OT/RT	8	8	9	6	7	8	10	8	9	5	6	6	9	7

	OCT				NOV				DEC				
	7	14	21	28	4	11	18	25	2	9	16	23	30
P&VE	84	81	85	80	73	74	82	69	78	77	72	72	71
MFG. ENG. DIV.	54	65	59	66	70	58	65	59	67	67	75	84	80
RPD	18	18	20	20	19	19	18	19	20	22	22	23	27
AERO	30	29	28	32	26	29	35	32	31	32	35	37	44
FUT. PROJ.	15	17	16	17	18	18	17	18	18	18	18	18	17
ASTRIONICS	34	33	35	36	32	30	34	31	32	34	33	37	34
COMP	27	24	31	23	21	24	34	33	39	36	23	28	36
OTHER	8	8	9	7	8	7	9	5	5	5	5	6	6
TOTAL	270	275	283	281	267	259	294	266	290	291	283	305	315
% OT/RT	6	6	5	5	5	3	7	4	7	7	8	3	1

	JAN				FEB			
	6	13	20	27	3	10	17	24
P&VE	78	85	87	83	84	83	91	93
MFG. ENG. DIV.	80	84	80	92	96	85	87	87
RPD	25	23	27	39	50	53	55	56
AERO	38	37	39	39	41	42	43	43
FUT. PROJ.	18	18	18	18	19	20	19	19
ASTRIONICS	38	41	44	42	40	42	45	43
COMP	30	27	31	29	37	33	35	33
OTHER	3	5	1	4	1	6	4	3
TOTAL	310	320	327	346	368	364	379	377
% OT/RT	7	7	9	10	9	11	9	9

	MAR					APR				MAY				JUN				
	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30
P&VE																		
MFG. ENG. DIV.																		
RPD																		
AERO																		
FUT. PROJ.																		
ASTRIONICS																		
COMP																		
OTHER																		
TOTAL																		
% OT/RT																		

