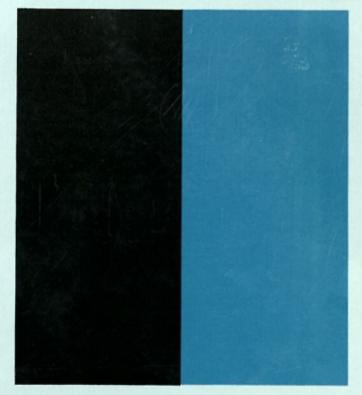
II.6

SPERRY RAND

EARTH ORBITAL WORKSHOP CAPABILITIES BROCHURE

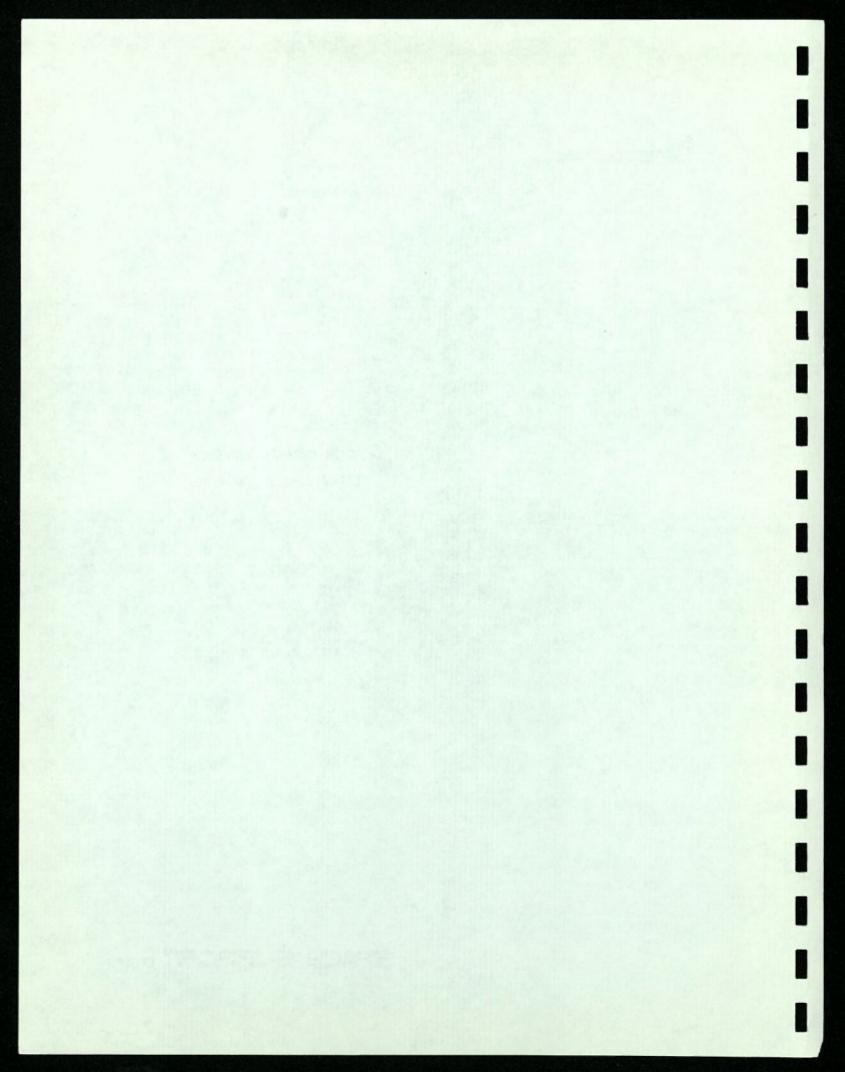


SPACE SUPPORT DIVISION



EARTH ORBITAL WORKSHOP CAPABILITIES BROCHURE

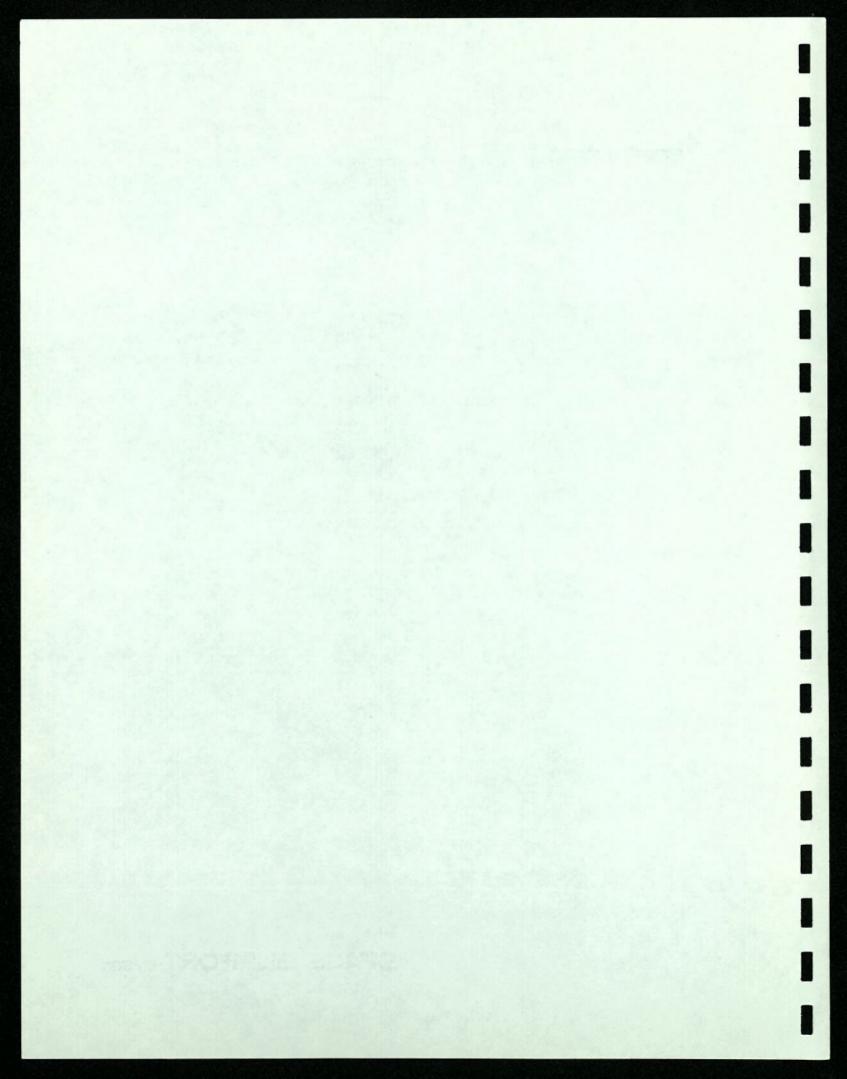
SPACE SUPPORT DIVISION







SPACE SUPPORT DIVISION



INTRODUCTION

The Sperry Rand Space Support Division presents this brochure to depict a competence and capability in the area of large earth-orbital workshops. Workshops that are:

- · In fabrication (ATM)
- · Proposed for Saturn V Vehicles (Bo & Mx)
- Conceptually designed for specific advanced applications (Nuclear Power)

Sperry's ability to offer a depth of experience in the orbital workshop area is directly attributable to the technical support the Space Support Division is providing to the MSFC Astrionics Laboratory. In this role a technical foundation and competence in design and development of orbital workshops has been established. The Apollo Telescope Mount provided the hardware, subsystem and system experience. Then follow-on studies developed the necessary mission analysis experience. Hence, an overall workshop capability has evolved.

The areas of demonstrated proficiency are:

EXPERIMENTATION

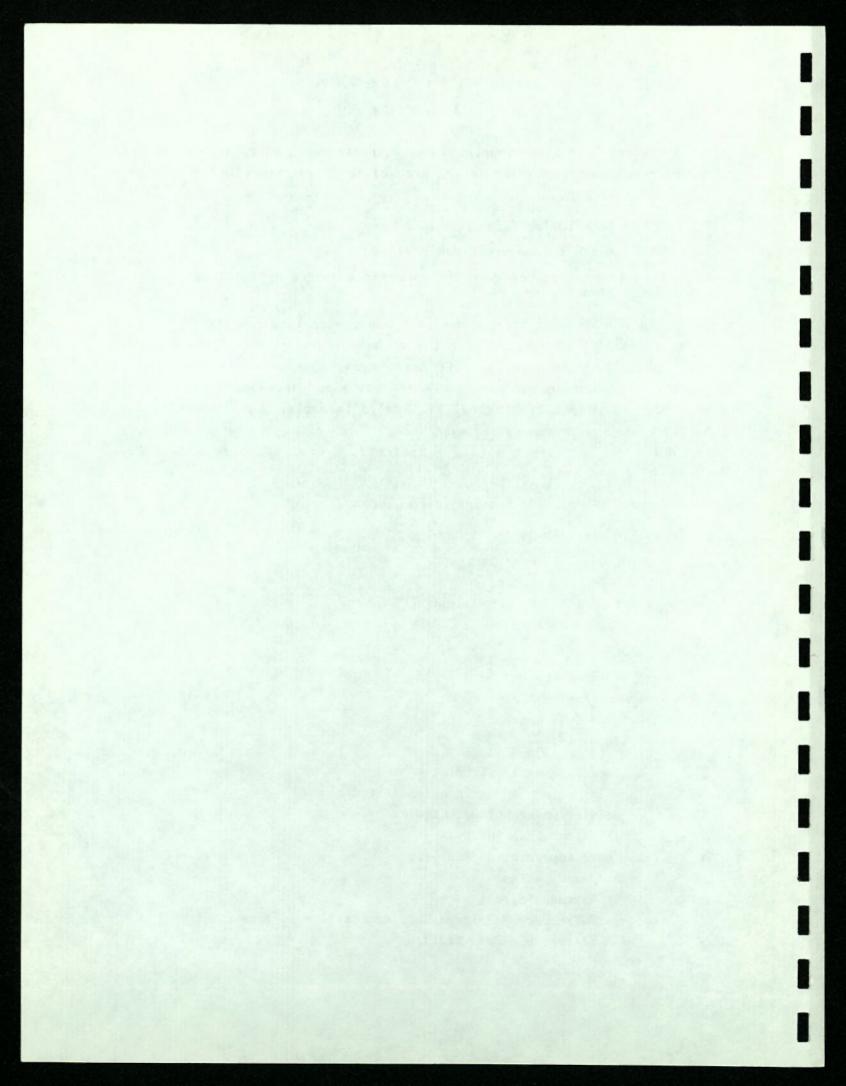
X-Ray Telescope Design X-Ray Camera Design Television System Design Laser Research

II. POWER

Solar Array Design Nucleonics Analysis Fuel Cell Design

III. COMMUNICATIONS

Data Compression Studies
Information Coding Techniques Studies
Modulation Techniques Studies
Phaselock Loop Analysis
Phase Compensation Analysis
Hardware Design
Antenna Systems
Pulse Code Modulated Data Acquisition Systems
Telemetry Ground Station



270-Channel Multiplexer Single Side Band/Double Side Band Filters Airborne Telemetry Power Supplies

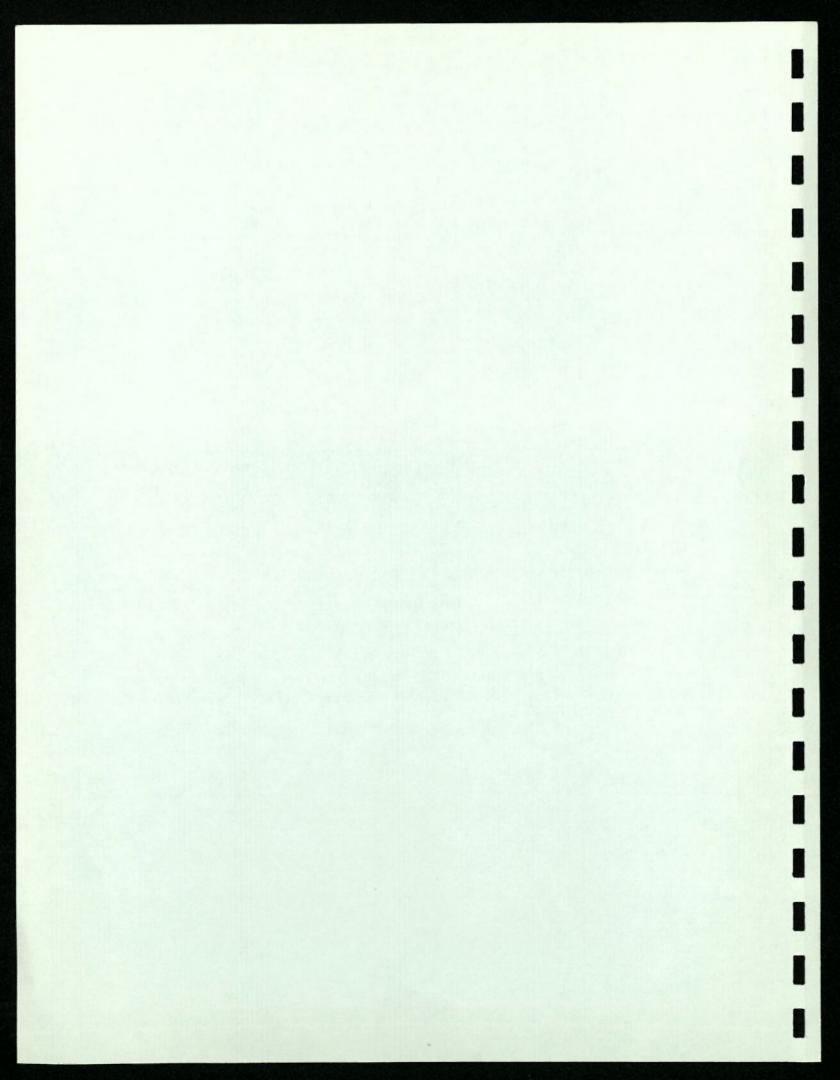
IV. CONTROL

Control Moment Gyro System Analysis
Experiment Pointing Control Analysis
Control System Analysis and Design
ATM
Orbital Workshop
Reaction Control Jets
Sizing
Fuel Consumption
Momentum Dumping
Optimal
Backup
Star Tracker Analysis

