SHUTTLE ORBITER
HABITABILITY STUDY

FINAL REPORT

OK - 12886
NAS 9 - 12479

110 EAST 59 STREET, NEW YORK, N.Y. 10022
RAYMOND LOEY/ WILLIAM SANTH, INC.
PREPARED FOR NASA BY

JANUARY 1972/DECEMBER 1972
developed, I needed to communicate our ideas and to establish a foundation for future tasks. Sketches, mock-ups, mechanical and models were the mediums quickly providing NASA with a variety of creative solutions for the Shuttle Orbiter Program as requested by MSC. It was our goal to provide design services as a consultant design office, we have provided habitability design services for the Manned Spacecraft Center, Houston, Texas, from January 24, 1972 to January 27, 1973. This report covers work accomplished by Raymond L. Lowry/William Shain, Inc.
TABLE OF CONTENTS

FOREWORD

PAGE

125
114
69
106
104
96
90
84
72
65
60
49
23
10
1

Shuttle Orbiter Storage Locker System
Housekeeping Equipment Stowage
Data Format Card
Shuttle Orbiter Passenger Coach - Full Scale Model
Positive Flexble Restraints (Phase II)
Positive Flexble Restraints (Phase I)
Orbiter - 1/20 Scale Model
Skewed Z-Axis Dock/Aftlock System Shuttle
Restraint System for Hygiene Facility (Phase II)
Temporary Restraints
Food System and Galley
Small Passenger Coach
Restraint System for Hygiene Facility (Phase I)
Shuttle Orbiter Passenger Compartment/Flight Deck
Shuttle Orbiter Crew Compartment/X-Axis Docking
modes into well defined activity areas. Specific criticism included:

compartment/HAB docking failed to coordinate the launch, Zero-G, re-entry orientation

generally, Raymond Loewy/William Suich, Inc, felt that the Shuttle Orbiter 040A Crew

Following the task assignment, a meeting was scheduled for January 12, 1972.

requirements for launch, Zero-G and re-entry modes.

to develop a working crew compartment configuration which satisfies the operational

bulkhead.

A 39'' passage through the crew compartment extending from the aftlock to the rear

immediate access necessary to emergency escape hatches and head during launch.

crew compartment consisting of a 94'' x 108'' x 196''L module.

6-man crew - maximum 6 crewmen occupy crew compartment at launch.

consider operation in 3 modes of orientation - launch, Zero-G, re-entry.

3 January 1972

MSC - Allen J. Loufore

Shuttle Orbiter Crew Compartment/X-Axis Docking
can be tailored to suit individual preferences.

(1) The crew compartment has been reconfigured to socially orient the space couches to allow the entire crew to have visual contact with each other. The couches between the wall position and the structural supports of the space couch.

A more integrated plan is needed.

Avionics is dispersed throughout the vehicle. A more integrated plan is needed.

Modesty throughout the craft is very limited in all flight modes. A specific passageway should be established to organize flow throughout the vehicle.

Mobility through the craft is very limited in all flight modes. A specific passageway should be established to organize flow throughout the vehicle.

Chapters 5 and 6 store for launch which require unique preflight and flight instructions.

To reach exit platform.

Access to the emergency escape hatch is awkward. Unnecessary maneuvering is required.

The systems engineer has no visual contact with the pilots.

Launch entrance to the Hygiene Compartment is difficult. Extreme body maneuvering is required to gain entrance.
by either one galley attendant or each crewman.

The area has been designed to accommodate 6 men for 7 days, operated
escape hatches. The area is positioned near the head, it is positioned on a wall opposite that of the
partitions. Located adjacent to the head, it is positioned on a wall opposite that of the

The galley provides minimal storage and work area with modular interchangeable com-

---

**Galley Compartment Description (Figure A)**

With some free passageway movement,

The space can support poles tend to overpower the compartment and interfere

celling, creating maneuverability room for the entire length.


couches along their structural supports fall to a position near the floor or
occupations can be altered, however, by shifting the two extreme space
between the four couches positioned near the outside space walls. The

A 39" passageway extends from the athlock to the rear bulkhead has been re-

---

**Disadvantages**

of 24" is required to house the adequate volume.

The cavities have been integrated in the area of the rear bulkhead. A deep

supports which double as mobility aids to the crewmen.

Easy accessibility to the head has been provided via an aisle and the coach

and a few steps to the outer skin.

The rear end of their couches provide a quick drop down to the rear bulkhead

The escape hatch has been placed adjacent to the rear bulkhead. An aisle at

To have visual contact with the pilote.

The system's control panels have been integrated to allow one systems engin-

---

(1) ~

(2) ~

(3) ~

(4) ~

(5) ~

(6) ~

---
A shield collector enables craft to gain access from the rear bulkhead position. The orientation of the craft requires maneuvering down the walls of the hatch, which has been paid to maneuvering into the gallery during pre-launch hold periods.

**Hygiene Compartment Description** (Figures 6 and 7)

**Preparation Area**

- Possibility of meal selection is somewhat limited due to storage capacity and
- Limited room for maneuverability (conflict with space couches from rear).
- Hallway adjacent obstructs passage while preparing food.

**Advantages**

- Food may be prepared at gallery unit.
  - (b) couch to hear food.
  - (a) Individual space couch preparation (food tray jacked into individual's
- Two options for heating food are provided:
  - Standard SkyLab food cans utilized.
- As well as housekeeping stowage in a minimum stowed area.
- If contains all stores, food preparation devices, food service implements,
- The gallery location is in an area readily accessible to the space couches.

**Disadvantages**

- Food may be prepared at gallery unit.
  - (b) couch to hear food.
  - (a) Individual space couch preparation (food tray jacked into individual's
- Two options for heating food are provided:
  - Standard SkyLab food cans utilized.
A4 - Loewy/Snaith Shuttle Orbiter Model in a Leisure Orientation

A5 - Full Size Mock-Up of Food Management Compartment
Difficult collector maneuverability in head for different orientations.

Must sit down to use hand wash and to urinate in re-entrant.

Trouser must be removed to urinate/dace.

Disadvantages

The 3 orientations.
Hygiene hands doors enable two opposite stabilizing motions convergent to

Units limited to one wall (modular replacement).

Pitch, zero-G.

Fecal collector and hand wash unit adaptable to 3 orientations (launch, I-G)

Advantages

Units interface with the walls through the center of the pivot.

Shifts into the various modes as does the fecal/urinal collector. All services to these
shifts into requirements in all attitudes. The handwash unit, faseded directly above,
achieved by pivoting the collector around an axis
the fecal collector is used in all phases of orientation including inter atmosphere I-G
EXISTING CONCEPT

A final presentation was scheduled for February 9, 1972.

SCHEDULE

To explore possible solutions to the problems of access to the space craft in the various orientation.

CONSIDERATION IN DESIGN FOR MANEUVERABILITY OF ELDERLY AND WOMEN.

Access to head and escape hatch during launch.

Orbiter passenger compartment size limited to 90" H X 108" W X 196" L.

6-man crew.

Operational in three modes of orientation: launch, leisure/sleep, re-entry.