WEEK OF HOLIDAY VEHICLE LAUNCH SCRUBBED VEHICLE LAUNCH WEEK

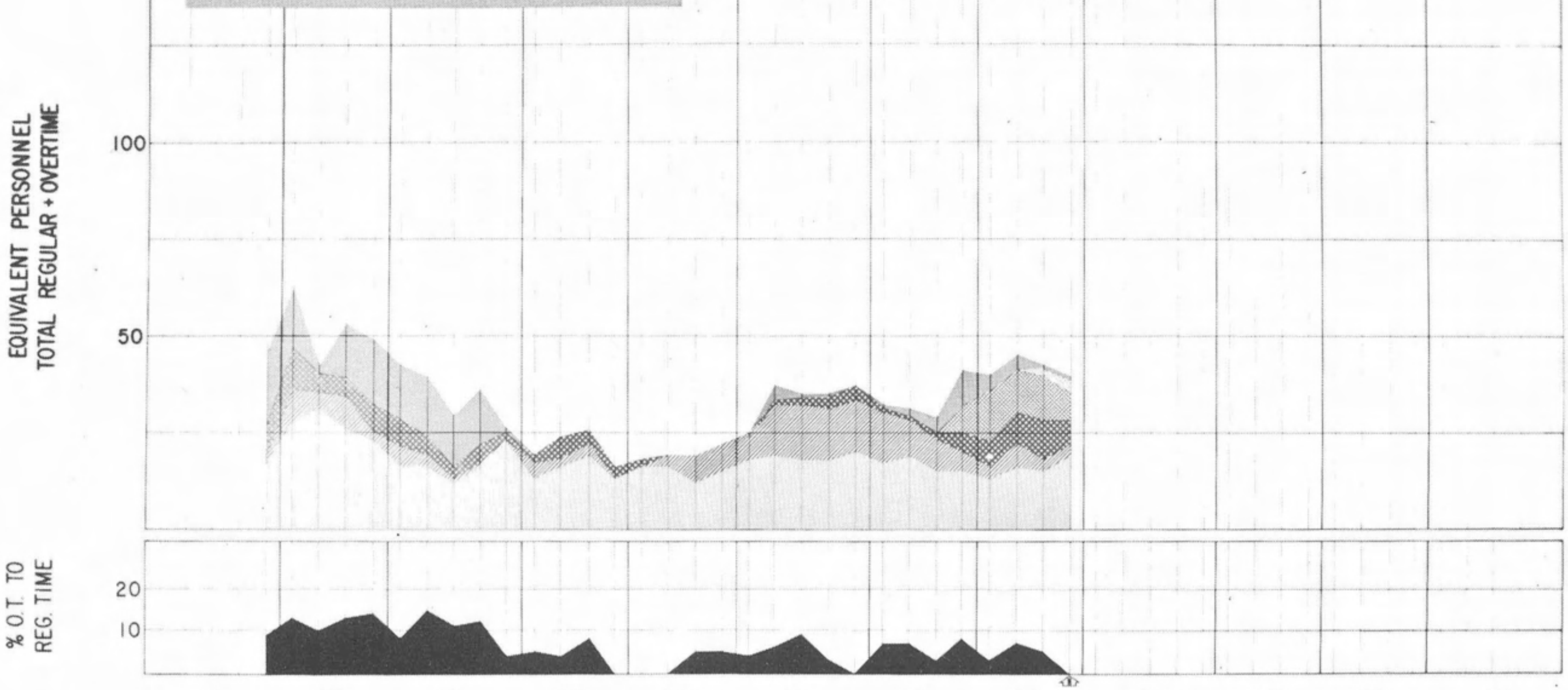
REV. G MAR. 9, 1962 M-TPC-S-38 (4) 62

Tech. Program Coord. office
(Crumpton)

Figure 4.

NOVA (LIQUID)

MANWEEKS OF EFFORT BY R&D ACTIVITIES FY'62



JUL 1 8 15 22 29 | AUG 5 12 19 26 | SEP 2 9 16 23 30 | OCT 7 14 21 28 | NOV 4 11 18 25 | DEC 2 9 16 23 30 | JAN 6 13 20 27 | FEB 3 10 17 24 | MAR 3 10 17 24 31 | APR 7 14 21 28 | MAY 5 12 19 26 | JUN 2 9 16 23 30

	JUL 29	AUG 5	12	19	26	SEP 2	9	16	23	30	OCT 7	14	21	28	NOV 4	11	18	25	DEC 2	9	16	23	30	JAN 6	13	20	27	FEB 3	10	17	24
AERO	17	28	31	26	23	16	16	12	16	23	13	16	19	13	16	16	12	15	18	19	18	18	20	17	19	15	15	13	16	15	19
COMP	2	8	4	8	2	5	3	1	1	0	4	2	3	0	0	3	7	7	6	13	14	13	13	13	9	8	5	3	6	3	3
P & VE	8	11	5	5	7	7	5	3	5	2	2	6	4	3	2	0	0	0	0	1	2	3	4	1	1	2	5	7	8	10	6
TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	13	11	11	7
FPO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
LVOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
OTHER*	19	15	2	14	17	14	15	13	14	1	0	0	0	0	0	0	0	0	0	4	1	1	0	1	2	4	9	4	4	1	1
TOTAL	46	62	42	53	49	42	39	29	36	26	19	24	26	16	18	19	19	22	25	37	35	35	37	32	31	29	41	40	45	42	39
% O.T./R.T.	9	13	10	13	14	8	15	11	12	4	5	4	8	0	0	0	5	5	4	6	9	3	0	7	7	3	8	3	7	5	0

WEEK OF HOLIDAY

* MFG ENGR., QUAL. DIV., ASTR. DIV.