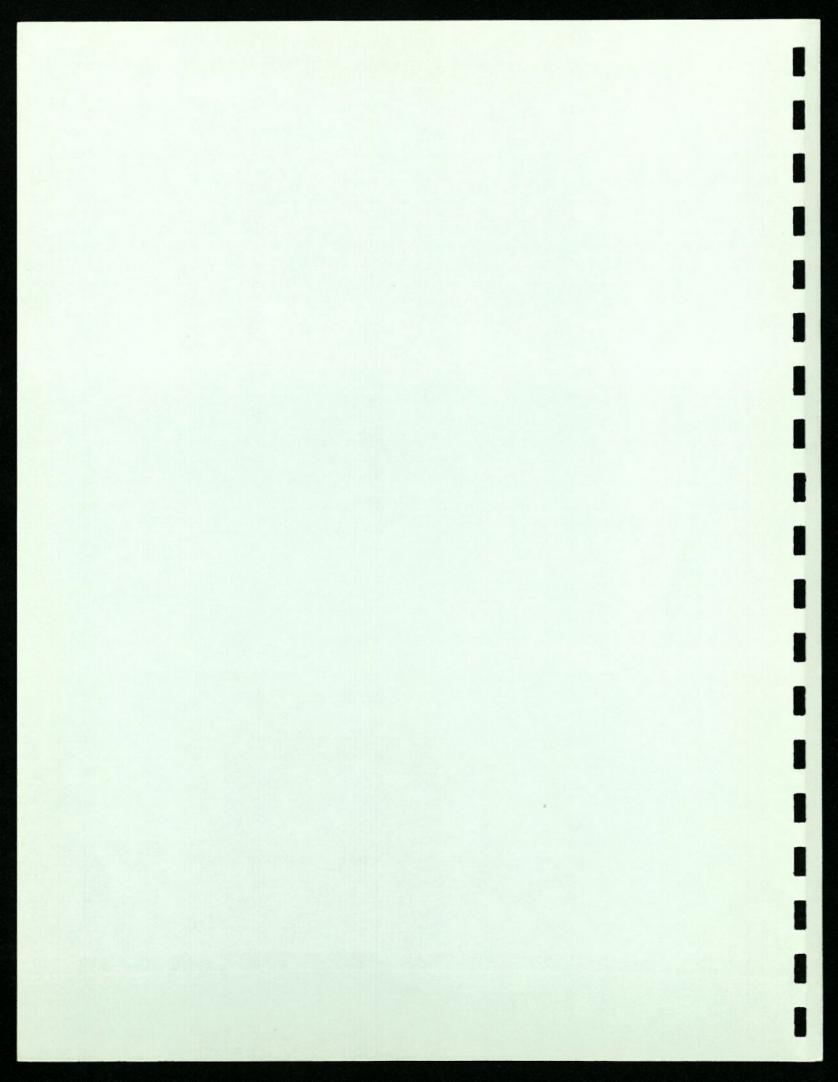
A summary of the engineering effort related to orbital workshop experience is presented in the Capabilities Section (Section II). In that section there are four subsections which are uniquely categorized by NASA's Phased Project Planning. The four steps of Phased Project Planning are Advanced Studies, Project Definition, Design, and Development and Operations Categorized as Phase A. B. C and D respectively.

The remainder of the brochure provides an insight into the Division's background, organization makeup and manpower level.

The capabilities reported herein were developed by the Space Support Division under Contract NASS-20055 to the National Aeronautics and Space Administration. George C. Marshall Space Flight Center, Astrionics Laboratory, Huntsville, Alabama.



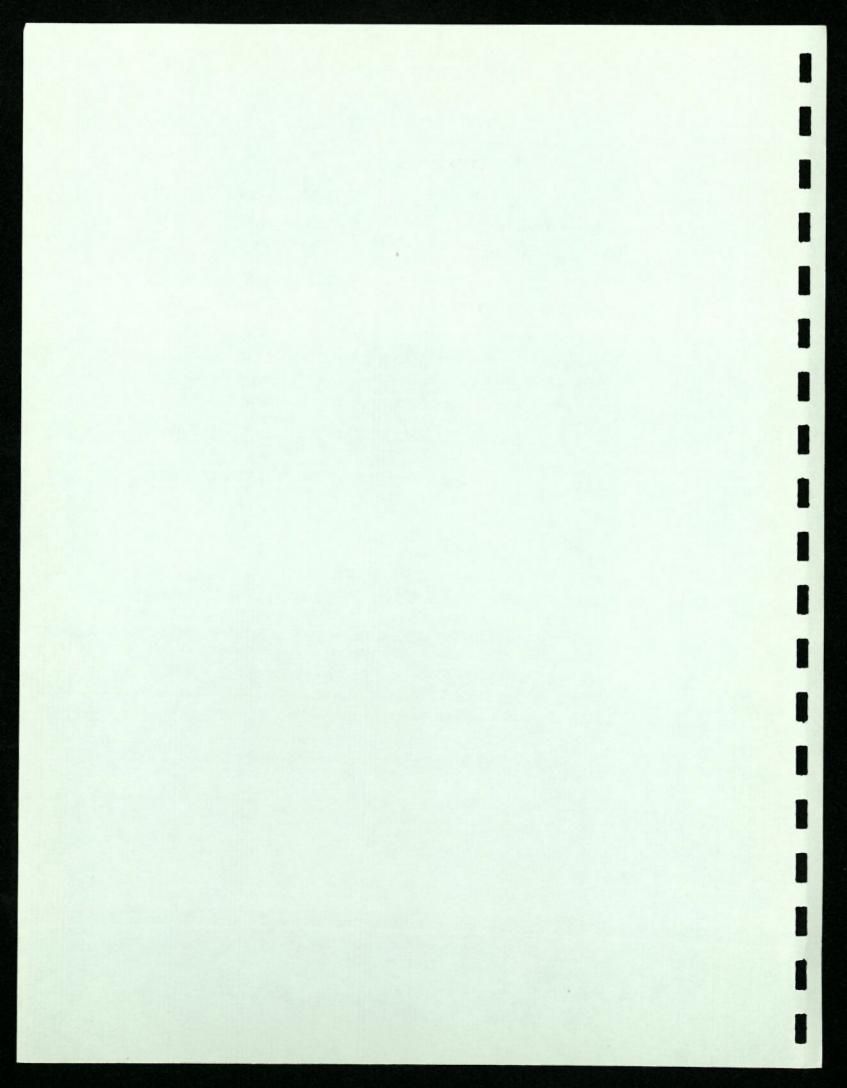
SECTION II
WORKSHOP CAPABILITIES SUMMARY



11. WORKSHOP CAPABILITIES SUMMARY

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В	Project Definition	2-9
С	Design	2-15
D.	Development and Operations	2-23



WORKSHOP CAPABILITIES SUMMARY

PHASE A - ADVANCED STUDIES

In the Advanced Study Phase concept feasibility studies of various mission approaches are made. Requirements for each are analyzed, engineering assessed and experiment programs grossly defined. From this a report is written detailing all analytical work, alternate solutions, tradeoff criteria and recommendations.

The Phase A definition adequately defines the work performed by the Space Support Division's Advanced Studies Group in support of the Astrionics Laboratory's Advanced Studies Office. The recent studies as documented by Sperry are:

A Study of the Backup Saturn I Workshops (AS210 Wet Launch) Astrionic Equipments' Potential for use in an Austere Dry Launch Saturn V Workshop (B)

An investigation into the system and sub-system modifications required to adapt the Saturn I "Wet Launch" workshop's backup eauipment to an austere Saturn V "Dry Launch" workshop was performed. Conversion time, cost and mission scheduling were traded off against versatility and lift capability.

SP 590-0132

Completion date: 9/68

Selected Studies of Some Conceptual Earth-Orbital Workshops

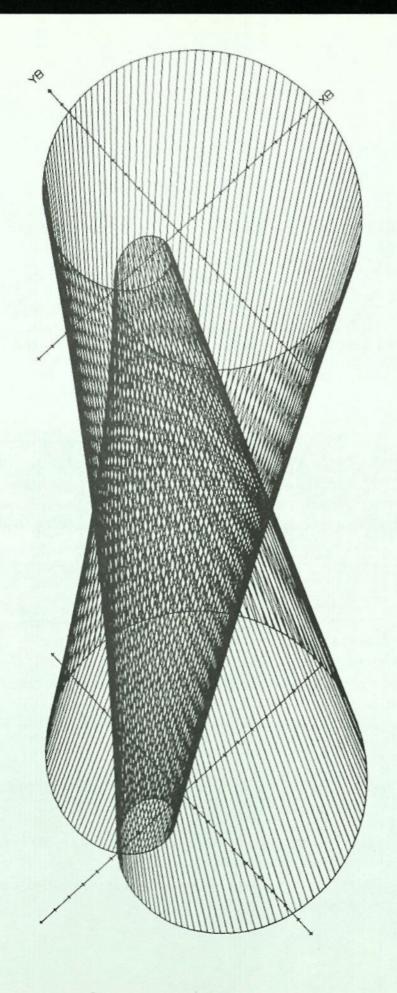
Systems analysis and trade-off studies were made on a number of conceptual earth-orbital workshops in an effort to size systems and obtain the best configuration. Areas studied included experiment payload, power systems, instrumentation and communications, thermal controls, control and display, and video imaging.

SP 590-0098

Completion date: 7/68

Attitude Control System Synthesis for Conceptual Saturn V Launched Earth-Orbital Workshop/Space Stations

Identified Eight Conceptual Workshop/Space Station configurations and studied in detail four to determine overall attitude control requirements to be expected. Then, using these requirements two potential attitude control systems are synthesized.



reflective elements of the telescope - hyperboloid tilted 30 arc seconds Distortion in ray bundle introduced by alignment inperfections in the with respect to the optical axis. General concepts were derived from NASA's current Saturn V Earth-Orbital Workshop/Space Station planning activities.

Disturbance torques considered are gravity gradient, aerodynamic, solar, magnetic and man motion. The control systems included reaction control jets, control moment gyros and various combinations of both.

SP 590-0097

Completion date: 7/68

Microwave Power Transmission Study for Space Applications

Considered the feasibility of transmission of power by microwave beaming from a master satellite to one or more smaller satellites. Theoretical and quantitative results are presented detailing the efficiency of each subsystem plus total system efficiency using either the elliptic or the parabolic reflector antenna.

SP 590-0072

90-00/2 Completion date: 4/68

Signal-to-Noise Considerations for Orbiting Astronomical X-Ray Telescope

Presented data that helps provide fundamental information on establishment of criteria to postulate on the temperature, density and composition of matter in the galactic and intergalactic space, presence and strength of magnetic and electric fields in space, the origin and distribution of cosmic rays and the creation of matter.

SP 590-0110

Completion date: 8/68

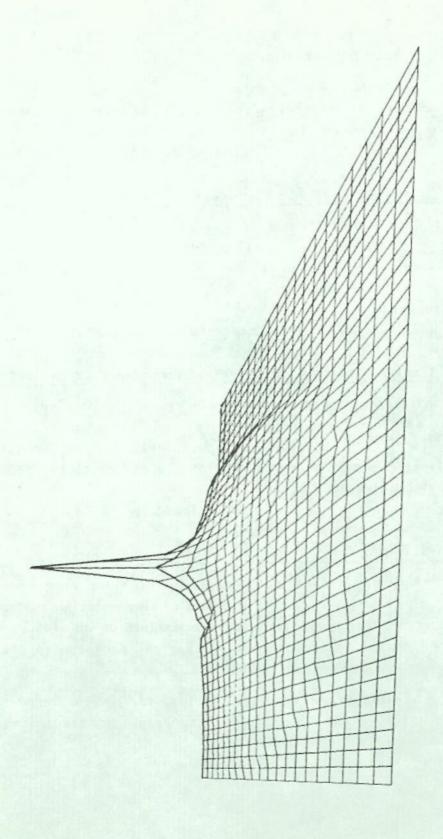
Large Aperture Telescope: Phase 1, 2, 3, 4 and Summary

Performed control system analysis on suggested high accuracy large aperture telescopes. The studies were confined to the fine pointing control of a one meter diameter large aperture telescope mounted on an SIVB type orbital workshop. The pointing accuracy of the systems analyzed is 0.01 arc second maintained for extended periods of time.

A two body analog simulation was developed to test the various hardware configurations and evaluate the effects of disturbances, including man motion, on pointing accuracy.

