development.

needed to communicate our ideas and to establish a foundation for future tasks. Sketches, mock-ups, mechanicals and models were the mediums quickly provide NASA with a variety of creative solutions for the Shuttle Orbiter Program as requested by MSC. It was our goal to be a consultant design office, we have provided habitation design services.


for the Manned Spacecraft Center, Houston, Texas, from January 24, 1972 to

This report covers work accomplished by Raymond L. Owen/William German Inc.
Following the task assignment, a meeting was scheduled for January 12, 1972.

Requirements for Launch, Zero-G, and re-entry modes were reviewed.

To develop a working crew compartment configuration which satisfies the operational requirements for Launch, Zero-G, and re-entry modes.

A 36" passage through the crew compartment extending from the cockpit to the rear cockpit was necessary to ensure easy escape paths and head during launch.

Immediate access necessary to emergency escape hatch and head during launch.

Crew compartment consisting of a 9x9x9 ft X 10 ft X 16 ft module.

6-man crew - maximum of 4 crewmen occupy crew compartment at launch.

Consider operation in 2 modes of orientation - launch, Zero-G, re-entry.

Shuttle Orbiter Crew Compartment/X-Axis Docking

Date Assigned: January 12, 1972

MSC - Allen J. Louterer

Shuttle Orbiter Crew Compartment/X-Axis Docking

Figure A

Existing Concept Analysis

Schedule

Task Objectives

Parameters

Date Assigned: January 12, 1972

MSC - Allen J. Louterer

Shuttle Orbiter Crew Compartment/X-Axis Docking

Figure A

Task Section
can be linked to suit individual preferences.

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

Advantages

between the wall position and the structural supports of the space couch.

between Figure 4(3) the head and gallety are shown a common wall with a "passageway" meant (Figures 4) the head and gallety are shown a common wall with a 20" passageway to define routes of travel and outline activity areas. In the crew compartment established to define routes of travel and outline activity areas. An aisle was

emphases was placed on the accessibility of the emergency escape routes during launch

Crew Compartment Description

Avionics is dispersed throughout the vehicle, a more integrated plan is needed.

should be established to organize flow through the vehicle.

 Mobility through the craft is very limited in all flight modes, a specific passageway

Chapters 5 and 6 store for launch which require undue preflight and flight adjustments.

to reach exit platform.

access to the emergency escape hatches 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

FIGURES A2 AND A3

LOW-ENTRY APPROACH
by either one galley attendant or each crewman.

The area has been designed to accommodate 6 mean for 7 days, operated

partments. 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 A5)

with some free passageway movement.

A 39" passageway, extending from the arthock to the rear bulkhead has been re-

Disadvantages

- Of 24" Is required to house the adequate volume.
- The arthocks have been integrated in the area of the rear bulkhead. A depth
- 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 other side.

The fall of their chairs provides a quick drop down to the rear bulkhead

The escape hatch has been placed adjacent to the rear bulkhead, an aisle at

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

The escape hatch or each crewman.
Hygiene Compartment Description (Figures 6 and 7)

Preparation Area:
(3) Possibility of meal selection is somewhat limited due to storage capacity and

(2) Limited room for maneuverability (conflict with space couches from rear).

(1) Gallery attendant obstructs passage while preparing food.

Disadvantages:

(b) Food may be prepared at gallery unit.

(a) Individual space couch food preparation (food tray jacked into individual's

couch to heat food).

Advantages:

(4) Two options for heating food are provided:

(3) Standard skylab food cans utilized,

as well as housekeeping stowage in a minimum sized area.

(2) In common all areas, food preparation devices, food service implements,

(1) The gallery location is in an area readily accessible to the space couches.
Difficult collector maneuverability in head for different orientations.

Must sit down to use handwash and to urinate in re-entry.

Trousers must be removed to urinate/defecate.

Disadvantages

- 3 orientations.
- Hygiene launder doors enable two opposite stabilizing motions compatible to
  - Limits limited to one wall (modular replacement).
  - Pitcher, Zero-C.

Fecal collector and handwash unit adaptable to 3 orientations (launch, I-C)

Advantages

- Units interlace with the walls through the center of the pivot.
- Suits into the various modes as does the fecal/urinal collector. All services to these
  - Satisfaction requirements in all situations.
  - The handwash units, installed directly above
  - Pitcher (Figure A9). This was accomplished by positioning the collector around an axis
  - The fecal collector to be used in all phases of orientation including inter-atomic-L-C

6
A final presentation was scheduled for February 9, 1972.

To explore possible solutions to the problems of access to the space couch in the various orientations.

Consideration in design for maneuverability of elderly and women.

Access to head and escape hatch during launch.

Orbiter passenger compartment size limited to 90" X 108" X 108".

6-man crew.

Operational in three modes of orientation: Launch, Leisure/Sleep, Re-entry.

13 January 1972

MSC - Allan J. Louviere

Shuttle Orbiter Passenger Compartment/Flight Deck
Avoid deterring any innovative ideas.

Shuttle orbiter hardware and systems were not a primary concern in the phase to
the prime objectives of this effort. The interface of these facilities within other
providing accessibility to the equipment necessary during each of these modes were
safety/launch, leisure/sleep and re-entry orientation of the space craft and

passenger compartment, especially during pre-flight and I-G flight.

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

1-G Horizontal Flight - The head should be available.

I-Lock and related features

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

immediate access to all space couches, the hygiene compartment and the escape

Launch - Under the effect of I-G the passengers on the launch pad should have

A. The primary modes of orientation within the Shuttle Orbiter Include:

problems of mounting and dismounting the space craft in its various orbita-

William Snith's, he was interested primarily in exploring solutions to the

In this study of the Shuttle Orbiter Passenger Compartment, Raymond Leowy/

APPROACH

TO BLY/SNAITH
Temporary clothing storage, as partitions to create semi-private quarters during sleep and provide areas for modular couches. The configuration enables the spacecraft slides to be utilized in Figures B and D to demonstrate the diversification possible in the arrangements of achieving access to the space couches.

As illustrated in Figures B and D, the couches used in launch are positioned to increase the mounting and dismounting accessibility. Supporting the space couches allow the crewmen to raise or lower them in order to access the headibility provided. The brackets for the flight deck crew to use in zero-G only.

For the flight couches shown in Figure B, utilizes these modular units, The compartment configuration enables easy mounting, escape and hygiene facility access. The headibility guarantees the comfort of the couch performer to enable the seating mode. The diversification as an example of modularization in the three couch orientation modes.

With the possibility of frequent "on-pad" servicing, it became evident that modular-approach A

Modular Compartments Environmental Systems.
Posts

B8 - Adjustable Couch Held in Place by Spring Tension

Private Quarters

50 - Couches Utilizing Partitions to Create Semi-

B5 - Horizontally Mounted Adjustable Couches

B7 - Space Couch Utilizing Overhead Clothing

Lift as Privacy Screen
TRACKED COMPARTMENT ENVIRONMENTAL SYSTEM (Figures B9-B12).