REV. G MAR. 9, 1962 M-TPC-S-30 (81)-62

TABLE III
COMPLETED CONTRACTS
FUTURE PROJECTS OFFICE
(As of April 15, 1962)

CONTRACT NR	STUDY TITLE	COMPANY	AMOUNT	CONTRACT TERM
NAS 8-800	SATURN C-2 OPERATIONAL PROCEDURES	Douglas	$ 88,713	November 60 - July 61
NAS 8-801	SATURN C-2 OPERATIONAL PROCEDURES	Martin	$124,126	October 60 - June 61
NAS 8-852	ORBITAL LAUNCH OPERATIONS	Douglas	$ 92,165	December 60 - July 61
NAS 8-861	FLIGHT PERFORMANCE MANUAL FOR ORBITAL OPERATIONS	Northrop	$ 57,380	January 61 - September 61
NAS 8-863	FLIGHT PERFORMANCE MANUAL FOR ORBITAL OPERATIONS	STL	$ 92,620	January 61 - September 61
NAS 8-864	ORBITAL DOCKING TEST	Lockheed	$150,000	December 60 - July 61
NAS 8-865	LAUNCH VEHICLE SIZE AND COST ANALYSIS	Douglas	$ 30,125	January 61 - October 61
NAS 8-866	LAUNCH VEHICLE SIZE AND COST ANALYSIS	STL	$105,764	January 61 - November 61
NAS 8-898	SIX TO TWELVE MILLION POUND THRUST LAUNCH VEHICLE	GD/A	$179,993	January 61 - August 61

COMPLETED CONTRACTS (CONT'D)

CONTRACT NR	STUDY TITLE	COMPANY	AMOUNT	CONTRACT TERM
NAS 8-899	SIX TO TWELVE MILLION POUND THRUST LAUNCH VEHICLE	NAA	$209,491	February 61 - August 61
NAS 8-900	SIX TO TWELVE MILLION POUND THRUST LAUNCH VEHICLE	Lockheed	$186,465	January 61 - August 61
NAS 8-1501	PARAGLIDER RECOVERY SYSTEM	Ryan	$145,828	January 61 - August 61
NAS 8-1502	PARAGLIDER RECOVERY SYSTEM	NAA	$170,000	January 61 - August 61
NAS 8-1513	TWO TO THREE MILLION POUND THRUST LAUNCH VEHICLE	GD/A	$115,565	February 61 - September 61
NAS 8-1514	TWO TO THREE MILLION POUND THRUST LAUNCH VEHICLE	NAA	$148,487	February 61 - September 61
NAS 8-1515	TWO TO THREE MILLION POUND THRUST LAUNCH VEHICLE	Martin	$163,040	February 61 - September 61
NAS 8-1535	ORBIT-LAUNCHED VEHICLES	GD/A	$ 53,322	March 61 - August 61
NAS 8-2435	SATURN C-3 LAUNCH FACILITIES	Martin	$ 99,500	July 61 - November 61
NAS 8-2437	ANALYSIS OF MEDIUM CLASS VEHICLES	STL	$114,128	July 61 - January 62

TABLE IV

FISCAL YEAR 1961
SURVEY OF CONTRACT AWARDS
FOR
COMPETING COMPANIES

Company	No. of Contracts	Contract Totals
GENERAL DYNAMICS	4	$ 461, 516
LOCKHEED	4	459, 458
MARTIN	4	451, 546
SPACE TECHNOLOGY LABORATORIES	4	387, 512
NORTH AMERICAN AVIATION	2	357, 978
CHANCE VOUGHT	1	207, 806
DOUGLAS	3	206, 924
RYAN	1	145, 828
BOEING	1	98, 503
NORTHROP	1	57, 380
TOTAL	25	$2, 834, 451

FISCAL YEAR 1962
EXPECTED EXPENDITURES FOR CONTRACTS
BY
STUDY AREA

OPERATIONS ANALYSIS	$ 125, 000
LAUNCH VEHICLES	3, 465, 000
ORBITAL SYSTEMS	200, 000
LUNAR SYSTEMS	456, 000
PLANETARY SYSTEMS	330, 000
TOTAL	$4, 576, 000

TABLE V
ACTIVE CONTRACTS
FUTURE PROJECTS OFFICE
(As of April 15, 1962)