SP 590-0034-0.1.2.3.4

Completion date: 5/68



High resulation energy diagram of image formed by x-rays in film plane of telescope (125,000 input rays were used to form energy diagram)

Phased Array Antenna Study - Phase I and II

A comprehensive study of the characteristics of phased arrays was performed. State-of-the-art information is presented from the literature on weight. size. gain. number of elements, scan and efficiency. Also detailed is the pattern effect due to radiator mislocation caused by manufacturing errors and thermal gradients.

SP 590-0108 SP 390-0134

Completion date: 8/68
Completion date: 9/68

Boom Extended Nuclear (Orbiting) Reactor Control Study

In suggesting nuclear reactors for large space stations the question of vehicle control came to the forefront. This study endeavers to answer that question by considering the reactor mounted on a boom extended from the side or end of the vehicle.

An investigation into the interrelations between the boom mounted reactor and the vehicle control system was performed. Analog and Digital simulation programs were developed to compute external disturbance torques, composite mass and inertia data. In addition, a complete two-body vehicle dynamic simulation containing a vehicle control system was developed to verify analytical results.

SP 209-01

Completion date: 12/68

An investigation of Redundancy Concepts Applied to Strapdown Inertial Sensors

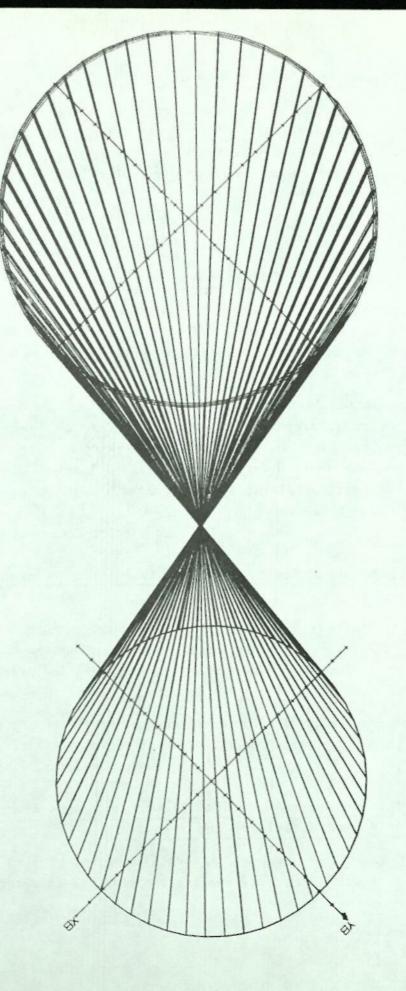
Strapdown inertial navigators appear to have a place in large space stations of the future. A study input, to system development, was a method to detect and isolate defective sensors by comparing individual sensor output with the mean output of all the sensors.

A digital program was developed to study various approaches and evaluate trade-offs in the detection and isolation of sensor malfunctions.

SP 590-0084 Completion date: 7/68

Saturn I/V Six Degree Dynamical Simulations with Iterative Guidance Modified for Advanced Vehicles and Missions

Strap-on solid fuel engines. Saturn V vehicles without the SII stage and variable thrust liquid fuel engines are analyzed to determine impact on



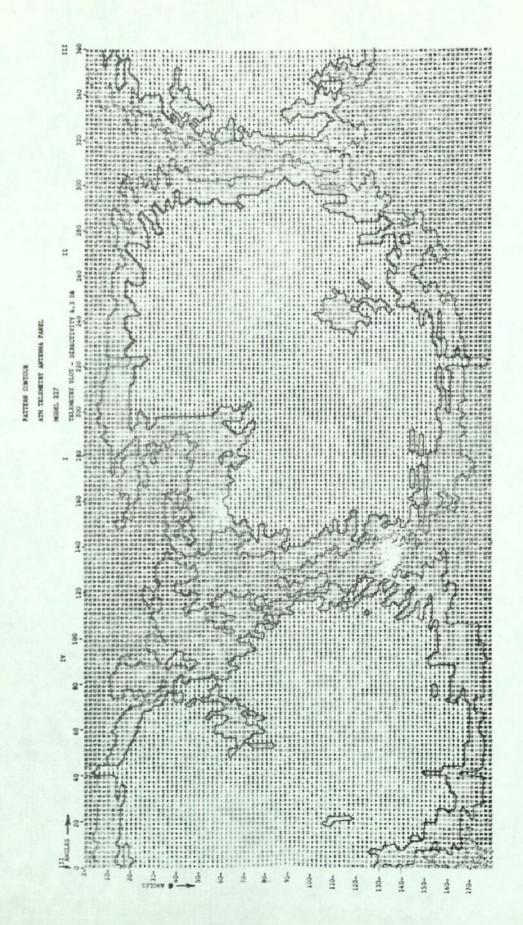
Ray diagram of perfect x-ray telescope viewing a point source of x-rays on optical axis 100 meters distant.

the present guidance modes. Full scale digital simulations have been developed utilizing the latest MARVESS trajectory techniques making lift-off to injection studies possible.

SP 209-TD-04

Completion date: 1/69





Pattern Contour for an Apollo Telescope Mount Telemetry Antenna panel

WORKSHOP CAPABILITIES SUMMARY

PHASE B - PROJECT DEFINITION

In the project definition phase selected concepts are refined, assessments of total mission requirements are made and a system analysis prepared. From the study results presented a project plan emerges which specifies a single concept, recommends a plan for phase C and presents a preliminary Project Development Plan.

The Sperry Rand Space Support Division by supporting the Astrionics Laboratory on the Apollo Telescope Mount Vehicle (ATM) was an integral part of the ATM Phase B endeavor. This produced experience by association which, in our opinion, gives a depth of knowledge in the area of large orbital space station technology obtainable only by day-to-day contact with the cognizant NASA organizations. A sampling of reports applicable to the phase B planning process is presented below.

Antenna Pattern Measurements

Analyzed three methods of measuring antenna patterns in relation to the antenna attitude in a 200 nautical mile orbit. The study was made to evaluate a contractor's proposal to NASA for measuring the characteristics of a large space erectable parabolic antenna. Comparison studies were conducted and recommendations submitted for the most accurate method of measuring antenna patterns.

RL # 16-022

Completion date: 5/66

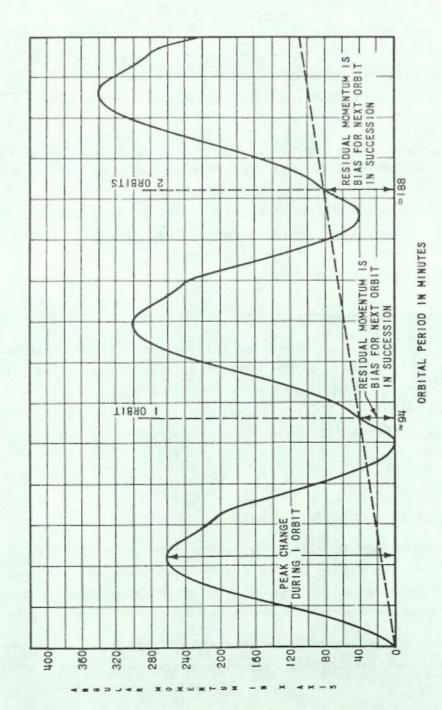
Discussion of the Torque Rectification Dump Scheme

Scrutinized contractor's proposal for a gravity gradient dump scheme designed for momentum relief of the Control Moment Gyros. The scheme utilized the rectification of the cyclic gravity gradient torques by changing signs of the commanded maneuver angles at specified times in the orbit.

The attractive and unattractive features of the scheme was presented after a detailed analytical and computer simulation study was performed. OWS-2-1 Completion date: 4/67

Double Gimbal Control Moment Gryos in Vehicle Attitude Control

The System for Inertial Experiment Pointing and Attitude Control (SIX-PAC) as proposed by NASA (Langley Field, Virginia) is investigated.



Angular momentum change due to aerodynamic drag torques about the elongated axis of an Apollo Telescope Mount (ATM) type vehicle.

The fundamentals of the CMG system are presented and the derivation of the equations for a space vehicle using the SIXPAC configuration is developed. Along with this a block diagram of the CMG and vehicle dynamics are developed for system study.

The characteristics of the CMG as an attitude control device are also discussed and a comparison with other attitude control schemes is made. Then advantages of the various systems are presented in conclusion.

SP 517-67-1

Completion date: 1/67

. Charger-battery Regulator Module - Prototype Test Model

An engineering analysis was performed to establish design requirements for the thermal, mechanical and vibration prototype of the ATM charger-battery-regulator-module. The packaging design required compliance with MSFC Document 50M02408, Environmental Design and Qualification Test Criteria for ATM Components. The thermal and vibrational analysis of the prototype charger-battery regulator was conducted to verify the packaging design per requirements of 50M02408.

RF # 10-004 Completion date: 7/68

Generation of Orbital Coordinate Systems and Aerodynamic and Gravity Gradient Torques

To evaluate and confirm the ATM control system configuration and interface a detailed soft mockup of the vehicle pointing and control system was developed.

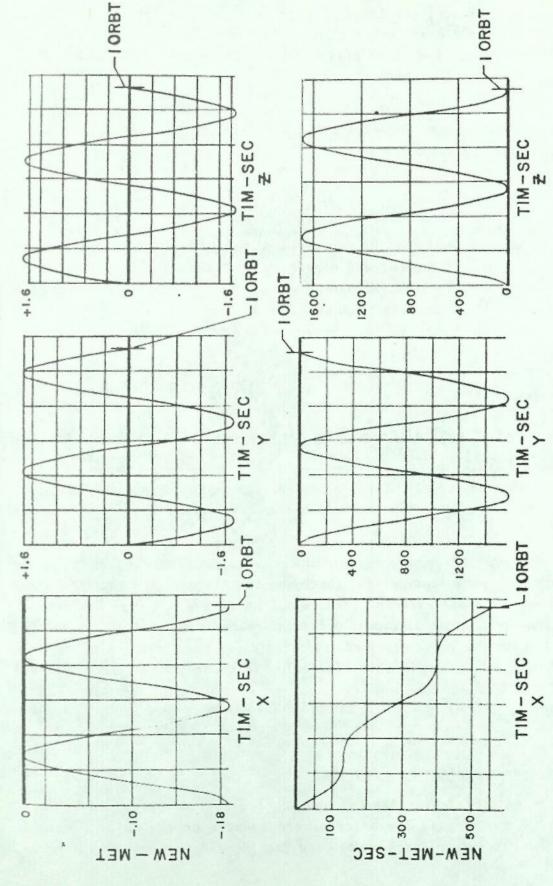
The developed program presents a complete Mathematical Model of an earth orbital space station. The Earth-sun-satellite motion model is simulated along with all external torques acting on the vehicle. The control system containing control moment gyros and reaction jets is also simulated making it possible to do detailed fuel studies of any earth orbital vehicle control system. Presently this simulation is programmed on both the 7094 digital and 8900 hybrid computers.

SP 522-0058 Completed: 4/67 Updated: 4/68

ATM Command and Telemetry Antennas

Originated the design concept and fabricated scale models and prototypes of ATM antennas. The antennas are mounted on the solar wings. An edge-mounted scimitar antenna was used for the 450 MHz command system and

GRAVITY GRADIENT TORQUE



MOMENTUM DUE TO GRAVITY GRADIENT

Plots of the external gravity gradient torque and resultant momentum for an Apollo Telescope Mount (ATM) type vehicle. an edge-mounted dipole antenna for the VHF telemetry. The design concept was formulated by building 1:20 scale models of the proposed antennas and checking the radiation characteristics on a 1:20 scale model of the Apollo Telescope Mount cluster.

RL # 16-006

Completion date: 11/68

A Technique for Stabilizing the ATM Vehicle for Extended Time Periods By use of Momentum Exchange Devices

If an ATM revisit is envisioned thermal control will be necessary. To supply thermal control a source of power will be required. If this power is provided by solar cells facing the sun a control system will be required either active or inactive. If an active system is used the system described in this report is applicable.

The study presents a momentum management scheme to permit control of the ATM with control moment gyros during the unmanned phase of the mission. The momentum management scheme reverses the direction of disturbance torque through simple CMG-controlled maneuvers, thus eliminating the requirement for reaction jets to relieve the unidirectional stored momentum of the control moment gyros.

Presented to

May 1967

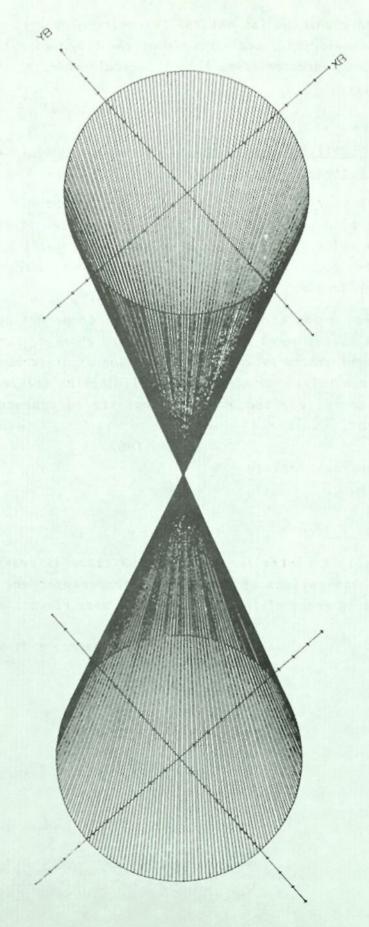
American Astronautical Society National Symposium

SIVB Stage Digital Filter

An all-digital flight controller for the SIVB stage is considered in detail. Several mechanizations of the digital compensator are designed and comparisons made by means of frequency response measurements and hybrid simulation.