**Disadvantages**

b. Self-contrained sleep compartment concepts exhibit tendency toward a claustrophobic feeling.

d. Limited mobility and varation in layout (Figures B2-B3).

**Advantages**

c. Privacy is provided.

d. Easy access to course.

Examples of compartment designs as one component.

- Service is easy and parts are interchangable.

Examples of positions elsewhere.

- It can be adjusted via spring post ends covered with a sponge material.
To increase accessibility to the space couches in the various modes of orientation,

**Description**

Articulated Space Couch Utilization.

- Occupant room is necessary to accommodate interchangeability of footplates.
- Problems of permanently attaching units to withstand launch "G" loads.

**Disadvantages**

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

**Advantages**

- One continuous area useful for experiments and leisure activities.
- Open space is possible by shifting all the couches to one end of the orbiter, exposing couch interchange through the tracks to jack mounts at inter vals. A completely fixed, permanently at launch, the couches, as well as space couch articulations, fixed permanently at launch, the couches, gate, and work stations, areas between them is utilized for crew maneuvering.
- The parallel track creates a flexible system which allows adjustments in mission.
Flexibility of compartment configurations.

Advantages

Mounting

faces during launch is also accomplished in this manner.

Figure B illustrates two revolving cylinders, each with two couches. Passengers in a compartment where the couches face each other, to a configuration where they project inward and the tracks can be maneuvered parallel to achieve their functions in various orientations. Illustrated in a position con-

increase the amount of compartment configurations variances, as well as main-

other than length. May be arranged to create a continuous 39" clear area extending the interior.

Increase I-C accessibility.
deck to the passenger compartment, yet allows for individual compartment identity.

Visual communications and adequate maneuvering area to translate from the flight
of the spacecraft. If visually extends one area into the next, it makes partial
open scheme by "loathing" the central deck creates passenger access on both sides
right deck and passenger compartment is illustrated in Figure 4-2, a relational
occurring concurrently. The extend of audio-visual communication between the
was emphasizes and considerations were made not to obstruct activities which were
unnecessary travel to the passenger compartment for this activity. Utility of space
enhanced and repositioned behind the seat as a sleep station. This alleviates
equipment at all times. Figure D illustrates the use of the flight crew seal pad
result in a more efficient use of space and provide for instant access to monitoring
approach would
accommodate restrooms for the sleep mode of operation. This approach would
accommodate restrooms for the operational standards. We investigated the possibilities of reconfigurinig it
lines and control monitoring. We investigated the possibilities of reconfigurinig it
not only the audio-visual communications
passenger from the operational standards, yet not in other audio-visual communications
concerned with separating the rest/crew and activity areas in the passenger can-
in showing as the flight deck, Raymond Lowry/William Sinclair, etc., was primarily

1

PROCEDURE

DESCRIPTION

PHIJGE DECK CONSIDERATIONS

ACTIONS

c. Large compartment usable area is necessary to accommodate these configurations.

Positioning of individual couch is dependent on location of others.

a. Extremely mechanical.

DESAVENANCES

3
a) Conflicting activity areas.

Disadvantages

3

d) Maximum accessibility to separate compartments from height deck.

c) Open deck concept gives the feeling of spaciousness.

b) Seats reserved available for high deck use.

a) Inter-compartment audio-visual communications provided.

Advantages

2
In order to fully evaluate the task, the facets of the facility and operational needs including the rectangular compartment are considered important. It is essential to analyze the entire hygiene system.

**TASK Objectives**

- Interior volume to approach 30" X 30" X 78".
- In C-Perf, crewmen may use the existing urinal facilities only.
- Rectal/urinal collector used in launch, ZC-0.
- Spl to 96th percentile personnel sizes.
- Accommodate male and female personnel.
- In atmosphere light - axes of oblique parallal to horizon.
- ZC-0.
- Launch - axes of oblique perpendicular to horizon.

**Parameters**

1. 14 February 1972
2. MSC - Gordon Rainbow
3. Restaurn system for hygiene facility (Phase 1).

**Date Assigned**

CENTER

**Task**

SECTION

**Remarks**

23
To allow enough head clearance, utilize space opposite the collector unit. An interior area of 40" X 30" is necessary. The area between accommodation back-up volume and external collector are adjacent walls. Figure C3 positions the handwash unit and external/central collector on adjacent walls.

To launch, above the handwash unit, provides head clearance if deflection is required prior launch. Figure C2 illustrates an alternate version of a hygene facility, back-up rear.

Restain concept.

The volumetric requirements of the hygiene facility and developing appropriate
preliminary studies of the hygiene facility conducted were aimed at minimizing
in the launch mode, space of the handwash unit while secured on the external/central collector as restrictive
its use in an awkward body orientation or conductive to easy waste elimination. Figure C1, the lack of head room in the secured external position (zero-C) changes
the existing system falls short in certain areas of compatibility with 50% to 95%
parts to required.

To facilitate "off-the-pad" refreshing, "no-pad" chevrons and space tight re-
not and personal hygiene unit, the units were designed as quick disconnect modules
represented a baseline for this task; the systems comprised a central/external collector-
the existing MSC Houston Shuttle Order Personal Hygiene Facility (Figure C1)
The arrangement allows for location of all facilities requiring plumbing and back-up of restaurant equipment. Possible locations are given the crewmen an option as to the amount of space required, which may be incorporated with side walls creating a comfortable and quiet environment.

A diagram shows the location of the facility and the plumbing required. The arrangement shown on Figure C4 reduces the central maneuvering area with the area, a 40" head clearance is maintained in a 30" X 30" facility.
By walking vertically through door.

1-G Pilfers - Handwash and urine collector are usable. Hygiene is accomplished.

ZERO-G-All systems in use.

the door into the floor restraint of the fecal/urinal collector
used by side access. Hygiene would be accomplished by stepping down through

Launch - Fecal/urinal collector used in seated position. Handwash could be

This orientation varies according to the attitude of orbiter.

pendicular to axes of shuttle orbiter. The use of waste management units in

This scheme positions the personal hygiene unit and fecal/urinal collector per-

the maximum extent possible.

Mobility aids and restraint provisions are built in or flush with surrounding to

the fecal opening for standing urination use only.

A second urinal opening, leading to the same collector tank, was placed below

eliminated.

headroom clearance problem for a person using the urinal/fecal collector is

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

creating a headroom clearance problem previously experienced. Orien-

Figure CI illustrates Approach B integrated into an MSC, Houston scheme,

volume of all components studied with no reduction in maneuvering ease.

in the area in which they are located. This approach required the minimum total

All mobility aids and resturants are built in or flush with the adjacent surfaces.
and I-G fitted modes.

**Figure C22** illustrates how a gel female would use the compartment during Zero-G

coupled into the unit he was utilizing.

