SHUTTLE ORBITER HABITABILITY STUDY

CONTRACT SUMMARY REPORT

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RAYMOND LOEWY/HELEN SMITH, INC.

JANUARY 1972/DECEMBER 1972

PREPARED FOR NASA BY

RAVING LEW,
WILLIAM SMITH, INC.
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SECTION A

TASK  Shuttle Orbiter Crew Compartment/X-Axis Docking

DESCRIPTION  X-Axis docking crew compartment configurations were reviewed and evaluated by fabricating a full scale, partial compartment mock-up and full compartment model.

The design recommendations which were developed and incorporated in the mock-up for this configuration were as follows:

1  Provisions for adequate escape aisle (passageway) from couches to emergency hatch.

   .  Reorganization of crew compartment component to improve social orientation of space couches.

   .  Flight engineer provided with ability to maintain visual contact with flight deck personnel.

   .  Galley location which is readily accessible to space couches.

   .  Convenient access to hygiene compartment throughout entire flight orientation.
A3 - Full Size Mock-Up of FOD Management

A2 - Lowry/Smith Shuttle Orbiter Model of Couches

In the Launch Orientation of X-Axis Docking Concept

A1 - Lowry/Smith Crew Compartment Configuration
deck area with much more versatile hardware.

To accomplish this goal would require a larger flight

mean of separate leisure and sleep facilities in this area.

area we were requested to look into with the objective being the establish-

The isolation of the flight deck from the crew compartments was another

convenience during launch, reentry and zero-G flight.

efficient use of the compartment, and into space coach related activities.

importance to consider less strenuous techniques of maneuverability through-

With the knowledge that future space flights may include the elderly, it was

During the various flight modes.

in developing concepts aimed at solving the problems of space coach access

In the Passenger compartment study, loeway/sinath was primarily interested

Shuttle Orbiter Passenger Compartment and Flight Deck Flexibility

DESCRIPTION

TASK

SECTION
The design of various restaruant systems was pursued after the hygiene con-

less space was utilized and component replacement was simplified.

To obtain useful data from a restaruant study, lowey/shalin, inc. considered

PRELIMINARY ANALYSIS

The relative merits of various restaruant concepts under identical conditions, is important to first base line a hygience component design to determine

DESCRIPTION

TASK

SECTION
the primary screen is in place. All are located within an arms length of the crewman and obtainable while moving controls and emergency equipment are organized for quick retrieval. Immediate access items, such as personal gear, environment, and additional crew support planes are designated to the maximum allowed space frame rather than being contained within it as in early concepts. The small passenger coach body support planes ride on top of the structural launch. It adjusts from flat for sleeping, to upright, for flight leisure and than the larger coach, maneuvers into the same orientations, and contains more storage space limited to 77.5" X 27" X 14" D. It performs the same functions and couch helped establish the design direction for the smaller one which was experience and knowledge gained from the development of a large passenger.

Small Passenger Coach
concepts as explained in the final report. Partition were achieved by incorporating specialized packaging and graphic 80 cubic feet, the desired goal. Reductions in food retrieved and pre-
minimized dead air space and reduced the overall volume to less than
than retrieved U-shaped facade as in the MSC system. This modification
layout was that we recommended that a single dual work facade be used rather
resulting in three concept systems. A significant change in the system
preparation process. Two dimensional sketch and layout studies conducted
a reduction in overall volume and a simplification of the food retrieved
a design concept they had developed for the abler with the goal being
MSC requested that Raymond Loewy/William Shank, Inc. review

DESCRIPTION

TASK

SECTION

Order Food System and Colony
When not in use, and collapsible units which would normally fold out of sight, and easy of access, the clothing restrooms were organized for maximum sexual efficiency.

A series by order level to prevent soling of relatively cleaner items. Recommended that the garments should be segregated into isolated places on the prevention of odor transfer between garments. We placed emphasis on the development of the overhead clothing storage unit, emphasizing was

DESCRIPTIVE TASK

SECTION
and disposable tissue underlays between the belt structure and the user's skin. Concepts presented included the use of non-porous, easily cleaned belts.

Physical access and minimum body contact were established and emphasis was placed on minimizing the surface parameters for an efficient seat belt to be used in the hygiene facility.

The system which was maximum simultaneity, an adjustable restraint device which we felt defined the objective of variations in their elbow and shoulder widths necessitated the design of a system to accommodate a full range of body sizes. The dimensional study demonstrated that the concept was unrealistic if the 95% male crew personnel when a seat belt restraint was not required, an elbow and shoulder restraint used by 5% female drivers and including a result of the Phase I study, interest was developed in investigating.

**DESCRIPTION**

**TASK**

**SECTION**
Reconfiguration.

used to their fullest extent because of present requirements placed on
the relationship between compartments. Special volumes have not been
lowly/sumptuous does not feel that this solution adequately produces a work-

Orbiter, it prevents effective use of the available spacecraft volume.

Orbiter, the model illustrated here does not illustrate the impact of the skewed Z-axis on
the Orbiter was constructed to analyze the impact of the skewed Z-axis in
A 1/20 scale model of an MSC layout of the Z-axis Docking Airlock Shuttle

Skewed Z-axis Docking/Airlock Shuttle Orbiter

DESCRIPTION

TASK

SECTION
The concepts developed were to allow the restrained individual to walk parallel to a work bench utilizing various movable or random access steps. Therefore, were the wrist and both feet. Natural bending and lifting the reach of a restrained individual. The re and that any rigid restraining device above the waist would inhibit stability. It was decided that a three point restraint was necessary for stability.

