EXPLANATION OF ILLUSTRATED SLIDES BY FRED TOERGE

SLIDE 1

Our first assignment for NASA was to consult on Habitability Aspects of the Saturn I Orbital Workshop, here shown in cutaway. This project posed some interesting design problems since the weight allocated for internal equipment and furnishings was extremely minimal, and the majority of habitability equipment would have to be launched in the limited volume of the multiple docking adapter. Once the workshop were occupied, the equipment would be moved into the crew quarters' section of the SIVB Tank and installed in the various compartments.

As was stated, the environment of the workshop would be zero G and it was desired to project a simulated earth ambiance through use of normal floor to ceiling and wall to wall relationships.

SLIDE 2

At the time of our entry into the program, a full scale mock-up of the crew quarters had been constructed. We were asked to offer suggestions for design of the equipment to be installed in the various compartments to support the three man crew. This slide shows the Waste Management Compartment which is identical in size to the adjoining Food Management Compartment.

In both these compartments it was our feeling that a major source of frustration would be the necessity of tethering and untethering the body so as to reach stowed equipment. We attempted to lay out all furnishings so that once a man had entered a compartment and achieved body restraint, all equipment would be within arm's reach.

SLIDE 3

Before commencing design of equipment for the Food Management Compartment we studied the food that was to be used. At that time all food was to be Apollo type. This slide shows the various packets comprising one meal for one crew-man. The cube in the background depicts the volume required to stow these food packets.

SLIDE 4

To assist in inventory and handling, we chose to combine three meals for the three man crew in one day modules. Here we show the nine volumetric cubes and a container of a size necessary to house them.

SLIDE 5

This is a mock-up of the finished food module. It would serve a dual purpose in that once emptied of food, it could be used to store garbage and debris. Graphics on the face of the module identify the mission day on which this food is to be consumed. After reconstituting some of the food, our major criticism was that the reconstituted food presented a particularly unappetizing appearance when viewed through the transparent Polypropylene bag. In the foreground we have packaged the Polypropylene bag within a freezer foil wrapper that is decorated to suggest a more sumptuous meal.

SLIDE 6

To reconstitute, an end flap of the wrapper is opened and the water gun inserted in the exposed valve. The wrapper being flexible allows kneading of the food water mix. The color band on the end of the wrapper codes the meal to an individual crewman.

SLIDE 7

Once reconstituted, the food is eaten by opening the opposite end flap and withdrawing the nozzle.

SLIDE 8

The food module can also be used to store drinking water through installation of an interior bladder.

SLIDE 9

Here we have racked modules containing sufficient food and water for fourteen days. The rack folds on itself for compact stowage in the MDA and once affixed to the Food Management Compartment wall, is swung open.

SLIDE 10

We presented a variety of approaches to furbishing the Food Management Compartment. This concept was selected by MSFC for further development. In our view the FMC will probably serve as a wardroom for the crew's leisure hours. To support this function, we have included an entertainment console on the wall above the food storage compartments. The remainder of the equipment is a two place lounge seat on the back wall, a dining table that swings up to allow access to the lounge, and an articulated chair in the foreground for the remaining crewman.

SLIDE 11

To study size relationships and human factor requirements, we constructed a crude full scale mock-up of the compartment. Several objectional features became obvious. The articulated seat in the foreground completely dominated the compartment and made movement within difficult.

SLIDE 12

We also felt we were introducing a crew safety problem in that to exit from the lounge in an emergency situation required an unnatural movement of lifting the table before moving to the door.

SLIDE 13

We then studied ways of correcting these problems. The chair was designed to stow beneath the console when not in use, and the table hinged so that it could be swung laterally under the console. In this way to exit the lounge seat one would move toward the door automatically displacing the table.

SLIDE 14

Finished mock-ups of the components were built for presentation to NASA. These are the two console halves, dining table and chair, nested for launch stowage.

SLIDE 15

Because of the zero G environment, a design parameter for all equipment was that it must be amenable to one hand installation freeing the other hand for body restraint. We offered several suggestions on how this chore could be lessened. Here we provide a crewman with two spring loaded reels mounted on a belt. Once in a compartment the cable ends would be affixed to the ceiling and floor and to opposite walls. Movement throughout the compartment could then be accomplished by the reels either paying out or taking up slack cable.

SLIDE 16

To mount, the equipment would first be indexed against its corresponding silhouette painted on the compartment wall. This would align the male/female brackets. Side movement then indexes the mounting holes to the lock pins, and forward pressure engages the pins.

SLIDE 17

Here the components are shown installed. The dining table is extended with its rear segment swung up to allow access to the lounge seat.

SLIDE 18

Once seated, the table segment locks down to provide body restraint through pressure on the thighs.

SLIDE 19

Each table segment is provided with recessed wells to hold the food packets while reconstituting.