Carried with the individual crewman around his waste it would be
positioned. Carried with the individual crewman around his waste it would be

![Diagram](image)

**Figure C21** demonstrates the use of a portable multi-purpose restraint adaptable

for.

well as properly positioning the body in a seated position on the fecal/urine collector.

hand aids minimize dirt when using the handwash and oral hygiene unit, as

mobility aids have been positioned to aid in function of the facility. Poor and

ton unit (in most schemes to several inches either side of a seated individual)

of a continuous space due to the different needs. By limiting the width of the fecal

of the elimination area of the crewman. We also felt it was essential to give the

the elimination area of the fecal gatherer an option to the external of restriction to decrease and reduce the feeling

through this study. Raymond Lowery/William Smith, Inc. has been concerned

RESTRAINT SYSTEMS

wash for better accessibility.

to the personal hygiene unit was the oral hygiene unit being centered over hand.

The personal hygiene unit is matted with cross contamination. The only change

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

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

In addition to making the most of the upper corners, this arrangement leaves

specific on the fecal collector with a diagonal of the compartment cross section.

To take maximum advantage of the space available we have achieved an individual

excess plumbing and overall equipment volume was minimized.

By placing the fecal/urinal collector and the handwash unit on adjacent walls,
Required resources and mobility aids appear to be:

- Dirt collection of bell and stowage cavity.
- Interference with hinged procedures.

This may be direction to explore.

A variance of contact of exposed skin areas with bell(disposable segments) which must be overcome include:

- Staining device essential. Problems related to the use of a lap belt system.
- Creation of the individual. The path of clamps will make use of a positive role.

A "lap belt" was considered as 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 helicopter facility.

Observations are noted:

Based on information gathered from the volumetric compartment, the following relationships:

Into maneuvering areas, fixtures and back-up components to figure volumetric

of the concerns on a volumetric requirement basis. We broke down the facility

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

STUDY EVALUATION

Launch orientation.

Figure C3 illustrates a 95% made using the compartment during Zero C and

38
Approach C.

toward the development of an elbow and leg restraint utilizing a revised restraint system for a hypoge Ortho facility (Phase II) will include effort directed

FUTURE REPORT

c. "Ellbow" restraint and/or "Lap" restraint (degree of use - option

b. Hand rails (to maneuver between fecthiches - option of crewman).

a. Foot restraint/leg (available for use at crewman's discretion).
## TASK OBJECTIVES

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### PARAMETERS

- **DATE ASSIGNED**: 14 February 1972
- **CENTER**: MSC - Gordon Rapsay
- **TASK**: Small Passenger Coach

*Raymond Loewy/William Spain, Inc. has applied the knowledge and experience gained in the development of a large passenger coach to the design of the coach described above.*

1. The coach will perform the same functions as the earlier larger model coaches.

2. Maximum dimensions: 77.7 L x 27.7 W X 14.4 D.

3. Accommodate 50% female - 95% male.

4. Lighting and communications.

5. Garment, personal gear, stowage, trash disposal, issue dispenser.

6. Provide crewman with comfortable personal area to include provisions for by rotating the coach along its longitudinal axis.

Reorientation of the coach phases of flight operations will be accomplished serve as a support (seat) for all modes of operation.
accomplish this adjustment by revolving the leg section 180° to expose
the legs for launch and straddle legs for sleep. Figures D2 and D3
illustrate the support to two basic configurations, bent
and extended. The coach paddling provides more usable area for body support.

Figure D1 illustrates the concept of maximizing the structural components
which was rather limited.

When the coach was configured for sleep and the amount of pry bar pro-
resisted in a controllable, but rather large until (6' X 14' X 9'W). The
constraint and adaptability to the various life modes, this coach
critically evaluated in a three dimensional model. Emphasis was placed
on developing the function support coach to a point which it could be
27" wide. The first generation passenger coach was aimed primarily
on the criticality of the first generation space coach, we approached
the problem from a structural viewpoint, looking at methods of achieving
the most efficient structure and, therefore, the best utilization of space.

Based on the critical elements of the first generation space coach, we approached
1972.

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

Equipment are included in the coach design.

of a restraint, cushions, enviromental controls and emergency
hydraulic lines, etc., have been conveniently located within arm's reach
immediate access items, including lassues, trash disposal, personal
any has increased the accessibility and overall usable coach space.

A less pronounced cushion configuration with a low retaining wall, if

PRELIMINARY PASSENGER
COACH STUDIES

APPROACH

TOE/W/NATH

SCHEDULE

41
Privacy

Toes an entrance/exit way from the couch when it is configured for

Sleep area located in front of the restrained individual which also has

screw in head over the head and screwing it on top of the couch. The ventilation which will be used to keep the privacy

up in the top of the couch structure would serve to keep the privacy

by pulling it up over the half of the couch base (Figure D). An individual restrained in

portable of the couch base. The arm structure shows the minimum weight. The arm structure shows how to provide complete visual privacy and

Two sleep compartments configuration concepts are illustrated in Figures

FIGURES D & D1
APPROACH B

FIGURES D & D2
APPROACH A

The main clothing storage area within the privacy area when the

configuration "A" increases and segregates the storage area of "V."

coaching is configured for sleep.

The space frame to visually lighten and soften the look of the couch. The

picture frame is adjustable over the back of the couch. The

cushion extends the entire usable width of the area with minimum space

"In under the couch space frame approach has been taken. The couch

To reduce weight, while creating a number of usable storage cavities, an angled launch and sleep orientation to a flat sleep mode.

the flat section necessary for the sleep mode. Figures D4 and D5 incor-
From behind, to a position over the crewman's head.

In the sleep mode, a canopy will pivot along the axis of coach rotation.

Located between the legs of the base of the coach.

The overthigh seat storage is located behind the seat back. Immediate

release configuration.

Optional. The first place the knee orientation during launch and

within this area the coach is adjusted for either seat or small passenger coach.

The structure of coach D surrounds the entire small passenger coach.

means enclosing them.

stratified crewman, a privacy screen can be drawn between the two sets

of the same axis of rotation as the coach to a location in front of the re-

the head of the coach. For the sleep mode, it is placed around

the overthigh storage is positioned on a cradle like structure oriented be-

by shifting the foot pad and seat back in and out.

to two points, the knee location and the back. The coach length is adjusted

concepts with an airline passenger seat arrangement. Adjustment is limited

"C approach suggests the possibility of combining a conventional coach

in many ways the Sky Lab crew compartments.

walls and sleep compartment doors; the sleeping compartment resembles

in the space frame throughout rails would be pulled up to double as side

directly to this front to storage module. To use long curtains recessed

reposition himself on the reverse side of the cushion with accessibility

structure. Within the coach in the sleep configuration, the crewman would

a vertical position, raising the coach 27 to 90 inches above the space frame

B1, the second variation, support rods stored into the structure pivot into

FIGURES DI7-D20
APPROACH D

FIGURES D13-D16
APPROACH C
The study established the credibility of the small passenger coach concept. From the station was not considered in this study phase. In general, introduced late in the concept development to allow for removal of the down requirement for the coach to fold to 28' x 28' x 39'. It was in the decision of scheme 'P', were considered desirable features. A break - The integral sleep compartment concepts of scheme 'P' and volume re-
Frozen foods will not be considered for the 42 man/day mission.

(Food type: dry 20%, shelf stable 20%, and perishable 20%)

All foods will be precooked, packaged, and served in individual containers.