SP 551-0045

Completion date: 4/24/68



Hyperboloidal and paraboloidal elements in perfect alignment - no distortion in ray bundle.

WORKSHOP CAPABILITIES SUMMARY

PHASE C - DESIGN

In this phase the final concepts are developed: designs are made to required specifications: and a total system analysis made. From this an analytical report is assembled and the finalized Project Development Plan (PDP) released.

The Apollo Telescope Mount (ATM), as the first large orbital workshop, has been through this phase. The Space Support Division's contribution in this phase, as documented, is presented in the following paragraphs.

ATM 50-56 X-Ray Telescope: Final Report

Final analysis of the optical properties of the SO-56 X-Ray Telescope is presented. Analysis includes ray tracing with special emphasis on ray diagrams, spot diagrams and point spread functions. All aspects of the X-ray reflection dynamics were considered.

OBS-3-1

Completion date: 3/69

ATM Configuration Management

Established a system for configuration control and documentation flow for the ATM program. The concept of a workable configuration management plan and documentation control plan was presented to and approved by the MSFC ATM Project Office; then documented and implemented. Technical documentation is generated from research and data gathering, as required, to determine a basic for the ATM program. The configuration management plan keeps engineering management informed on the program status.

RL # 18-002

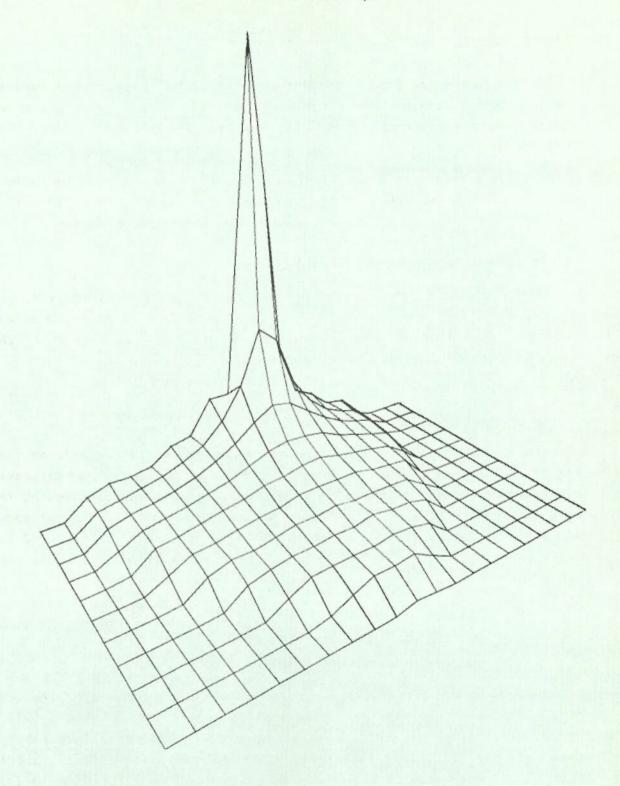
Completion date: This is a continuing program.

ATM Experiment Interface Control Documents

Reviewed and analyzed experimenter and ATM electrical circuits, and maintained electrical systems compatibility between experimenters, MSFC, and Manned Spacecraft Center by generating electrical interface control documents and electrical interface defining documents. Reviewed experimenter's proposed changes and recommended acceptance or refusal by the Configuration Control Board.

RL # 09-012

Completion date: 4th Quarter/70



Energy diagram of image formed by x-rays in film plane of telescope

Cable and Distribution System

A 700-cable distribution system is currently being designed to provide control, power distribution, and data transmission interconnections between a 52-rack, 260-panel electrical support equipment checkout system and the ATM. An analysis has been made of the entire cable and distribution checkout system to establish design goals and criteria. A study of the Saturn V. 500FS system was made to determine usability of cables for the design. A continuing systems interface study is being performed and cable interface control is being maintained.

RL # 09-006

Completion date: 11/68

ATM Distributors

Preliminary studies of ATM power, measuring, and command signal distribution requirements established the need for especially designed distributors. The distributors route commands, measurements, and electrical power between the command capsule control panel, the ATM experiment packages, and the electrical support equipment, both prior and subsequent to launch of the ATM. Designed the complete distributors to include housing, cabling, and components. Thermal vacuum tests are performed to verify the design. A reduction in the number of distributors required is achieved through the utilization of TO-5 type relays.

RL # 9-004

Completion date: 8/68

Optimal Desaturation of Control Moment Gyro Systems in Orbit

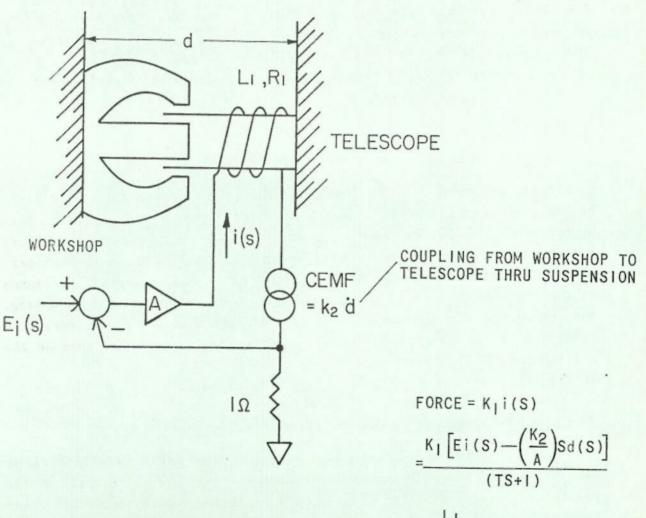
Space vehicles on missions that require fine pointing will perhaps utilize Control Moment Gyros (CMGs) for a long time to come because of the precise pointing capability offered by a continuous controller. Like other systems, CMGs do run out of "fuel" (which, in this application is measured by CMG gimbal angles). The "saturated" condition (analogous to an empty fuel tank) is reached when the CMG gimbal angles approach their limits. External torques must be applied to the vehicle/CMG system to reset the gimbal angles. A systematic approach to this "refueling" process is described using the free "fuel" source available in the gravity gradients.

The problem of momentum desaturation of pointing control systems with CMG controllers is cast into the format of a minimal energy optimization problem. The system model has the form of a linear time-varying equation with a state and control independent. time-varying forcing function.

OWS-3-4

Completion date: 1/69

TELESCOPE TO WORKSHOP MAGNETIC SUSPENSION DYNAMICS



A magnetic suspension of this type can be an almost perfect isolator, expecially when feedback principles are applied. Coupled force due to workshop motion is reduced by open loop gain A. In addition, the isolation characteristics are essentially frequency invariant.

$$T = \frac{L_{I}}{A + R_{I}}$$

$$K_{I} = 1.47$$

$$K_{2} = 1.65$$

$$A > 1000$$

ATM Clock

Designed the logic and packaging of the ATM clock to provide ultrastable time references for various ATM experiments. The clock is capable of providing time references in milliseconds, seconds, minutes, hours, and days, with a stability of 1 x 10^8 throughout the temperature range of -20 degrees to 85 degrees Celsius. The clock can be reset to any time period by ground command signals, and has a reliability of 0.99965. One prototype unit was fabricated and tested.

RL # 17-008

Completion date: 9 67

ATM Switch Selector Panel

Prepared Class I documentation of the ATM switch selector panel. The panel is required for ATM selector switch test and check out. The packaging design of the panel (component layout) was prepared to meet MSFC requirements. Documentation was completed in accordance with MSFC Drawing 40M-00224A.

RL # 10-013

Completion date: 12/67

ATM Electrical System Networks

The electrical circuitry to interconnect all ATM subsystems and to perform switching, control, power distribution, and signal conditioning functions is currently being designed. The system consists of three power distributors, five control distributors, three measuring distributors, a transfer assembly, a controls and display logic distributor, and approximately 500 interconnecting cables. The subsystems are designed to ATM specifications.

RL # 09-011

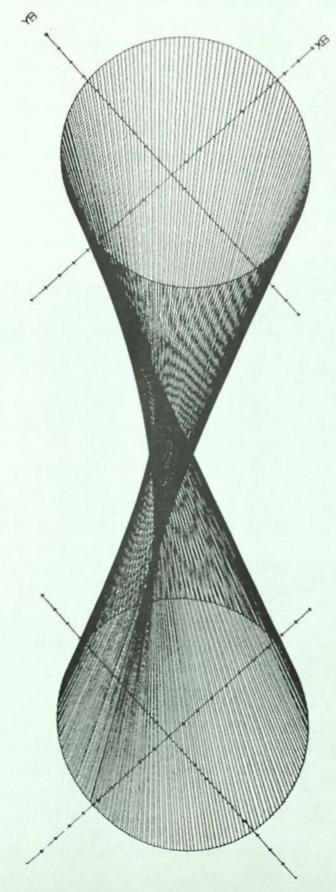
Completion date: 1/69

Time - Division Multiplexer

A time-division multiplexer was designed to accept up to 270 data inputs of 0 to 5 volts in amplitude, and to provide two parallel output wave trains. The multiplexer has 30 primary channels with a sampling rate of 120 samples per second. Principal subassemblies of the multiplexer are: the dc/dc converter and regulators that provide isolation of signal and missile power grounds: an isolation amplifier for each output; main channel multiplexer cards: calibrator; and clock and timing subassembly. One multiplexer was breadboarded and successfully tested. Documentation and prototype fabrication are in process. Several of these multiplexers shall be used on the second ATM flight.

RF # 16-025

Completion date: 9/68



reflective elements of the telescope - hyperboloidal element de-centered Distortion in ray bundle introduced by alignment inperfections in the by 0.002 inches.

Control Circuitry for Data Acquisition System

Designed the amplifier and switch assembly to be used on the ATM to amplify and select the proper output of redundant PCM digital data acquisition subsystems. Switching between the two PCM subsystems is accomplished by commands to internal control circuitry. These control circuits employ electro-optical devices to provide maximum isolation between the external command signal circuitry and the control circuits.

RL # 17-005

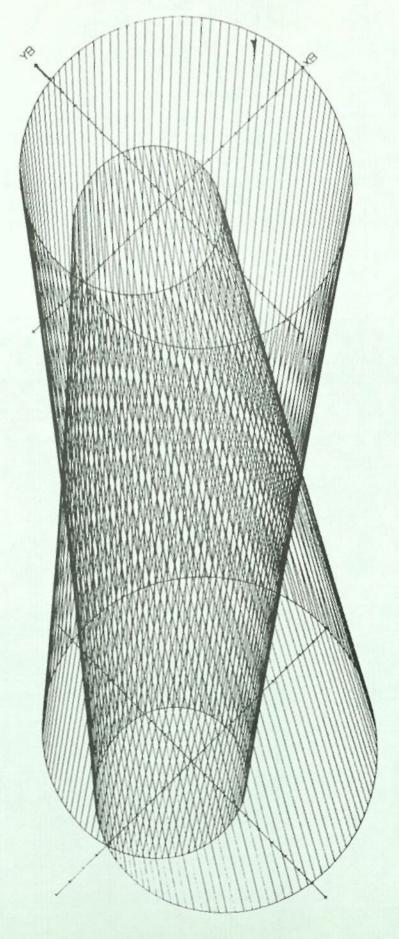
Completion date: 11/67

Charger-Battery Regulator-Module Documentation

This effort involves preparation of the specification, and the acceptance preliminary and qualification test procedures for the Apollo Telescope Mount (ATM) charger-battery-regulator module. A review of the ATM power requirements and prototype circuitry provided detail requirements for the three documents. The specification establishes purchasing/manufacturing requirements: the acceptance test procedure sets forth module acceptance standards: and the qualifications test procedure details environmental operating requirements for the modules.

RL # 10-001

Completion date: 4/68



reflective elements of the telescope - hyperboloid tilted 15 arc seconds Distortion in ray bundle introduced by alignment inperfections in the with respect to the optical axis.

WORKSHOP CAPABILITIES SUMMARY

PHASE D - DEVELOPMENT AND OPERATIONS

In this final phase the tasks of developing, manufacturing, testing and operating the products designed to achieve the mission goals are carried out. The Space Support Division's capability in this area is readily demonstrated by presenting assigned tasks and describing the design development and testing effort put forth on each. The following paragraphs describe the Apollo Telescope Mount (ATM) Phase D effort.

X-Ray Telescope - Camera and Electronics Design: 5-056 Design

The X-ray telescope-camera and electronics for the S-056 X-ray telescope experiment which will measure soft X-ray radiation originating in the solar atmosphere has been designed. developed. and produced. The X-ray telescope system comprises an X-ray telescope with film camera and an X-ray event analyzer (X-REA).

The X-REA and telescope-camera are two independent measuring systems which will be attached to the ATM in a manner which will allow both systems to measure radiation from the same source. The information obtained from these two measuring systems will provide a better understanding of solar flares and the physical processess which take place in the sun.

