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"Management of the Space Program at a Field Center"

As a background for my discussion of the Marshall Space Flight Center's management and procurement practices, let me first give you a thumb-nail sketch of the Center itself, and its role in the development of the Saturn vehicles for Project Apollo.

(LIGHTS OFF)

SLIDE 1 -- Map of MSFC (M-MS-G 67-5-62)

The Marshall Center was formed in 1960 by the transfer from the U. S. Army to NASA of about 4400 Civil Service employees and an integrated complex of engineering, laboratory, fabrication, and test facilities then valued at 100 million dollars. Our employees now number about 7,000, and our facilities have been enlarged through additions and new construction.

SLIDE 2 -- MSFC Manpower (M-CP-D 503)

Marshall's civil service personnel include many with experience in rocketry stretching back over the past two decades. This chart shows the broad categories of employees.

SLIDE 3 -- Aerial View of MSFC Laboratories (M-PIO)

The Marshall Center has the facilities and personnel for conducting a rocket program all the way from conception through design, development, fabrication, and testing -- with the aid of major contributions from contractors. Our in-house technical competence is concentrated in nine major divisions, which are not project-oriented, but are aligned along the lines of professional disciplines such as mechanical engineering, electronics, flight mechanics, and the like. Division personnel participate in active projects, future project studies, and supporting research. They keep their knowledge up to date and judgment sharp by keeping their hands dirty at the work bench on in-house projects selected specifically for using and nurturing their competence.

SLIDE 4 -- S-I Stages in ME Division (M-PIO)

Prototype stages of rockets are fabricated in our Manufacturing Engineering Division for research and development testing. This picture, which was made in January, 1963, shows the fabrication of three first-stage boosters (S-I) of the Saturn I vehicle.

The fourth booster, in the right background, was flight tested at Cape Canaveral March 28. This was the fourth straight success in the Saturn I flight testing program. It again demonstrated the soundness of the engineering design in clustering eight engines, and paid further tribute to the painstaking efforts of our people to obtain the maximum in quality assurance and reliability in manufacture, inspection, testing, and launching.

SLIDE 5 -- Static Firing of S-I Stage (M-PIO)

Two or three static firings are conducted on all stages fabricated at the Marshall Center before they are taken by barge to the Cape for flight tests. This test stand is part of a complex that includes a dynamic test stand for checking out an entire Saturn I vehicle, a highly instrumented blockhouse, and facilities for component and engine testing.

An entirely new test complex is under construction for the larger Saturn V/Apollo launch vehicle.

SLIDE 6 -- Saturn vehicles (M-MS-G 126-62)

The primary task of the Marshall Center for the next few years is to provide Saturn launch vehicles to support Project Apollo. The Saturn I will test the Command and Service Modules of the Apollo Spacecraft in earth orbit. The Block I vehicles include the first four Saturn I's which have already been launched, with only the first stage live.

The next Saturn I launch, scheduled for later this year, will flight test the first of the Block II vehicles, with both stages live. The Saturn IB will test the entire Apollo Spacecraft, including the Lunar Excursion Module, in earth orbit. And the Saturn V, which can place 120 tons into earth orbit, or boost 45 tons to escape velocity, will lift the three-man Apollo Spacecraft to the moon.

SLIDE 7 -- Martian Electric Spaceship (M-PIO-VA4)

Our second category of assignments from NASA includes research related to launch vehicle development. In a third area we perform advanced system studies for space transportation concepts in the future. The Martian Electric Spaceship is an example of this type of study. Here you see an artist's concept of a 360-ton spaceship, powered by a 40-megawatt nuclear-electric power plant, which could be used for carrying a crew from an earth orbit to a Mars orbit.

SLIDE 8 -- MSFC Future Projects (M-MS-G 125-21-62)

The Future Projects Office at Marshall is the focal point for coordinating all contract studies and in-house efforts related to future space transportation systems. It charts the course for our future, analyzing and appraising the many ideas for better space transportation advanced by outside sources or members of our own Center. Many of its studies must view launch vehicle-spacecraft systems as units.

For only after the entire mission profile has been studied, can an intelligent demarcation line between earth launch vehicle, deep space propulsion system, and spacecraft proper be drawn. In our studies we seek to establish the relationship between the state-of-the-art, performance, schedule, cost, and probability of mission accomplishment and growth potential. Study results are fed into the NASA Long Range Plan, which is updated every year. Such an up-to-date appraisal of future possibilities will permit top NASA management to make sound program decisions.

SLIDE 9 -- MSFC Manpower by Program (M-CP-D 112)

The Marshall Center's civil service personnel have been distributed according to their direct or indirect support of programs in this chart. More than 85 per cent of our Marshall effort goes to support D. Brainerd Holmes' Office of Manned Space Flight. This chart also shows that almost 80 per cent of our employees are supporting the three Saturn launch vehicle programs. While these people possess a wide variety of talents and have years of specialized experience in rocketry, we do not claim to be able to carry the ball alone.