Keeping:

Galley volume 100 cu. ft. (80 cu. ft. Galley facility - 20 cu. ft. house -

the unit.

All food and equipment related to the galley function to be stored in

One-man food preparation and clean-up.

3 meals per day with limited choice per meal.

42 man days (6 man/7 days - 14 man/3 days).

PARAMETERS

DATE ASSIGNED: 14 February 1972

MSC - Gordon Brewery

Food System and Galley

CENTER

TASK:

E

SECTION
Semi-enclosed area containing spills, but does not isolate attendants.

Storage units and preparation equipment are limited to an attic span width.

Attendant not required to stand in congested area.

Work counter is directly to the front for viewing ease.

### Positive

Includes 35 cu. ft. of work tools, volume and 80 cu. ft. of hardware volume.

MSC Houston's existing concept has a total volume of 113 cu. ft., which includes 35 cu. ft. of work tools. The initial review meeting was scheduled for April 26, 1992.

- 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

### Figure E1

EXISTING CONCEPT ANALYSIS OF SCHEDULE

1. Task
2. Use of conventional food preparation systems.
3. Minimize time, decisions, and skills required.
4. Provide for selection of courses per meal.
5. Provide for snack and leisure foods.
### Activity/Equipment Relationships Within the Cafeteria

<table>
<thead>
<tr>
<th>Activity</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving</td>
<td>Serving Cart, Trolley, Tray Dispenser, Water Injector</td>
</tr>
<tr>
<td>Food Preparation</td>
<td>Food Preparation Area, Oven, Refrigerator, Portable Water System</td>
</tr>
<tr>
<td>Meal Preparation</td>
<td>Meal Preparation Equipment, Cleaning Agents, Cleaning Equipment</td>
</tr>
<tr>
<td>Storage</td>
<td>Storage Units, Refrigerator, Freezer</td>
</tr>
<tr>
<td>Miscellaneou</td>
<td>Miscellaneou</td>
</tr>
</tbody>
</table>

**Notes:**
- Collection: Containers, storage bins, wet and dry wipes, vacuum.
- Water supply units, cather, heater.
- Lighting, ventilation, air conditioning.
- Toilets, utensils and beverage containers.

(X) Indicates a relationship and need for access.

---

### Existing MSC Food System and Cafeteria Concept

![Diagram of Existing MSC Food System and Cafeteria Concept](image)

- **Equipment:**
  - Serving Cart, Tray Dispenser, Water Injector, Food Preparation Area, Oven, Refrigerator, Portable Water System, Cleaning Agents, Cleaning Equipment, Storage Units, Refrigerator, Freezer.

- **Miscellaneous:**
  - Miscellaneou.

---

---

---
soup and salad choice was offered. A selection of two vegetable types was possible. A single
dessert. A selection of two vegetable types was possible. Soup or salad, bread
For the purpose of this study, the types of food available was limited

Selection

choice of selecting which meals he will eat on a specific day.
mission, subject to dietitian approval. In flight, he will have the
To ensure the crew obtains the proper amount of nutritional content

Menu

particular function.
ies within those proximity and the need for their access during a
clearly emphasizes the necessity of locating some units for specific
pecific pieces of equipment have been illustrated in Figure 2. Three

study ANALYSIS

Activity Equipment Relationships

by the galley attendant and added time in meal selections.
Dispersed placement of preparation facilities requires frequent body maneuvers
Duplication of volume creates unnecessarily large galleys.
Refigerator access requires attendant to step back and bend.

Negative
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 located them on individual stowing preparation racks by food type.
Prior to meal service, the crewman selects what food items he desires 
if judged at the size of the crew increases.
Requirements, built of modular units, additional storage components may be 
required. A radical new restaurant system which allows the attendant to move as 
a radial arm restaurant system which allows the attendant to move as 
around the galley around the outside curvature of the vehicle and utilizes 
amount of work and storage area accessible to the attendant, this scheme 
use of the system and to increase the 

Food preparation requires that the attendants have both hands free.

To minimize volumetric requirements of the system and to increase the 

Hands free restaurant concepts have, therefore, been developed.
next meal module into the access area. The column from which it was retrieved is still in place, and the food rests on the top of the tray inserts. As the tray is removed into the waste storage module, the restaurant's now empty food cans into the waste storage module. Once the tray is removed from the vacuuming system, the food rests on the rear-off sheet with the proper temperature.

On the proper return line, the tray is then returned to the galley, where the tray is removed from the vacuuming system. The tray has been pre-loaded by the attendant, and as such, is ready to be used by the next customer. It is a tray that is to be off schedule. The proper food for the crew members is selected, and includes all of the required food items.

There are items that are required to be stored in the tray holders, which can be closed while on the trays. The entire meal, come on a separate sheet. The sheets are aluminum backed, which doubles as a protective seal, while on the trays.

Any meal can be tailored by the attendant. A particular day, and the crew members may select to order the meal to a menu, and the attendant's mobile phone is used to place the order. The attendant then selects the menu to be delivered to the customer.

Before the mission begins, each crew member has the opportunity to select the menu of individual courses, and organize their meal to their liking. The attendant will remind the customers that they have ordered their meal, and when the meals are delivered, the attendant will remind the customers to eat the meal. The attendant will then inform the customers that the meal is ready. The attendant will then arrange the meal, and return the tray to the galley.
For access when next needed, the tape is pulled, the remaining cans stay at the front of the refrigerator. When "push" the required number of cans of a given type may be removed. When holes with an indentifying perforated tape. By pulling on the tape "pull" access to the food cans is simplified by linking them together in refrigerator.

Until such access would not normally be required during food preparation, housekeeping equipment and water storage are located at the base of the preparation areas.

Waste disposal chute is located at extreme left of work counter. Thus provides easy access when emptying trays, yet removes it from prime preparation unit as 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, situated immediately below the display, is accessible for easy counter storage and waste unit.

Prime work functions easily viewed including dispenser, water dispenser, compact layout enables operation from a single fixed reference point.

For the following approach includes:

Each crewman is allowed to substitute any food item on a given day, with-
This figure is sufficient to include all necessary hardware.

In and gallery need not exceed a 50 cu. ft. eaching standing volume.

From the results, it appears that the total volume for a food sy-

The chart summarizes the relative volumetric requirements of different

Study Results (Figure E16)

meal.

of and the tray is cleaned and returned to the rack for the following

Soled 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 stores are identified with the crewman’s name and number.

The storage area includes stores for 4 trays. The

store area serves the dual purpose of tray display and tray

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

trays followed by chilled foods.