CONTRACT NR	STUDY TITLE	COMPANY	AMOUNT	CONTRACT TERM
*NAS 8-853	ORBITAL LAUNCH OPERATIONS	CVA	$207,806	December 60 - April 62
NAS 8-1531	EARTH-LUNAR TRANSPORTATION SYSTEMS	Martin	$155,954	February 61 - May 62
NAS 8-1600	SATURN D DESIGN	GD/A	$210,312	May 61 - August 62
NAS 8-1601	SATURN D DESIGN	Lockheed	$228,520	May 61 - August 62
**NAS 8-2438	LARGE LAUNCH VEHICLES UTILIZING SOLID PROPELLANT	Boeing	$103,999	June 61 - March 62
NAS 8-2469	INTERPLANETARY TRANSPORTATION SYSTEMS	Lockheed	$ 69,189	October 61 - April 62
NAS 8-2599	LAUNCH VEHICLE SIZE AND COST ANALYSIS	STL	$124,995	March 62 - September 62

*Study effort under present scope of work is completed, awaiting further funding.

**Study effort under present scope of work is completed, negotiating Solid NOVA Task Assignment as Phase II.

TABLE VI
PENDING CONTRACTS
FUTURE PROJECTS OFFICE
(Funds Committed to Procurement and Contracts as of April 15, 1962)

STUDY TITLE	COMPANY	TOTAL FUNDED	APPROXIMATE TERM
POST-NOVA LAUNCH VEHICLE	RAND/Open Bid	$ 180,000	May - October 1962
REUSABLE TEN TON ORBITAL CARRIER VEHICLE	Open Bid (2)	$ 219,210	April - October 1962
REUSABLE GROUND LAUNCH VEHICLE IN THE FIFTY TO ONE-HUNDRED TON ORBITAL PAYLOAD CLASS	Boeing/NAA	$ 300,000	June - November 1962
*NOVA SOLID PROPELLANT VEHICLE PRELIMINARY DESIGN	Boeing	$ 140,000	April - September 1962
ADVANCED LUNAR TRANSPORTATION SYSTEM	Open Bid (2)	$ 400,000	May - October 1962
*PLANETARY TRAJECTORY MANUAL	Lockheed	$ 80,000	April - December 1962
EARLY MANNED PLANETARY MISSION	Open Bid (2)	$ 180,000	May - November 1962
LOW-ACCELERATION SPACE TRANSPORTATION SYSTEM	RAND	$ 70,000	April - October 1962
**APPLICATION OF SOLID PROPELLANT MOTORS TO FUTURE SATURN C-1 CLASS VEHICLES	Open Bid (1)	$ 200,000	June - December 1962
***EARTH ORBITAL OPERATIONS <u>MANUAL</u> AND LUNAR FLIGHT HANDBOOK	Martin	$ 150,000	May - November 1962 Request
NOVA VEHICLE SYSTEM	Open Bid (2-3)	$2,100,000	May - December 1962

*These are follow-on studies to present contracts.

**This study will be managed in SATURN Systems Office with equal amounts ($100,000) contributed to the contract by Future Projects Office and SATURN Systems Office.

***These funds were borrowed from Advanced Vehicle Studies money.

FUTURE PROJECTS OFFICE

TABLE VII

FISCAL YEARS

1963 - 1964

PROJECT IDENTIFICATION LIST

(Funds Shown Are Planning Figures Only)

SUMMARY

PROJECT NR		FY 63 ($10^3)	FY 64 ($10^3)
P-0 to -99	VEHICLE SUBSYSTEMS	300	700
P-100 to -119	LAUNCH VEHICLES	1,500	2,400
P-120 to -139	ORBITAL SYSTEMS AND ORBITAL OPERATIONS	1,200	2,400
P-140 to -149	LUNAR TRANSPORTATION SYSTEMS AND OPERATIONS	950	850
P-150 to -169	LUNAR BASE CONSTRUCTION AND OPERATIONS	400	2,400
P-170 to -179	PLANETARY TRANSPORTATION AND OPERATIONS	400	400
P-180 to -189	MARTIAN SYSTEMS AND OPERATIONS	-	850
	TOTAL	4,750	10,000

NOTE: This tentative project identification list was compiled for discussion and planning purposes only. It lists the projects which MSFC is either actively pursuing, participating in, or proposing to initiate at Marshall or any other appropriate NASA Center in the area of future projects.

