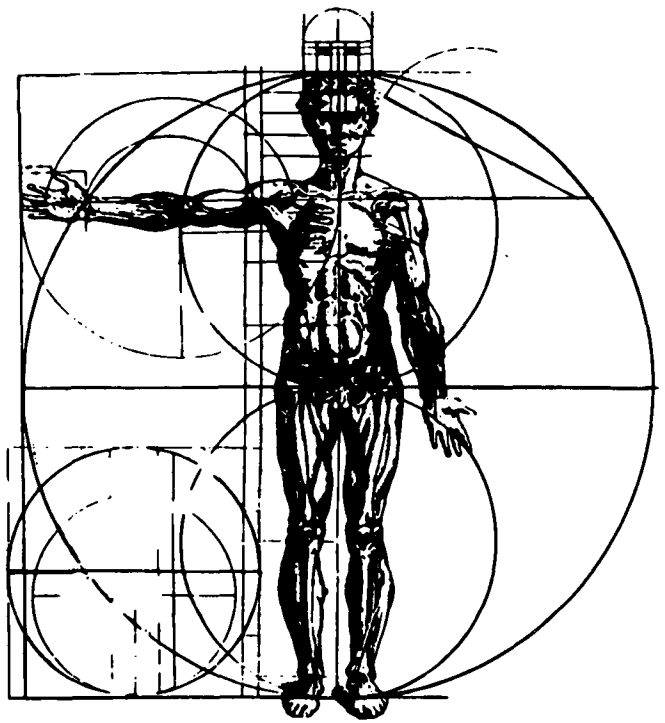
FINAL REPORT



HABITABILITY STUDY
EARTH ORBITAL SPACE STATIONS

JANUARY 1972/JUNE 1972

PREPARED FOR **NASA** BY
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DRA

FORWARD

This report covers work accomplished by Raymond Loewy/William Snaith, Inc. from January 1 through June 30, 1972 for the National Aeronautics and Space Administration at the Marshall Space Flight Center, Huntsville, Alabama, under Contract NAS8-28362.

Specifically, our work has been primarily aimed at supporting the Shuttle Payload Carriers, such as, the Sortie Carrier and RAM. The nature of the services provided is in the form of sketches, renderings, scale models, full scale mock-ups and reports required to fully explain the design recommendations.

TABLE OF CONTENTS

SECTION A

TASK — Develop a cosmetic exterior for the man/systmes Payload Carrier Simulator.

CENTER — MSFC - H. Watters

DATE ASSIGNED — January 10, 1972

PARAMETERS

1 — The basic simulator structure must be maintained.

2 — All electrical equipment must be easily accessible.

3 — The treatment must not impair safety regulations.

4 — The treatment will be executed in three phases of development.

TASK OBJECTIVES — To design an exterior which compliments the interior of the simulator, is easily maintained, and provides for traffic flow for visitors without disturbing the on-board crew.

SCHEDULE — Preliminary concept sketches were presented on February 16, 1972 with a final presentation of a scale model on March 14, 1972.

ANALYSIS OF EXISTING WORK — The Payload Carrier Simulator -PCS- is located in Building 4619 in which several development mock-ups exist, similar in size and shape as the PCS. The study mock-ups are painted plywood and are far more pleasing in appearance than the PCS, the only finished working structure in the group.

1 The entire structure is covered with 3'X5' panels of PVC and taped at the seams causing a warped surface and an untidy appearance.

2 The windows and equipment airlock are too high to see into, and difficult to pass equipment through.

3 The electrical equipment -circuit breakers, etc.- is placed in a location which would be a possible danger for visitors

4 The random location of the windows and stanchions disrupt the continuity of the cylinder.

OUR APPROACH
FIGURES A1 - 5

It is our intention to make the PCS stand out visually and appear to be the finished product to which the development mock-ups contributed We established the following requirements:

1 A platform should be placed on the equipment airlock/emergency exit side to better serve those functions and to control the traffic flow of visitors.

2 The platform should be carpeted to reduce the amount of dirt that could be tracked into the simulator and to absorb sounds made by the observers that might disturb the crew.

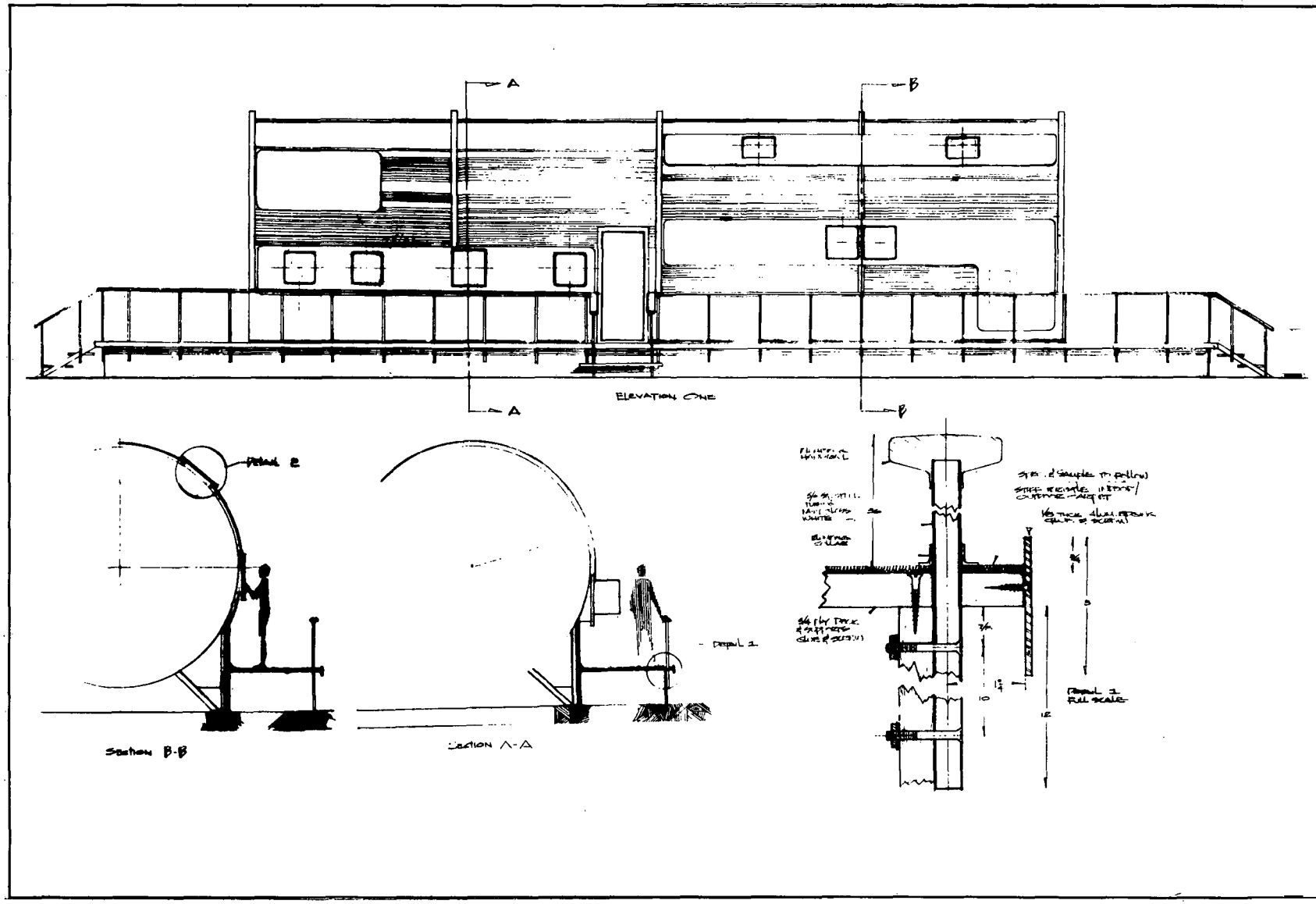
3 Cover the cylinder stanchions and electrical equipment boxes.

4 The PVC panels should be covered with a textured material

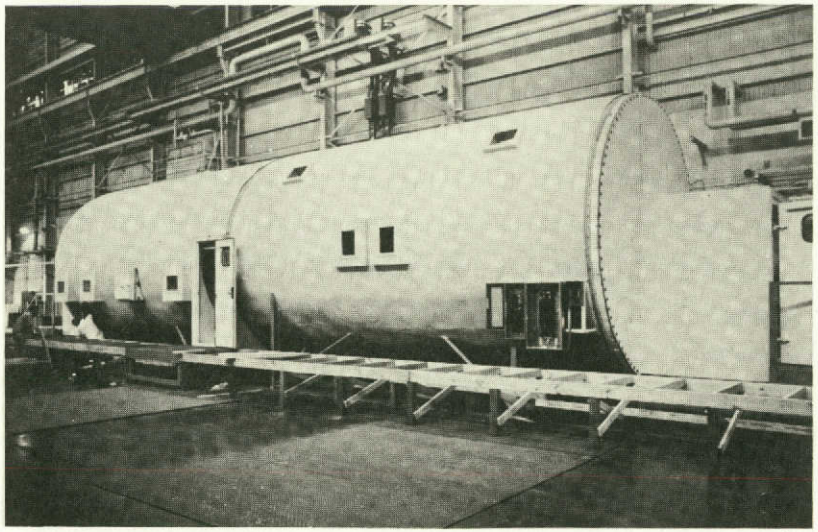
5 Visually tie the windows together to arrive at a logical order that reflects the interior arrangement.

DESCRIPTION

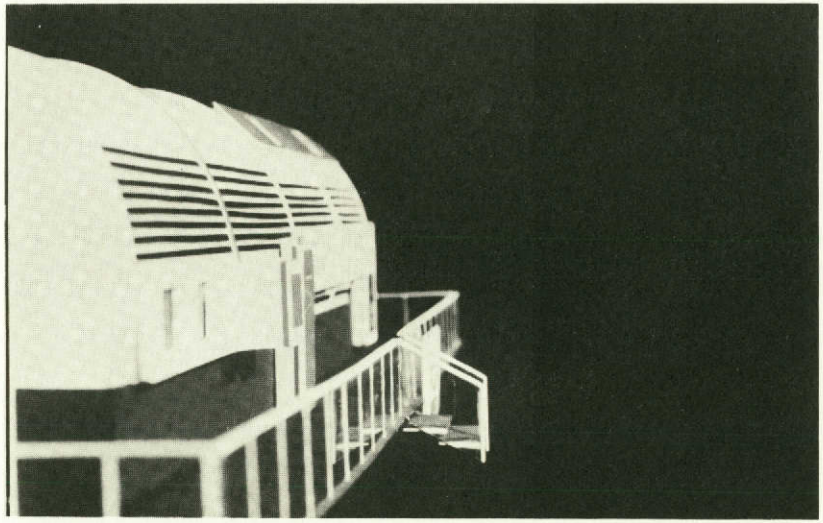
The catwalk platform runs between the two entrances at each end longitudinally along the front where the equipment airlock and emergency exit are located. The entire platform and stairs at each entrance/exit is covered with blue carpet which runs up to the window line. Each window group is covered with a plywood facia which runs half the length of the cylinder. The PVC is painted with white laytex texture paint, and wooden strips painted black are applied longitudinally at random to accentuate the horizontal silhouette. Red is used randomly as an accent color.



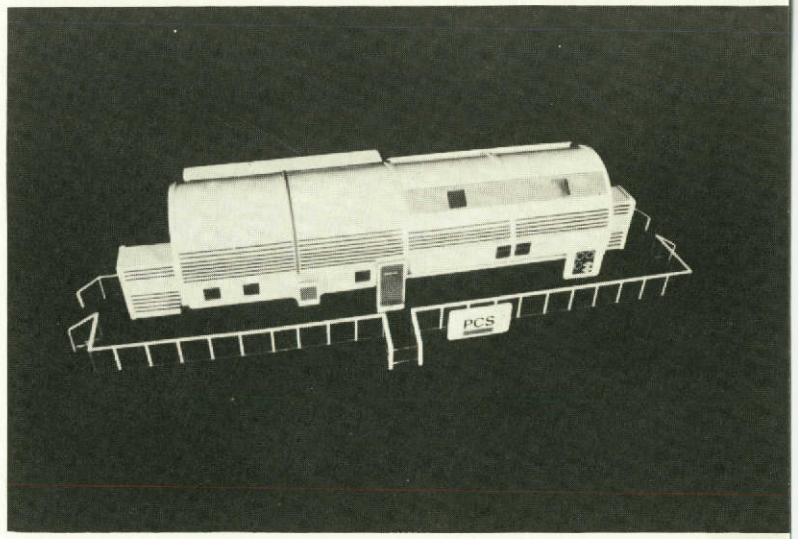
A1 - Drawing and Detailing of Cosmetic Treatment for the PCS Exterior



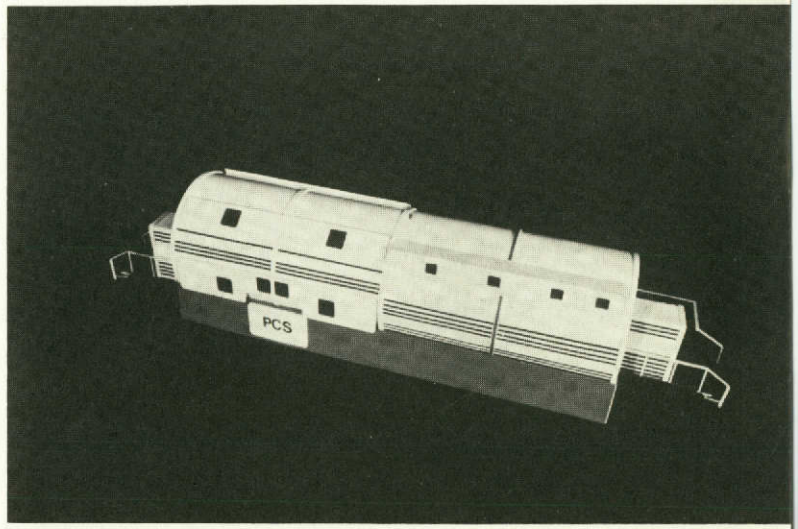
A2 - Existing Payload Carrier Simulator



A3 - 1:20 Scale Model of PCS Showing Completed Exterior Renovation



A4 - Front View of Scale Model of PCS



A5 - Rear View of Scale Model of PCS

SECTION B

TASK	To develop a crew quarters for the RAM Sortie program.
CENTER	MSFC - H. Watters
DATE ASSIGNED	February 2, 1972
PARAMETERS	An eight foot long by thirteen feet six inch diameter cylinder will be the maximum volume used for the crew quarters.
1	The RAM Sortie is zero gravity oriented.
2	The crew quarters should accommodate four men for seven days.
3	It should include a head and galley accommodating 28 man days.
4	An entertainment console should be included.
5	Two concepts should be explored:
	a Utilize the shuttle launch couches and
	b Individual staterooms.
TASK OBJECTIVES	Development of interior arrangements that will be attractive, comfortable, offer some degree of privacy, and be easily maintained.

SCHEDULE

Preliminary concept sketches and scale models were presented on February 17, and during the week of March 13, 1972, a full scale foamcore and plywood mock-up was installed in Building 4619 at MSFC.

ANALYSIS OF EXISTING WORK

None.

OUR APPROACH PHASE I FIGURES B1 - 6

Interior arrangements were studied first in conceptual sketches and then translated into 1:20 scale models.