Prepared, the items in the oven are removed and placed in appropriate

trays. Ambarin items on the menu are then placed in serving trays. When

trays identified by person hold cans in the same position as they occur on serving

Trays require heating are placed in the hot air convection oven. Rounden racks

Water is added to those items requiring refrigeration and those items which

and in determining which foods must be heated and where they are found.

the attendan would arrange them on a master board which provides graphic

scope of the items offered that day. After receiving the selected menu,

the crewman desires it, he could interchange any meal item within the

decide in which of the three storage areas an item may be located. Should

beside labels which are pre-arranged on the menu. Labels would be-

of each day for this mission duration. Meal items are printed on ad-

Three menus are issued to each crewman representing the three meals
### Food System and Galley Relationships

<table>
<thead>
<tr>
<th>Equipment</th>
<th>MSC Requirement Study</th>
<th>Approach A</th>
<th>Approach B</th>
<th>Approach C</th>
</tr>
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<tr>
<td><strong>Food Storage</strong></td>
<td></td>
<td>7.0</td>
<td>5.4</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>Refrigerator</strong></td>
<td></td>
<td>5.5</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Oven</strong></td>
<td></td>
<td>6.5</td>
<td>5.5</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Tanks</strong></td>
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<td>3.3</td>
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<td>3.3</td>
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<tr>
<td><strong>Heater/Chiller</strong></td>
<td></td>
<td>7.6</td>
<td>7.6</td>
<td>7.6</td>
</tr>
<tr>
<td><strong>Potable Water</strong></td>
<td></td>
<td>7.8</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>TOTAL POTABLE WATER</strong></td>
<td></td>
<td>7.8</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>TOTAL WORK COUNTER VOLUME</strong></td>
<td></td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>HOUSEKEEPING</strong></td>
<td></td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Waste</strong></td>
<td></td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Cups and Utensils</strong></td>
<td></td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Trays</strong></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Standing Volume</strong></td>
<td></td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td><strong>TOTAL HARWARE VOLUME</strong></td>
<td></td>
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<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>TOTAL VOLUME</strong></td>
<td></td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
</tbody>
</table>

**Notes:**
- Included in housekeeping.
- N.A. Not applicable.
- Food storage modules are used.
- Food held in icy.
In the development of the overall clothing storage, particular emphasis was placed on the prevention of odor cross-contamination. It was felt that the different levels of odor producing garments should be segregated.

Mission Duration: 7 days

Target size: 30" x 24" x 4" minimum 1.67 cu. ft. (MSC Study 30"

Overnight garment storage to include: 1 pair pants, 1 pair socks, 1 pair of underwear, 1 shirt, 1 jacket.

Base of access from a single restocking point.

accommodate all necessary clothing apparel.

TASK OBJECTIVES

1. 2

PARAMETERS

DATE ASSIGNED

Gordon RPSavy

Temporary Restorables

MSC - Gordon RPSavy

Center

Task

SECTION

14 February 1972
Door transfer from soiled to clean items appears to ensure that clothing storage is included with clean garments and personal gear.

Storage unit. Producing garments, i.e., trousers, blouses, and shoes near the bottom of the storage unit, measures 31" W x 43" L, (1'232 sq. in.), positions the higher order and shirt to the left and trousers and blouses to the right. Directed downward, the garments have been organized with the jacket directed upward. The garments nearest the belt of the storage unit with air flow products items are placed near the base of the storage unit with air flow products directed upward. The higher order and shirt to the left and trousers and blouses to the right. Directed downward, the garments have been organized with the jacket directed upward. The garments nearest the belt of the storage unit with air flow products items are placed near the base of the storage unit with air flow products directed upward.

Storage volume can be established. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. 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By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space. By calculating the total area encompassed by the items, a total free space.
in the front of the base is pulled up into place to seal the unit. The rear of the unit is secured in place by closing the rear door. Once clothing items are in place, a second roller shade located in the rear of the unit is pulled up into the unit and secured to prevent the rectangular frame from wreaking. This roller shade is used to minimize the rear view requirement when not in use. To use the unit, the folded rear of Figure 9, a collapsible parallel frame type is used to minimize the area required for storage.

Minimum Area Requirements

Clothing Ideas. The unit folds in half when closed to minimize the area required for storage. The rear of the unit is secured in place by closing the rear door. Once clothing items are in place, a second roller shade located in the rear of the unit is pulled up into the unit and secured to prevent the rectangular frame from wreaking. This roller shade is used to minimize the rear view requirement when not in use. To use the unit, the folded rear of Figure 9, a collapsible parallel frame type is used to minimize the area required for storage.

FiguRES 5-82
APPROACH B

APPROACH A

LOWE/SNITH

5

4

3

2

Partitioned Cavity Requirements

Method of access and restraint not demonstrated.

Not enough area available to store clothing neatly, wrinkle free.

Ventilation of air non-existent.

No odor separation between high and low odor producing garments.
Clothing is retained, when rotated, acts as the cover for the unit. 

Placed strategically on the band and clothing, The belt, on which the belt is open continuously, clothing items are retained with Velcro structure. Freedom of entries the top. Figure 12 demonstrates the use of easy access. Figure 11 is mounted under the couch, provided into front position for

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

Down position, while lower odor items are retained in the unit. When clothing is retained, high odor items are prolonged to a that.

In Figure 10, multiple frames fold into each other to produce a flat.
devices, it necessary should be accomplished without utilizing mechanical

of adapting the system to personnel from 5% female to 95% male. Also, to

show restraint system. Specifically, the study was to examine the problem

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

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 reclined/erect

volume within the hygiene facility.

Flty cubic foot is established as the accepted maneuvering space and clear

developed.

Utilize the accepted "L" shaped hygiene compartment (Lofty/Snatch - MSC

<table>
<thead>
<tr>
<th>TASK OBJECTIVES</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>DATE ASSIGNED</td>
</tr>
<tr>
<td>5</td>
<td>CENTER</td>
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<td>TASK</td>
</tr>
<tr>
<td>3</td>
<td>MSC - Gordon Raby</td>
</tr>
</tbody>
</table>
| 2               | SECTIO

April 5, 1972
squared.

Previously pecked vertical heater, diagonally opposite the shifter, has been

Lateral head clearance has been increased over the fascial collector. The

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

in the top front. The total height of the unit has been decreased enabling

modulated to receive a spherical acetabular bubble with individual hand holds.

The hand-wash unit previously positioned within the access has been

---

Phase II: Variations in the Hygiene Compartment Configuration

This phase or illness may make a back up positive restraint system necessary.

This phase may be used by the crew personnel as it is being used. Temporary periods of

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

Elbow Restraint

Belts and related mechanisms may still easily and prove difficult to clean.

Attachment points interfere with wipe motions.

Exposed skin areas contacting belt is considered undesirable.

Lap Belt Restraint

A final presentation was scheduled for May 31, 1972.
is one which requires consideration. When an object has been coated with the ethanolic areas of another body, the psychological disturbance in the knowledge will have skin contact. The psychological disturbance, on the other hand, may be more than one at the same time. The psychological disturbance, which tend to overshadow its positive attributes. The psychological disturbance, as generally noted in the past, the lap restraint has many ingenious qualities.

Lap Restraint (Figure C9-C16)

Stationary elbow restraint appears unstable and impractical.