P-0 to -99 VEHICLE SUBSYSTEMS

Mech. ??

Project Nr		Fy 63 (10^3)	FY 64 (10^3)
P-40	Electrical and Electronic System Design Manual for Advanced Space Vehicles	100	100
P-50	Self-Sustained Power Plants in the 1 MW to 10 MW Range	-	200
P-60	Nuclear Propulsion System Design Manual for Conceptual Design of Advanced Space Vehicles	100	100
P-61	Engine Design Requirements for Reusability and Very Long Lifetimes	100	100
P-62	High Performance Engine Study	-	200
	Subtotal	300	700

P-100 to -119 LAUNCH VEHICLES

Project Nr		$\$10^3$ FY 63	FY 64
P-100	Launch Vehicle Operational Analysis	300	200
P-101	Light Launch Vehicle	200′	100
	Reusable Vehicle in the < 5 Ton Payload Class (B 70?)		
P-102	Medium Launch Vehicle	200	400
	Reusable Orbital Carrier Vehicle in the Ten Ton Class as Follow-On for TITAN III and SATURN C-1		
P-103	Large Launch Vehicle		
	a. Reusable Orbital Carrier Vehicle in the 50 to 100 Ton Class as Follow-on or Derivative of SATURN C-5 Vehicle	400	400
	b. Paraglider Study for C-5	100	300
P-104	Very Large Launch Vehicle	200	600
	Post-NOVA Class With More Than 200 Tons of Payload With Emphasis on Escape Missions		
P-105	Super Launch Vehicle	-	200
	Vehicles in Payload Class of More Than 1000 Tons to Escape, such as ORION		
P-107	Operational Advanced Nuclear Third Stage	100	200
	Phoebus Power Density in the 4000 to 8000 MW Class		
	Subtotal	1500	2400

P-120 to -139 ORBITAL SYSTEMS AND ORBITAL OPERATIONS

Project Nr		FY 63 $\$10^3$	FY 64
P-120	Orbital Systems Integration	300	350
P-122	Hydrogen Tanker Vehicle Pedigo	100	100
P-124	Mark II Space Laboratory	100	200
	Non-Rotating Space Laboratory and Orbital Launch Support Facility Compatible With SATURN C-5		
P-125	Mark III Space Station	100	400
	Rotating Space Station for about 30 to 50 Personnel, Compatible with NOVA and SNAP 8		
P-126	Orbital Facility Complex	-	200
	Required for Support of Multiple Satellite System Operation, Plus Support of Lunar Base and Support of Planetary Expeditions		
P-127	Orbital Personnel Taxi	-	100
P-128	Orbital Maintenance and Construction Vehicle Bottle	-	100
P-129	Orbital Rescue Vehicle and Interorbital Ferry	100	100
P-130	Orbital Maintenance Capsule - Bottle ??	100	100
P-131	Space Vehicle Human Engineering Design Manual	300	500
P-132	General Space Vehicle Space-Environment-Simulator Facility	100	250
	Subtotal	1200	2400

P-140 to -149 LUNAR TRANSPORTATION SYSTEMS AND OPERATIONS

Project Nr		$\$10^3$ FY 63	$\$10^3$ FY 64
P-140	Advanced Lunar Transportation Systems Operations Analysis and Systems Definition	200	200
P-141	Flight Performance Manual Including Orbital Operations	50	50
P-142	Advanced Chemical Orbital Launch Vehicle For Direct Cargo Delivery in Connection With SATURN C-5	100	-
P-143	Expendable Nuclear Ferry Vehicle RIFT Derivative	100	-
P-144	Reusable Nuclear Orbit-to-Orbit Ferry Vehicle	200	200
P-145	Lunar Shuttle Vehicle Chemical, Orbit-to-Surface-to-Orbit	100	100
P-146	Advanced Cargo Supply Carrier Post-NOVA Class, Direct Transfer, Expendable	200	300
	Subtotal	950	850