SCHEME A FIG. B3 AND B4

Scheme A is a transverse deck layout using the shuttle orbiter launch couches. The four couches are placed in one-half of the cylinder, perpindicular to the floor. Each crew member, one per couch, has two storage lockers for clothing and personal articles. It is possible to achieve privacy by pulling a curtain out from the storage walls to the couch. The couches are gimbled so they can be oriented to give each crew member a maximum amount of openness, and environmental change.

The wardroom is in the center of the second half of the cylinder. It is possible to converse from couch to wardroom and the entertainment wall - T.V , radio, clock, etc. - is visible from any couch. The head and galley are on either side of the wardroom.

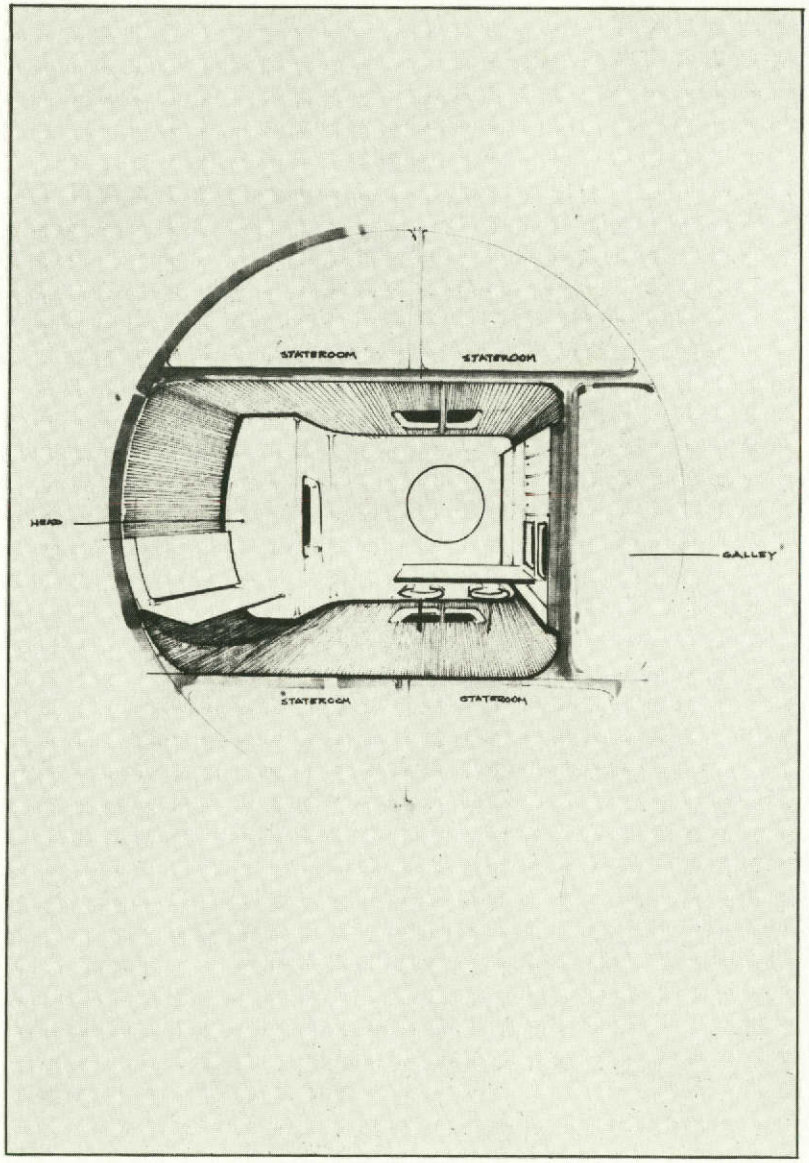
SCHEME B FIG. B2 AND B5

Scheme B is a longitudinal layout split into three levels. The lower level, half the cylinder, has the wardroom and galley. The wardroom has a four seated couch with table in front and two swivel chair restraints connected to it. Across from the couch is the entertainment wall. Below the entertainment wall is the entrance to the galley which is visually separated from the wardroom. There is a food pass-through in the entertainment wall to ease serving.

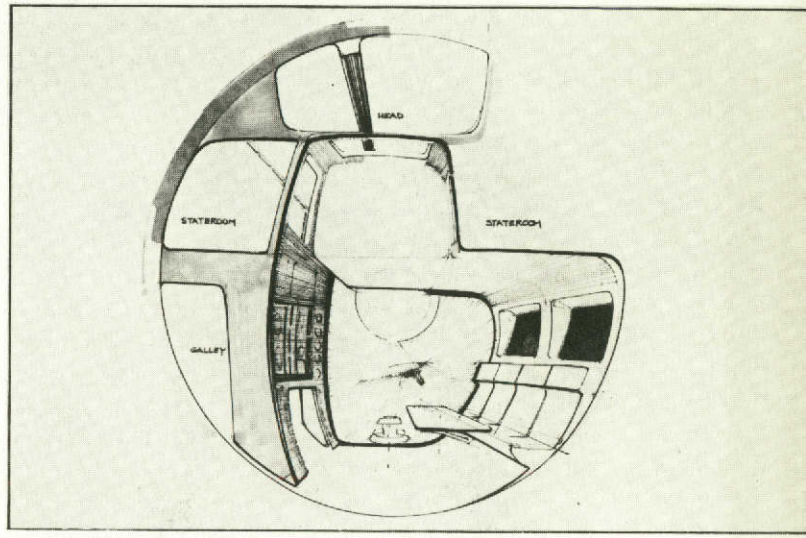
Above the wardroom and galley are four individual staterooms containing a zero gravity bunk and individual storage compartments. Two stateroom entrances are at one end of the cylinder and two at the other end. Above the stateroom entrances are the entrances to the head. This separation of entrances offers a maximum of privacy which would be a convenience with mixed crews.

SCHEME C
FIG. B1 AND B6

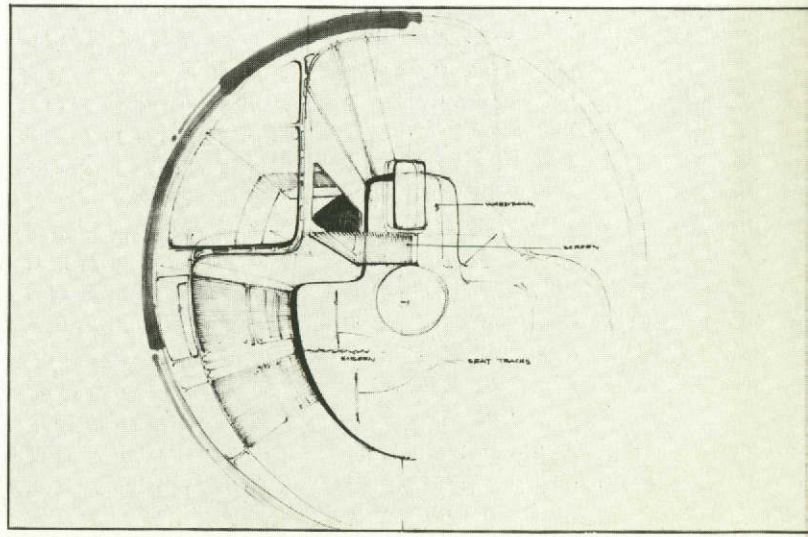
Scheme C is a longitudinal layout with the galley, wardroom and head on the central level. In the wardroom is a three seat restraint across from the entertainment wall. The entertainment wall has a food pass-through from the galley. A table with four seat restraints adjoins the entertainment wall. At the other end of the wardroom are the entrances to the head and galley and on the floor and ceiling are the entrances to the staterooms. Each stateroom has a private entrance, zero gravity bunk, and personal storage modules. Separating each pair of staterooms is a folding wall so that the space may be changed from a totally private room to a shared space.



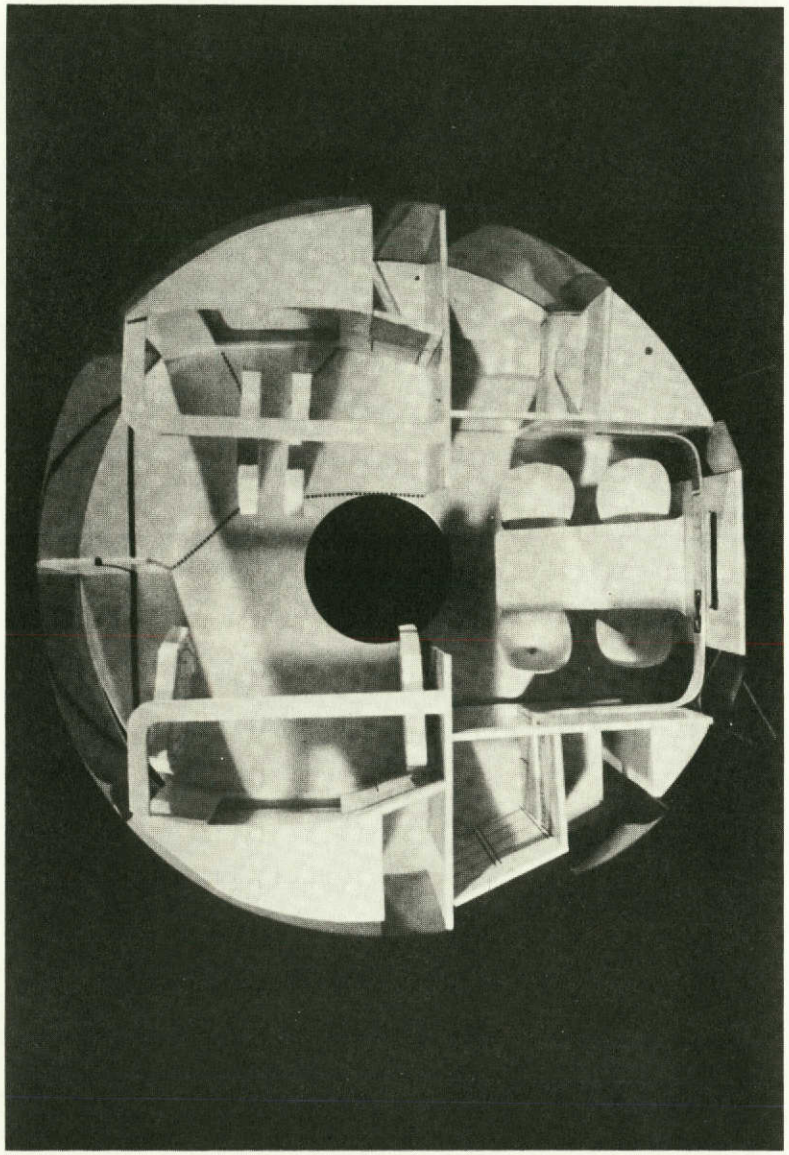
B1 - Phase I - Conceptual Sketch of Scheme C



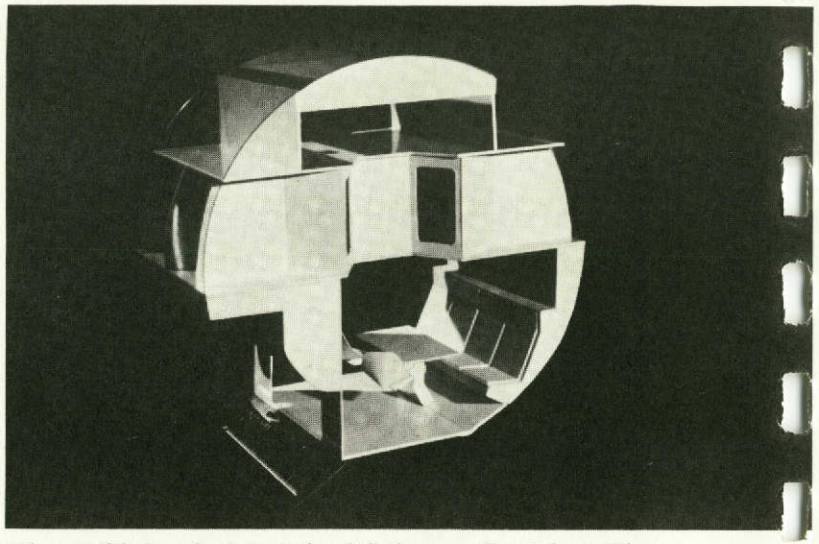
B2 - Phase I - Conceptual Sketch of Scheme B



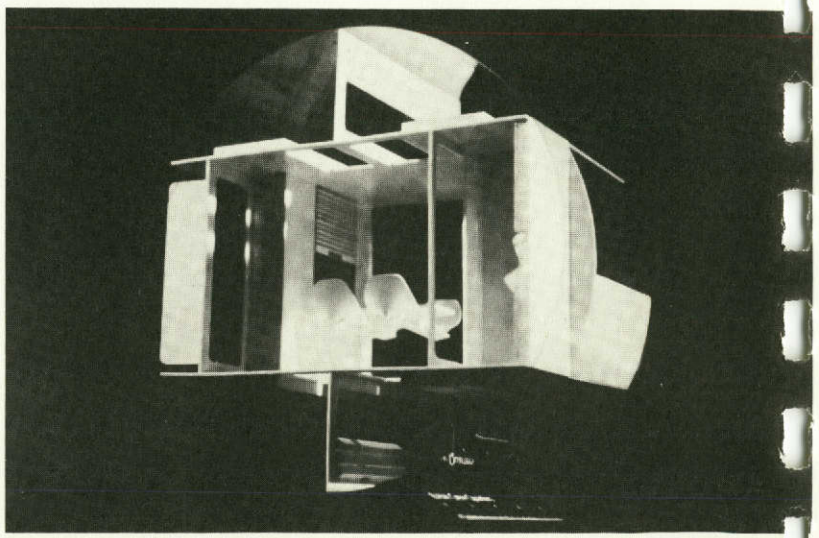
B3 - Phase I - Conceptual Sketch of Scheme A