Although individual illustrations centered on either the foot or waist area, both areas are required to adequately produce a positive restraint.

As necessary to complete a particular task, it was determined that a successful flexible positive restraint

of the necessary for restraint, thus allowing him to concentrate fully on his task. To cover the largest area possible without a conscious awareness of limited amount of controlled movement was desired in order to allow a crewman the development of a flexible positive restraint which will allow a crewman

Flexible Positive Work Station Restraint (Phase I)
I - Foot Restraint with Foam Pad and Tension

14 - Foot Restraint with Foam Pad and Tension

I2 - Horizontally Adjustable Restraint Arm Which

13 - Machine Positioning Devices on Sole of Shoe and

Fastener on Belt

Flexible Restraint Arm Which Adjusts to Bullet
slope configuration of the crewman's shoe
and reverse movement along a track. The foam covered
bars conforms to
An adjustable toe bar located near the base of the unit allows forward

bench.

Length adjustment allows the crewman to adjust his distance from the
track allows the arms to slide the length of the bench while the arm
in use, the arms fold out of a recess and couple into the crewman's belt.
Sliding track with couplers located on adjustable fold away arms. When
from the bench. The front surface of the bench also incorporated a
free lateral movement with slack adjustment to enable movement away
belts system was located on the front surface of the bench which allowed
was constructed incorporating all of the selected concepts. A closed loop
To better evaluate the effectiveness of each system, a presentation model

selected location.

reversing bar and an adjustable toe bar restrict to restraint leg in a
including a waist belt which incorporates with fold away arms, continuous
Positive restraint (Phase II)
12 - Demonstration Model of Center of Belt Fastener

13 - Adjustable Arms on Guide Rail With Bullet Fasteners

14 - Demonstration Model Using Toe Bar Adjustment with Spring Tension

15 - Continuous Revolving Belt with Tension Adjustment and Two "D" Ring Fastening Points
neutral buoyancy testing.

neural networks and personal effects. Privacy is provided for by a roll
visions, which are accessible while on the space couch are included to
support for crew members during launch and reentry. Storage pro-
during leisure, sleeping, eating periods in zero-G and provide proper

The couch is designed to provide all immediate needs of the crewmens

Shuttle Orbiter Passenger Couch - Full Scale Mock-Up

DESCRIPTION

TASK

SECTION
the card, the models developed stress the simplicity of frame-structure.

Planations to personalize the responses. To prevent crew harassment with

It is lower/attention feeling that all answers should be better but allow ex-

s-

es.

recorded and transferred to ground control for analyses for future missions. All responses to questions on the data format sheet are voice for evaluation of tasks and equipment at scheduled intervals in the Skylab.

The data format card is designed to serve as a guide to Skylab astronauts.
Instructions:

1. Select the correct code(s) and corresponding letter code(s). Enter code(s) in the spaces provided. Use a code from each category. Enter each category letter code in the spaces provided. Enter the numeric value of the code(s) in the spaces provided. Use a code from each category. Enter each category letter code in the spaces provided. Enter the numeric value of the code(s) in the spaces provided.

2. Complete the table below.

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3. Enter the total score in the space provided.

Total Score: ___
A light visual scale model of the selected concept was fabricated and pre-tested.

The design of the unit was developed with the aid of full scale human models if necessary. The models are enclosed to prevent dispersion of their use priority, and are entirely enclosed to prevent dispersion of cleaning agents and wardrobe items. The storage units within the caddy may be carried as one or separately. The storage units within the caddy are designed as two interlocking units which interlock.

The caddy and vacuum unit were designed as two interlocking units which interlock.

The housekeeping equipment stored in the galley facility consists of:

- Master supply unit
- Domestic vacuum unit
- Portable vacuum unit
- Additional master parts
- Disinfectants
- Wipes
- Whips

Description

Task

Section
threaded fillings arranged in a matrix in the structure.

are attached to the interface structure by torching threaded fasteners into
location based on the physical constraints of that location. The outer cases
option would be to provide the largest storage unit possible for each storage
able in various sizes based on a set modular growth pattern, i.e., 2.4" X 2.4" X 2.4" etc. The objective of the master locker

The system developed utilizes standard storage locker which would be available.

The methods of restacking are interchangeable. Tray sizes are dependent on the size of the storage locker being used. However, the components on the trays are restricted using various techniques. The

unit to a location within the spacecraft. Single tray or several as a unit if necessary, to transport to that particular
This gives a crewman an option in order to remove an entire locker, a
transaxles (mounted horizontally, verticallly, as a unit or individually).
inside the storage lockers is a system of trays (stated into "C" shaped ex-

not designed as a shuttle component.
design of each piece of equipment which are single mission related and
is that a flexible storage system will reduce requirements for custom
transporting a variety of experiments, equipment and mission supplies.
therefore, a locker system must be developed which will lend itself to
mission storage requirements may vary from one mission to another.

DESCRIPTI0N

TASK

SECTION
contain, may be removed as desired. The system from which individual trays in total groups and the items they required. The end result of this system is that a totally flexible storage between horizontal trays allows one to subdivide the case horizontally at any requirements. Stacking various with trays into the locker vertically Be- increments into any propositions desired relative to mission storage re- and interlock with each other in the same manner. Using trays as wide by using flat tray inserts which interlock with the extruded inside walls, the interior of the master storage locker is then divided up as required.
FOREWORD

As required by NASA Contract #N9A-912479, this Report summarizes each study which are more thoroughly covered in the final reports of the Center, Houston, Texas. Selected illustrations and copy briefly all tasks completed during the 1972 contract period. This report

PREPARED