PARAMETERS

DATE ASSIGNED

13 January 1972

MSC - Allen J. Louviere

CENTER

Shuttle Orbiter Passenger Compartment/Flight Deck

TASK

B

SECTION
Avoid deterring any innovative ideas.

Shuttle orbiter hardware and systems were not a primary concern in this phase to

the Shuttle orbiter of this effort. The interface of these facilities within other

provided accessibility to the equipment necessary during each of these modes were

safeguarding launch, leisure/sleep and re-entry orientation of the space coach and

passenger compartment, especially during pre-flight and I-C Flight.

With the knowledge that future space flight may include the elderly, it was impor-

1) Horizontal Flight - The head should be available.

2) Launch - Under the effects of I-C the passengers on the Launch pad should have

immediate access to all space coaches, the flight crew compartment and the escape

pitches).

3) Leisure/Sleep - In Zero-G Flight all areas of the passenger compartment should

attack and related facilities.

beat the primary modes of orientation within the Shuttle Orbiter include:

problems of mounting and dismounting the space coach in the various orien-

William Swain, Jr. was interested primarily in exploring solutions to the

In this study of the Shuttle Orbiter Passenger Compartment, Raymond Leavy/
Temporary clothing storage arrangements to create self-serve quarters during sleep and provide areas for modular couches. The configuration enables the spectator seats to be utilized in the arrangements of Figures 6B and 6J demonstrating the diversification possible in the arrangements of Figures 6B and 6J, illustrating the space couches.

To increase the mounting and dismounting accessibility, the space couches allow the crewman to raise or lower them in order to access the seating at each level. Figure 6D is another modular example of the flexibility provided. The brackets for the right deck crew to use in zero-g only.

For the right deck, couches, shown in Figure 6D, utilizes these modular units. The diagonal couches shown are easy mounting, escape, and hygiene facility access. The configuration demonstrates the handheld procedure the couch performs to enable the passenger to be completely reached quickly between missions. Within these couch, storage and services, interfacing capable on earth would enable the passenger to be a component worth preserving. Cushions, including the possibility of frequent "on-pad" service, it becomes evident that modular...

Description

Modular Compartment Environmental Systems

APPROACH A
Tackled Compartments Environments System (Figures B9-B12).

Approach B

- Limit mobility and variation in layout (Figures B9-B3).

Disadvantages

- Central aisle provides efficient traffic pattern.
- Flexibility of couch positions (Figure B9).
- Privacy screen provided by available storage unit doors (Figures B9 and B7).
- Easy access to couches.
- Privacy is provided.
- Couch and sleep compartment designed as one component.
- Servicing is easy and parts are interchangeable.

Advantages

- Repositioned elsewhere.
- Orientation, it can be readjusted via spring post ends covered with a sponge material.
- Positional repositioning ease. Positional repositioning during launch in the corridor.
Articulated Space Couch Utilization

To increase accessibility to the space couches in the various modes of orientation,

**Description**

**Advantages**

1. Tracks allow easy "stacking" of couches to create an open space.
2. Removable panels enable in-flight environmental changes.
3. Modulars easy to remove for servicing.

**Disadvantages**

- T excess room is necessary to accommodate interchangeability of facilities.
- Problems of permanently attaching units to witherand launch "C" loads.

**Approach**

One continuous area useful for experiments and leisure activities.

Open space is possible by sliding all the couches to one end of the module, exposing couch interface through the tracks, and jack mounted at intervals. A completely articulated interface along the tracks for zero-C activities. All services to the area, as well as space couch articulated. Fixed permanently at launch, the couches extend to extend payloads. The far sides of the tracks include area for services, i.e., hydraulics.

The parietal track creates a flexible system which allows adjustments in mission.
Flexibility of compartment configurations.

other lengths.
May be arranged to create a continuous 36" clear area extending the interior.

a increased C-accessibility.

Advantages

mounts the advantage of being able to utilize activities without interfering with others during work station.

Each eaws several couplings which are laced in various configurations. This layout enables several couplings to be used for leisure activities without interfering with others during work station.

The lower floor are used during launch, the hubs are free to rotate and pivot allowing the end of each spoke axis just as in prior cases for each of the six couplings. Only a floor and ceiling track, two, three spoke hubs are able to be freely repositioned.

Figures 25 and 26 expose the possibilities of compartment configurations. Mobilized by

hatch during launch is also accomplished in this manner.

mount and dismount the couplings in their vertical orientation and then are rotated.

Figure 1 illustrates two revolving cylinders, each with two couplings. Passengers

in a configuration where the couplings face each other.

venuer for access, they pivot inboard and the tracks, can be maneuvered parallel to achieve their functions in various orientations. Illustrated in a position con-

increasing montability ease.

79
APPROACH

Fligh Deck Configurations.

Advantages.

- Large compartment usable area is necessary to accommodate these configurations.
- Positioning of individual couch is dependent on location of others.
- Extremely maneuverable.

Disadvantages.

1

Description

In looking at the flight deck, Raymond Lowery/William Smith, Inc. was primarily

20
a. **Disadvantages**

- Maximum accessibility to separate compartments from high deck.
- Open deck concept gives the feeling of spaciousness.
- Sleep rest area available for high deck use.

b. **Advantages**

- Inter-compartment audio-visual communications provided.
In order to fully evaluate the task of reservoir systems, Raymond Lowey/William Shanklin, Inc., considered it important to analyze the entire hydrgene system.

**TASK OBJECTIVES**

6

- Interior volume to approach 30" X 30" X 78".

- In L-G filter, concentrate may use the standing ventilation facility only.

- Pecal/Urinal collector used in launch, Zero-G.

- 30th to 95th percentile personnel sizes.

- Accommodate male and female personnel.

**PARAMETERS**

In atmosphere, liquid - axis of oblique parallel to horizon.

- Launch - axis of oblique perpendicular to horizon.

Hydrgene compartment to be operational in three attitudes:

- 14 February 1972
- MSC - Gordon Raysey
- Bearstar System for Hydrgene Facility (Phase I).

DATE ASSIGNED

CENTER

TASK

SECTION
to allow enough head clearance.

Utilize space opposite the collector unit. An interior area of 40' X 30' is necessary
The area in between accommodates back-up volume. This volume would normally
Figure C) Positions the handwash unit and recol/urinal collector on adjacent walls.

To launch
above the handwash unit provides head clearance if detection is required prior
bases would be needed for detection prior to hit of (upper left wall). The cavity
Figure C) illustrates an alternate version of a hygiene facility. Back-up recol

Results concepts.

The preliminary studies of the hygiene facility indicated were aimed at minimizing

in the launch mode.
Use of the handwash unit while seated on the recol/urinal collector is restrictive
its use in an awkward body orientation or contribute to easy waste elimination.
Figure C) The lack of head room in the seated recol position (zero-G) shoot
The existing system fails short in certain areas of compatibility with 90% to 95%

parts it requires.


The existing MSC Houston Shuttle Orbiter Personal Hygiene Facility (Figure C)
medicinal preliminary review held in March to discuss concepts developed to date,
A final presentation of this task was scheduled for 4 April, 1972, with an inter--
C5 Hygiene Facility - Tissue Dispenser

C3 Recal Utral Collecor on Adjacent Walls

C2 Airline Version of a Hygiene Facility

Economy of Space by Placing Handwash Unit and...
The arrangement allows for location of all facilities requiring plumbing and back-up of resturant's desirers.