B4 - 1:20 Scale Model of Scheme A Which Utilizes Four Space Couches



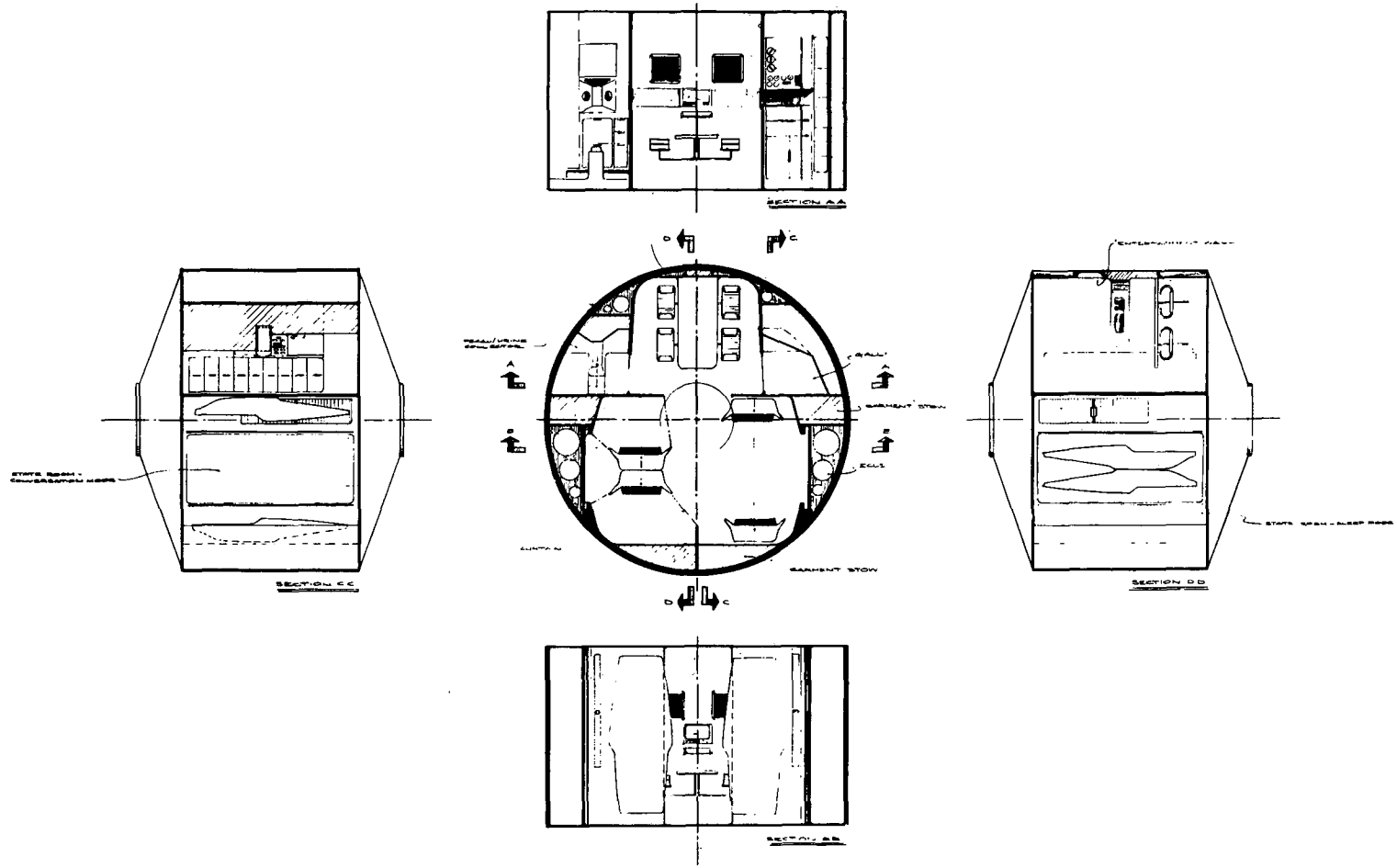
B5 - 1:20 Scale Model of Scheme B with a Three Level Longitudinal Layout



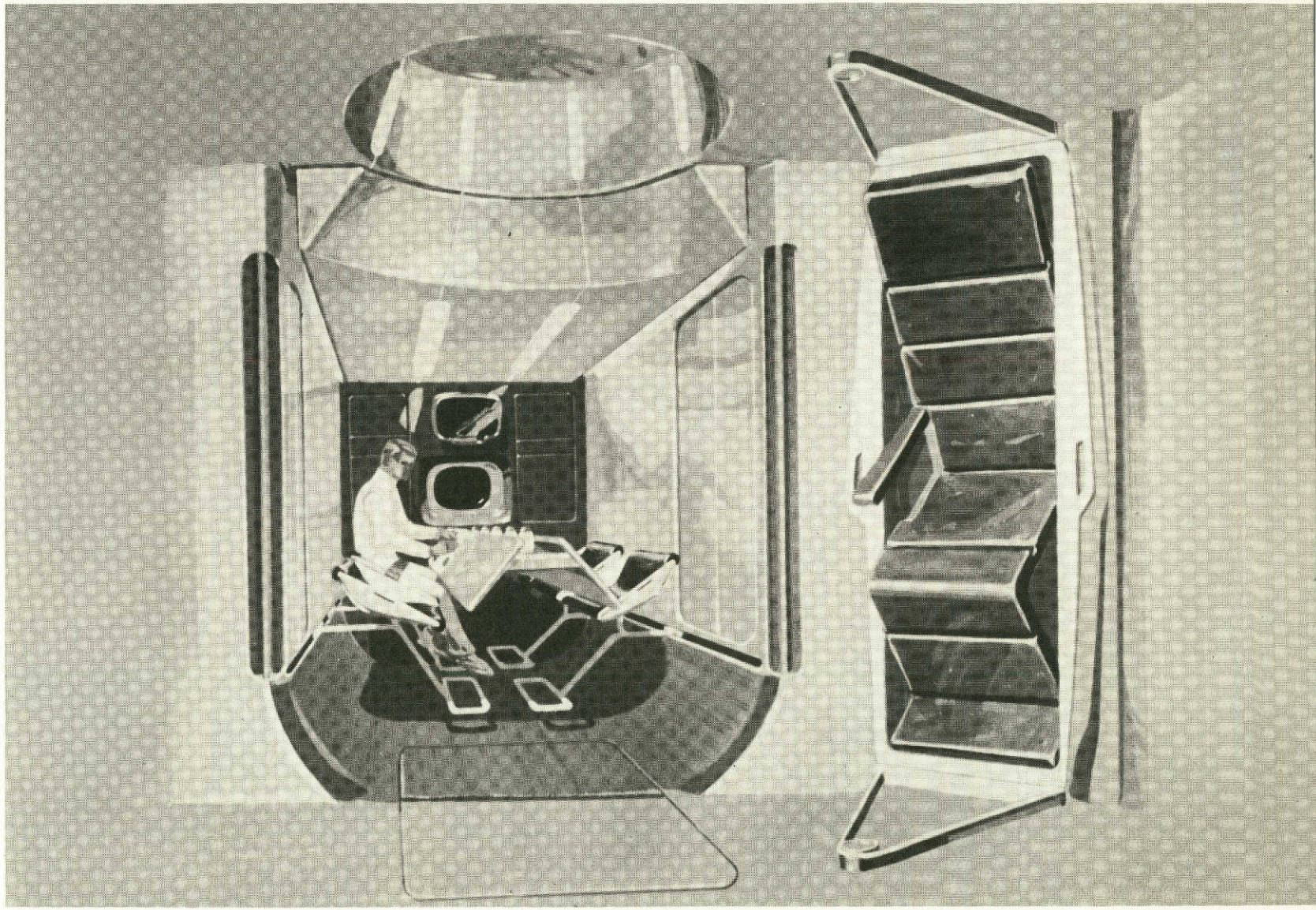
B6 - 1:20 Scale Model of Scheme C with a Longitudinal Core and the Staterooms Above and Below

PHASE II
FIGURES B7 - 12

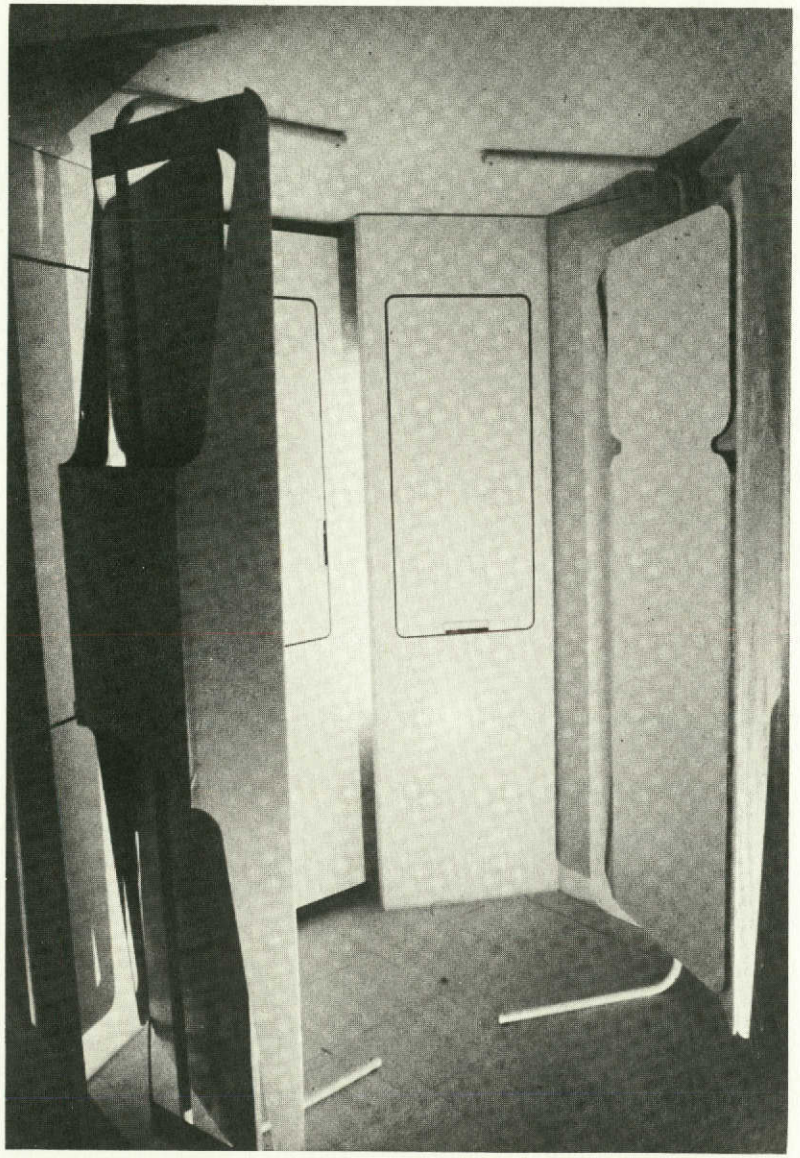
At the review of Schemes A, B and C, it was decided to construct a full scale mock-up of the RAM crew quarters based on Scheme A. Raymond Loewy/ William Snaith, Inc., built the mock-up of foamcore at the New York office and assembled it in the plywood cylinder at MSFC during the week of March 13, 1972.



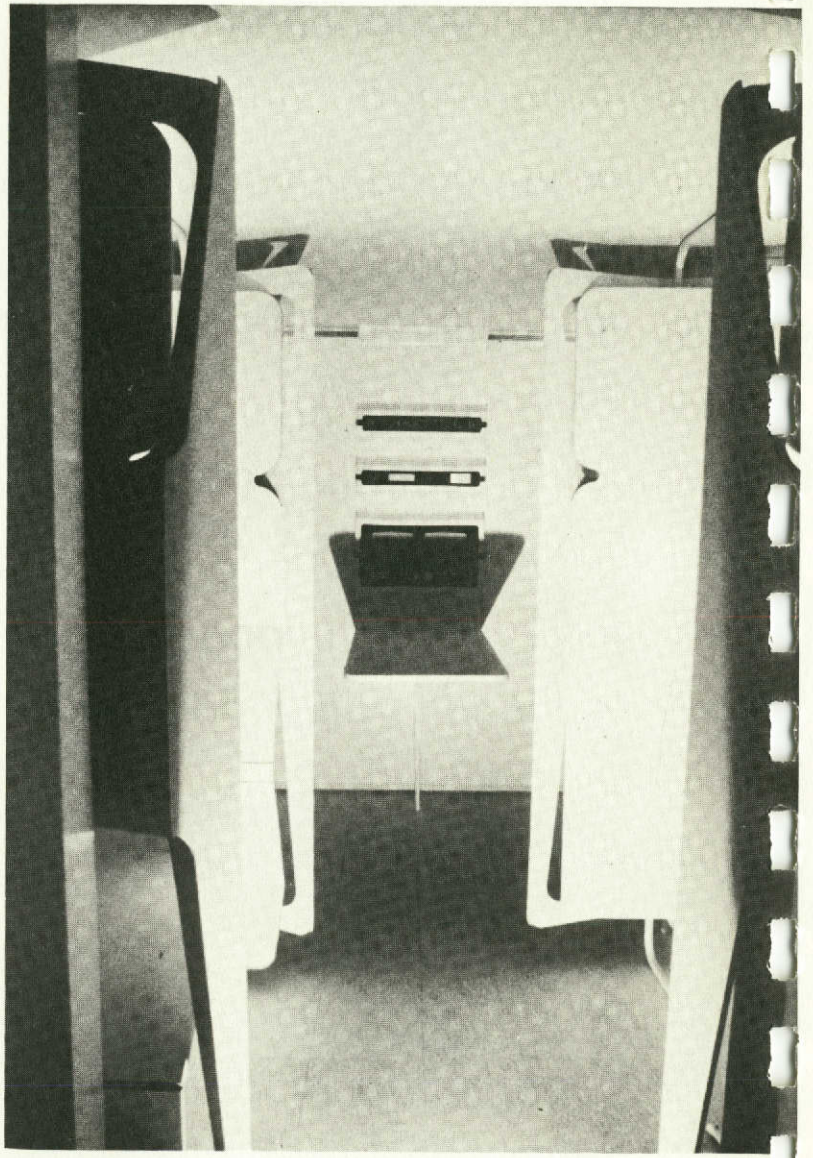
B7 - Schematic Drawing of Full Scale Mock-Up of RAM Crew Quarters



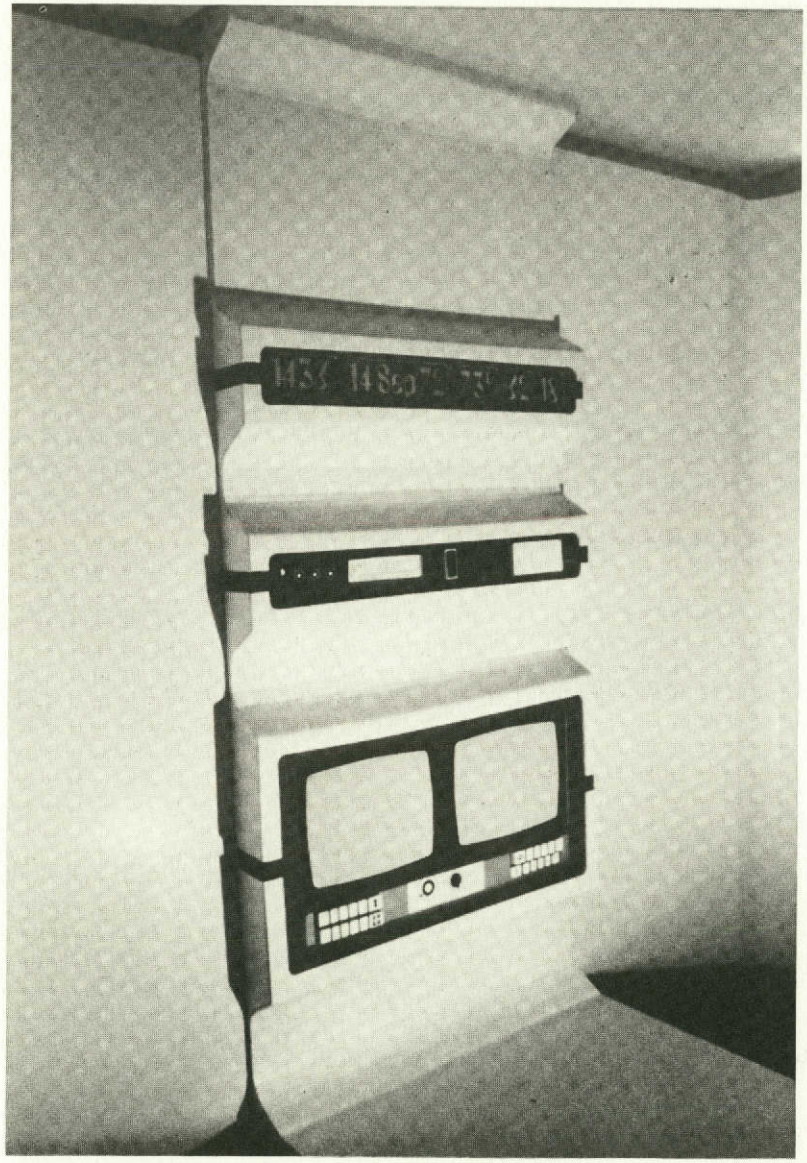
B8 - Rendering Depicting Interior of the Ram Crew Quarters. View Shows Wardroon, Entertainment Wall and One Space Couch