Because the extent of pronation varies substantially between subjects, a

recesses.

obstructable situation, and create potentially unhygienic undercuts and

The concern repositioning of any restraint would impose on the crew an

would be necessary to decrease the hygene compartmental wall width.

for a 90% female. To adapt to a smaller individual a mechanical device

reach deep enough to accommodate a 90% male would be unusable largen\n
recesses comported with a wide range of body sizes indicated that a stationary

Restraint.

of the hygene restraint study tested the feasibility of an active elbow

inherent in development possibilities of an elbow restraint. Phase II

The results of the Phase I study of the hygene compartment created

Elbow Restraint (Figure C9-C8)
Eight Points of Restraint (defined by Martin Neutral Buoyancy Study):

Three Points of Restraint: Observations include:

Information gathered from the restraint study reinforce the utilization accomplished.

on each side of the collector as guide rails, these adjustments could be
whit of this amount would be negligible. But by utilizing the handle rails
verted more than two-inches from the center of the thigh. A restraint
although there is a difference, a comfortable seated dimension never
recollect using the belt restraint indicates the different body widths:
The photo series of 97% female - 95% male crewwmen seated on the seat
experience cramps.

stretch is not practical, such as during periods when an individual is
be controlled by the user. The belt may be only used when conscious re-
rectactor is an upright position when no use. The amount of action
able when seated in the soiled. It can be easily cleaned when soiled. It can
ble non-porous material, such as styrene requires little maintenance.

but plotted by the crewwman.

where it comes in contact with skin. These are not part of the restraint,
the issue is disposed of, another position pads under the restraint
a tissue roll and portion of it is placed over the center. After use,
utilization. One illustrates a retractorable belt which when drawn captures
several of the connexes. It enables each crewwman to select the degree
board illustration a crewwman desires within the reality. The availability of
body insulation a crewwman desires within the reality. The degree of skin
the degree of skin contact, while using the hygiene compartment, varies.
| The extent of restraint mobility should be kept minimal because of its  |
| The degree of tension should be kept up to the individual.          |

| An option of personal isolation from communally used units may be   |
| preferred over lap belt restraint.                                 |

| Hands: Guide rails properly placed may suffice and, in fact, be    |
| preferred over lap belt restraint.                                 |

| A 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.

Hygiene and Safety unit positioned on same side of the orbiter with common wall surface. Accommodate six men for seven days. Bay and wheel well.

Maintenance position for the reaction control system, equipment information. Utilize the skewed Z-axis dock/Articock system in a shuttle orbiter configuration.

April 5, 1972
mode.
enable the crewman to mount the local collector safety in the pre-launch

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
couches, can be used to descend into the hygiene compartment. To
hygiene compartment. A ladder, connected to the floor launch occupied
The possibility of launch pad delays necessitates pre-launch access to the

Hygiene Compartment

The unsecured vertical drop from the top couch to the rear bulkhead in the
orientation is limited.

The accessibility of the hygiene compartment to all occupied couches in launch
head movements of the attendant.
Altock protrudes into the presser position of the gallery interface with the
within the unit.

access to the hygiene compartment is extremely difficult; no steps exist

FIGURE H2-H6
APPROACH
TOEY/SNAITH

4

3

2

1

FIGURE H1
EXISTING APPROACH
ANALYSIS OF
Creating a large pass-through area permits the coaches to be located close to the deck during zero-G periods. This feature is to be retained during the various flight modes. The space coaches have been mounted on support columns which enable a large pass-through the compartment and is stored during zero-G and re-entry between the second and third coach. This does not limit passage or compartment 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 feet and the maneuvering room rotated 90 degrees allowing the top forward the nose of the orbiter. To eliminate these hindrances, the food management unit has been standing volume so that the attendant's head movements by the attendant during meal preparation. The attendant produces into this food management unit.

In the original layout, the entrance to the hygiene compartment is obstructed.
allow for lateral or radial movement. Flexible restaurant concepts were developed in early work bench studies to
address movements. Concerning to the individual's physical maneuvering patterns during the tasks
water restaurants, the restaurants studied should be adaptable enough to and allow him to concentrate fully on his particular task. Unlike existing to free the crewman of conscious awareness of the necessary for restaurant, the development of a positive flexible restaurant is being pursued in order.

Restaurants 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

EXISTING CONCEPTS ANALYSIS OF TASK OBJECTIVES

PARAMETERS

DATE ASSIGNED

MSC - Gordon Ryasy

Positive Flexible Restaurants (Phase 1)

SECTION

MAY, 1972

CENTER TASK

I

I
<table>
<thead>
<tr>
<th>Rank</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>With no adjustment required on site (work station, etc.).</td>
</tr>
</tbody>
</table>
Difficult ingress and egress.

Presssure behind knees.

Lateral movement restricted.

Unfavorable

Restricted posteriorly.

Vertical adjustments possible.

Favorable

Comments (Figure 1a)

Requires excess amount of space.

Lateral movement limited to radial pattern.

Unfavorable

Hands free movement allowed.

Vertical movement allowed.

Favorable

Comments (Figure 1b)
allowing the desired activity to be performed. With the use of the deck or adding-on, these concepts provide additional positive features while the user has a multitude of foot locations to select from.

The proximality of the front edge of the work surface to the user's water makes

**Wedge Restraints (Figures 116 - 119)**

mechanical slips and peel type systems.

**Waste Mounted Restraints (Figures 119 - 115)**

- Caution possibility
- Surface area to provide the user a choice of foot to
- Applied to its surface. The other half could be placed in front of the work
- Control by the crewman. This half of the restraint is embedded or
- Wear, also the sole portion because of the use in maneuvering and
- The foot

**High Traction or Interlocking Restraint (Figure 18)**

- During movement, be used as a high traction surface for pushing or maneuvering assistance
- Shoe under the ball of the foot has not been altered, thus allowing it to
- Non-porous surface. One common denominator is that in all cases the
- Of the interface equipment or surface preparation (6) requires a smooth
- Wear. Restraint concept is shown in Figure 15 - 17. Require various degrees
- Of a work station, the foot wear should not interfere with normal move.
- Its effectiveness as a restraint assist. We feel that when not in the area
- In several concepts, portions of the shoe has been recommended to improve

**Our Approach**
Techniques

14 - Demonstration Model of "D" Ring Fastening Belt

12 - Continuous Revolving Belt with Single Center of Reel Fastener

13 - Demonstration Model of Center of Belt Fastener and Two "D" Ring Fastening Points

11 - Continuous Revolving Belt with Tension Adjustment
J6 - Variations of Alternate Fasteners

J5 - Adjustable Arms on Guide Rail with Bullet Fasteners

J7 - Demonstration Model of Adjustable Arm

J8 - Detail of Fastener
mechanism which provides for adjustible positioning of a bar foot rest.

relative to the work station for maximum effectiveness. FIGURE 112, the flexibility
by enabling the crewman to select the location of the toe bar

heights. CONVENTIONAL fixed toe bars allow lateral
of the toe bar has been increased. 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-

foot and effectiveness of the toe bar and allow for an increase in flexibility.