P-150 to -169 LUNAR BASE CONSTRUCTION AND OPERATIONS

Project Nr		$\$10^3$ FY 63	$\$10^3$ FY 64
P-150	Systems Requirements and Integration	200	300
P-151	Mark I, Lunar Shelter Compatible with C-5, for First APOLLO Crew	100	100
P-152	Lunar Scientific Station and Housing Complex	-	200
P-153	Lunar Power Facilities	-	200
P-154	Communication Facilities	-	200
P-155	Lunar Workshop and Storage Facilities	-	200
P-156	Lunar Surface Personnel Carrier	-	200
P-157	Lunar Base Construction and Utility Vehicle	100	100
P-158	Propellant Storage Facilities	-	200
P-159	Propellant Production Facilities	-	300
P-160	Food Production Facilities	-	200
P-161	Lunar Launch Facilities	-	200
	Subtotal	400	2400

P-170 to -179 PLANETARY TRANSPORTATION SYSTEMS AND OPERATIONS

Project Nr		$\$10^3$ FY 63	FY 64
P-170	Operations Analysis and Systems Definition	-	100
P-171	Flight Performance and Trajectory Manual	100	100
P-172	Early Manned Planetary-Interplanetary Expedition	200	100
P-174	Advanced Electrical Ferry Vehicle for Planetary Missions	100	100
	Subtotal	400	400

P-180 to -189 MARTIAN SYSTEMS AND OPERATIONS

P-180	Systems Requirements and Integration	-	100
P-181	Flight Mechanics in the Martian Gravity Field and Atmosphere	-	150
P-182	Orbit-to-Surface Shuttle Vehicle	-	100
P-183	Manned Surface Roving Vehicle for Mars	-	100
P-184	Mars-Earth Return Vehicle	-	100
P-185	Manned Air-Breathing Exploration Vehicle	-	100
P-186	Space Carrier Vehicle for Mars Base Supply With Direct Entry	-	100
P-187	Earth Orbit to Mars Orbit Vehicle (Advanced Nuclear Phoebus and Beyond)	-	100
	Subtotal	-	850

TABLE VIII

REPORTS ON STUDY CONTRACTS
FUTURE PROJECTS OFFICE

SATURN C-2 OPERATIONAL PROCEDURES STUDY

NAS 8-800 - Douglas Aircraft Company, Inc.

July 1961, (Final Report)
Report SM-38771, One Volume
UNCLASSIFIED.

NAS 8-801 - The Martin Company

June 1961, (Final Report)
Report ER 11816, Two Volumes
UNCLASSIFIED.

ORBITAL LAUNCH OPERATIONS STUDY

NAS 8-852 - Douglas Aircraft Company, Inc.

June 1961, (Final Report)
Report SM-38770, One Volume
UNCLASSIFIED.

NAS 8-853 - Chance Vought Corporation, Vought Astronautics Division

June 1961, (Phase I Report)
Report AST/EIR-13491, Three Volumes
UNCLASSIFIED.

January 1962, (Phase II Report)
Report 00.26, Eight Volumes
CONFIDENTIAL.

FLIGHT PERFORMANCE MANUAL FOR ORBITAL OPERATIONS*

NAS 8-861 - Northrop Corporation, Norair Division

September 1961, (Final Report)
Report NOR.61-208, One Volume
UNCLASSIFIED.

*The Martin Company furnished Marshall with 75 copies of its "Orbital Flight Manual," ER 11648, on a no cost basis.

NAS 8-853 - Space Technology Laboratories, Inc.

September 1961, (Final Report)
One Volume
UNCLASSIFIED.

ORBITAL DOCKING TEST STUDY

NAS 8-864 - Lockheed Missiles and Space Company and Space Technology Laboratories, Inc.