SLIDE 10 -- Contractor Participation in MSFC Effort (M-CP-D 639)

When our personnel were transferred to NASA to form the Marshall Center, we naturally left the Redstone, Jupiter, and Pershing weapon system projects with the Army.

Since we were then working primarily on the Saturn I launch vehicle project, our in-house effort in 1960 comprised 19 per cent of our total budget. Our own efforts have increased steadily since that time because of the additional tasks given us. But our total effort has taken such great jumps each fiscal year, that our in-house operations represent a decreasing percentage of our total budget--only eight per cent in the proposed FY64 budget.

SLIDE 11 -- MSFC Michoud Plant (M-MS-G 67-8-62)

In addition to expanding our facilities at Huntsville, we have acquired the 43-acre Michoud Plant in New Orleans for the assembly of vehicle stages, and have started construction on a nearby site in Mississippi for static testing units fabricated at Michoud and by contractors on the West Coast. These government-owned facilities will be operated by contractors.

One of the reasons for selecting the present method of operation at Michoud and at the Mississippi test site was the deliberate intention of keeping competition open within industry for contracts to build future stages. We did not believe that the government should construct major, unique, and expensive fabrication or testing facilities at a contractor location if doing so might later present a disadvantage to other sources in the competitive selection process.

SLIDE 12 -- Saturn I Major Contractors (M-MS-G 67-35-62)

Each stage of a launch vehicle is a complex system of its own, with propulsion, structure, electrical network, and controls. This slide shows the prime contractors and the major sub-contractors for the Saturn I.

We will build eight S-I stages for the Saturn I at Marshall. The Chrysler Corporation as prime contractor is under contract to produce 21 S-I stages at Michoud and may ultimately produce many more. The second stage is being developed by Douglas at Santa Monica, California. Mason-Rust, Inc., is our operating services contractor at Michoud.

SLIDE 13 -- Saturn V Major Contractors (M-CP-D-317)

The first stage booster (S-IC) for Saturn V is being designed jointly by the Marshall Center and the Boeing Company. Marshall will build three S-IC stages for ground tests, as well as the first flight booster. Boeing is presently under contract to produce ten S-IC flight stages at Michoud. The second stage (S-II) is being developed by North American Aviation at Downey and Seal Beach, California. S-II stages will be brought by ship through the Panama Canal to Mississippi for static firing. The third stage (S-IVB) comes from Douglas Aircraft Corporation. It will be designed, developed, and manufactured at Santa Monica, California, and static fired at Sacramento.

SLIDE 14 -- Small Business Firms in Saturn (M-MS-G)

A survey made at the Marshall Center in February of this year among the stage and engine contractors in the Saturn vehicle programs showed that small business firms received more than 50 per cent of the dollars sub-contracted by our prime contractors. We are vitally interested in the selection of sub-contractors, for the sake of our reliability program. We try to encourage our prime contractors to use only those sub-contractors and vendors who have demonstrated their competence through the production of equipment that has been certified and man-rated.

There is an unconfirmed story about one of our astronauts being asked by a newspaperman how it felt to be in orbit. He replied: "Well, how does it feel when you know your life depends on 150,000 parts, all bought from the lowest bidder?"

Seriously, in this area there must be a delicate balance between sole-source restrictions that seek to extend competition, and the reliability attainable through procurement from a contractor who has clearly outstanding abilities in a specialized area. Some companies have acquired unique technical experience, facilities, and equipment that would cost hundreds of millions of dollars to duplicate.

SLIDE 15 -- Saturn Systems Office (M-SAT-5)

The Saturn Systems Office exercises project management at the Marshall Center for the Saturn vehicles. Project management could be defined as the direction of the efforts of many diverse and highly specialized organizations into a single coordinated program to produce a single end objective. The project manager must work by a carefully planned schedule that ties each step of his program together in time and space. He directs, coordinates, programs, and budgets his available resources to achieve a single aim. And his project, an entity within itself, must merge with the projects of other managers, to complete the overall program, Project Apollo.

Since the Saturn Systems Office is basically a technical project management operation, it is staffed largely with technical personnel. They are supported as necessary by administrative, budgetary, and programming personnel from other staff offices, and receive technical assistance from the personnel in Marshall's nine operating divisions.

SLIDE 16 -- MSFC Project Management Offices in Contractor Plants (M-MS-G 130-62)

The Marshall Center retains technical direction for all of its research and development contracts, including those placed and administered by other government agencies. To insure daily personal contacts and to provide a sure, clear line of communication, the Saturn Office locates resident managers in the plants of each prime contractor.