FIGURES 19-12 illustrate toe bar concepts conceived to increase the com-

r recess under the benches front edge.

the side of the crewman's belt. When not in use, the arms fold away into

made concepts on the ends which connect to female concepts attached to

stop side movement when not desired. ADJUSTIBLE length arms contain

ege of the work surface. The side adjustment has a latching 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 C
Seating controls and intercom were to be included, but not functional.

Emergency oxygen, rear-seat流产/Smitty concept, Wash contaminate, emergency oxygen,

movable clothing obstacle and one for small personal items. The mock-ups would include a re-

landing, and general O-G habitability. The mock-up was to include a re-

struck personnel and maneuver into several orientations: launch, re-entry,

buoyancy testing. The concept was to be capable of accommodating various

be constructed to withstand rollback and escape in I-G and neutral

then to see whether further effort was warranted. The mock-up was to

features incorporated into the lowey/Smitty concept and to evaluate the

lowey/Smitty was directed to fabricate a mock-up to demonstrate the

is to be provided forShephard.

and personal effects and must be accessible from the cockpit. Privacy

work. Shortwave provisions are to be included for the crewman's garment's

crewman's needs for rest and recreation, eating, sleeping, and clerical

per crew member. The multi-functional concept is to provide all the

to concentrate several habitation systems into one piece of equipment

due to limited volume within the spacecraft, consideration must be given

January, 1972

DATE ASSIGNED

MSC - ALLaurence

CENTER

TASK

SECTION

Shuttle/Olden Passager Coach - Full Scale Mock-Up

PARAMETERS

TASK OBJECTIVES
The shading for seats:

The system does not afford the coach occupant complete privacy, but rather deploy both shade systems from a retracted position in the coach. The and front privacy. The system was designed so that an individual could base of the coach which contained a folder made by part shade for side over-the-head privacy and a hip-hop roller shade device located at the Figure K8, consisted of a roll of shade for the coach. Initially illustrated in Figure K3, the system, shown in preliminary concept was built into the mock-up based on the a stowable privacy screen system was built into the mock-up based on the

(See Figure K6) were fabricated to allow for full range testing.

ion (Figure K7) and one fixed in the launch/re-entry position.

Two coach platform inserts, one fixed in the head post frame which was bonded to the interior of the libretto shell for mock-up.

To meet rear usage requirements, we fabricated a 2" x 1/4" steel bar

Requirements stated in TASK OBJECTIVES.

low/energy to develop the coach concept in more detail as per the version of the coach which was used to construct a Preliminary soft mock-up.

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

EXISTING

OUR APPROACH

Figures K4-K8
and stacking center with items to be evaluated.

Reorganizes the card into a sleeve carrying constant ranking instructions.

Once the data for compartment data on the revolving wheel, L2-L4
are any one response, avoiding unnecessary search for data, L2 is a
Raymond Lowery/William Spaulding, Inc. They isolate information pertinent
Figures L2-L4 show examples of preliminary concepts developed by

PRELIMINARY APPROACH

the entire sheet for appropriate items.

With a consulting display information for the individual to search
Card received for reference, in our opinion, it prescribes the crewman
Card illustrates an example of a Data Formant
Developed by MSC, Figures L2 illustrates an example of a preliminary concept

EXISTING CONCEPT

Proper procedure for use and present a legible sequence.

To prevent crew confusion with the card, it should clearly outline the
feeling that all comments should be brief, but allow for personalized responses.
During periods of task and compartments evaluation, it is Lowery/Spaulding's

TASK OBJECTIVES

Task development.

To ground control to be considered an input for future mission design and
Task evaluation, All evaluations will be voice recorded and transferred
be used several times during the mission for a guide for equipment and
be carried in pockets of the Skydak crewman's garments and is to
The Data Format Card, limited to two sides and 5 x 8 inches in size.

September, 1972

DATE ASSIGNED

MSC - Gordon Rysavy

CENTER

Data Format Card

TASK

SECTION
Viewing Cut One

12 - Preliminary Revolving Format Card

I.2 - Existing MSC Data Format Card

PART 1 - REVOLVING FORM.

[Diagram of a revolvable card with various sections and annotations]

1. DESIGN AND DEVELOPMENT

2. MECHANICAL CHARACTERISTICS

3. ELECTRICAL CHARACTERISTICS

4. MECHANICAL AND ELECTRICAL PERFORMANCE

5. APPLICATIONS

6. OPERATING INSTRUCTIONS

7. ENVIRONMENTAL CONDITIONS

8. PROTECTION AND MAINTENANCE

9. CONSTRUCTION AND INSTALLATION

10. MATERIALS

11. MAINTENANCE AND REPAIR

12. ACCESSORIES AND SPARE PARTS

13. SPECIFICATIONS

14. PRICE AND DELIVERY

[Table or list of specifications and details]

[Diagram or illustration of a revolvable card with arrows and labels]

STATE NAME AND DATE (VOICE RECORD ALL REMARKS)

N/A 74-0 A
The Data Format Card concept is currently being re-evaluated due to

Conclusions

required.

One item in the cut-out window at a time, concentrating on the sliding section. The positions of the equipment to be tested are on the sliding section. The positions only

Table Format Card. Information has been displayed in an ordered sequence

Final Approach

Figures 15 and 16 show the final results in the development of a refined

is being pursued at MSC.

meaningful evaluation sections and the option to elaborate when desired

dissatisfaction with the basic concept. A verbal response with more
Limited supplies needed to clean these areas.
The portable unit, re-supplied at the master stowage unit would contain:

- Foot of length for galley area - total length, eight feet.
The vacuum requires three feet of hose on the caddy and a detachable five

and filled general (G. P. ) bags.

Compartments for waste generated during housekeeping chores

Station area and easy passage through hatches.

Placement of the caddy on the body must allow close movement at work

The caddy and the vacuum must be usable as one unit or individually.

The master stowage unit.

The caddy must be capable of being loaded and used while stowed in the

as follows:
The requirements of the housekeeping caddy and master stowage unit are

September, 1972

MSC - Gordon R. Gers

Housekeeping Equipment Stowage

TASK

PARAMETERS

DATE ASSIGNED

CENTER

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

Excessive amount of time.

Assembling the unit for use away from the master unit requires an entire unit for attachment or the hose.

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

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

No logical organization of components placement is apparent.

The caddy must be removed to reload.

Following problems do exist, however:

- The pressurized master storage unit exposes all cavities to the housekeeping area.
- There is emphatic to access requirements and zero-movement order of frequency of use. Develop a unit form and restraint system to locate all items within unit for maximum ease of accessibility and in agers and devices so as to prevent escape of fluids.
- Develop a clean form to prevent soil build up. Contain carrying cleaning
5. Pick up full C. P. bags, if necessary.