Figure C9 - Use of elbow or shoulder restarant incorporated with side walls creases desirable.

and limit essential body movement.

Figure C8 -9 Hhigh restarant which create pressure disturbing to some crewarmen

Static body positionning.

Pigure C7 - Shoulder restarant storage carry which be a dirt collector. Down.

on uniform requires proper apparel.

Figure C6 - Location of restarant too near seat area. Necessary of .D".ing

Desirable.

and limit essential body movement.

Figure C5 - 9 Hhigh restarant which create pressure disturbing to some crewarmen.

restarant system concems for the hygiene facility follows:

A cross section of general comments received on the preliminmary critique of the

with the area, a 40" head clearance is atained in a 30" X 30" facility.

By positioning the towel/ventilation on a diagonal of figure C3 to 30" X 78", it reduces the central maneuvering area.

The arrangement shown on figure C4 reduces the central maneuvering area.
By walking vertically through door.

1-O Pitches - Handwash and urine collector are usable. Hygiene is accomplished.

Zero-G-all systems in use.

Launch - Rectal/urinal collector used in seated position. Handwash could be used by side access. Hygiene would be accomplished by stepping down through the door into the door restemal of the rectal/urinal collector.

This orientation varies according to the attitude of orbiters.

This scheme positions the personal hygiene unit and rectal/urinal collector perpendicularly to axis of shuttle orbiter. The use of waste management units in this scheme are built in or flush with surrounding to the maximum extent possible.

Mobility aids and restroom provisions are built in or flush with surrounding only.

A second urinal opening, leading to the same collector tank, was placed below the rectal opening for standing urination use only.

Eliminated.

headroom clearance problem for a person using the urinal/rectal collector is 180° as shown in Figures C15 and C16, the

turning the rectal/urinal collector 180° is somewhat similar to the NASA arrangement; however, by

This arrangement eliminates any integrated into an MSC, Houston scheme.

Figures C15-C18 illustrate Approach B, which

in the shuttle launch, the handwash unit is now accessible in all orientations.

creating a headroom clearance problem previously experienced. Or, it

alowing the vehicle will continue to include into the compartment with volume of all containers required with no reduction in maneuvering ease.

All mobility aids and restrooms are built in or flush with the adjacent surfaces.

APPROACH C

FIGURES C17-C18

APPROACH B

FIGURES C15-C16
Restraint Studies

Throughout this study, Raymonn Lowey/Müllmann Blanch, Inc. has been concerned wash for better accessibility.

to the personal hygiene unit was the axial hygiene unit beneath centered over hands.

The recal collector has been positioned low in the compartment relative to

the round stands in the lower corner taking maximum advantage of that space.

Excess plumbing and overall equipment volume was minimized.

By placing the recal/utlal collector and the handwash unit on adjacent walls,
Required restrictions and mobility aids appear to be:

- Dirt collection of belts and sludge cavity.
- Interference with wipe procedures.
- May be direct to explode.

A avoidance of contact of exposed skin areas with bel(P)disposable segment

which must be overcome, include:

- Straining device essential. Problems related to the use of a lap belt system.
- Creation of the individual. The pain of crampons will make use of a positive re-

A lap belt was considered a necessary stop gap device to be used at the dis-

utilizing the equipment needed.

The total compartment volumetric requirements is approximately 150 cubic feet.

Approximately 50 cubic feet is required for maneuvering within a highe 1.

facilities.

Observations are noted:

Based on information gathered from the volumetric compartment, the following

relationships:

into maneuvering areas, figures and back-up compartments to figure volumetric

of the concept of a volumetric requirement basis. We broke down the facility

The chart shown in Figure C4 was developed to provide a comparable analysis.

STUDY EVALUATION

Launch orientation.

Figure C3 illustrates a 95% make using the compartment during Zeno-C and
Approach C.

Toward the development of an elbow and lap restraint utilizing a revised restraint system for a hypogeon facility (Phase II) will include effort directed

c. "Elbow" restraint and/or "lap" restraint (degree of use - option
b. Hand rails (to maneuver between facilities - option of crewman).
a. Foot restraint/recl (available for use at crewman's discretion).
The couch will perform the same functions as the earlier larger small passenger coach, with maximum dimensions of 77.5" L x 27" W x 27" H. It has applied the knowledge and experience gained in the development of a large passenger coach to the performance of the task of assembling 77-1/2" L x 27" W x 14" D. Maximum dimensions, 77-1/2" L x 27" W x 14" D, accommodate 50% female - 50% male. Lighting and communications.

Garment, personal gear storage, trash disposal, issue dispensers, provision crewmen with comfortable personal area to include provisions for by rotating the couch along its longitudinal axis. Reorientation of the couch phases of flight operations will be accomplished serve as a support (seat) for all modes of operation.

14 February 1972
date assigned
MSC - Gordon Rysavy
center
Small Passenger Couch
task
section
A less pronounced cushion configuration with a low retaining wall, if any, has increased its accessibility and overall usable couch space. Immediate access items, including tissues, trash disposal, personal hygiene kits, etc., have been conveniently located within arm's reach of a restrained crewman. Environmental controls and emergency equipment are included in the couch design.

**SCHEDULE**

Following the task assignment, a final presentation date was scheduled for April 4, 1972, with an intermediate preliminary review in March, 1972.

**LOEWY/SNAITH APPROACH**

Based on the critique of the first generation space couch, we approached the problem from a structural viewpoint, looking at methods of achieving the most efficient structure and, therefore, the best utilization of available space. By placing the main structural runs under instead of around the perimeter of the couch, we were able to take full advantage of the 27" width. The first generation passenger couch was aimed primarily at developing the trunion support concept to a point which it could be critically evaluated in a three dimensional model. Emphasis was placed on comfort and adaptability to the various flight modes. This effort resulted in a comfortable, but rather large unit (84"L X 36"W X 14"D.) The main storage volume was rather limited and was not accessible when the couch was configured for sleep and the amount of privacy provided was rather limited.

**PRELIMINARY PASSENGER COUCH STUDIES**

Figure D1 illustrates the concept of minimizing the structural components and extending the couch padding to provide more usable area for body support. This concept restricts the support to two basic configurations, bent legged for launch and straight legged for sleep. Figures D2 and D3 accomplish this adjustment by revolving the leg section 180° to expose
Privacy

To reduce weight, while creating a number of usable storage cavities, an angled launch and sleep orientation to a flat sleep mode, portion an adjustable link which serves as a base of the couch. The last section necessary for the sleep mode. Figures 4 and 5 depict:

Figure D9 and D10. Figure D9 illustrates a concept in which the principle of

Two 3-compartment configuration concepts are illustrated in Figures

Fourable through the armrest adjustments.
not requiring access, the seat back-to-seat length relationship is:
- Luggage equipment (II internal) and rugged external equipment (entertainment)
- Space at the foot ends has been reduced and would be used for: v
- "configuration "P" increases and segregates the store area of "A"."
From behind, to a position over the crewman’s head.
In the sleep mode, a canopy unit pivots along the axis of couch rotation
located between the legs of the base of the couch.
"C" approach suggests the possibility of combining a conventional coach
and many ways the SkyLab crew compartment.
walls and sleep compartment doors; the sleeping compartment resembles
in the space frame outboard rails would be pulled up to double as side
directly to this front to storage modules. To achieve long curtains recessed
reposition himself on the reverse side of the cushion with accessibility
structure. With the couch in this deep configuration, the crewman would
a vertical position, raising the couch to 3½ inches above the space frame
B2, the second variation, support rods stored in the structure pivot into

FIGURES D17-D20
APPROACH D

FIGURES D13-D16
APPROACH C

FIGURES D17-D20
APPROACH D

FIGURES D13-D16
APPROACH C
the study established the credibility of the small passenger coach concept. The study estimated the potential for removal of the

...
Parameters

Date Assigned
14 February 1972

MSC - Gordon Rysavy

Center

Task

Section
Semi-enclosed area contains spillage, but does not isolate attendants.