Resident managers are supported by on-site staffs of technical, administrative, and contractual personnel. The size of the staff varies from a handful of specialists in some offices, to about 175 currently assigned to Michoud Operations in New Orleans. Through daily personal contacts at the contractor's plant, the resident manager can provide rapid direction to resolve problems, and may even spot and resolve potential problems before they become stumbling blocks. If the resident manager finds a problem beyond the scope of his staff, he returns it to the Saturn Systems Office. This office can draw on the technical knowledge of our nine in-house divisions. The solution is returned to the contractor through the resident manager's office.

SLIDE 17 -- Saturn Project Management (M-SAT-4)

The Saturn Office brings project direction and hardware development together. It is the only office on this chart with responsibility for both. The offices on the two levels above the Saturn Office have responsibility for project direction and review only; while the levels below this office are responsible for producing the actual hardware.

SLIDE 18 -- Saturn Primary Field Operations (M-SAT-66)

The nation-wide primary field operations of the Saturn Office are divided into three categories: stage development and production, testing, and launch.

For example, S-II stages for the Saturn V will be developed and produced by North American Aviation at Downey and Seal Beach, California. North American will accomplish research and development testing in its own facilities at Santa Susana, California, and acceptance testing at NASA's Mississippi Test Operations. The joint effort of both NASA and contractor personnel will be required when the stage is launched as part of a composite vehicle at Cape Canaveral.

SLIDE 19 -- Contractor Management Plan (M-SAT-185)

Contact with contractors is maintained through two major channels -- one for technical information, the other for contractual changes. Both channels originate and end at common points, however: the Saturn Office and the Resident Manager's Office at the contractor's plant.

If the solution to a technical problem requires contractual changes, the necessary negotiations are handled through the contracting officer in the Saturn Office and the contracting officer on the resident manager's staff. The resident contracting officer continuously monitors contractual performance and naturally reports directly to the resident manager.

SLIDE 20 -- Typical Contractor Reporting Requirements (M-SAT-191)

The keystone of Marshall's contractor management is daily personal contact with the contractor by our resident manager.

This personal-contact management is supported, however, by formal contractor reporting requirements. These reports are used as management tools to review progress against previously defined program milestones. These reports vary from teletypes on static firing tests to a quarterly motion picture film report. Two of the most important are a Contract Status Report and a Monthly Financial Report. Together they contain enough information for measuring all contractor efforts from budgeting to testing.

SLIDE 21 -- Saturn Working Groups (M-SAT-184)

We have two types of Saturn technical groups -- working groups and coordination panels. Our nine Saturn working groups focus the best technical talents of Marshall employees and our contractors on vehicle system problems. The chairman of each group is appointed by the Saturn Office, and is responsible for all group actions, including the naming of members to his group.

The communications pipe-lines illustrated at the right of the slide have proven simple and workable. The analyses and recommendations of the Marshall-industry working groups are channeled to the Saturn Office project managers in the form of action items. The project manager forwards the necessary resulting instructions to the contractor, through the resident manager.

If the contractor questions the technical direction, he can respond through the resident manager to the Saturn Office. From here the response may be returned to the responsible working group for further consideration, completing the chain of communications.

SLIDE 22 -- Saturn/Apollo Interface Organization (M-SAT-188)

The Saturn vehicle must be compatible with the spacecraft and launch facilities. This is accomplished through inter-center coordination panels, which are very similar to the working groups in organization and methods of operation. The panels are composed of scientific and technical personnel from the Marshall Center, from Houston, and the Cape. In resolving technical problems, the panels have the full support of each field center's technical capabilities and those of their associated contractors. The coordination panels refer unresolved matters, when necessary, to a Space Vehicle Review Board made up by the Center directors. Major program decisions of this board are again reviewed by Mr. Holmes' office.

Working level contacts are daily and routine among Marshall, Manned Spacecraft Center, and Launch Operations Center personnel, both in-house and contractor..

There have been as many as 1900 Chrysler and 1200 Boeing employees working closely with our Marshall Center employees at Huntsville on booster stages for the Saturn I and Saturn V.

LIGHTS ON

Now -- how does the Marshall Center go about selecting launch vehicle, stage, or engine contractors?

First, a procurement plan is drawn up for all research and development projects of more than $100,000. If the cost is expected to exceed five million dollars, the plan is submitted to the NASA Associate Administrator for approval. If the amount is expected to be less than five million dollars, the center director approves the plan.

The procurement plan includes a description of the proposed hardware, a list of all known sources, the method of procurement to be used, steps to be followed, a realistic time schedule for completing each major phase of the procurement action, the recommended type of contract to be used and any special features, such as reliability requirements, which are planned for inclusion in the contract.

If the ultimate cost of the work to be contracted is expected to exceed one million dollars, a Source Evaluation Board is appointed to evaluate the proposals submitted. Senior technical, business management, and procurement personnel are appointed to the board by the Center director, or are recommended to the NASA Associate Administrator for appointment if the contract is expected to exceed five million dollars.