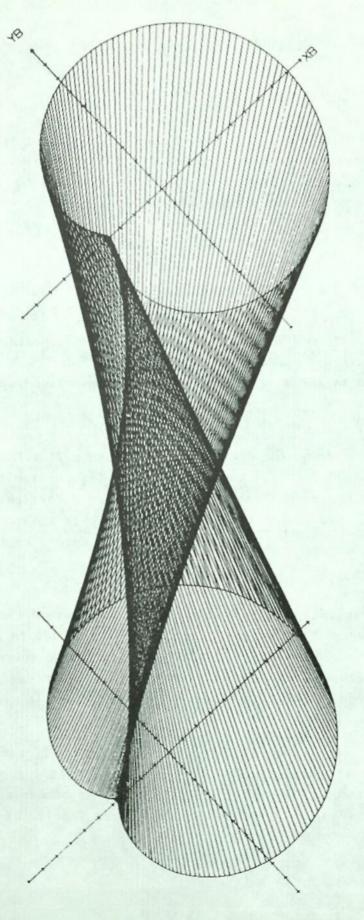
OBS-4-1

Completion date: 1/69

ATM Television System Design

A television system for the Apollo Telescope Mount (ATM) has been designed and developed. This system is installed in the ATM to enable astronaut viewing of solar activity from earth orbit through several different telescopes and consists of two (2) low-light-level TV cameras, two (2) vidicon TV cameras, an EIA sync generator, and two (2) wideband video switches.

The low-light-level television camera utilizes a SEC vidicon capable of excellent picture quality (600 TV lines) at 3 x 10^{-3} footcandles and usable picture quality (200 TV lines) at 5 x 10^{-5} footcandles. The camera can be used as a light-integrating device down to levels below 10^{-7} footcandles.



reflective elements of the telescope - hyperboloid tilted 7.5 arc seconds Distortion in ray bundle introduced by alignment inperfections in the with respect to the optical axis. The ATM vidicon camera is a high resolution (800 TV lines) system utilizing a standard 5403 ruggedized vidicon with excellent performance down to I x 10^{-1} footcandles. Usable pictures can be obtained down to 5 x 10^{-3} footcandles.

OBS-4-2

Completion date: 1/69

Electrical Power Subsystem for Apollo Telescope Mount (ATM)

This task comprised the design and development of the ATM electrical power subsystem which furnishes the electrical power required by all other ATM subsystems and experiments.

The ATM electrical power subsystem consists of 18 photovoltaic direct energy conversion sources. 18 power conditioning-energy storage groups. and the required interface/interface networks and power distribution circuitry that provides remote system control capability, system monitoring, and power management information.

OWS-4-3

Completion date: 1/69

270 Channel Multiplexer

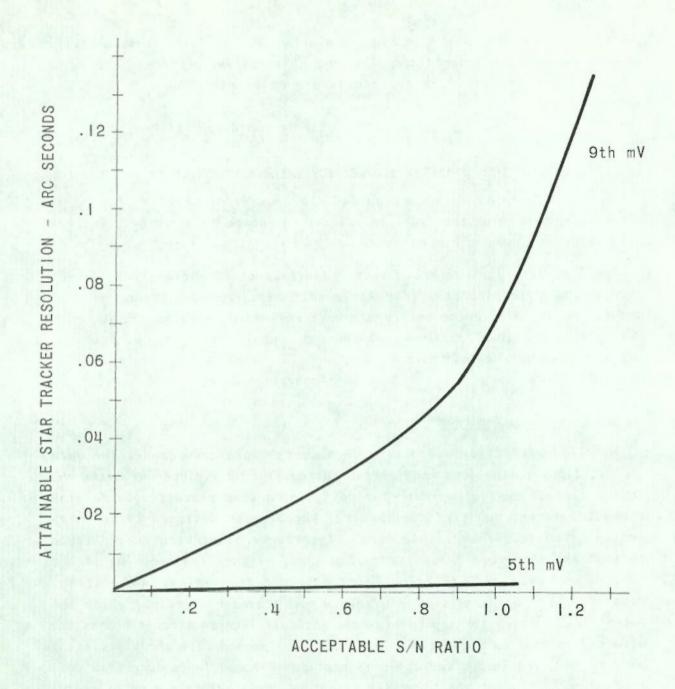
The 270 multiplexer was designed to accrue data and channel the data via 270 lines to the data acquisition system. The multiplexer utilizes the latest circuit configurations, including integrated circuits. To develop the multiplexer, the electromechanical package was designed using integrated circuits with weldable leads. Interconnections were accomplished through the motherboard and flexible printed circuit cabling. The flight housing was designed utilizing three configurations-almag sand casting, aluminum sheet weldment and an aluminum dip brazed housing; of which the latter was selected for implementation. The multilayered circuit boards are attached in an accordion fashion with flexcabling and with shock-resistant padding inserted into a cavity configuration. The module is currently designated as backup for the first ATM flight and will maintain a prime status for the second ATM flight upon completion of prototype development.

RL # 04-008

Completion date: 6/68

AC/DC Power Supply

An ac/dc electronic power supply was designed and fabricated to furnish dc power to the ATM platform modules and ac power to the ATM gyro spin motor. The dc portion of the power supply is equipped with a step-up switching preregulator. a dc-to-dc converter and a pulse regulator. The



The performance attainability of a star tracker, for a particular guide star brightness, as a function of the acceptable signal to noise ratio.

ac output is equipped with a crystal-controlled oscillator, followed by a binary countdown. The dc input voltage is required to remain between 24 to 32 volts to maintain a dc power output of 250 watts and 35 volts ac at 1600 Hz.

RL # 22-009

Completion date: 12/66

Ground Support Electrical Power System

A power system is currently being designed to furnish power to the ATM solar bus and or load bus and to the electrical support equipment when performing ground checkout of the ATM. The design effort includes an overall system analysis to establish design criteria, an evaluation of existing systems to determine their adaptability to the ATM requirements, and a comprehensive study of each subsystem to provide details needed for preparation of the preliminary design drawings. Fabrication drawings and preliminary early-order parts lists are also being prepared.

RL # 09-009

Completion date: 11/68

Hydrogen-Oxygen Fuel Cell Design and Test

Four years of detailed experience has been obtained in the design, operation and test of Hydrox fuel cells. Approximately 8000 hours of operation of 2-kilowatt Allis-Chalmers (AC) systems have been logged by division personnel in the study and test of these power sources. Significant developments have resulted from research conducted on single fuel cell sections on evaluation consoles developed and fabricated by this Division. OWS-4-4

Completion date: A continuing

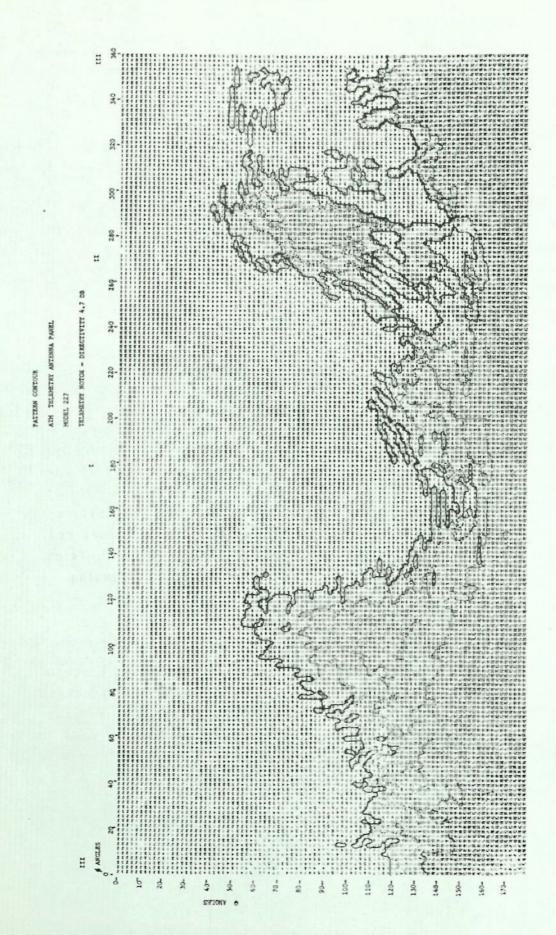
effort

Sun Sensor and Star Tracker Computer Simulator

A computer simulator is currently being developed for ground checkout of the sun sensor and star tracker. The simulator performs a function similar to that of the on-board digital computer during flight; it generates an interrogate pulse, together with clock pulses, that are used in the internal electronics of the fine sun sensor and star tracker for timing purposes, gating, and shifting of the data. It also accepts serial binary data of the direction and magnitude of the resolver rotation and the resolver zero, and presents them to the display panel. The simulator will be tested when fabrication is completed.

RL # 13-001

Completion date: Estimated 6/68



Pattern Contour for an Apollo Telescope Mount Telemetry Antenna panel

Packaging Design for the Charger Battery Regulator Module (CBRM)

Performed the packaging design and documentation of the ATM CBRM, which included engineering design, drafting, and checking. The packaging design required compliance with the Environmental Design and Qualification Test Criteria for ATM Components specification. The purpose of the CBRM is to provide regulation, conversion, and storage of solar-cell power to the ATM while in an earth orbit.

RL # 10-006

Completion date: 11 68

S-Band Helical Array Antenna

Designed a S-band helical array. The array consists of a single helix. with a gain of 8 db. mounted upon a common base plate. adjacent to an array of four helices. The array has a gain of 12 db. The dual gain feature was utilized to provide hemispheric earth coverage from an altitude of 8.000 to 23.000 statute miles. A coaxial switch directs the rf signal to either antenna radiator. A four helical array was used for the high gain radiator because of antenna height restrictions on the Saturn V Instrument Unit. A laboratory model verified the design dimensions. A shop prototype was fabricated from design drawings. Qualification tests to flight certify the antenna were performed and the qualification test report published.

RL # 16-012

Completion date: 10/66

Power Control and Monitor Panel

A control panel. for monitoring and controlling the generation and distribution of ATM electrical support equipment power. is currently in the preliminary stage of development. The subsystem will simulate the ATM solar sources and control the Charger-Battery-Regulator Modules (CBRM) during ground checkout. The control panel also has override control capability for controlling the switch selector encoded assembly.

RL # 09-003

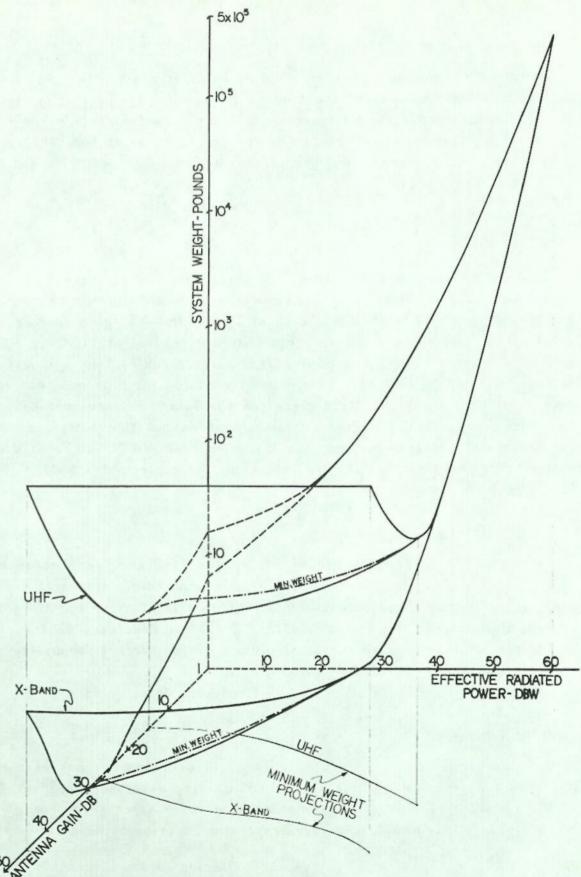
Completion date: 2/68

Solar Simulator

A solar simulator, for testing solar cell performance, has been engineered and designed for use in the ATM quality assurance program. The simulator tube, capable of illuminating a 24-by 26-inch area, has a 100 mw cm 2 intensity capability at any temperature setting between $10^{\rm o}$ and $90^{\rm o}$ Celsius.

RL # 10-022

Completion date: 11 67



Satellite Television Transmission System Weight Hypersurfaces - system weight trends as a function of antenna gain and effective radiated power.

Portable Solar Reflectometer

A portable solar reflectometer for measuring reflective property of materials in space is currently under development. The instrument will make measurements over a wave-length range of 2500 Å to 2.5 microns in eleven bands. Data obtained from measurements is to be recorded on a magnetic tape recorder, which is an integral part of the reflectometer. The purpose of the reflectometer is to make reflectance measurements of paint samples and/or other materials which may be affected by the space environment. RL # 16-027

Advanced Optical Communications Systems Research and Development

Research in this area involves state-of-the-art theoretical and experimental studies of visible and infrared laser systems, with an aim to the eventual development of a deep-space laser communications link. Included in this program are projects that involve laboratory photomixing experiments, beam steering and alignment technique studies, the design and testing of signal processing and information retrieval electronics, laser stability and control studies, and the development of transmitting optical systems.

RL # 01-001

Completion date: This is a continuing program.

Advanced Optical Tracking Systems Research and Development

Under this program, research and development is being conducted on a precision optical tracker that utilizes a visible laser transmitter for monitoring the elevation and azimuth angles, angular rates, range, and range rate of a spacecraft during the critical launch phase which occurs immediately after liftoff. Current activity in this program involves the prototype development of laser amplitude modulations, modulator drivers, and diverse detection and demodulation electronics.