Storage units and preparation equipment are limited to an armspan width.

Attendants not required to stand in congested area.

Work counter is directly to the front for viewing ease.

**FIGURE 81**

EXISTING CONCEPT ANALYSIS OF MSC Houston's existing concept has a total volume of 113 cu. ft., which includes 33 cu. ft. of working volume and 80 cu. ft. of hardware volume.

The initial review meeting was scheduled for April 26, 1972.

Provide for snack and leisure foods.

Provide for selection of courses per meal.

Human factors layout to reflect frequency of use of various units.

Use of conventional food preparation systems.

Minimize time, decisions, and skills required.

To develop food system and facility concepts which emphasize:.

**TASK OBJECTIVES**
## Activity/Equipment Relationships Within the Cafeteria

(!) indicates a relationship and need for access.

**EQUIPMENT**

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**ACTIVITY**

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**Existing MSC Food System and Cafeteria Concept**

[Diagram of existing MSC food system and cafetria concept]

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**STORAGE**

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**MEAL PREPARATION**

[Diagram showing meal preparation areas]
Soup and salad choice was offered, and dessert. A selection of two vegetable types was possible. A simple
choice of selecting which meals he will eat on a specific day.

Selection

To insure the crew obtains the proper amount of nutritional content.

Menu

Particular function.

To express which choices provide simultaneously, and the need for their access during a
certain emphasis of locating some units of specific equipment have been illustrated in Figure E2. The
relationship between the activities performed in the galley and

Activity Equipment Relationships

3

1

Dispersed placement of preparation facilities requires frequent body maneuvers.

Duplication of volume creates unnecessarily large galley.

Refrigerator access requires attendant to step back and bend.

STUDY ANALYSIS

Negative

2

1
At the meal's completion, the food trays are returned to the galley and upon which six food trays are placed.

The counter surface utilizes the vertical surface in front of the attendant serving trays.

After necessary refrigeration or heating, the cans are placed in individual and locates them on individual sliding preparation racks by food type.

Prior to meal service, the crewman selects what food items he desires included as the size of the crew increases.

Refrigerated, built of modular units, additional storage compartments may be required. A radial arm restraint system which allows the attendant to move as a result of the galley around the outside curvature of the vehicle and utilizes about of work and storage area accessible to the attendant, this scheme to increase the amount of work and increase the requirements of the system and to increase the

To minimize volumetric restraints have, therefore, been developed.

Refrigeration requirements that the attendants have both hands free.

6 Refieldset Systems

Food cans necessary to supply 6 men for a 7-day mission.

Food volume quantities are based on the fact that 7 food cans are the

Figures 3-3-37 A

Approach A

Food Volume Quantities

5
Next meal module into the access area. The column from which it was retrieved, a slight pressure forces the filled with all 6 (1/4) tray inserts, it is sealed and repositioned on top of another, now empty, food can. Into the waste storage module. Once when an individual returns his tray, he places the tear-off sheet with the

to the proper temperature. It is then placed into the galley or the crewman's coach to bring the food and condiments which are stored above the tray lowerator. The tray had been pre-loaded by the attendants, and select his beverages, utensils
if a crewman were to eat off schedule, he would obtain his tray which

quited. Directions on the tray direct the attendants to which food item is to be used on the trays. The and when a food item is stored cold, a cavity is present on the sheet. When those cans requiring refrigeration are placed in the tray lowerator.

backed which double as a protective seal mat, while on the trays. The entire meals come on "rear-off" sheets. These sheets are aluminum

any meal by notifying the attendant. Identified for a particular day and meal, a crewman may interchange meal he desires on a particular day. They are then packaged in modules before the mission, each crewman has the opportunity to select the

and organizing of individual courses. Their convenience without retaining a minimum of the breaking out the food trays enable individual crewmen to warm their own food at the approach B eliminates the food heating procedure. Heating calls in

pictures BS-33

approach B

to limit the amount of involvement which is required by the attendant.
For access when needed, the tape is pulled, the remaining cans stay at the front of the shelf. When the required number of cans of a given type may be removed, the right-hand side of the hole is pulled through the perforated tape. By pulling the tape, pull-out access to the food cans is simplified by linking them together in a single line. Housekeeping equipment and water storage are located at the base of the preparation areas.

Waste disposal chute is located at the extreme left of work counter. This beverager dispenser and utensil storage immediately below.

The refrigerator unit is centrally located between food storage areas with the oven.

Food storage areas surround the primary work area and are adjacent to reference to hot items list.

The area, shown in the display below, is accessible for easy counter storage and waste unit.

Prime work functions easily viewed including display, water dispenser, compressor layout enables operation from a single fixed rest area point.

For the following approach includes:

Each crewman is allowed to substitute any food item on a given day, with the exception affecting the meal preparation by the attendants. Restaurant
Approach C
Perspective of Attendee Preparing Meal

E13 Identification and Storage Technique of Food Cans

E14 Individual and Master Menu Cards
C: CD
0
- M 'O
o
C'D
|-
|-

Study Results (Figure E16)

meal.

of and the tray is cleaned and returned to the rack for the following
Solely trays are returned to tray racks by the user. Cans are disposed

utensil pick-up.

beverages are prepared by the individual crewman at the time of tray and

trays and slots are identified with the crewman's name and number.