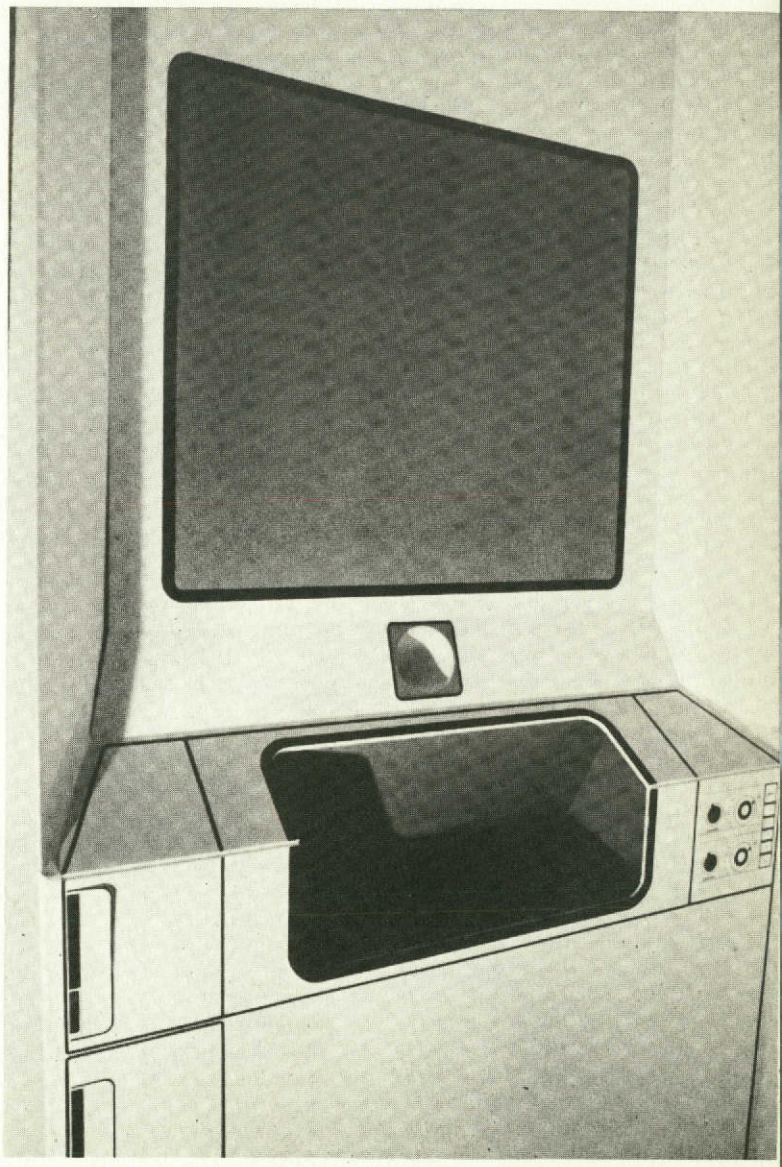
B9 - Phase II - Full Scale Mock-Up Showing Staterooms and Couches



B10 - Phase II - Full Scale Mock-Up Looking Through the Stateroom Area into the Wardroom



B11 - Phase II - Detail of Entertainment Wall



B12 - Phase II - Detail of Hygiene Area

SECTION C

TASK	Develop a zero gravity general purpose work station for the RAM Sortie Module.
CENTER	MSFC - H. Watters
DATE ASSIGNED	March 23, 1972
PARAMETERS	The work station is to be designed specifically for the RAM Sortie Program. The work station should be operative in orbit -Zero-G - and during reconfiguration - One-G -. It should be usable by more than one crewman. The work station should be made so that it can be easily updated, reconfigured or relocated. The unit should be designed for minimum cleanup and maintenance, and it should provide some portability for distant repair work.
TASK OBJECTIVES	To design and develop a Zero-G work area to be used for general maintenance and mission experiment support, the area or "work station" should contain all the tools, parts and material necessary for tasks ranging from in-orbit repair to the buildup of new hardware vital to the completion of in-orbit experiments. Figure C1 lists, generally, the provisions necessary to complete the workbench functions.
SCHEDULE PHASE I	Raymond Loewy/William Snaith, Inc. presented to MSFC, in sketch form, preliminary concepts of the overall workbench scheme and auxiliary items such as small parts storage and equipment restraints on April 13, 1972.

PHASE II — Raymond Loewy/William Snaith, Inc. constructed a soft full scale three-dimensional representation of the proposed General Purpose Workbench and presented it on May 8, 1972.

PHASE III — The completed full scale hard mock-up was installed at MSFC in the CVT on June 28, 1972.

OUR APPROACH — Our approach has been to first define the variables and components which must be provided for to evolve an efficient, effective design concept. These variables and components are:

1. User: 5 - 95% male, fixed or moveable restraint, etc.
2. Task Characteristics: Object size, torque requirements, skill level required, etc.
3. Tools and Processes Required: Brazing, screwing, filing, bending, drilling, etc.
4. Storage Requirements: Tools, spare parts, fasteners, raw materials, etc.
5. Environment: Zero-G, One-G, Light Level, etc

Once these elements have been established, the next step is to define the functional or "use" interrelationship existing between the various elements and how these relationships effeft the placement of these objects relative to man, the focal point of any task.

Generally speaking, we feel that the workbench organization, inclusive of permanent storage and temporary holding facilities as well as controls and

work surface components, should reflect logical use patterns, frequency of use of various components, and reach and sight line characteristics of the user.

Once the general organization has been determined, the individual component's concepts are defined. The following partial list of parameters pertains:

1 The components should require minimum setup and cleanup time

2 To the maximum extent possible, storage and retrieval should be a one-hand operation.

3 Storage systems should protect and hold contents during launch and re-entry.

4 Provide debris control and handling of liquids and gases - brazing and soldering.

5 Provide torque resistant method of restraining objects of various sizes and shapes.

6 Provide a forearm restraint for long term fine detail work.

7 Provide information system for repair task guidance.

8 Provide a non-restrictive personnel restraint system - up to two people.

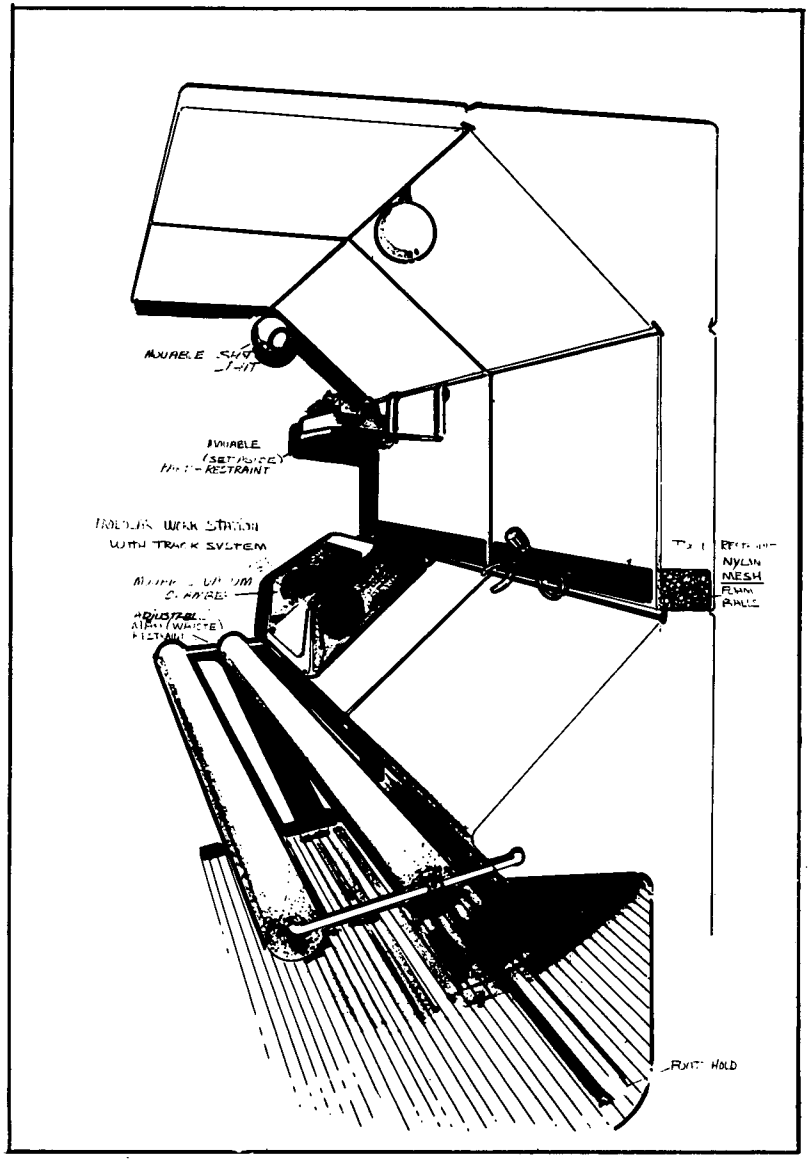
DESCRIPTION
PHASE I
FIGURES C2 - 12

Preliminary Concept Development:

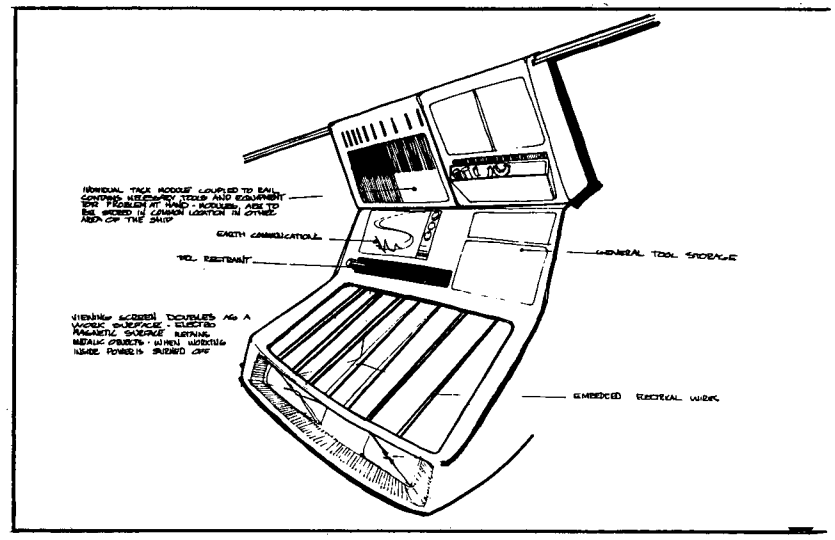
Raymond Loewy/William Snaith, Inc. first explored the design of the workbench with conceptual sketches. Figures 2, 3, and 4 are conceptual sketches of the overall workbench. Figures 5 through 8 describe small parts storage concepts, and figures 9 through 12 depict various concepts which the lack of gravity necessitates, such as parts, restraints, liquid handling, vacuum for free-flying particles and gases.

CALIBRATION	CLEANING AND DECONTAMINATION	MAINTENANCE FACILITIES	SPARES	OTHER
2 Beam O'Scope Multimeter Signal Generator Cal. Gas Stowage and Outlet Flowmeter Mass Measuring Device Pressure Gages Thermometer	Wet Sink & Exhaust Cleansing Agents Wipes, Brushes Water Supply	Vise Equipment Restraints Microfiche Viewer and Film Computer Terminal with Keyboard, CRT and Camera Soldering Gun and Solder (as part of general purpose glove box) Tools: Drill, Visegrips, Pliers, Screwdrivers, Wrenches, Crimping Tool, Files (Abrasives), Saw, Ruler, Micrometer, Flashlights Containers Work Lighting Trash Container Tape, Sticky Back Velcro Battery Charger Event Timer	Pins Plugs Screws Solder Wire	Possible Laminar Air Flow

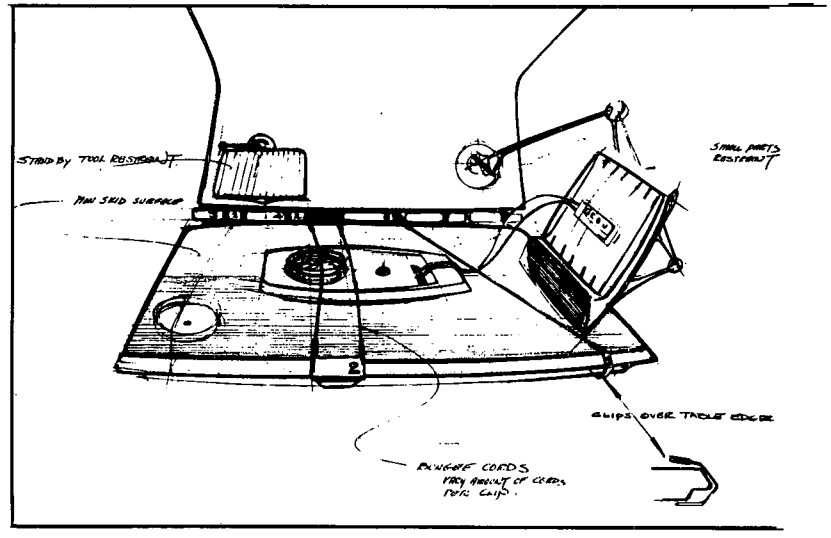
C1 - The General Provisions Necessary to Complete the Workbench Functions



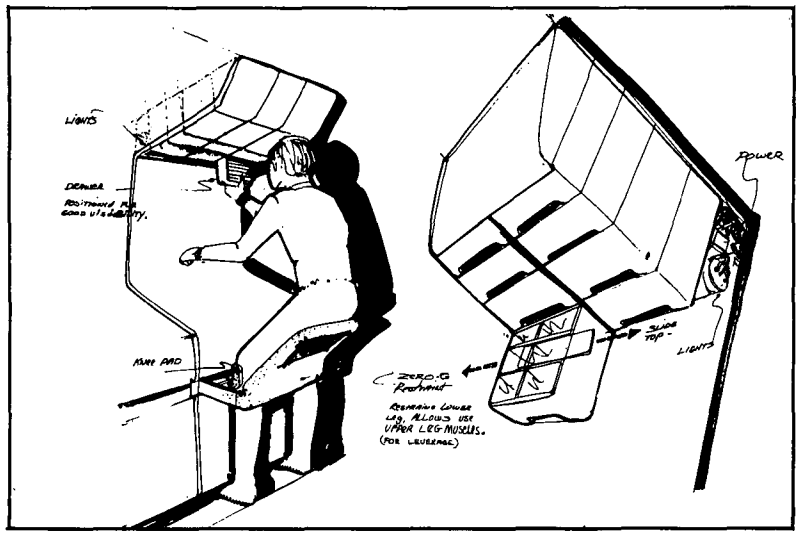
C2 - Phase I - Overall Workbench Conceptual Scheme