July 1961, (Final Report)
Report 2-11-61-1, One Volume
CONFIDENTIAL.

LAUNCH VEHICLE SIZE AND COST ANALYSIS

NAS 8-865 - Douglas Aircraft Company, Inc.

September 1961, (Final Report)
Report SM-38626, One Volume
UNCLASSIFIED.

NAS 8-866 - Space Technology Laboratories, Inc.

June 1961, (Phase I Report)
Report 9862.2-41, One Volume
UNCLASSIFIED.

November 1961, (Phase II Report)
Report 8981-0005-RU-000 & 8981-0006-RC-000
Two Volumes
CONFIDENTIAL/RESTRICTED DATA

STUDY OF SIX TO TWELVE MILLION POUND THRUST LAUNCH VEHICLE

NAS 8-898 - General Dynamics/Astronautics

August 1961, (Final Report)
Report AE61-0567, One Volume
CONFIDENTIAL/RESTRICTED DATA

NAS 8-899 - North American Aviation, Space & Information Systems Division

August 1961, (Final Report)
Report SID 61-263, Two Volumes
CONFIDENTIAL.

NAS 8-900 - Lockheed-Georgia Company

September 1961, (Final Report)
Report ORD 279, Three Volumes
CONFIDENTIAL/RESTRICTED DATA

STUDY OF A PARAGLIDER RECOVERY SYSTEM FOR THE SATURN BOOSTER

NAS 8-1501 - Ryan Aeronautical Company

August 1961, (Final Report)
Report 61B075, One Volume
UNCLASSIFIED.

NAS 8-1502 - North American Aviation, Space & Information Systems Division

August 1961, (Final Report)
Report SID 61-233, One Volume
UNCLASSIFIED.

STUDY OF TWO TO THREE MILLION POUND THRUST LAUNCH VEHICLE

NAS 8-1513 - General Dynamics/Astronautics

August 1961, (Final Report)
Report AE61-0734, Three Volumes
CONFIDENTIAL.

NAS 8-1514 - North American Aviation, Space & Information Systems Division

September 1961, (Final Report)
Report SID 61-264, Two Volumes
CONFIDENTIAL.

NAS 8-1515 - The Martin Company

September 1961, (Final Report)
Report ER 11850, Three Volumes
CONFIDENTIAL.

EARTH-LUNAR TRANSPORTATION SYSTEM STUDY

NAS 8-1531 - The Martin Company

August 1961, (Phase Report)
Report ER 11873, One Volume
CONFIDENTIAL.

ORBIT-LAUNCHED VEHICLES STUDY

NAS 8-1535 - General Dynamics/Astronautics

September 1961, (Final Report)
Report AE61-0790, One Volume
CONFIDENTIAL/RESTRICTED DATA.

SATURN D (NUCLEAR ROCKET UPPER STAGE) DESIGN STUDY

NAS 8-1600 - General Dynamics/Astronautics

November 1961, (Phase I Report)
Report AE61-1017, Four Volumes
SECRET/RESTRICTED DATA.

NAS 8-1601 - Lockheed Missiles and Space Company

December 1961, (Phase I Report)
Report LMSC-704191, One Volume
CONFIDENTIAL/RESTRICTED DATA.

ANALYSIS OF MEDIUM CLASS VEHICLES

NAS 8-2437 - Space Technology Laboratories, Inc.

February 1962, (Final Report)
Report 8624-0003-RC-000, One Volume
CONFIDENTIAL.

STUDY OF LARGE LAUNCH VEHICLES UTILIZING SOLID PROPELLANT

NAS 8-2438 - The Boeing Company, Aero-Space Division

February 1962, (Phase I Report)
Report D2-20500, Six Volumes
SECRET.

TABLE IX
REPORTS AND PAPERS
FUTURE PROJECTS OFFICE

NASA TECHNICAL NOTE

NASA TN D-597, "Long Range Planning for Space Transportation Systems," H.H. Koelle, January 1961, UNCLASSIFIED.

MSFC TECHNICAL PAPERS

MTP-FPO-60-1, "Crew Support Equipment," J.W. Carter, October 17, 1960, UNCLASSIFIED.