The prime work area serves the dual purpose of tray display and tray

Ltrays followed by chilled foods.
prepared, the items in the oven are removed and placed in appropriate
trays. Ample items on the menu are then placed in service trays. When
identified by person holding cans in the same position as they occur on service
requisite heating are placed in the hot air convection oven. Fourteen racks
Water is added to those items requiring refrigeration and those items which

old in determining which foods must be heated and where they are found.
the chart summarizes the relative volumetric requirements of different
units. From the results, it appears that the total volume for a food sys-

The figure is sufficient to include all necessary hardware.
### Food System and Galley Comparisons

*Includes data on maintenance and repair.*

<table>
<thead>
<tr>
<th>Equipment</th>
<th>MSC Requirement</th>
<th>Approach A</th>
<th>Approach B</th>
<th>Approach C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerator</td>
<td>5.5</td>
<td>6.1</td>
<td>5.5</td>
<td>*</td>
</tr>
<tr>
<td>Oven</td>
<td>5.5</td>
<td>6.5</td>
<td>5.5</td>
<td>*</td>
</tr>
<tr>
<td>Food Storage</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>13.4</td>
</tr>
<tr>
<td>Total Portable Water</td>
<td>7.0</td>
<td>7.2</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Total Server Set</td>
<td>2.0</td>
<td>3</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td><strong>Heater/Chiller</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Housekeeping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trash</strong></td>
<td>6.5</td>
<td>2.2</td>
<td>1.8</td>
<td>*</td>
</tr>
<tr>
<td>Total Trash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standing Volume</td>
<td>N.A.</td>
<td>1.0</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Cups and Utensils</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Trays</td>
<td>N.A.</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Waste</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total Hardware Volume</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Total Volume</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

* N.A. = Not Applicable

---

**FOOD SYSTEM AND GALLEY RELATIONSHIPS**

<table>
<thead>
<tr>
<th>Total Vol.</th>
<th>2.0</th>
<th>12.9</th>
<th>6.3</th>
<th>4.3</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Vol.</td>
<td>N.A.</td>
<td>1.0</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Cups &amp; Utensils</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Trays</td>
<td>N.A.</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Waste</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total Hardware Volume</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Total Vol.</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
In the development of the overhead clothing storage, particular emphasis was placed on the prevention of odor cross-contamination. It was felt that the different levels of odor production garments should be segregated.

<table>
<thead>
<tr>
<th>TASK OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Duration: 7 days.</td>
</tr>
<tr>
<td>Target size: 30&quot; X 24&quot; X 4&quot; minimum 1.67 cu. ft. (MSC study 30&quot; X 24&quot; X 5&quot; minimum)</td>
</tr>
<tr>
<td>1 pair brites, 1 pair socks, 1 pair shoes.</td>
</tr>
<tr>
<td>Overhead garment storage to include: 1 pair socks, 1 shirt, 1 jacket, 1 pants.</td>
</tr>
<tr>
<td>Base of access from a single resting point.</td>
</tr>
<tr>
<td>Accommodate all necessary clothing apparel.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Assigned: 18 February 1972</td>
</tr>
<tr>
<td>MSC - Gordon Rysavy</td>
</tr>
<tr>
<td>Temporary Reserve</td>
</tr>
<tr>
<td>TASK CENTER</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

65
Solded clothing storage is included with clean garments and personal gear. Odor transfer from solded to clean items appears.

Storage unit: producing garments, 1, 2, trousers, blazers, and shoes near the bottom of the scheme B, measuring 31" X 43" (1,230 sq. in.) positions the higher door and skirt to the left and trousers and blazer to the right. Directed downward, the garments have been organized with the jacket directed upward. The garments items are placed near the base of the storage unit with air flow produce volume can be established.

The position of the garments fasteners and the location and size of the door barrier are kept to a minimum.

The overall dimensions of the garment restraint systems developed were used around it and prevent garments from becoming wrinkled.

Clothing should be stored in such a manner as to permit adequate ventilation.
in the front of the base, is pulled up into place to seal the unit.

Once clothing items are in place, a second roller shade is used to cover the entire area.

A roller shade curtain is placed in the part of the base arm, is pulled up into the unit, the folded parts of the frame are secured with clips.

In Figure 8F, a collapsible parallel frame type frame is used to minimize the minimum area required for storage.

Clothing items in the unit folds in half when closed to minimize the wall space required for storage.

Clothing is stored by placing it high in the closet and over the structure and over the clothing by taping an art high retention access to the structure.

Figure 8F illustrates parallel bungee cords, which clean up the appearance of the unit without creating tangles of cord and individually sized bungee cords to minimize free space. Figure 8F utilizes individual clothing items within a minimal door separation and clearly defines separate, proper clothing placement.

These schemes return the clothing items within partitioned cavities. They also provide ventilation of air, non-existent.

No odor separation between high and low odor producing garments.
F6 Partitioned Cavity Restraint - Individual Article Compartment

F5 Partitioned Cavity Restraint - Clothing Tucked Around Support

F8 Partitioned Cavity Restraint - Netting Restrained

F7 Partitioned Cavity Restraint - Bungil Cord Restrained
Clothing is restrained, when rotated, acts as the cover for the unit.

Please strategically on the band and clothing. The belt, on which the
a half open continuous belt. Clothing items are restrained with Velcro
structure. Fresh air enters the top. Figure P12 demonstrates the use of
easy access. Again a plurality frame support is utilized within a partitioned
Figure PII is mounted under the couch, projected into front position for

An over covering is drawn to conceal the entire unit when in use.

Down position, while lower odor items are restrained in the up position.

When clothing is restrained, high odor items are pivoted to a
In Figure PII, plurality frames fold into each other to produce a flat
devices.

It is necessary that additional work be directed at the development of the

MSC requested that additional work be directed at the development of the

MSC objectives.

Adaptable from 5% female to 95% male crewman.

Techniques of restraint should be simple.

Degree of restraint should be the option of the individual.

Three points of restraint are necessary when using the rear/vertical collar -

Volume within the hygiene facility.

Fitly cubic foot is established as the acceptable maneuvering space and clear

developed.

Utihze the accepted "L" shaped hygiene compartment (looney/smith - MSC

April 5, 1972

MSC - Gordon Rybery

Restraint System for Hygiene Facility (Phase II)

DATE ASSIGNED

CENTER

TASK

SECTION

PARAMETERS

TASK OBJECTIVES

6

5

4

3

2

1
squared.

Previously, a vertical collector, diagonally opposite the sifter, has been
rearward head clearance has been increased over the rear collector. The

an individual seated on the rear collector, to use the unit more easily.

in the top front. The rear height of the unit has been decreased enabling
modestly to receive a spherical acrylic bubble with individual handholes

The hand wash unit previously configured with frontal access has been

Phase II Variations in the Hygiene Compartment Configuration

Phase II Variations in the Hygiene Compartment Configuration

The elbow restrictor, being an active one, requires the conscious aware-

Elbow Restrictor

Belts and related mechanism may soil easily and prove difficult to clean.

Attachment points interfere with wipe motions.

Exposed skin areas contacting belt is considered undesirable.

Lap Belt Restrictor

A final presentation was scheduled for May 31, 1972.

FIGURE C.2

APPROACH

LOW/STAFF

EXISTING APPROACH

ANALYSIS OF

SCHEDULE
Is one which requires consideration, that an object has had contact with the elimination areas of another body, will have skin contact. The psychological disturbance in the knowledge a commonly used facility, has increased with which more than one creman, which tend to overshadow the positive attributes. The hygiene compartment, as generally noted in the past, the lap restraint has many ingenious qualities because the extent of protrusion varies substantially between creman, a receptacle elbow restraint appears undesirable and impractical, and create potentially unhealthy undercuts and objectionable situation, and create potentially unhealthy undercuts and the concern regarding of any restraint would impose on the crew an increase in the hygiene compartments would decrease the hygiene compartment's wall width, for a 50% female, to adapt to a smaller individual a mechanical device for just a large enough to accommodate a 98% male would be unduly large. Thus, conducted with a wide range of body sizes indicated that a stationary restraint of the hygiene restraint studied tested the feasibility of an active elbow. The results of the Phase I study of the hygiene compartment created
Three points of restraint (defined by Martin Nettell Buyagany Study):

1. Poor Restraint

Observations include:

Information gathered from the restraint study reinforces the utilization accomplished.