RL # 01-002

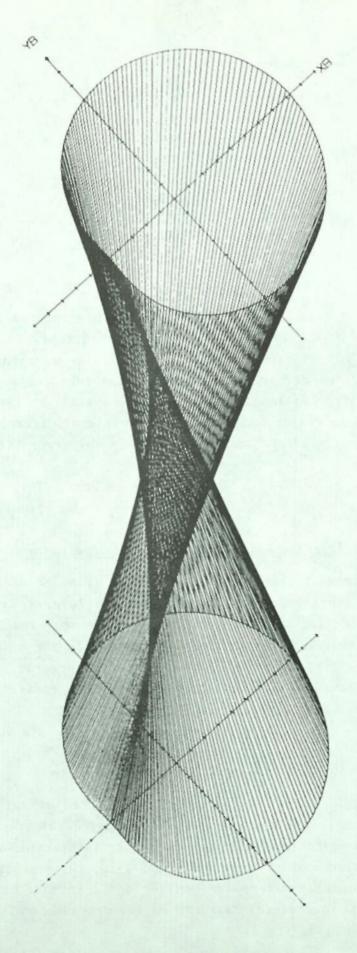
Completion date: 4th Quarter/68

Gas Laser Research

This research and development program is directed at optimizing the parameters of gas laser photomixing systems for potential use in tracking and communication applications. Current program activities include projects involved in the measurement of laser mode stability, the prototype development of scanning interferometers for monitoring laser mode patterns, and the experimental and theoretical research on the dependence of photomixing on optical path length difference.

RL # 01-003

Completion date: This is a continuing program.



reflective elements of the telescope - hyperboloid tilted 3 arc seconds Distortion in ray bundle introduced by alignment inperfections in the with respect to the optical axis.

Laser Atmospheric Propagation Studies

These studies involve the experimental and theoretical research on the random phase variations in laser radiation during long-distance atmospheric propagation. Activities are oriented to the design and development of a laser system that is to be employed in the measurement of the phase variations of an amplitude-modulated laser beam as it traverses various atmospheric path lengths.

RL # 01-005

Completion date: This is a continuing program.

Optical Component Development

This R&D effort is organized to provide optical systems-components integration and correlation technology. The program consists of an optical systems design study that is being conducted in conjunction with an optical components design and development activity (mirrors. lenses); which in turn results in the integration of the individual components into complex optical systems. A current design and development project is to design large f-number lenses with minimal low-order Seidel abberations.

RL # 01-004

Completion date: This is a continuing program.

Advanced Semiconductor Memory Devices Research

Theoretical and experimental research studies into the use of a metal-insulator-semiconductor (MIS) device, as a bistable active memory element, were performed. The device utilizes the tunneling effect between the semiconductor and the insulator to store trapped charges.

RL # 01-009

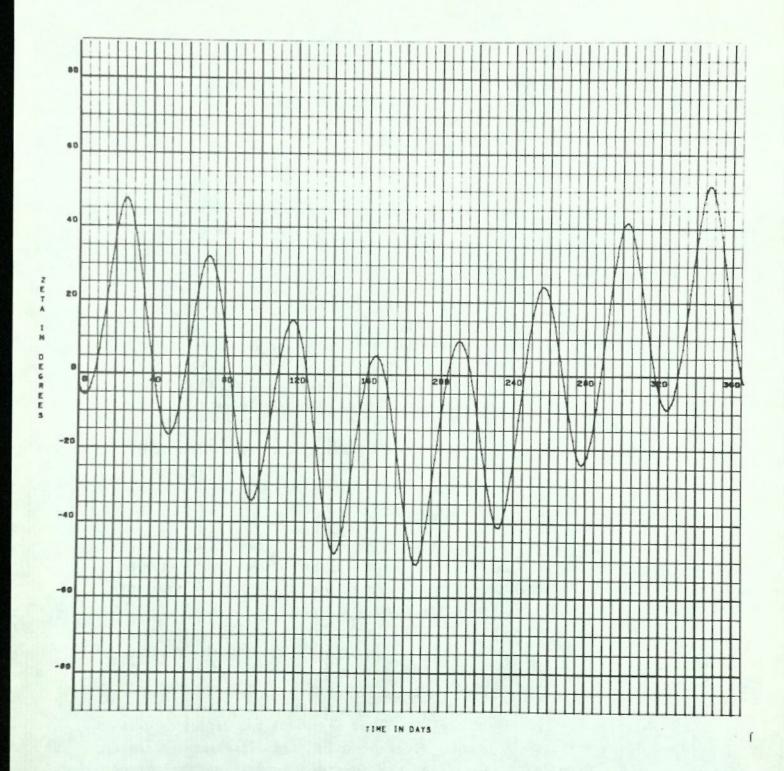
Completion date: This is a continuing program.

Advanced Semiconductor Materials Research

Research studies involve state-of-the-art epitaxial and diffusion techniques. Current research includes development of deep diffusion for power transistors, deposition of silicon nitrides and oxides, and epitaxial growth of semiconductor materials.

RL # 01-006

Completion date: This is a continuing program.



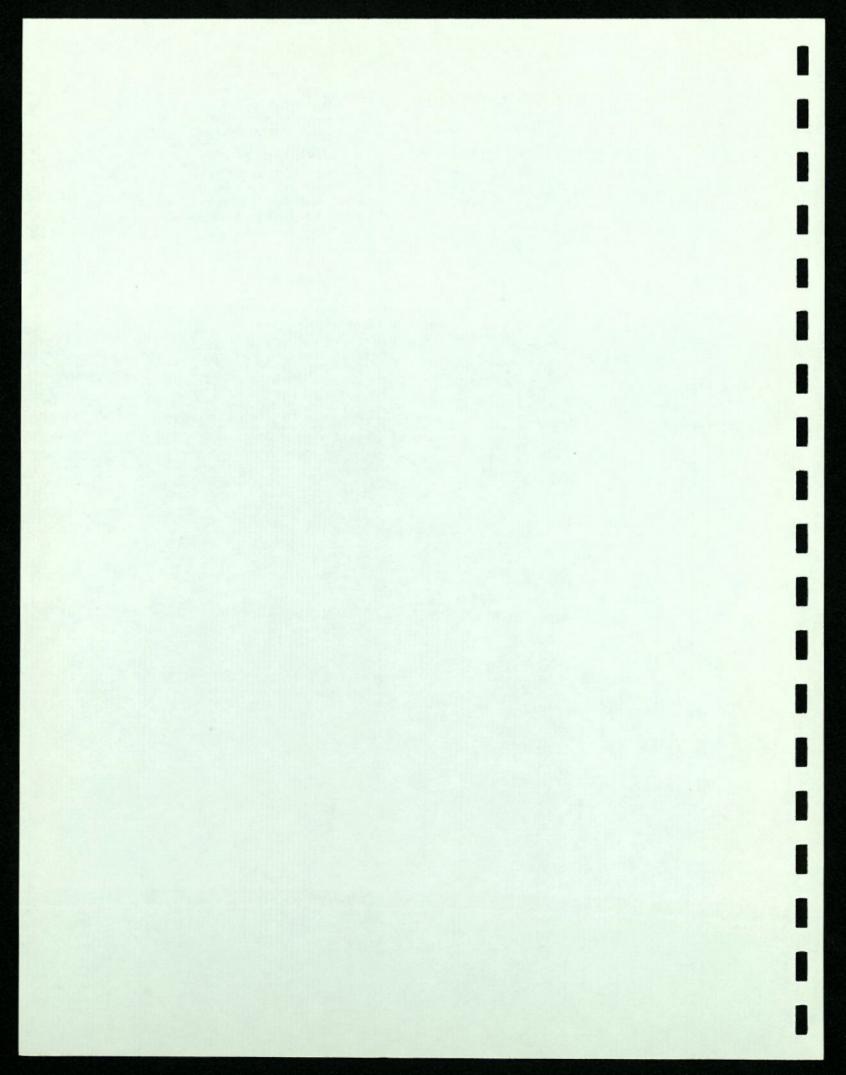
The Zeta angle versus time plot depicts the angular change the solar vector makes with its projection on to the orbital plane during a one year period. The high frequency variations are caused by orbital regression while the low frequency - I cycle per year - variation is caused by the earths journey about the sun. The inclination of the orbital plane referenced to the equator for this plot is 28.5 degrees.

Non-linear Magnetics Memory Research and Development

This research effort is involved with state-of-the-art studies of magnetic thin-film memory materials and device techniques. Areas researched include magnetic material properties, techniques of deposition, and the development of advanced memory systems.

RL # 01-008

Completion date: This is a continuing program.

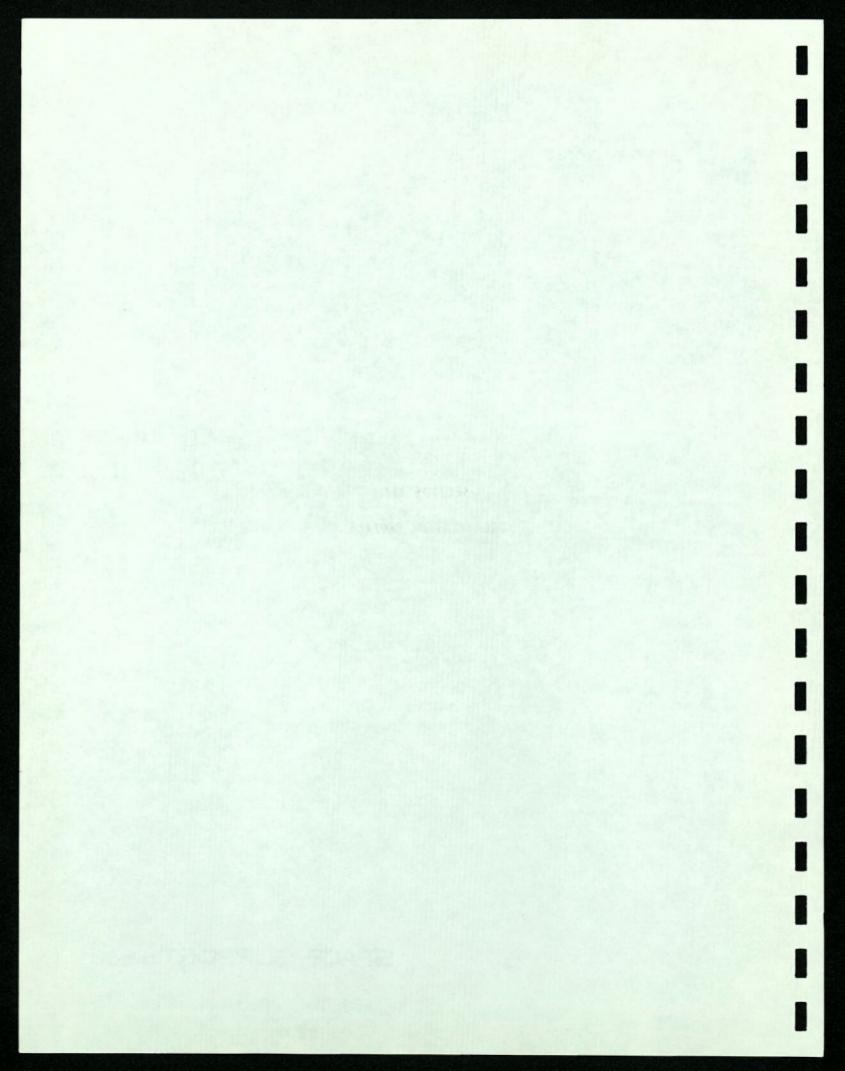




SECTION III

ORGANIZATION PROFILE

SPACE SUPPORT DIVISION



III. ORGANIZATION PROFILE

The Space Support Division is an operating unit of the Sperry Group of the Sperry Rand Corporation as illustrated in figure 1. The division was founded in Huntsville. Alabama in 1965 to support the National Aeronautics and Space Administration. George C. Marshall Space Flight Center. Astrionics Laboratory. In all technical disciplines. The Space Support Division is fulfilling its mission by designing and producing, to the exacting requirements of the Astrionics Laboratory, many complex systems in support of the Apollo Telescope Mount, Orbital Workshop and Saturn/Apollo programs. The division is also furnishing spacecraft reliability and test engineering services to the Goddard Space Flight Center. In addition, a contract was recently signed with the Army Corps of Engineers that requires the application of aerospace technology to the tactical facilities of the SENTINEL Anti-ballistic Missile System.