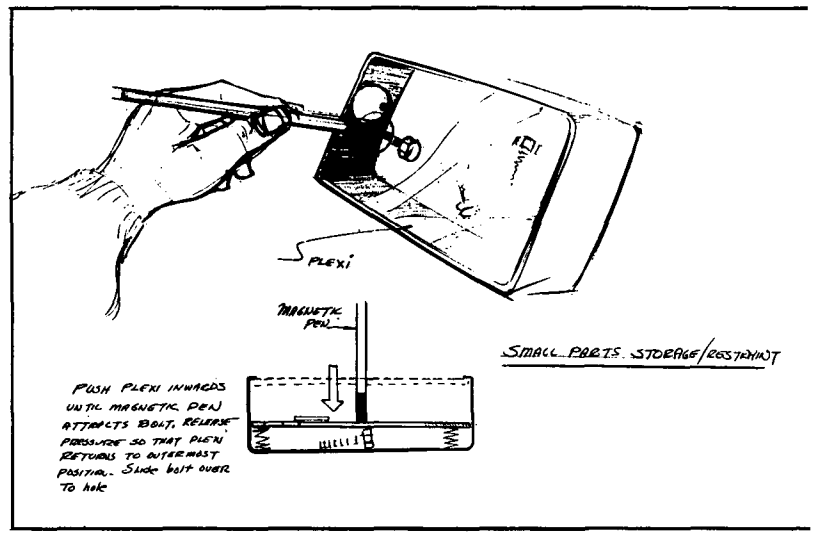
C3 - Phase I - Overall Workbench Conceptual Scheme



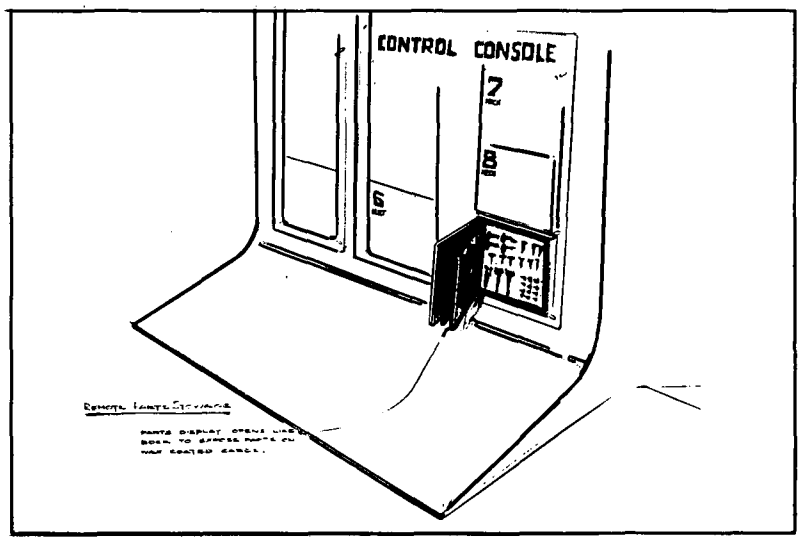
C4 - Phase I - Overall Workbench Conceptual Scheme



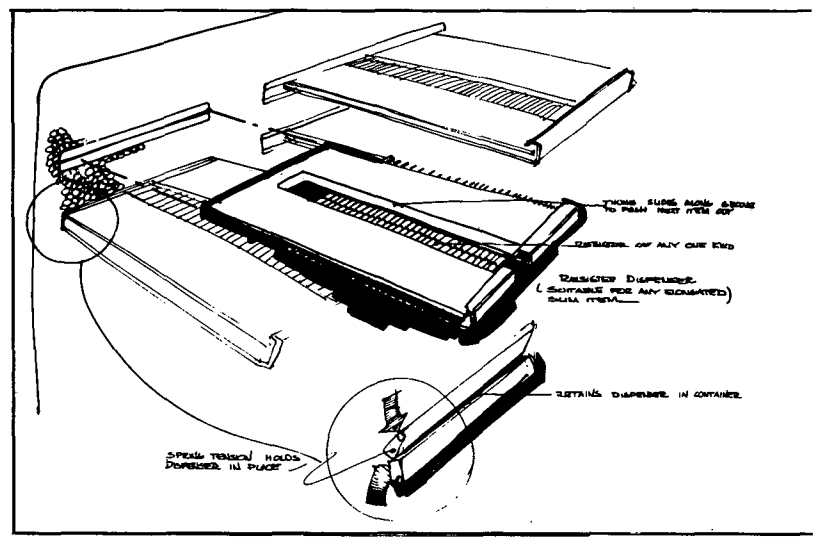
C5 - Phase I - Small Parts Storage



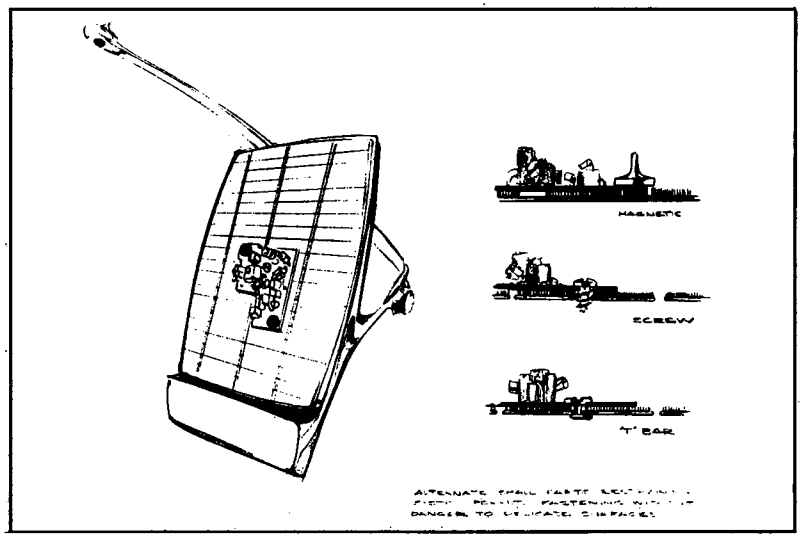
C7 - Phase I - Small Parts Storage



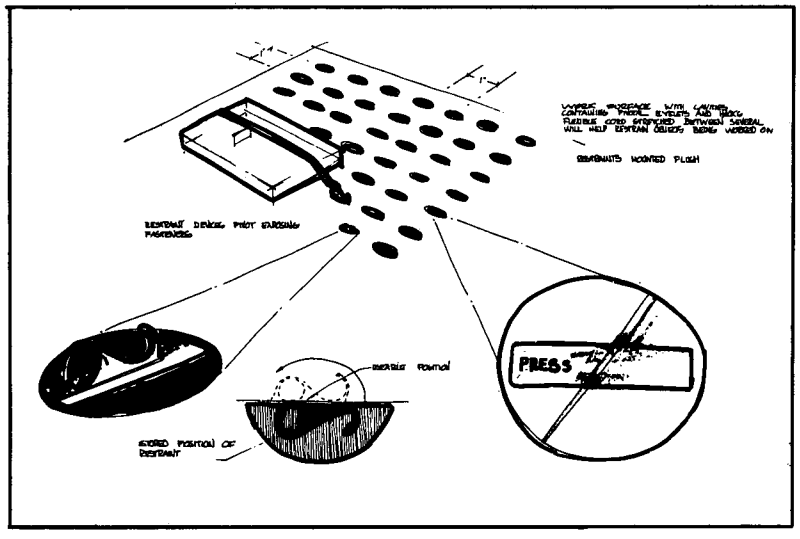
C6 - Phase I - Small Parts Storage



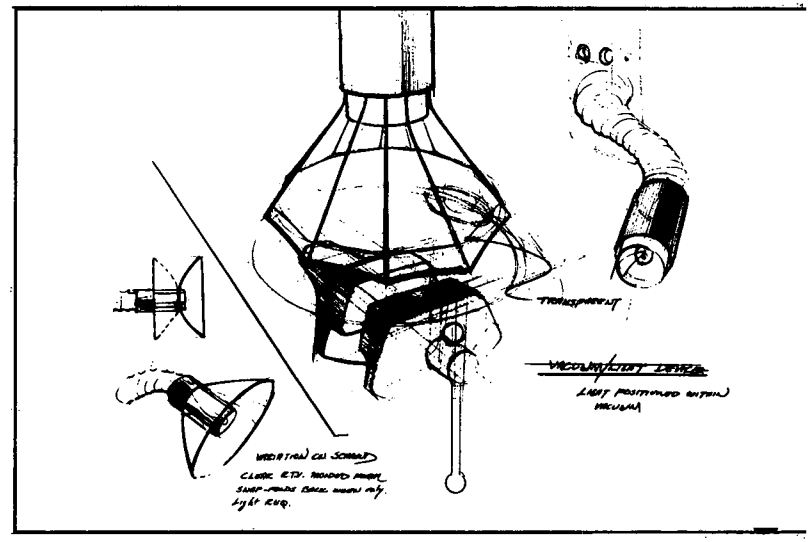
C8 - Phase I - Small Parts Storage



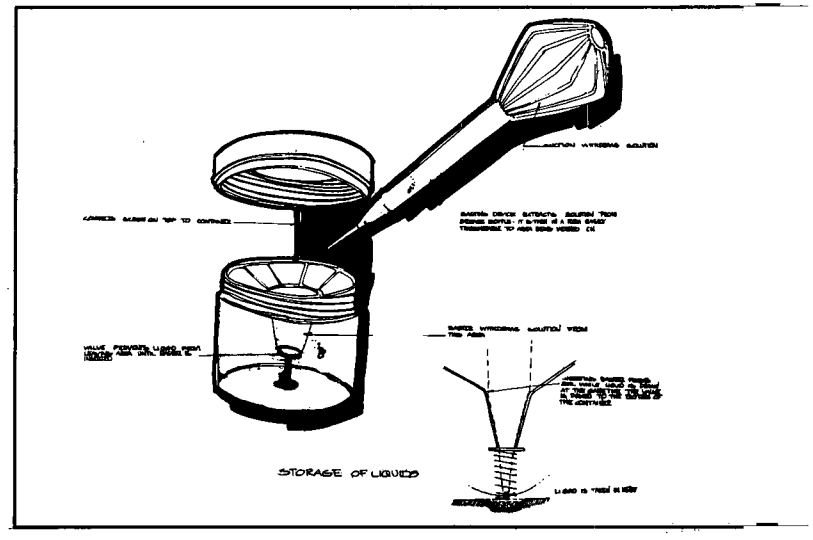
C9 - Phase I - Small Parts Restraint



C10 - Phase I - Small Parts Restraint



C11 - Phase I - Air Vaccuum/Spotlight



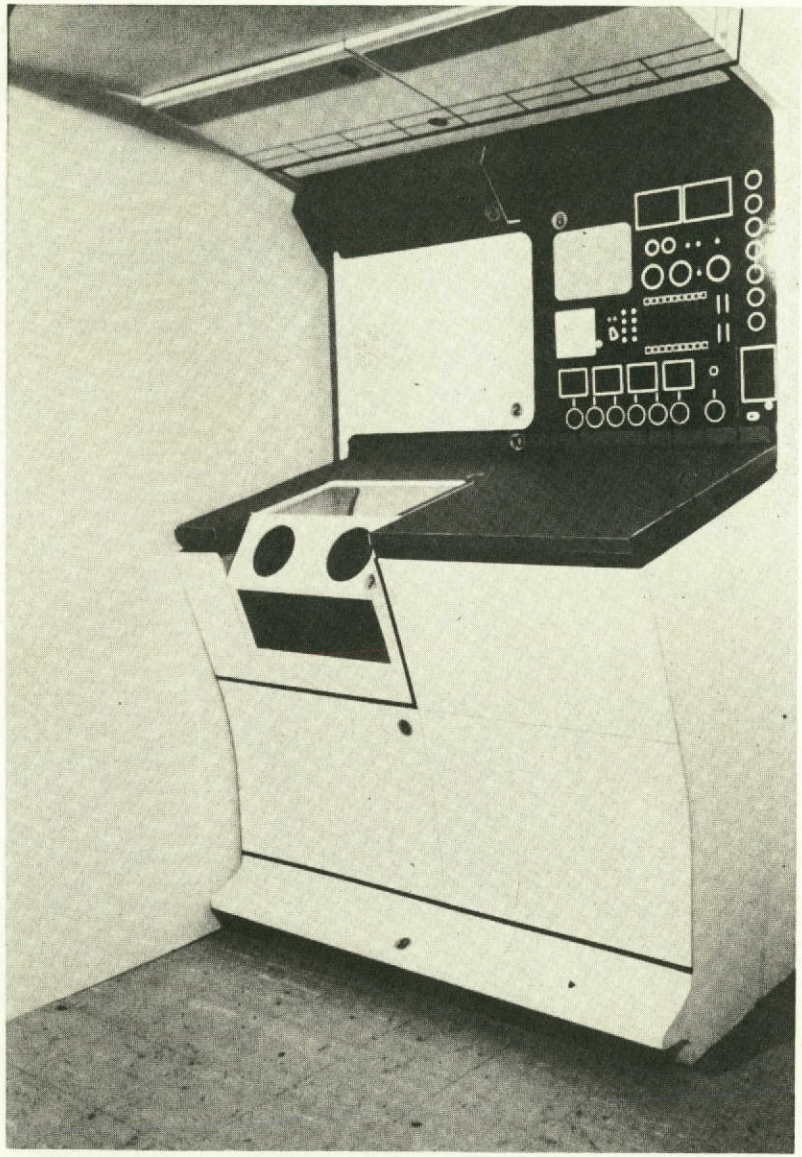
C12 - Phase I - Liquid Dispenser

PHASE II
FIGURES C13 - 17

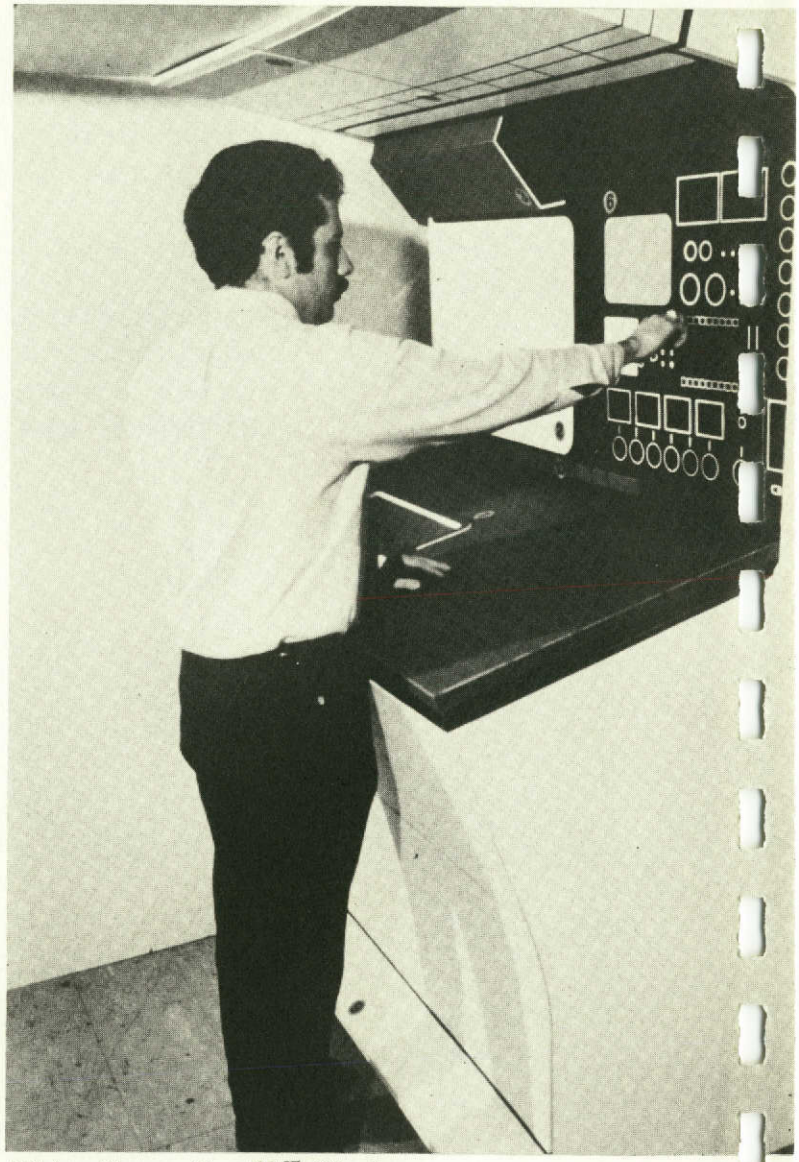
Representative Mock-Up:
Raymond Loewy/William Snaith, Inc. constructed a full scale three-dimensional representation of the proposed General Purpose Workbench presented in figures C13 through C16 showing the overall size, human/machine relationship, and some detail concepts such as sink, work surface restraint and electrical control board. Figure C17 is a drawing that describes the general layout and components of the workbench.