On each side of the collector as guide rails, there are adjustments could be with an amount of this amount would be negligible. But by utilizing the hand rails, a restraint varied more than two inches from the center of the sitter. A restraint collector using the belt restraint indicates the different body widths.

The photo series of 95% female - 95% male cream seen seated on the rear

Experience cramps.

Stretches is not practiced, such as during periods when an individual is not controlled by the user. The belt may be only used when conscious.

Recreation in an upright position when not used. The amount of concentration and can be easily cleaned when soft. It can be re-formed to accommodate

Flexible non-porous material, such as styrene, requires little maintenance.

But pleased by the cream seen.

Where it comes in contact with skin. These are not part of the restraint.

If the tissue is disposed of, another position pads under the restraint. After use, a gentle roll and posture is by placing cream to the center. After plains

One illustrations a retractable belt which when drawn captures of utilization. One illustrations a retractable belt which when creamed

Several of the concepts, if enables each cream seen to select the degree

Of "near-off" classes as a means of isolating body contact is proposed in

The availability of

The degree of skin contact, while using the hygiene compartment, varies
Limited effects. The extent of restraint mobility should be kept minimal because of its

degree of tension should be kept up to the individual.

desirable - disposable restraint cover issues. An option of personal isolation from communally used units may be

preferred over lap belt restraint.

c. Hands: Guide rails properly placed may suffice and, in fact, be

d. Lap belt: when manual restraint is not possible or desirable.
The final presentation of the 1/20 scale nose model of the shuttle orbiter was scheduled for May 31, 1972.

Analyze the existing approach and develop recommendations to improve the overall habitability of the crew compartment.

Reaction control system restricted to nose location.

Common wall surface between hydrogen and helium unit positioned on same side of the orbiter with accommodation six men for seven days.

Bay and wheel well.

Maintenance position for the reaction control system, equipment, and furniture.

Utilize the skewed Z-axis dock/artichoke system in a shuttle orbiter config.

April 5, 1972

Skewed Z-axis Dock/Artichoke System Shuttle Orbiter 1/20 Scale Model

SCHEDULE

TASK OBJECTIVES

5

4

3

2

1

PARAMETERS

DATE ASSIGNED

TASK

SECTION

H
Hygiene Compartments

1. Access to the hygiene compartment is extremely difficult: no steps exist.
2. All lock protrudes into the present position of the Gally's interior with the unit.
3. The accessibility of the hygiene compartment to all occupied coaches in launch.
4. The unimproved vertical drop from the top coach to the rear buttockhead in the launch.
5. Orientation is limited.
6. The possibility of launch pad delays necessitate pre-launch access to the launch.
7. Hygiene compartments can be used to descend into the hygiene compartment. A ladder, converted to the four launch occupied hygene compartment. A ladder, converted to the four launch occupied hygene compartment to mount the rear collector safely in the pre-launch mode.

Two-section tambour door is utilized. Steps are located in the walls to facilitate entry into the compartment in all modes of operation. A large two-section tambour door is utilized. Steps are located in the walls to facilitate entry into the compartment in all modes of operation.
creating a large pass through area
permissions the coaches to be located close to the deck during zero-C periods
item to be repositioned during the various light modes. This feature
the space coaches have been mounted on support columns which enable

Light

cabinet through the compartment and is stored during zero-C and re-entry
between the second and third coach. This does not limit passage or command
during the pre-launch period, a removable bulkhead has been installed
To prevent the possibility of a long dangerous fall from the top space coach

Passenger Compartment

has been greatly increased.

Hygiene entrance is now at the attendant’s seat and the maneuvering room
rotated 90 degrees offering the top forward nose of the orbiter. The
eliminate these interferences, the food management will have been
standing volume so that it ends to limit the attendants’ head movements.
In the original layout, the entrance to the hygiene compartment is obstructed

Food Management
allow for lateral or radial movement.

Flexible restaurant concepts were developed in early work bench studies to

assessments.

conform to the individual’s physical maneuvering patterns during the tasks

water restaurants, the restaurant should be adaptable enough to

and allow him to concentrate fully on this particular task. Unlike existing

to free the crewman of conscious awareness of the necessary for the

The development of a positive flexible restaurant is being pursued in order

Restaurant flexibility to allow limited controlled movement.

Adaptable to a variety of work stations, displays and surfaces.

Operational with a minimum of effort.

(15 minutes or more).

Positive restaurant to be used during relatively long periods of time

May, 1972

MSC - Gordon Ryaby

Positive Flexible Restaurants (Phase 1)

Existing Concepts

Analysis of

Task Objectives

4

3

2

1

Parameters

Date Assigned

Center

Task

Section
No fore/ail adjustment provided.
I No vertical adjustment provided.

Unfavorable:
With no adjustment required on sight (work station, etc.).

Adaptable to all individuals.
Lateral movement allowed.
Base of ingress and egress.

Favorable:
Commens (Figure 12)
Difficulty of ingress and egress.

Unfavorable:
Tension adaptable.
Capability of adjustments for different sized individuals.
LatITUDE of shift right to left.

Commens (Figure 11)
3 Difficult ingress and egress.
2 Pressure behind knees.
1 Lateral movement restricted.

Unfavorable:

2 Restricted positively.
1 Vertical adjustments possible.

Favorable:

Comments (Figure 14)

2 Requires excess amount of space.
1 Lateral movement limited to radial pattern.

Unfavorable:

2 Hands free movement allowed.
1 Vertical movement allowed.

Favorable:

Comments (Figure 13)
The wedge rests in which the individual may require to perform this activity, allowing the deck or platform to be modified. These concepts involve positive restraint while the crew has a multitude of feet placements available. Either integrated with the anchor or located at the base of the work station, these concepts rely on positioning of the foot in accordance to property re-

Wedge Restraints (Figures 116 - 119)

mechanical slide and reel type systems. The proximity of the front edge of the work surface to the user's water makes Water Mounted Restraints (Figures 119 - 115)

cation possibilities.

suitable over a large enough area to provide the user a choice of foot lo-

Water Mounted Restraints (Figure 115)

High Pressure or Interlocking Restraint (Figure 15)

during movement.

be used as a high friction surface for pushing or maneuvering assistance

be used as a high friction surface for pushing or maneuvering assistance

In several concepts, portions of the shoe has been recognized to improve

Our Approach

95
I-13 - Continuous Revolving Belt as Waist Restraint with Velcro Mating Surfaces as a Foot Restraint

I-12 - Waist Restraint with Foam Mounted Tension Device

I-15 - Adjustability of Slide Mounting Arm

I-14 - Schematic of Telescopic Fold Away Arms with Locking Mechanism
using these systems.

[Image 0x0 to 569x756]

A PROPOSAL FOR

DEVELOP TEST MODULATION OF SELECTED CONCEPTS ILLUSTRATED IN SECTION 1.