4. Deposit used dry wipe in C. P. bag.

3. Dry wipe.

2. Wet wipe.

1. Sanitation and/or disinfection agent.

**Wipe Cleaning**

1. Use expanded sponge and/or wet wipe.

**Emergency Clean**

4. Switch accessory (repeat 3).

3. Clean area.

2. Attach vacuum accessory to hose nozzle.

1. Attach hose.

**Vacuum Cleaning** (Either in storage until or remote location)

The following use description was established:

Design and Development of Housekeeping Systems for Mained Spaceships,

Using the work sequence described in paragraph I, of the "Preliminary
around hose and it did not appear that the unit would inhibit movement.

strabl, the individual has access to all stored compartments 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

Figures M2-M6
STUDIES
ARRANGEMENT
PRELIMINARY

Following the task sequence evaluation, preliminary three dimensional

5. Full C. P. bag storage.

4. C. P. bag dispenser.

3. Dry wipe towel dispenser.

2. Sanitation and disinfectant agents.

1. Sponge/wet 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 on an infrared reel houses the cord when not in use. When

top for easy access.

During periods of crewman transfer andall controls are placed near the

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

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

The selected crewman 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 cheer to avoid inhibiting leg movement, as illustrated in Figure M3.

vacuum unit were 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 M3 and M4 represent a convenient location of stored components.

manageable by a left hander.

(size 1-1/2"

The minimal 3-1/2"

Peripherals recess, shoulder and water straps rest a

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.

inches.

Modular breakdown at locker height to increments of 6', 12', 18 and 24

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

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

PARAMETERS


Shuttle Orbiter Storage Locker System

DATE ASSIGNED

MSC Houston - Gordon Ryavy

CENTERS

May 1, 1972

TASK

SECCTION
Removal of requirements to completely rebuild if one complete column were to be removed; 2

Which is restricted to that designed into the system: 1

Con

Storage lockers removable for replacement and access; 3

Structured to withstand launch vibrations; 2

Allows for better adjustments based on 6 modular increments; 1

Pro

Incorporating prior to launch,

a system with enough flexibility to allow for last minute changes in needed supplies within the orbiter crew compartment, MSC desired;

provide for the containment of a variety of experiment, equipment,

requested from lowend to highend; develop concepts for a locker system which because mission requirements vary from one mission to another; MSC

adequate restorations within locker to secure wide variety of items;

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

the craft;

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

Withstand intensive launch vibrations.
Hinged and Restrainted
N4 - Preliminary Storage Locker Concept Wall

Drawer Access
N2 - Preliminary Storage Locker System with

Tracks and Exposed Locking Levers
N3 - Preliminary Storage Locker with Concealed

Existing MSC Storage Locker System
N1 - Existing MSC Storage Locker System

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128
the same manner. Using pallets as wide as the master case interior,
reduce inside walls of the master case and interconnect with each other in
by using these extended, interlocking inserts until the ex-
The interior of the master storage case may be divided up as required

to the problem.
locking system of extended storage pallets was conceived as an answer
- illustrated in Figure NG an inter-
containers will accommodate the variety of article sizes and shapes
the problem still exists as to how the interior of the
modular system. Figure NG illustrates a problem which we addressed lightly in the pre-

Figure NG illustrates a problem which we addressed lightly in the pre-

WSG pointed out that a locker which was not made up of one piece, would be
size storage units from a few common units as illustrated in Figure NG.
loosely/semithick, i.e., also studied a modular technique for assembling various
the brackets into a slot and lowering the locker into place.
for vertical space between each storage unit. The "key" requires sliding
until engages the support wall. A displacement edge in the requirement
be mounted, threaded tension bars are utilized to locate the storage
in C and act as a bearing surface upon which the key slot brackets may
The "shell" feature under the lockers and support while loading units

130
Position when not in use.

Corner spacing is of interest to the storage unit which recedes to a further utilization consists of the bases located. There exist new bases which for height use, the storage system locks to the support panel. However, we understand that problems exhibitability. Also, such bases were considered for use in securing the

In a square matrix to allow for horizontal and vertical positioning

In the mounting plane, these recesses are arranged in a 2 x 2 internal

Located at each rear corner of the locker in case, shaped recesses

Master locker installation is accomplished by inserting positioning cones

3) Locker Mounting

Figures N0-N13 show a few of the rear side charts, presented.

Figure N9 shows a cut-away detail of the locker mechanism selected and

Slices and shapes to the patterns.

With the acceptance by MSC of the pallet system, detailed concepts were

II

Development Phase

May be removed as desired.

Detailed sketches of pallet and the items they contain. Detailing pallets in total groups of pallets and the items they contain of this system is that a total of the existing system from which in

Result allows one to subdivide the case horizontally as required. The end result vertical length patterns into the case vertically between horizontal patterns distinguishes desired relative to mission profile requirements. Shown

the case can be subdivided vertically on one inch increments into any
Lacon traps to be mounted in the same locker horizontally or vertically.

The accessibility of the storage locker system is dramatized in Figures 3, 4, and 5.

(c) Locker Interlocking

That the handle lever serves to locate any alpha-numeric identification, double door lockers acts independently. The illustration also shows that each door lock on the and door access hole. As Figure 4 shows, each door lock on the located on all front interior surfaces and the corner mounting socket head.

N7 illustrates a close up view of repetitive track extraction shapes

placed by any of the other formats.

Specializing four 12W X 12H X 18D/24W X 24H X 18D with could be re-

All storage locker combinations are a breakdown of 24W X 24H X 18D.

12H X 18B, 12H X 24W X 18D, 18W X 24H X 18D, 24H X 18D, 12H X

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

special cases may exist where unusually large lockers may be required

(b) Locker Sizes

In locker mix.

Each locker is supported independently allowing last minute changes.

are threaded at the rear end for torquing to the mounting surface.

are access holes behind which are located "lock" heads which

from surface in each of the front corners (Figure N7 and N8)

face the lockers to the wall is accomplished from the front

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of the locker module.

Identical tray supporting capabilities as those mounted on the interior
are in Figure N22. The extrusion on these trays would have the
extension adaption inner which would be used to form tray grounds
�s equipment or experiences on the trays. Figure N24 is an
Figures N24-N28 represent several concepts for reconfiguring compo-

served and the direction in which it will best accept the launch loads.
The tray orientation will be established by the character of the article

Component Resistances

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
hinge located on the front hand grip is shipped 180° direction rods
on the two outer edges of the trays. To lock the tray in place, a
riffls with a slight resistance caused by shock mounted foam pads
is demonstrated in Figure N23. The trays slide in between two ex-
the required area of the space or a group of trays located together and carry them to
as illustrated in Figure N22, the drawers 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 C-loads and space
Principles involved, as illustrated in Figures N30–N37.

A demonstration model of the storage locker system was constructed.

Figure N27 enables some components, usually of medium size, to hang completely free. The netted pouch is twisted and hooked to hanging Figure N27 enabling some components, usually of medium size, to hang completely free. Figure N27 has an insert made of wedge-shaped elasticized pouch suspended between the sides of the tray.

An elasticized pouch suspended between the sides of the tray enables suspension of articles when the lid is opened in 0–D.

For smaller articles, Figure N26 has an insert made of wedge-shaped elasticized pouch suspended between the sides of the tray.

Small objects are placed on an adhesive coated surface which prevents dispersion of articles when the lid is opened in 0–C.

The unit has a cover enclosing the entire area. For larger objects sealed in a container,  strips in two directions would prevent the expected vibrations from shifting the object free.