PHASE III
FIGURES C18 - 27

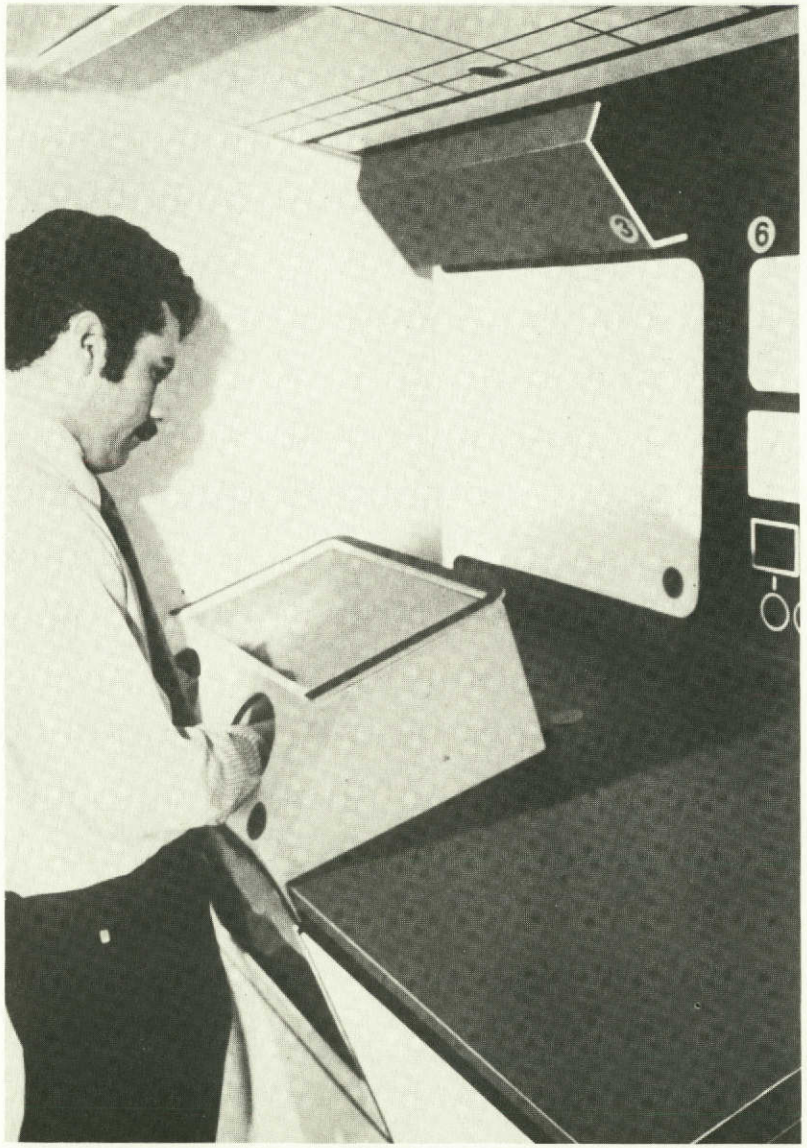
Marshall Space Flight Center accepted the layout and design of the General Purpose Workbench which was proposed during Phase II. Raymond Loewy/William Snaith, Inc. constructed a full scale mock-up of high fidelity and semi-operative for meaningful evaluation by the scientific community concerned. Figures C18 through 27 show the mock-up installed in the Certification and Verification Testor - CVT- at MSFC.



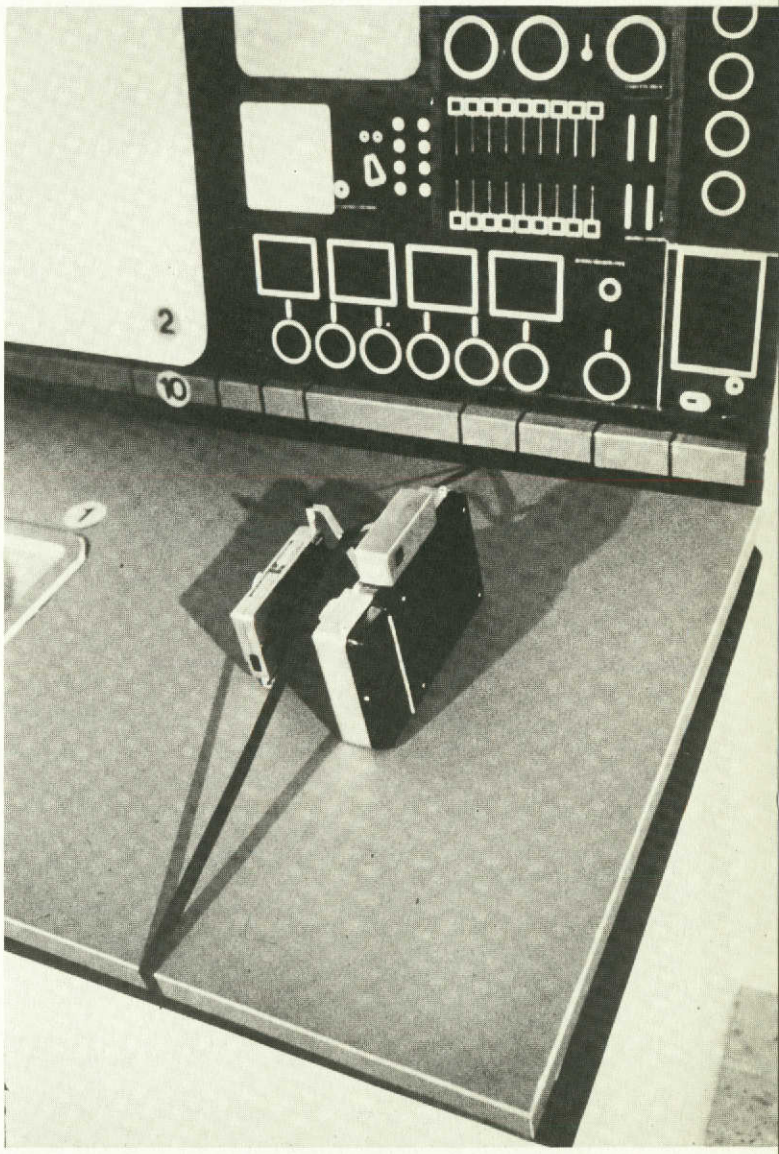
C13 - Phase II - Representative Mock-Up



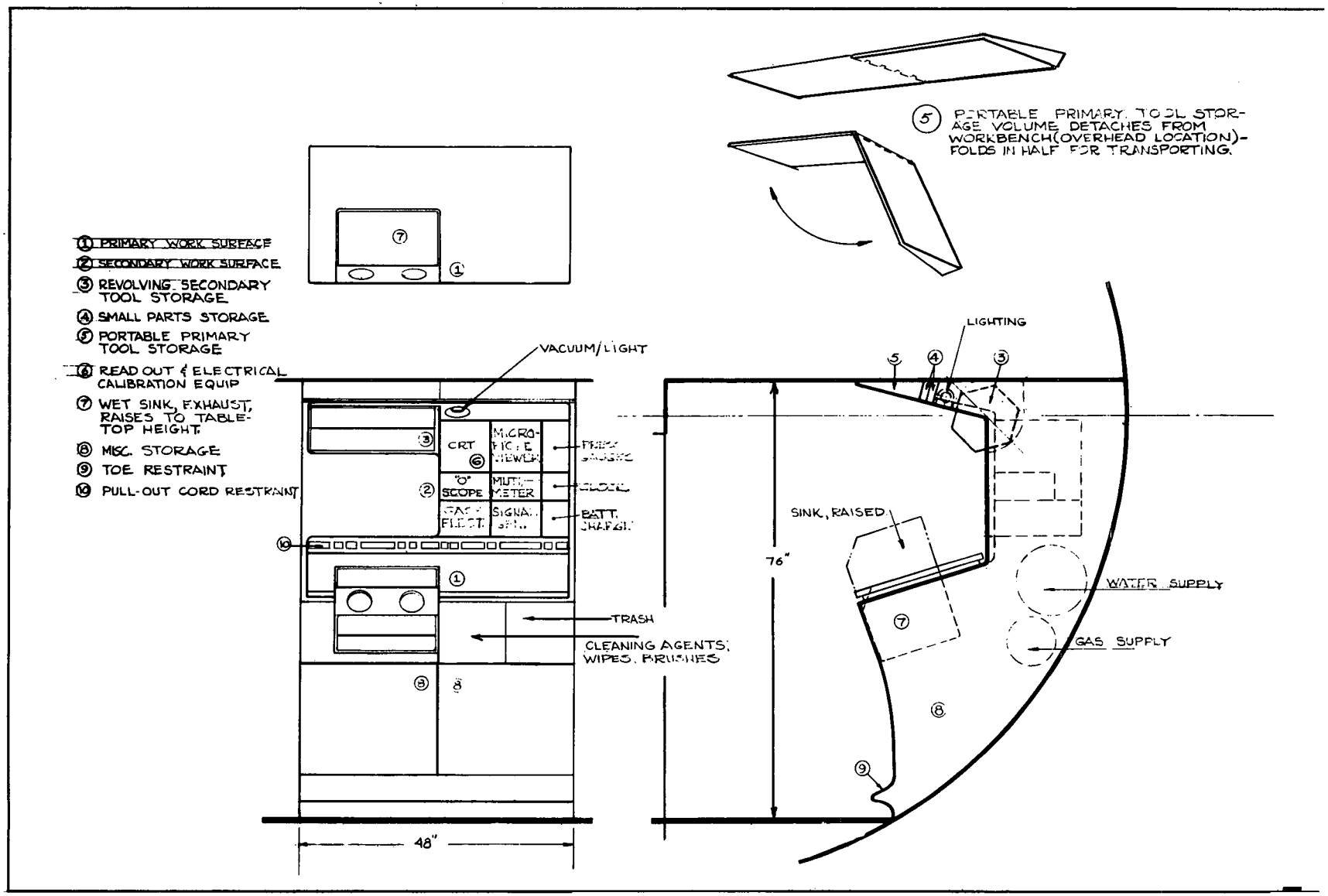
C14 - Phase II - 50% Worker



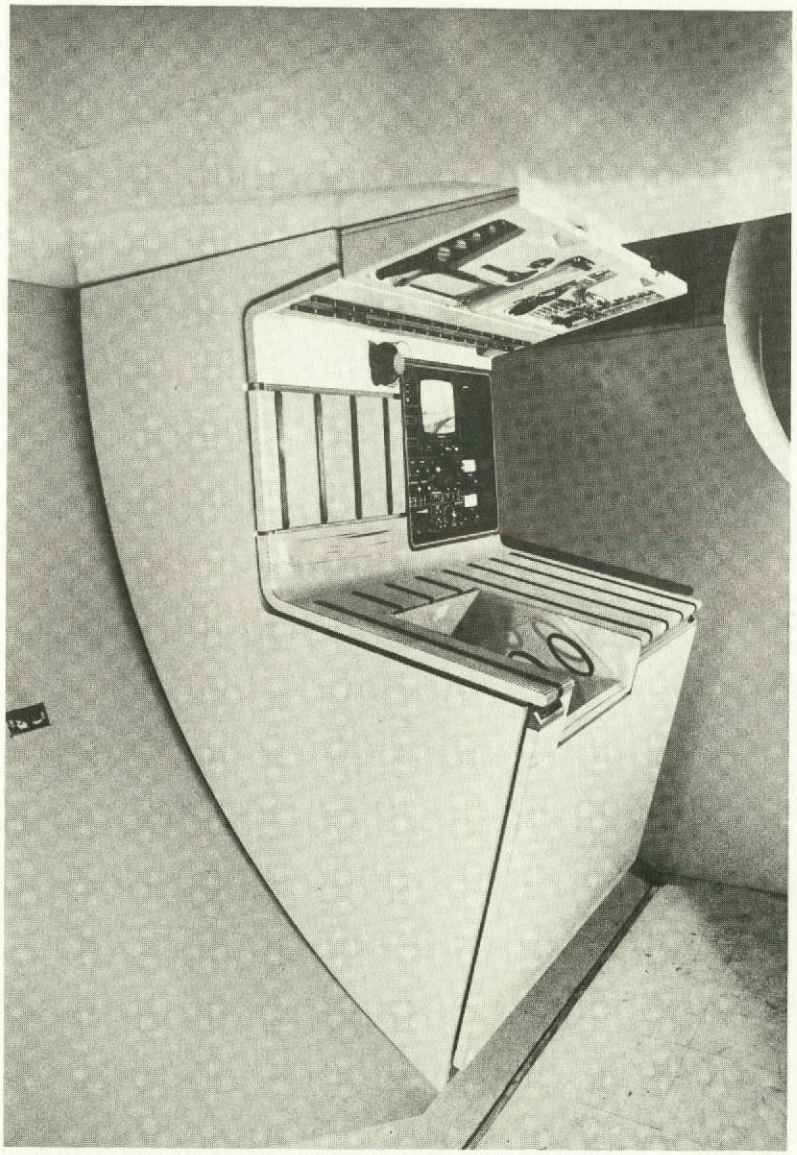
C15 - Phase II - Liquid Handling



C16 - Phase II - Equipment Restraint

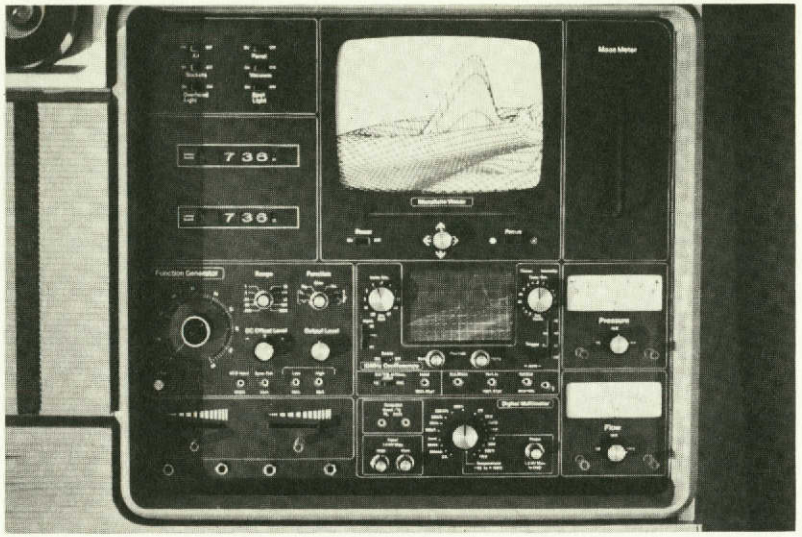


C17 - Phase II - Schematic of Overall Workbench

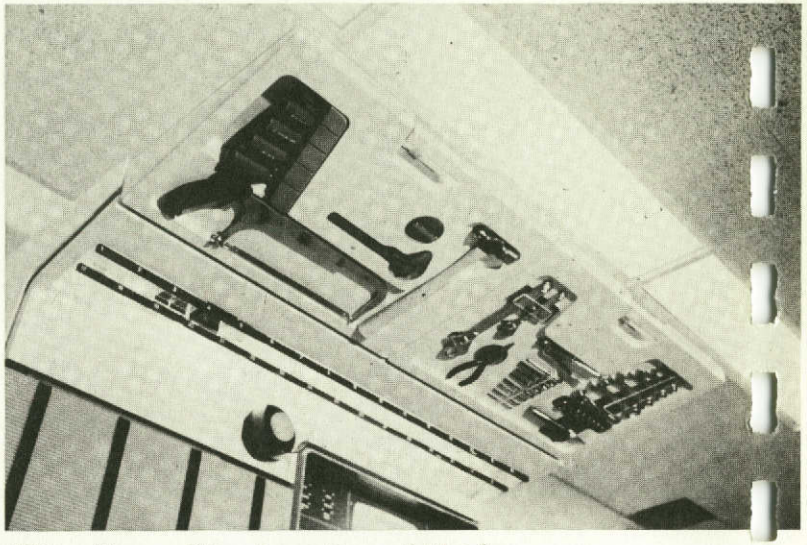


C18 - Phase III - Completed Workbench Installed in the CVT at Marshall Space Flight Center