SLIDE 20

The right console end contains the water gun on top, beneath are the water metering device, controls for water heating and for the interphone. The interphone speaker can be seen to the left.

SLIDE 21

Here the water gun has been removed from its pocket. The swung open compartment to the right stows mouthpieces for the individual crewmen, once again color coded.

SLIDE 22

An orifice on the rear of the console gives access to a garbage collection bag.

SLIDE 23

These are the completed components installed in the mock-up at Huntsville.

SLIDE 24

This concept for arrangement of the Waste Management Compartment was selected for development. The fecal collector is mounted at an angle to the sidewall to facilitate access. Storage cabinetry and waste processors are mounted to allow use to an occupant restrained on the collector. The area in the left foreground would accommodate a body wash stall.

SLIDE 25

We read the Cornell University Study entitled "The Bathroom" by Professor Kiera. Many of his observations relative to the effect body positioning has on elimination should prove equally as valid in a weightless condition as under 1G. The report compares body position on varying toilet configurations with the optimum natural body position for defecation.

The natural position is shown at the top of the slide. Below are illustrated three recommended variants. We chose to utilize the lean-on position since this posture can be assumed without completely removing the trousers.

SLIDE 26

This is a crude full scale mock-up of the approved concept incorporating a toilet amenable to the lean-on position. We found movement to and from the toilet was difficult and available space precluded mounting all necessary equipment within arm's reach.

SLIDE 27

We moved on to this configuration in which the toilet is mounted in the corner of the back wall angled toward room center. Storage and driers are within easy reach of a seated crewman. The cabinet to the right houses personal hygiene implements.

SLIDE 28

In planning crew quarters for the upcoming space station in which artificial gravity will be induced through rotation of the living spaces, Coriolis force must be considered. For example . . . Areas of high activity should be placed in the center of a deck along the spin axis since movement toward the perimeters of the deck angled from the spin access becomes difficult.

SLIDE 29

To overcome the feeling of confinement, the obvious answer would seem to be to provide many windows since the view would be spectacular. However, if one considers that the decks will be spinning at a 4 RPM rate it might become disconcerting and even tend to bring on vertigo if the sun or earth were to come into view 4 times each minute, particularly if attention were being focussed away from the window and this distraction were being picked up in zone of peripheral vision.

SLIDE 30

To lessen the effect on the inner ear all displays and consoles should be oriented in a vertical mode to reduce movement of the head around its longitudinal axis.

SLIDE 31

All berthing should be planned to position the body parallel to the spin axis.

SLIDE 32

Also it must be considered that as one moves from the extremities of the station toward the point of rotation, gravitational effects are lessened. When one moves from lower to upper decks gravity decreases; from upper to lower decks gravity increases.

SLIDE 33

We have developed a multitude of layouts for the station. This is an early version showing a three deck consist with the dining, leisure deck at the bottom, crew living above, and command and control at the top.

SLIDE 34

This is a model of the previous rendering.

SLIDE 35

Another view of the model showing the dining hall.

SLIDE 36

Since the laboratories will be in a zero G state, it is here that design can be directed at utilizing total available volumes. Here we have a laboratory deck with an unbroken passageway bisecting its vertical dimension. From this passageway, equipment supporting various scientific disciplines are located in depressed pockets top and bottom.

SLIDE 37

Or the laboratory could be housed in a sphere with the various experiments mounted in facets around the perimeter.

The experiments are reached from a gimballed floor that revolves and tilts to place the seated crew member in proximity to the equipment.

SLIDE 38

The laboratory deck could be conceived as a grouping of individual spheres joined by airlocks.

SLIDE 39

Or it could be a large sphere containing a smaller sphere. The interior of the small sphere housing living quarters and the inner skin of the large sphere and outer skin of the smaller sphere mounting experiments and displays.

SLIDE 40

An extension of the last thought would be to house a Polyhedron within a cylinder. Each facet of the polyhedron mounting experiments.

SLIDE 41

In a zero G stateroom such as this entrance is through a circular hatch. The sleep restraint and bed table are mounted along the major plane while the desk, chair and toilet are mounted along the minor plane. To support orientation alternate light sources are provided so that light is always directed from the overhead regardless of the plane one is in.

SLIDE 42

A convenient method of mounting associate equipment and displays in zero G would be in a depressed circle fitted with a gimballed waist restraint at center. Once restrained, all equipment can be reached by body rotation.

SLIDE 43

We are currently working on interior detailing of crew spaces. This is a concept for a stateroom that could accommodate one or two men through use of a pull down upper bunk. It must be considered when planning accommodations for the space station, that while artificial gravity will be normally provided through rotation of the decks, all furbishings must be amenable to use in zero G since the station will periodically be spun down for maintenance and repair.

Thank you.