4. RESTRAIN TO ALLOW LIMITED CONTROLLED MOVEMENT.

3. ADAPTABLE TO A VARIETY OF WORK STATIONS, DISPLAYS AND SURFACES.

2. OPERATIONAL WITH A MINIMUM OF EFFORT.

1. POSITIVE RESTRAINT TO BE USED DURING RELATIVELY LONG PERIODS OF TIME.

POSITIVE RESTRAINTS (PHASE II)

DATE ASSIGNED

M/E, 1972

 CENTER

MSC - Cronin Rangers

SECTION
Techniques

14 - Demonstration Model of "D" Ring Fastening

13 - Demonstration Model of Center of Belt Fastener

12 - Continuous Revolving Belt with Single Center of Belt Fastener and Two "D" Ring Fastening Points

11 - Continuous Revolving Belt with Tension Adjustment
mechanism which provides for adjustable positioning of a bar foot restraint. Relative to the work station for maximum efficiency. 10 illustrates the

flexibility by enabling the crewman to select the location of the toe bar.

Conventional fixed toe bars allow lateral

side of the toe bar to distribute pressure over a larger area of the foot

All concepts shown utilize a high friction elastomeric material on the under-approach C

- Figures 19-112 illustrate toe bar concepts conceived to increase the com-

- A recess under the benches front edge, a recess under the benches back edge, the side of the crewman's belt. When not in use, the arms fold away into

- Male concepts on the ends which connect to female concepts attached to the end of the work surface. The side adjustment has a tightening device

- By use of a sliding restraint device held in a track attached to the front

- The concept shown in Figures 15 through 18 permits lateral movement

Approach B
Seal controls and intercom were to be installed, but not functional.

Earlley lowey / Stalith concer / Wash contaimers, emergency oxygen,
movable clothing container and one for small personal items as per the
landing, and General 0 - C habitation. The mock-up was to include a 2 -
static personal and maneuver into the small versions: launch, re-entry,
baysancy tests. The mock-up was to be capable of accommodation various
be constructed to withstand牢固树立 insect and effresses. The mock-up was to
them to see whether further effort was warranted. The mock-up was to
loewy / Stalith was directed to fabricate a mock-up to demonstrate the

is to be provided for shepang.

and personal effects and must be accessible from the couch, perfectly
work. Storage provisions are to be included for the crewman's garments
crewmans' needs for rest and relaxation, eating, sleeping and clothing.
per crew member. The multi-functional couch is to provide all the
consideration to accommodate specific habitation needs. In one piece of equipment
Due to limited volume within the spacecraft, consideration must be given

January, 1972

MSC - 41 Lounge

Shuttle Orrier Passenger Couch - Full Scale Mock-Up
The system does not afford the couch occupant complete privacy, but rather deploy both shade systems from a restatetd position in the couch. The system was designed so that an individual could and from privacy. The system was designed so that an individual could base of the couch which contained a folder three part shade for side over-the-head privacy and a zip-up roller shade device located at the Figure K8, consisted of three roller shades in the top of the couch for 
preliminary concept illustrated in Figure K3. The system shown in a 
rollable privacy screen system was built into the mock-up based on the 

(Figure K6), were fabricated to allow for full range testing. 
ion (Figure K7) and one fixed in the launch/re-entry/social position. 

To meet the useage requirements, we fabricated a 2" x 1/4" steel bar

Requirements stated in TASK OBJECTIVES.
lowery/South to develop the couch concept in more detail as per the

Figures K1-K3 illustrate a mechanical drawing and sketches of the selected

Figures K1-K3 illustrate a mechanical drawing and sketches of the selected

existing
and shading center with items to be evaluated.
recognizes the card into a sleeve carrying constant rotating instructions
clue card form with compartment data on the revolving wheel. L-3-4
at any one response, avoiding unnecessary search for data. L-2 is a
Raymond Leowey/William Stainhe, Inc. They isolate information pertinent
Figures L-2-L-4 show examples of preliminary concepts developed by

Preliminary Approach

Existing Concept

Task Objectives

Parameters

Date Assigned

Center

Task

Section

September, 1972

MSC - Gordon Byasy

Data Format Card

The Data Format Card, limited to two sides and 5 x 8 inches in size, is
The Data Format Card concept is currently being re-evaluated due to required changes.

Conclusion

Final Approach

Figures 15 and 16 show the final results in the development of a refined approach.
The portable unit, re-supplied at the master stowage unit would contain limited supplies needed to clean these areas.

The vacuum requires three feet of hose on the caddy and a detachable five foot general (G.P.) bag.

The vacuum, requires three feet of hose on the caddy and a detachable five foot general (G.P.) bag.

Provisions for waste generated during housekeeping chore areas are easy passageways through facades. These passageways are fully accessible to the moveable and loaded and used while stowed in the master stowage unit.

The caddy must be capable of being loaded and used while stowed in the master stowage unit as follows:

The requirements of the housekeeping equipment and master stowage unit are:

September, 1972

MSC - Gordon Bays

Housekeeping Equipment Stowage

DATE ASSIGNED

CENTER

TASK

SECTION

PARAMETERS

TASK OBJECTIVES

5

4

3

2

1
No provision has been made for maintaining the vacuum hose while maneuvering through the spacecraft.

The open configuration of the caddy does not provide spillage protection.

Excessive amount of time.

Assembling the unit for use away from the master will require an entire unit for attachment of the hose.

Use of the vacuum while in the galley area requires its removal of the unit.

No restraint device has been provided for use away from the master.

No logical organization of component placement is apparent.

The caddy must be removed to reload.

The following problems do exist, however: The present master storage unit exposes all cables to the housekeeping athlete. Empathetic to access requirement and zero-G movement. Order of frequency of use: Develop a unit form and restraint system. Locate all items within unit for maximum ease of accessibility and in sequence and devices so as to prevent escape of fluids. Develop a clean form to prevent soil build-up. Complain carrying cleaning
Use expanded sponge and/or wet wipe.

Emergency Clean

4 Switch accessory (repeat 3).

3 Clean area.

2 Attach vacuum accessory to hose nozzle.

Attach hose.

Vacuum Cleaning (Either in storage unit or remote location).

The following use description was established:

Design and Development of Housekeeping Systems for Managed Spaces: Preliminary
Using the work sequence described in paragraph 4 of the preliminary
around hose and it did not appear that the unit would inhibit movement.

stabilize. The individual has access to all stored components and the wrap
position under the arm wrapping to the rear was considered the most de-

Body placement and task operations of the caddy were studied and a

Relationships

and to evaluate the effectiveness of the proposed component layout to-

ferred to obtain minimum overall area to enclose the necessary items

contain the housekeeping equipment. The required volumes were con-

studies were conducted to define the approximate volume necessary to

Following the task sequence evaluation, preliminary three dimensional

1. Full C. P. bag storage.

2. Dry wipe towel dispenser.


4. C. P. bag dispenser.

5. Sponge/seat wipe dispensers.

use as follows:

We have arranged the storage units based on the frequency and order of
to prevent an accidental recall.