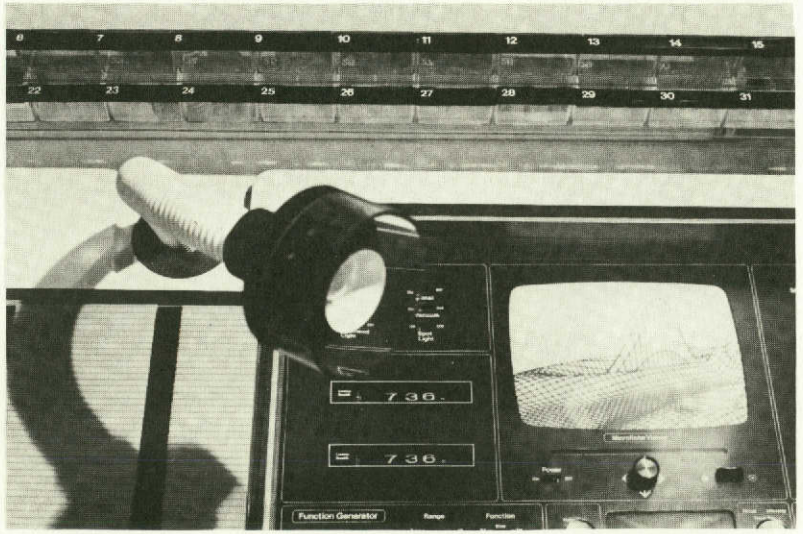
C19 - Phase III - Closeup of Completed Workbench



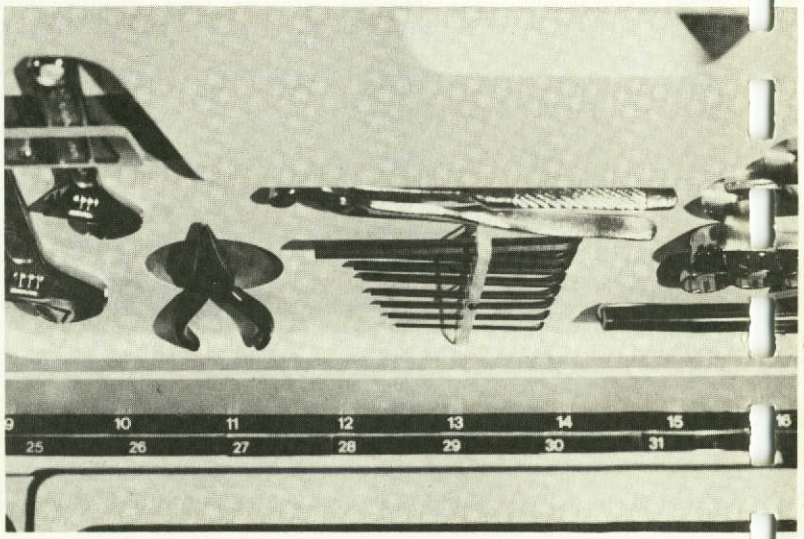
C20 - Phase III - Detail of Control Board



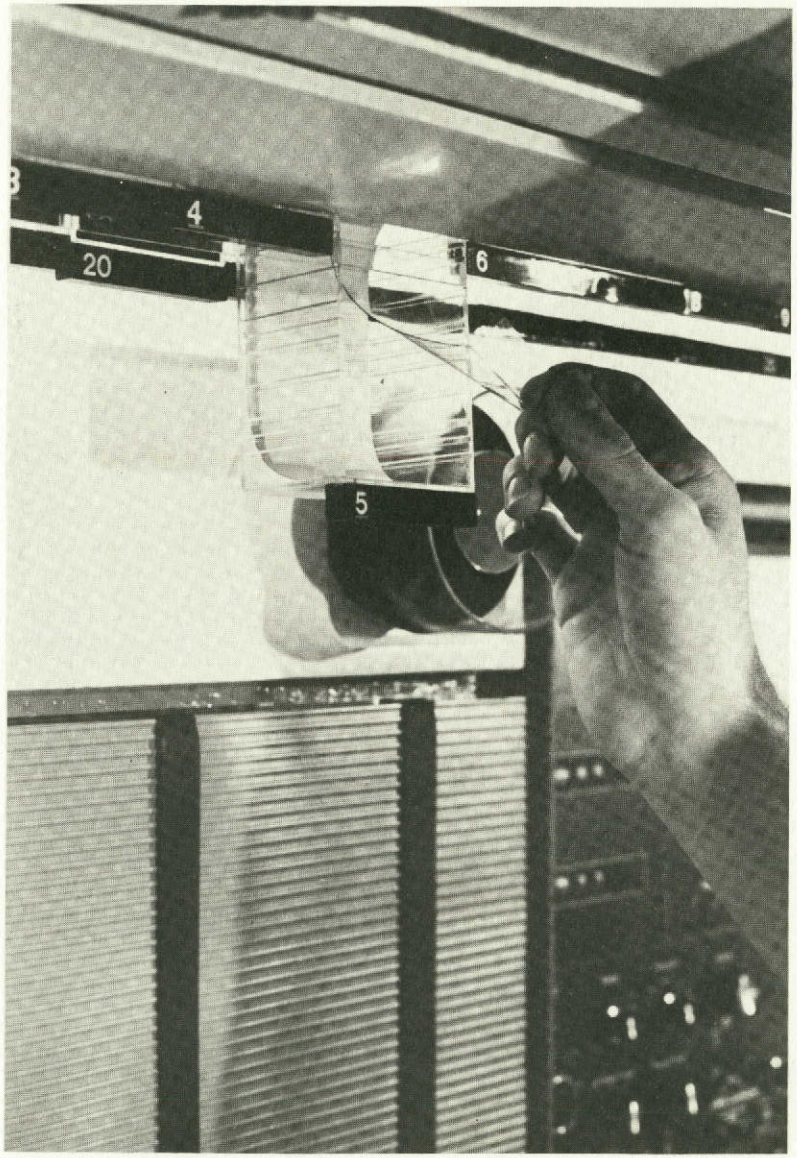
C22 - Phase III - Location of Tools



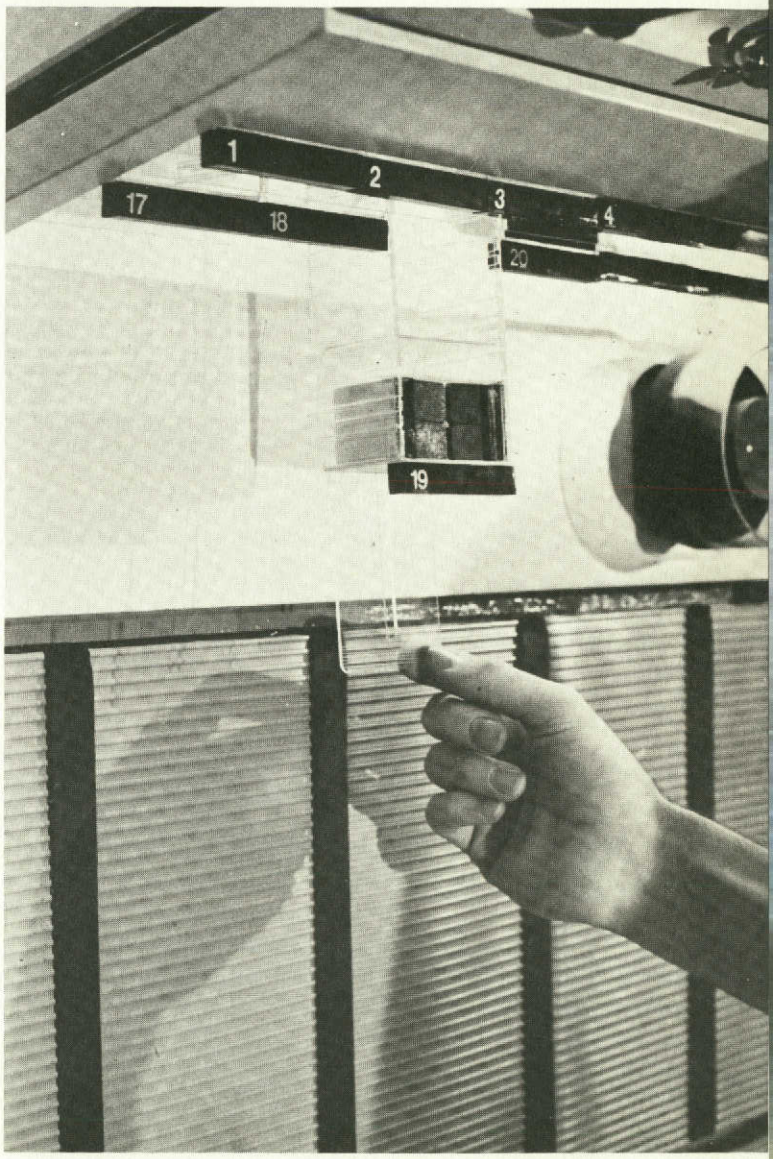
C21 - Phase III - Moveable Vaccuum/Spotlight with Small Parts Storage Boxes Above



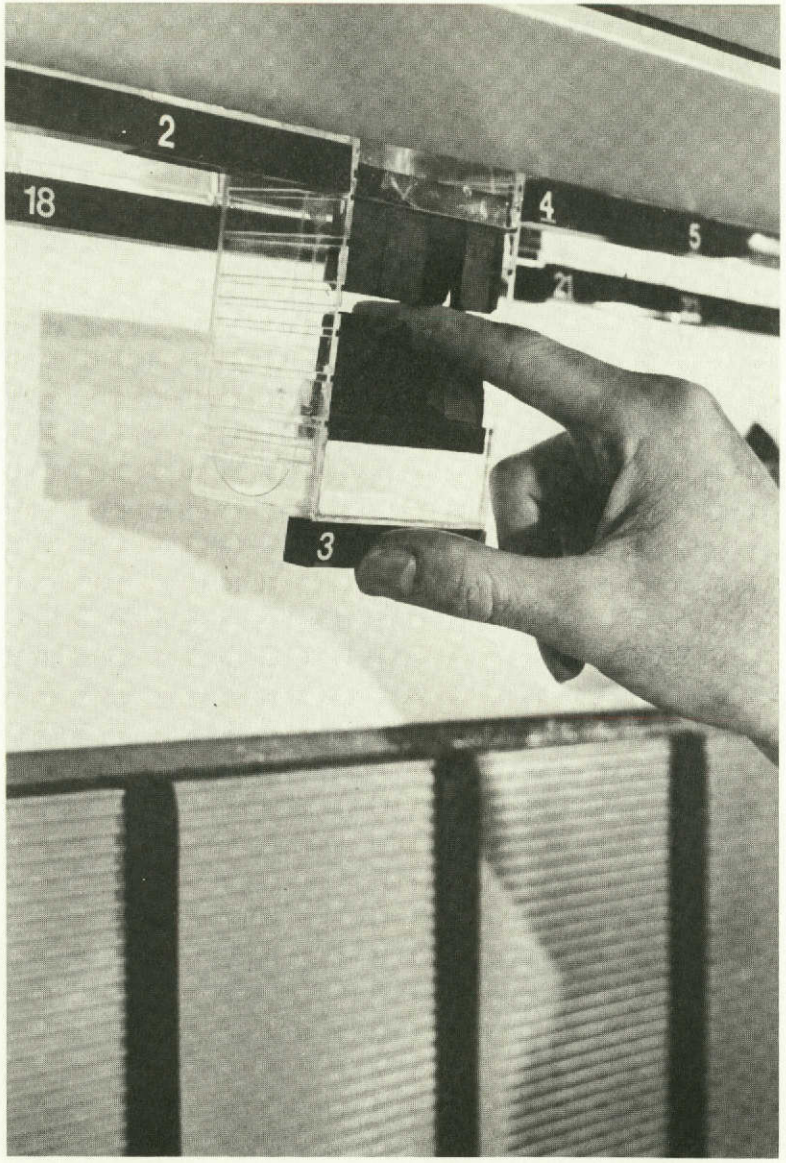
C23 - Phase III - Detail of Tool Restraints



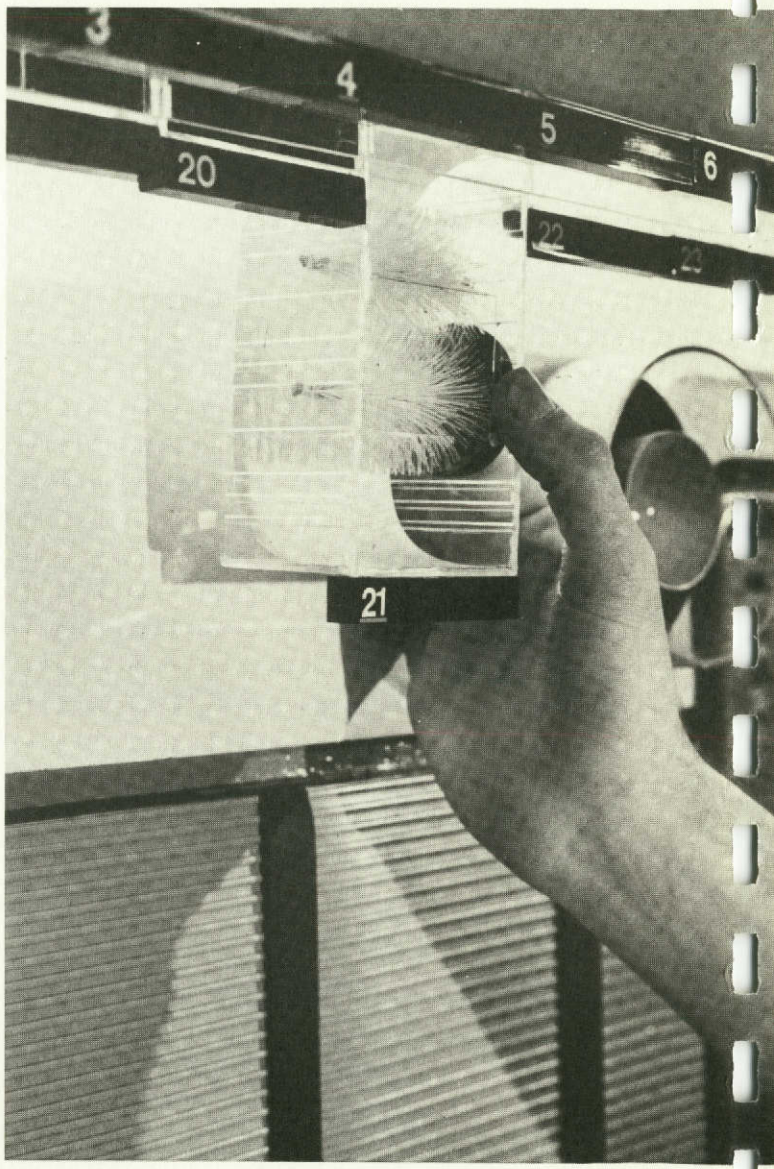
C24 - Phase III - Small Parts Storage



C25 - Phase III - Small Parts Storage



C26 - Phase III - Small Parts Storage



C27 - Phase III - Small Parts Storage

SECTION D

TASK — Develop a general - non-specific- modular storage unit.