MTP-FPO-60-2, "Economy of Space Flight," H.H. Koelle & W.G. Huber, October 28, 1960, UNCLASSIFIED.

MTP-FPO-60-3, "Project Space-Lift (U)," H.H. Koelle, November 22, 1960, CONFIDENTIAL.

MTP-FPO-61-4, "Orbital Docking and Operations Program (U)," J.W. Carter, February 17, 1961, CONFIDENTIAL.

MTP-FPO-61-5, "Orbital Rendezvous and Docking Aspects of the Marshall Center Launch Vehicle Technology Study Program," J.W. Carter, February 17, 1961, UNCLASSIFIED.

MTP-FPO-61-6, "MSFC Systems Engineering Capabilities (Abstracts of Reports)," Compiled by Future Projects Office, November 1, 1960, UNCLASSIFIED.

MTP-FPO-61-7, "Economic Considerations of Future Launch Vehicles (U)," W.G. Huber & C.H. Rutland, November 9, 1961, CONFIDENTIAL.

FPO INTERNAL NOTES

M-FPO-1-61, "Manned Lunar Landing: The Probability of Mission Success (U)," H.O. Ruppe, W.G. Huber & J.C. Hughes, September 8, 1961, CONFIDENTIAL.

M-FPO-2-61, "On the Economy of Interplanetary Transportation Systems," H.O. Ruppe, September 14, 1961, UNCLASSIFIED.

M-FPO-2A-61, "An Estimate of Success-to-Failure Rate for Future Launch Vehicles (U)," H.H. Koelle, September 18, 1961, CONFIDENTIAL.

M-FPO-4-61, "On the Problem of Optimum Acceleration for Orbit-Launched Vehicles," H.O. Ruppe, September 29, 1961, UNCLASSIFIED.

M-FPO-5-61, "Development Trends of Astronautical Rocket Propulsion Systems," H.O. Ruppe, October 23, 1961, UNCLASSIFIED.

FPO BULLETINS

Bulletin No. 1, July 15, 1960, UNCLASSIFIED.

Bulletin No. 2, October 19, 1960, UNCLASSIFIED.

Bulletin No. 3, March 16, 1961, UNCLASSIFIED.

Bulletin No. 4, September 1, 1961, UNCLASSIFIED.

Bulletin No. 5, March 1, 1962, UNCLASSIFIED.

MISCELLANEOUS REPORTS AND PAPERS

"On the Optimum Size of Orbital Carrier Vehicles Based on Overall Economy," H.H. Koelle, XI International Astronautical Congress, August 1960, UNCLASSIFIED.

"Presentation on Some Space Flight Guidelines for the Quartermaster Research and Engineering Command (U)," J.W. Carter, February 21, 1961, CONFIDENTIAL.

"Orbital Operations Preliminary Project Development Plan (U)" Coordinated by P.J. deFries, September 15, 1961, CONFIDENTIAL.

"Handbook of Astronautical Engineering," Edited by H.H. Koelle, Published by McGraw-Hill Book Company, October 1961, UNCLASSIFIED.

"How Much Space Flight Can We Afford?" H.H. Koelle, ARS Preprint 2211-61, October 1961, UNCLASSIFIED.

"Comparison of Lunar and Martian Mission Requirements and Payload Conversion Factors, H.H. Koelle, H.O. Ruppe & H.F. Thomae, XII International Astronautical Congress, October 1961, UNCLASSIFIED.

"On the Evolution of Earth-Lunar Transportation Systems," H.H. Koelle, Prepared for "From Peenemuende to Outer Space," December 1961, UNCLASSIFIED.

"On the Theory of Optimization of Step Rockets," H.O. Ruppe, Prepared for "From Peenemuende to Outer Space," December 1961, UNCLASSIFIED.

"MSFC Position Statement: Solid Propulsion Systems in Large Space Vehicles," Coordinated by Future Projects Office, March 30, 1962, UNCLASSIFIED.

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