The outlet cord, an integral reel, houses the cord when not in use. When

for easy access.

during periods of crewwman transfer and all controls are placed near the

The vacuum hose is stored flush with the back of the unit to prevent snagging
to all units.

storage while vertically down the crewwman's side for equal ease of access

The selected crewwman is configured as a wrap around unit, positioning all

however, access to the rearmost storage unit is difficult.

detachable vacuum unit. The user's arm is free to move unhindered,

a slim side mounted caddy is illustrated in Figures M5 and M6 with a

then the crewwer to avoid inhibiting leg movement, as illustrated in Figure M5.

vacuum unit where to be used, it would have to be mounted in an area other

it does not obstruct the user's passage through hatches, however, if the

Figures M5 and M6 represent a convenient location of stored components.

manageable by a left hander.

size (1-0.5/2" X 1/2") was considered restricting and the layout was un-

The minimal 3-1/2 inch with allows free arm movement. Overall

peripheral recess, shoulder and waist straps rest against the body.

Figure M2 is a side mounted vac/caddy. The vac hose is stored in a
and limit weight to manageable limits.

Fronal area size limitation, 24" X 24", to facilitate movement in order

Depth limited to 18 inches.

Modules break down at locker heights to increments of 6, 12, 18 and 24
inches.

Simplified installation methods to facilitate ground crew re-supply process.

System to be loaded in 1-C, utilization of system in 0-G.

SCHEDULE

May 1, 1972

MSC Houston - Gordon Pressly

Shuttle Orbiter Storage Locker System

DATE ASSIGNED

CENTER

TASK

SECTION

PARAMETERS


A final demonstration model was constructed and pre-

Further investigation was warranted due to the importance of the storage

for several proposed systems for storage lockers, it was decided that

for June 21, 1972. As interest grew at the Manned Spacecraft Center

The tentative due date for concept development was originally scheduled
requirement to completely rebuild if one complete column were to be removed.

Which is restricted to latch designated into the system.

Storage lockers removable for replacement and access.

Structured to withstand launch vibrations.

Allows for design adjustments based on 6 modular increments.

Inventory prior to launch.

A system was enough flexibility to allow for least minute changes in
and mission supplies within the other crew compartment. MSC desired
provide for the compartment of a variety of experiments, equipment,
requested that low/medium develop concepts for a locker system which
because mission requirements may vary from one mission to another, MSC

Adaptive storage within locker, to secure wide variety of items.

Provisions to carry locker, or part of it, to other areas of the craft.

Ability to remove storage lockers in 0-G and transport to other areas of

Withstand intense launch vibrations.
I:

Preliminary Phase

APPROACH

LOW-Y/SNATH

I.

No visible means of transporting individual lockers.

4. Inconveniency method of relocating components of a locker to others.

Areas of the careful.
the same manner. Using pallets as wide as the master case interior.

The interior of the master storage case may be divided up as required

by using these extruded flare pallet inserts which interlock with the ex-

treme 3, 4, and 5, in turn. At this point, the pallet inserts will accommodate the variety of article sizes and shapes

modular growth. The problem still exists as to how the interior of the

storage area is to be used. To overcome this need, a color-coded system was conceived as an answer.

A crewman from the general storage area was used to number and letter, lead the crew to areas within the crew compartment the system would be

utilized an alpha numeric graphic system. The approach shown,

section of the on-board inventory of stored items. The approach shown,

Figure 17 illustrates a problem which was addressed lightly in the pre-

viously published literature. An MWC pointed out that a locker which was not made up or one piece, would be

destroyed by launch vibrations.

The breach into a slot and lowering the locker into place.

for vertical space between each storage unit. The "key" requires sliding

for vertical space between each storage unit. The "key" requires sliding

with a displacement edge in the requirement

be mounted. Threaded tension bars are utilized to control the storage

be mounted. Threaded tension bars are utilized to control the storage

in 1-C and act as a bearing surface upon which the key slot breakers may

The "shelf" feature under the lockers and support while loading units

The interior of the master storage case may be divided up as required

by using these extruded flare pallet inserts which interlock with the ex-

treme 3, 4, and 5, in turn. At this point, the pallet inserts will accommodate the variety of article sizes and shapes

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destroyed by launch vibrations.
Position when not in use.

1. Lock Mounting

Figure 10-12 shows a few of the restant coil types present.
Figure 10-9 shows a cut-away detail of the locking mechanism selected and locked as shown to the pallets.


cases and shapes to the pallets.

With the exception of MSC of the pallet systems, detail concepts were developed regrading methods of locking the pallets to the master storage with the acceptance by MSC of the pallet systems, detail concepts were

Detail Development Phase

May be removed as desired.

Additional pallets on total groups of pallets and the items they contain vertical length patterns into the case vertically between horizontal patterns. Stating propositions desired relative to mission storage requirements. Stating
Laden trays to be mounted in the same locker horizontally or vertically.

The flexibility of the storage locker system is dramatized in Figures 6r, 6t, 8o, and 10a. Figure 6r shows a close up view of repetitive track extension shapes placed by any of the other forms.

Specialties four 12W X 18H, 12H X 18D, and 12H X 18W X 18D modules have been limited to the following sizes: 6H X 24W X 18D, 12H X 24W X 18D, 12W X 18D, 12H X 24W X 18D, and 24H X 24W X 18D.

In locker sizes.

Each locker is supported independently allowing last minute changes are threaded at the rear end for tagging to the mounting surface.

Specific cases may exist where unusually large lockers may be required.

Refer to the lockers to the wall is accomplished from the front surface and does not require opening the locker. Located on the
of the locker module.

Identical tray restraining capabilities as those mounted on the interior
as in Figure N22. The extrusion on these trays would have the
extra-long adapter insert which would be used to hold tray grounding
ports, equipment or experimenter's on the trays. Figure N24 is an

Figures N24-N28 represent several concepts for restraining compone-

The tray orientation will be established by the character of the article

(d) Component Restraints

holding on to the tray handle.

The locking action can be accomplished with the thumb while

tray

into a slotted portion of the extrusion to the left and right of the
lower located on the lower hand grip is slipped 180° direcction rods
on the two outer edges of the trays. To lock the tray in place, a
transitions with a slight resistance caused by shock mounted foam pads
it is demonstrated in Figure N23. The trays slide in between two ex-
the required area of the space and a detail of the locking mechanism
of a group of trays locked together and carry them to
as illustrated in Figure N22, the components are able to remove in-

of the storage locker by sliding trays out.

The drawer type character of the trays allow access to the deep end

available.

depending on orientation requirements relative to G-loads and space
Principles involved, as illustrated in Figures N30-N37.

A demonstration model of the storage locker system was constructed to better illustrate the concept and evaluate the practicability of the principles involved, especially during extreme launch vibrations.

Reference with each other, especially during extreme launch vibrations.
- Between nets and between trays should be adjusted to prevent inter.
- On components at desired intervals for proper restarter. Space be -
- To hang completely free. The netted pouch is twisted and hooked

Figure N37 enabling some components, usually of medium size,
Figure N37 pouch suspended between the sides of the tray in
An elasticized pouch suspended between the sides of the tray at.

Senses dispersion of articles when the lid is opened in 0-9.
- Small objects are placed on an adhesive coated surface which pre-
- For smaller articles, Figure N26 has an insert made of wedge-shaped

Figure N25 is a general purpose restarter, an insert used mainly

139