CENTER — MSFC - H. Watters

DATE ASSIGNED — April 13, 1972

PARAMETERS

1 — The modular storage unit overall size will be a 24 inch cube.

2 — The "storage locker" must accept any size or shape component within the 24 inch module.

3 — The packing system must protect the contents from vibration and shock which occurs launch and re-entry.

4 — All stored components must be easily accessible without disturbing other components

TASK OBJECTIVES

1 — To provide preliminary concepts to pack components to withstand launch and re-entry loads.

2 — After evaluation of preliminary concepts, a full scale mock-up will be developed from the selected scheme or schemes.

3 — The mock-up will be built within the 24 inch module, and the packing concept will be made modular to accept any size and shape component.

SCHEDULE — Preliminary concept sketches were presented on May 8, 1972 and the full scale mock-up was delivered to MSFC on June 28, 1972.

APPROACH — Figures D1 through D4 are examples of the preliminary concepts developed for

packing components.

DESCRIPTION
PHASE I

Figure D1:

The enclosure is lined with foam on five sides with the component set snuggly into the foam. The sixth side - also lined with foam- is adjustable to close up the box.

Figure D2:

One side of the box is lined with foam and adjustable straps snug the components to the foam.

Figure D3:

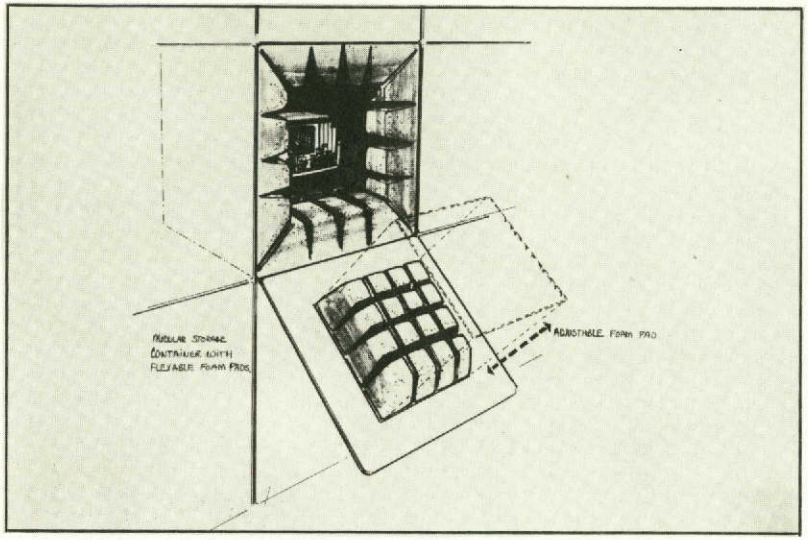
This concept sandwiches the components between two layers of stretch material which slides into the box on grooves on the side walls which allows adjustment in height.

Figure D4:

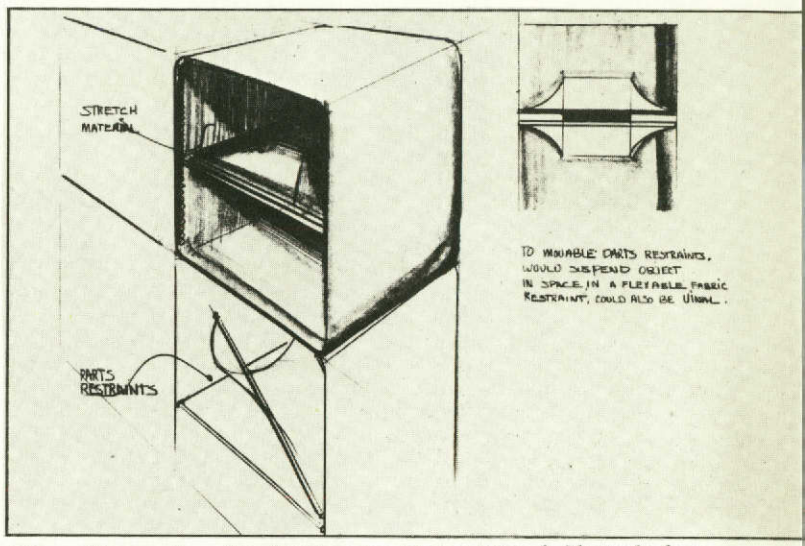
On opposing walls in the box, are springs with foam pads that hold the contents firmly in place.

PHASE II

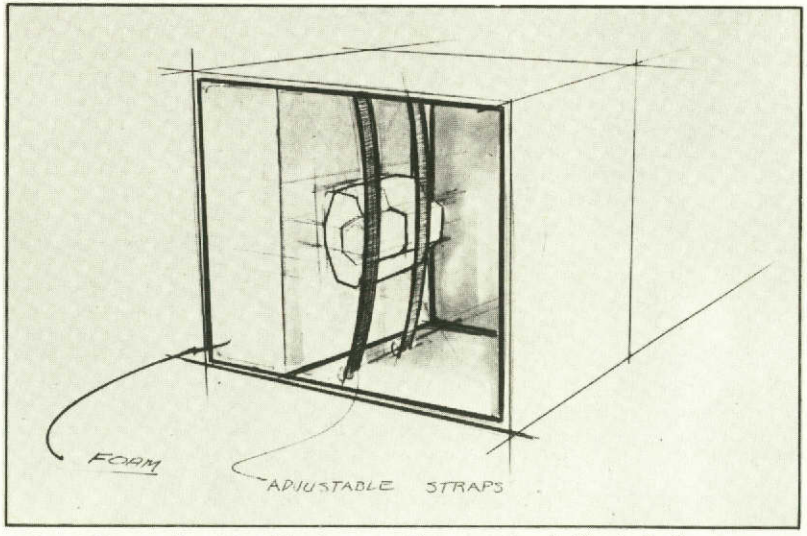
Figures D5 through D8 are photographs of the completed mock-up of the General Purpose Storage Module. The 24 inch modular box is subdivided into a modular system which accepts a variety of component sizes and shapes. There are four different inner box sizes, each one pulls out and opens down the entire length of the box allowing access to components stored in the back. The walls of the inner boxes are lined with foam and numerous adjustable straps hold the components snuggly to the foam. Each box can be pulled out of the storage module and transported to a work site. The logging of the stored components is done with an alpha-numerical system. The 24 inch box is assigned a number and the inner boxes a letter. Below the letter is listed the contents stored in that inner box.



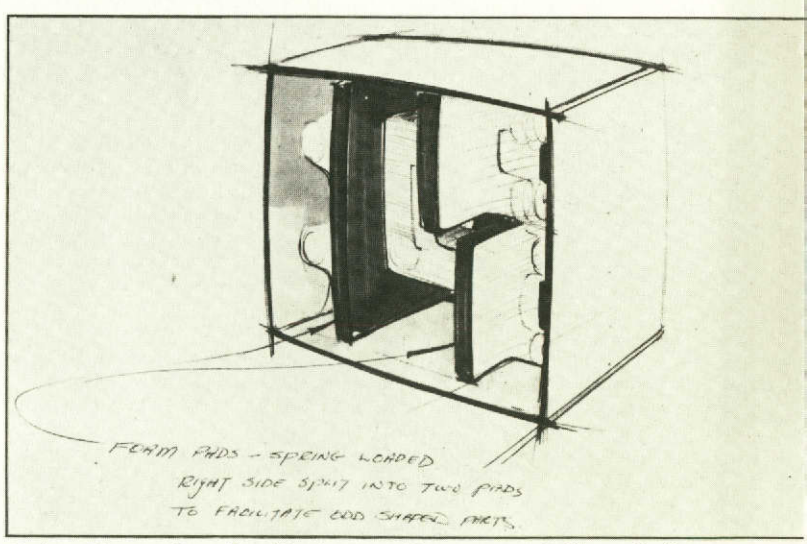
D1 - Phase I - Preliminary Conceptual Sketch for Modular Storage Unit



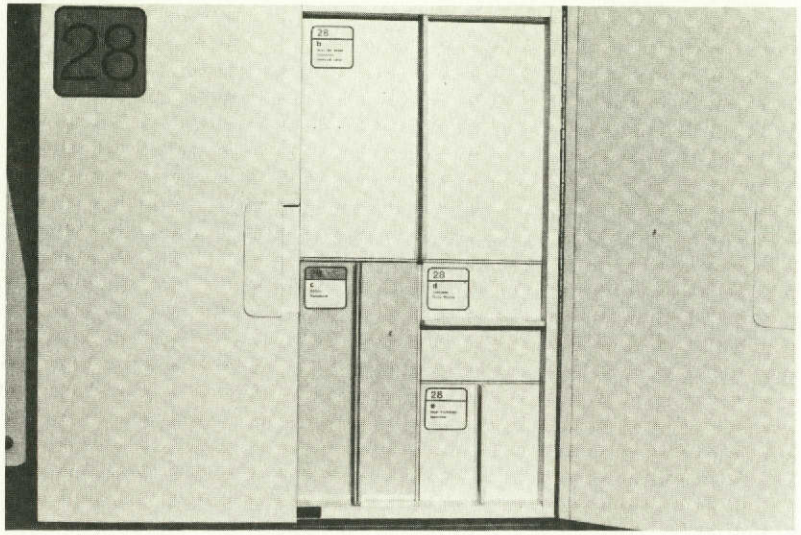
D3 - Phase I - Preliminary Conceptual Sketch for Modular Storage Unit



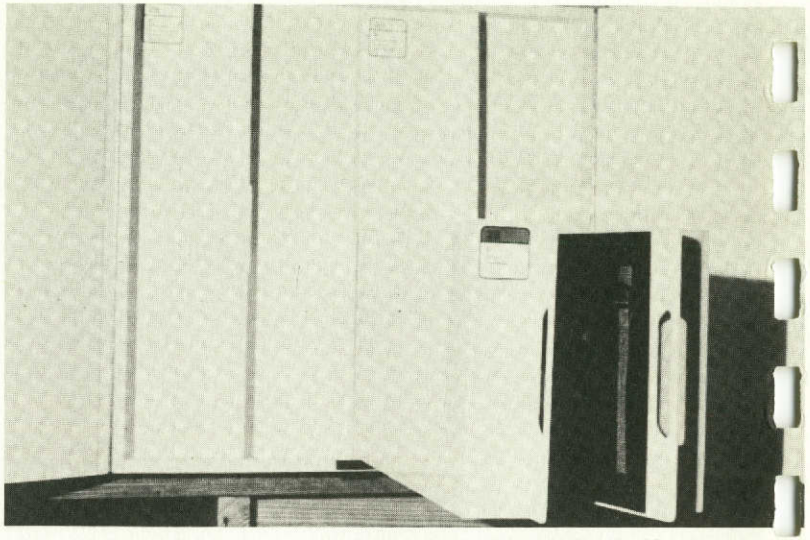
D2 - Phase I - Preliminary Conceptual Sketch for Modular Storage Unit



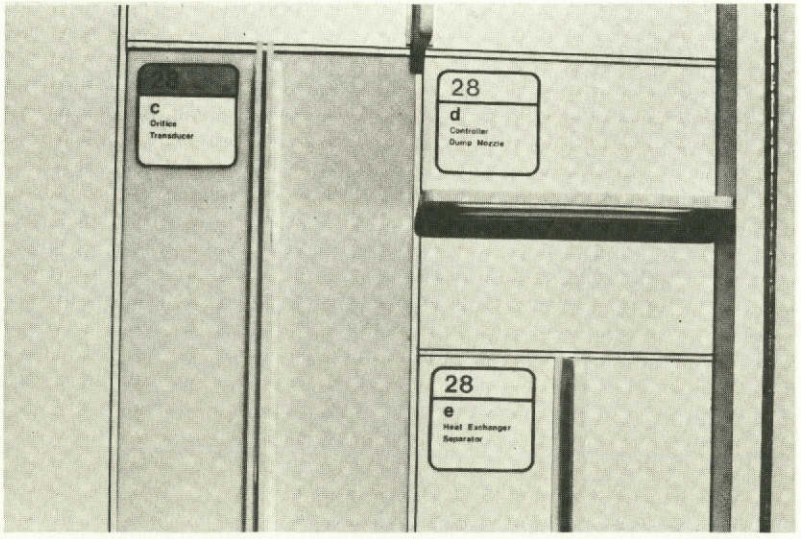
D4 - Phase I - Preliminary Conceptual Sketch for Modular Storage Unit



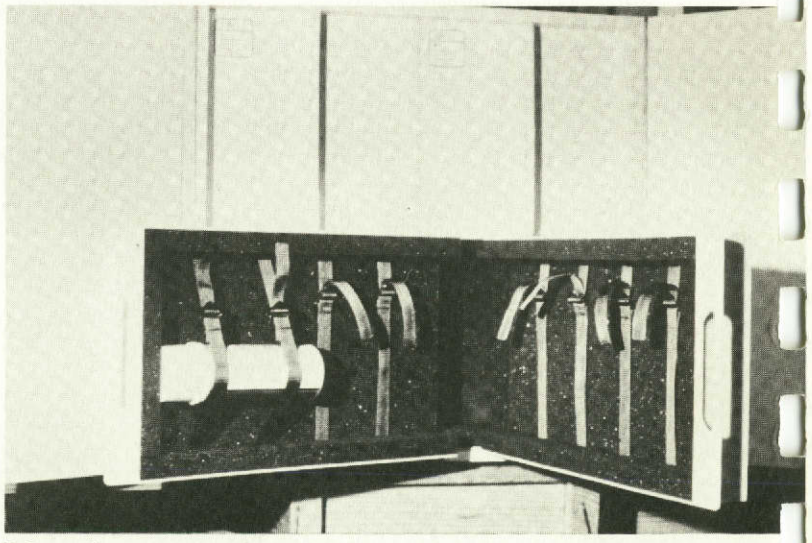
D5 - Phase II - Full Scale Mock-Up of Storage System Illustrating Breakdown of Modules



D7 - Phase II - Individual Storage Module Pulls Out and Opens



D6 - Phase II - Detail of Graphic Communications System per Module



D8 - Phase II - Interior of Individual Module is Lined with Foam. Stored Components are Strapped in Place