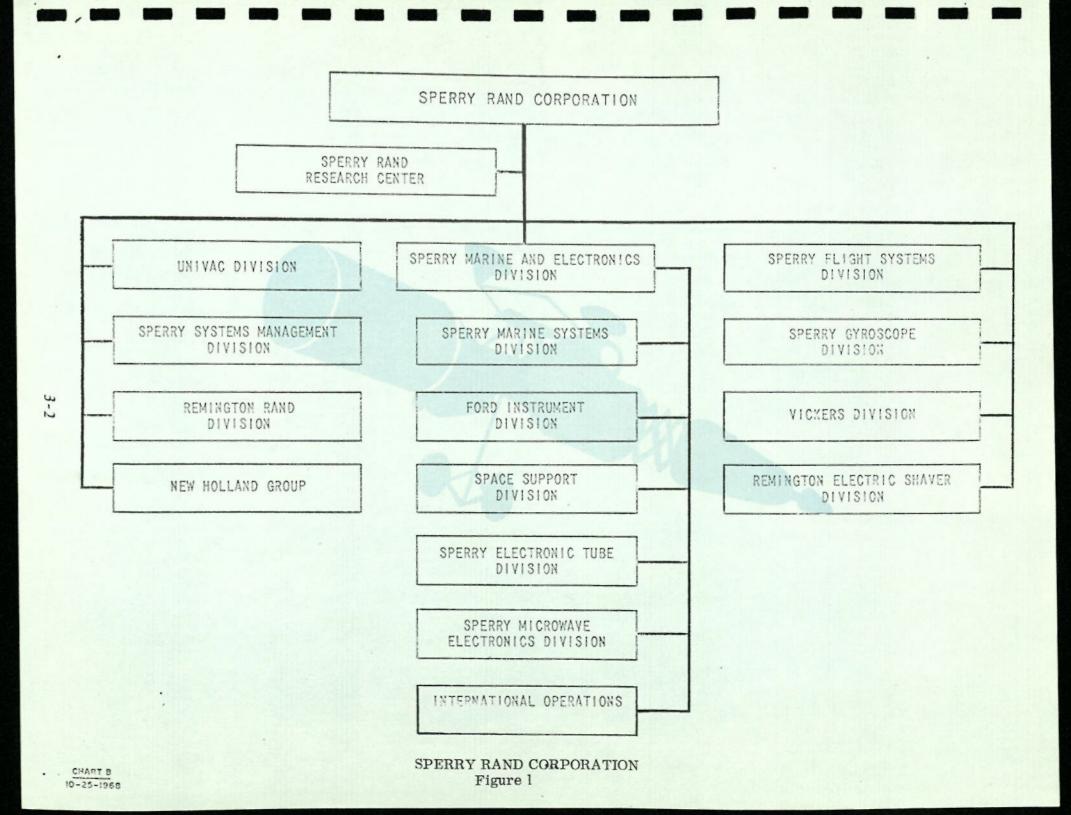
From July 1966 through June 1968 the Space Support Division furnished engineering services to the Jet Propulsion Laboratory for the design of spacecraft and spacecraft systems.

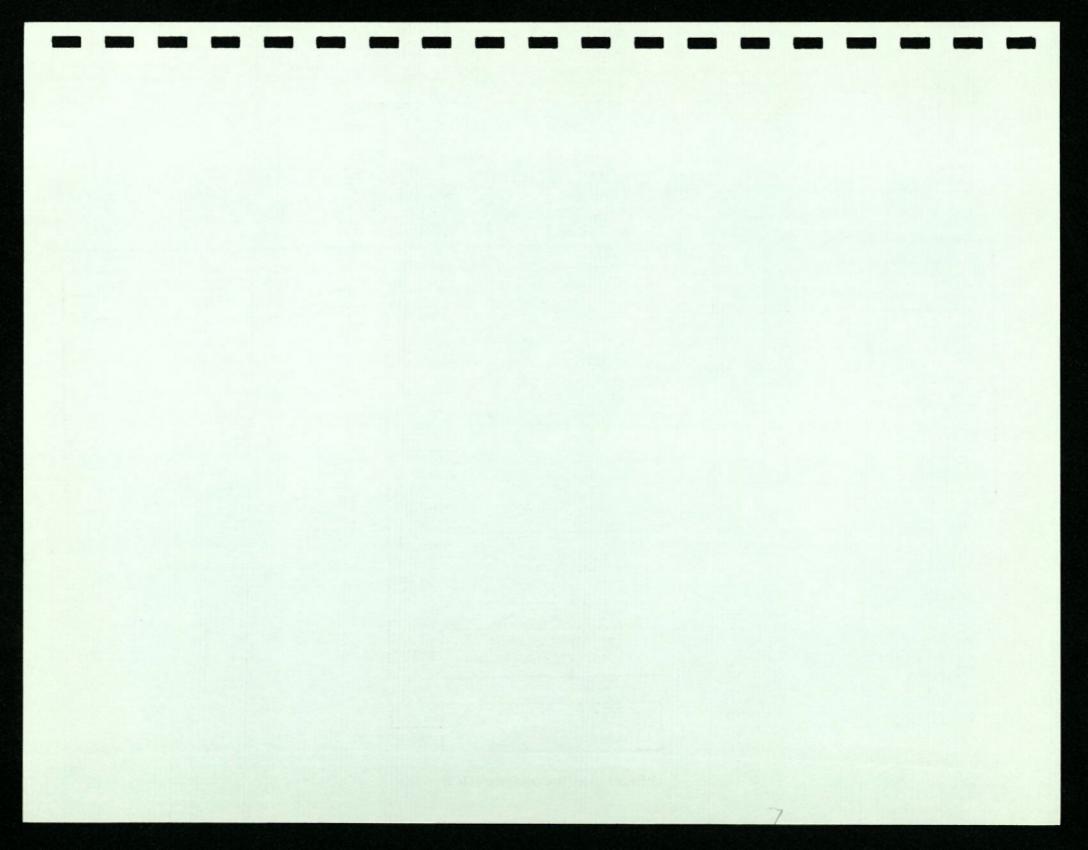
FACILITIES AND STAFFING

The staff of the Space Support Division is currently at the level of 840 employees. This staff includes 600 employees working in direct support in facilities of the Marshall Space Flight Center (MSFC) Astrionics Laboratory in Huntsville, Alabama. There are 235 employees working in direct support of the Goddard Space Flight Center in Greenbelt, Maryland. A substantial portion of our employees are housed in Space Support Division facilities in Huntsville, Alabama, consisting of three buildings containing 53,000 square feet of floor space. These facilities provide administrative, engineering, laboratory, and prototype manufacturing areas.

The engineering area includes a well-equipped laboratory in which experimental and prototype models are developed and tested.

A Sperry Rand Corporation computation facility is located near the Space Support Division engineering facilities. A Univac IIO8 computer is available to support simulation requirements, data reduction, and budget and payment records.





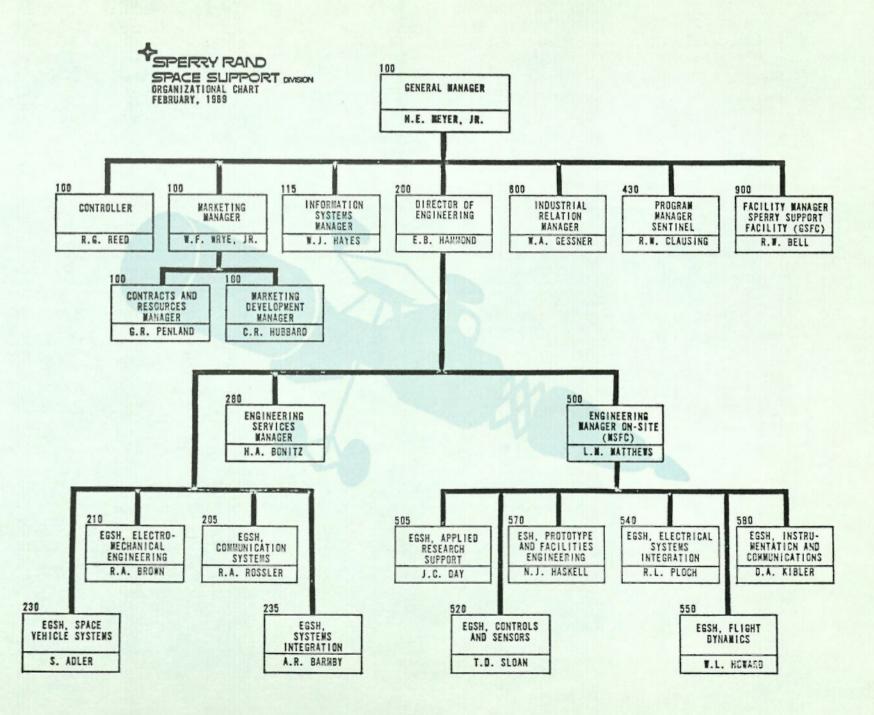
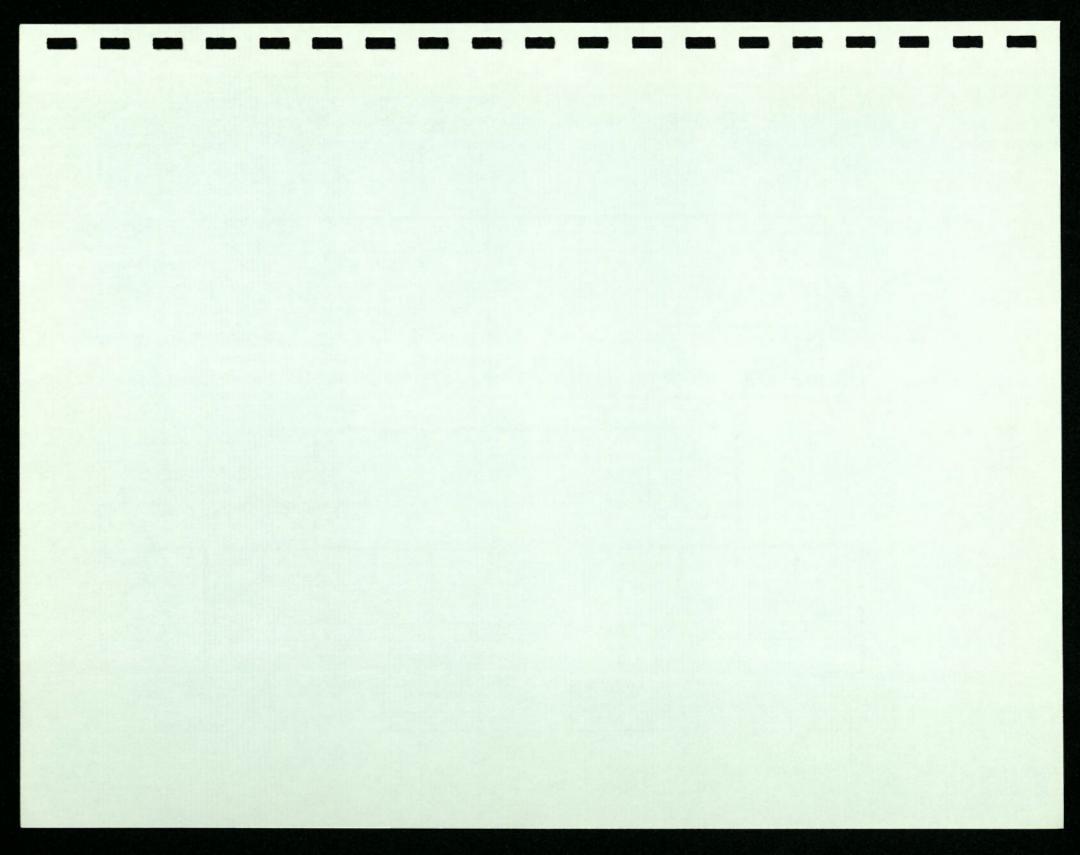


Figure 2. Space Support Division



ENGINEERING

Approximately half of our engineering employees located in Huntsville. Alabama are engaged in on-site support of the Astrionics Laboratory. The remainder of the Engineering Department employees occury 23.300 square feet of the Space Support Division facility. This staff includes engineering and scientific employees responsible for study, development, test and documentation work related to Space Support Division programs. An engineering design department provides design and drafting for development engineering groups. The engineering staff includes two doctorate degrees, approximately fifty masters degrees, over two hundred bachelor degrees and over one hundred associate degrees.

PAST PERFORMANCE

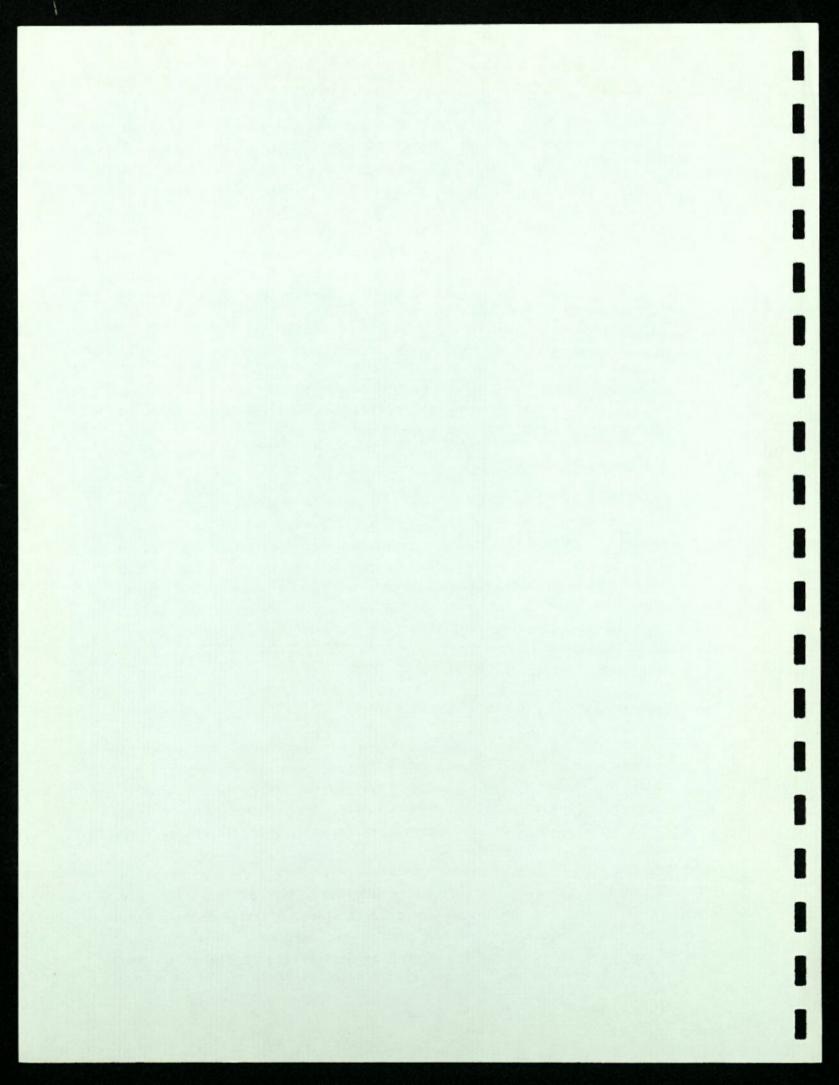
Sperry Rand Space Support Division for the past three years has achieved a technical performance rating of excellent or better, and a technical management rating of superior on support services contracts.