The Board determines the qualification criteria to be used in the evaluation of proposals from potential contractors. In addition to the many technical factors relating to design, development, and test programs, the board develops a list of factors relating to business management. These may include project organization, manpower and facilities availability, direct and related experience, past performance, project scheduling, estimates of cost, subcontracting structure, labor relations record, quality assurance programs, and others -- such as, does the contractor give trading stamps?

After the board drafts the minimum qualification criteria, it gives the statement to the procurement office for preparing a final source list. The board reviews the list, making recommendations for additions or deletions, in an effort to achieve a balance between permitting maximum competition and avoiding the solicitation of companies which will not have a reasonable chance of being competitive. The early elimination or withdrawal of those firms which clearly do not have the experience or capabilities to perform the work is beneficial to the company, and also reduces the effort required in the selection process.

A pre-proposal conference is usually held next. Here the technical and business details of the procurement will be presented, and the company representatives may ask questions. Any company may send representatives to this conference, whether it is on the source list or not.

Companies considered qualified will then be asked to submit proposals. Again, any company that wishes may submit a proposal. The engineering time and expense for submitting a proposal is substantial, however; we think it is only fair and reasonable to advise any interested company when its qualifications appear marginal for a particular job.

Requests for proposals issued by the Purchasing and Contracting Office should ask for enough information to satisfy the needs of the Source Evaluation Board for information, and no more. The ground rules to be followed in selecting a contractor should be stated clearly. The major factors to be evaluated are stated, and their relative importance explained.

After proposals are received, they are given a thorough evaluation by the board. The technical and management aspects of proposals and of companies are considered together, for they are closely related. The proposal alone is never the sole basis for evaluation. Information is obtained by board members from other government departments as to their past experience with the companies which have submitted proposals.

After the proposal and the company's record of past performance are studied, actual plant visits are made. Advisory committees or consultants may be used for obtaining additional information.

Upon completion of the evaluation, the board prepares its findings and submits them to the Center director or the Administrator of NASA, depending upon which official has authority to make the final selection. The board normally arranges for an oral presentation to the selecting authority, during which the members may also answer any questions he may have.

The board does not make a recommendation to the selecting official. That is his decision alone. The board's findings should provide him with the kind of analysis of the qualifications of the competing companies, based on their proposals, on past performance, and on current capability that will facilitate the selection. The goal of this entire procedure is to make it possible for the responsible official to select the contractor which appears to be best qualified to perform the work successfully within the required schedule at a reasonable cost.

The board tries to give him enough information so that he will not have to make a decision on faith and intuition, without sufficient thought and study. The board's findings are as accurate, complete, and thorough as it is possible to make them before they are submitted to the decision-making authority.

Our personnel at the Marshall Center have always believed that it is better to build a rocket in the factory than on the launch pad. It is true that the final test of a rocket system is a successful launch.

But this is a poor and expensive method of checking the soundness of design, the quality of workmanship, or reliability of a rocket system. Our Quality Assurance Division has the heavy responsibility for seeing that each launch vehicle is ready for flight testing when it delivered to the launch site. This task is accomplished through a Quality Assurance program that penetrates the plants of our prime contractors and subcontractors in depth. A variety of comprehensive tests on components and systems and on the composite vehicle are made on the ground to assure that each mechanical and electrical system will operate properly in the air.

Representatives of our Quality Assurance Division have important roles in contract negotiation in an effort to assure reliability. We found long ago that you cannot assure quality by inserting in the contract a well-intentioned but meaningless statement that says, in essence, "Please do a good job." We try to tell the contractor in detail what we want, and how he can obtain it. And we go into his plants to help him establish a sound inspection and testing program.

The NASA NPC-200 series of documents which outline specific quality assurance requirements are included as a part of all major NASA contracts. NASA's quality control procedures are the stiffest ever faced by American industry. These documents must be supplemented, however, with development of new and better materials, better design, better techniques in manufacture, and improved means of evaluating the end items produced.

To create a product which we can commit to the rigors of space, we must do more than that which we can describe in specifications and procedures. We must have the dedicated support and concern of all elements of industry and government for obtaining the ultimate in perfection. This is the type of quality program which we cannot define legally, for it involves an attitude more than a procedure. It is, however, a program which we can afford, because it requires far more dedication than dollars.

The extreme cost per vehicle now precludes extensive "testing to failure" as a means of verifying the flight-worthiness of vehicles, or even major vehicle sub-systems. This means that more emphasis will have to be given to quality and reliability in all up-stream activities, such as design, selection of materials and components, manufacturing and assembly, and so forth.

We consider the money spent on reliability, quality assurance, and testing programs one of our soundest investments in Project Apollo.

The payoff to our efforts will come when three astronauts blast off for the moon in the not too distant future, and about one week later return safely to earth.

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