COST REDUCTION AND CONTROL

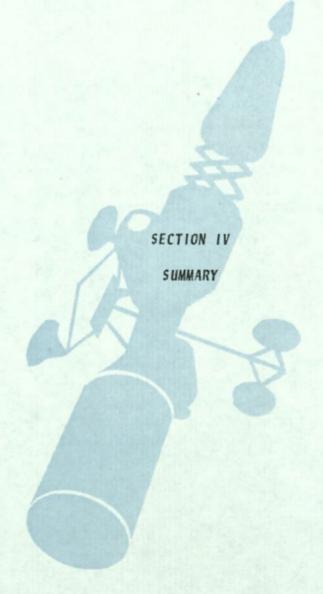
Sperry Rand Space Support Division is currently involved in an effective cost reduction program (ORBIT) in which all employees are consistently urged to participate. This program meets the cost reduction guidelines as set forth by both DOD and NASA. The program is coordinated by an assigned individual and is guided by an established procedural manual which complies with both government and corporative guidelines. In the 2 1/2 years since its inception, a gross savings of \$1.170,134 has been reported. Through February 28, 1968, 538 suggestions have been submitted representing an employee participation of 66%.

PROJECT MANAGEMENT

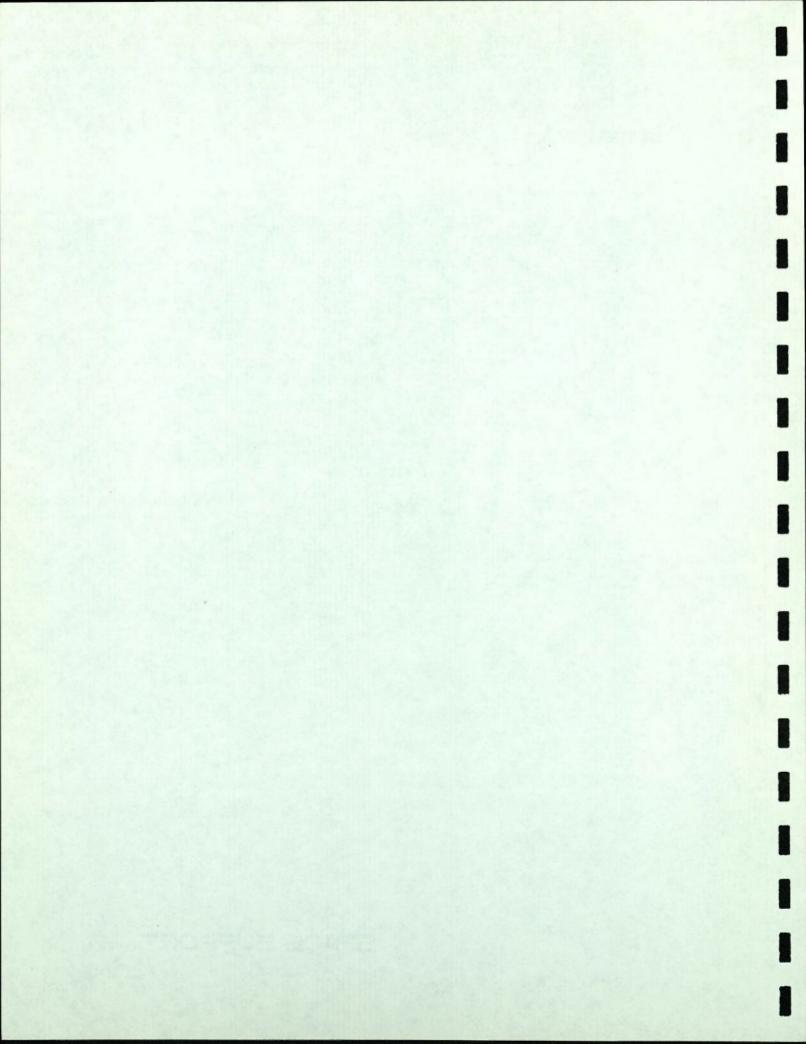
The Space Support Division has developed a project management point-of-view as the result of its three and a half years experience in support of aerospace agencies and has evolved an organization geared to the achievement of project goals on time. Within budget, and Within predetermined performance specifications. The management techniques developed cover the planning. control. and supervision of engineering and design resources and include the whole range of systems engineering, project control. configuration and data management. test. and procurement. The result is the integration of the several functional departments of the division into a total management system. Each contracted task is assigned to a project manager who assumes complete responsibility and accountability to divisional management and to the customer for successful accomplishment of the program.



SPERRY RAND



SPACE SUPPORT DIVISION



IV. SUMMARY

The qualifications, facilities, and capabilities of Sperry Rand Space Support Division may be summarized as follows:

Personne l	840 total	-	of	which	40	percent	are	engineers.
						1	***	engineer s.

Facilities	53.000 square fee	t of	modern	well	equipped	fa-
	cilities.					

Quality	Dedicated by policy and practice to the highest
	attainable level of quality control consistent
	with the cost aspects of the program. Experi-
	enced in complying with DOD and NASA quality
	specifications.

Controls	A modern UNIVAC 1108 computer is utilized in
	the management of man-hours schedules and cost
	control.

Experience	Proven success on support services contracts
	for the Astrionics Laboratory, George C.
	Marshall Space Flight Center; Jet Propulsion
	Laboratory and Goddard Space Flight Center.

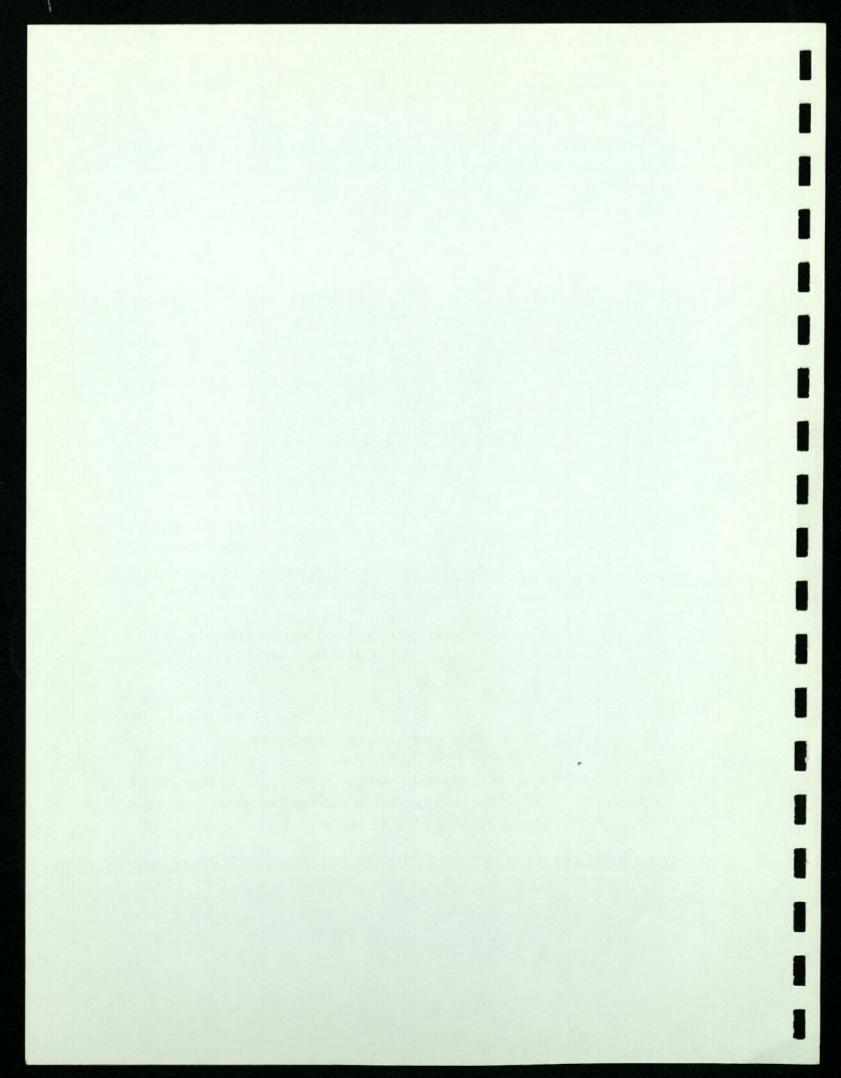
Security	Secret facility clearance granted by Defense
	Contract administrative services region, At-
	lanta, Georgia

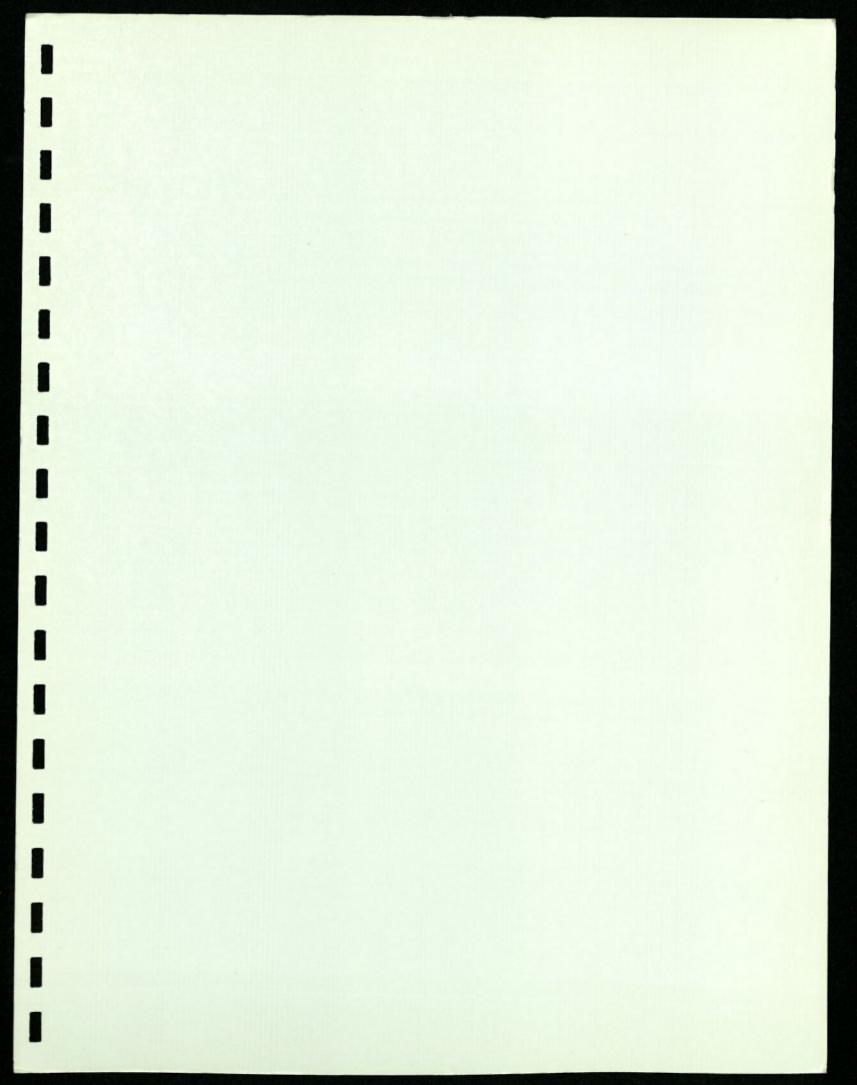
Cost Savings	Gross savings of \$1,170,134 in 2 1/2 years with
	66 percent employee participation.

Additionally, through the corporate policy of synergistic operations, the Space Support Division can draw on all corporate resources when technical consultation, manpower, or equipment are needed.

1

I





DESIGN . DEVELOPMENT . STUDIES .

ENGINEERING SUPPORT

- * RANGE INSTRUMENTATION
- ♦ AUTOMATIC CHECKOUT
- ♦ GUIDANCE AND CONTROL SYSTEMS
- **♦** TELEMETRY
- ♦ ELECTRONIC POWER SYSTEMS
- **♦** CONFIGURATION MANAGEMENT
- ♦ FLIGHT DYNAMICS AND SIMULATION
- * ELECTRICAL AND ELECTRONIC SYSTEMS
- ♦ SPACE AND SATELLITE COMMUNICATIONS
- * NAVIGATION SYSTEM ANALYSIS
- * RELIABILITY ANALYSIS

FABRICATION

