

NASA TECHNICAL NOTE



NASA TN D-8018

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SPACE STATION INTERIOR DESIGN:
RESULTS OF THE NASA/AIA
SPACE STATION INTERIOR
NATIONAL DESIGN COMPETITION

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • JULY 1975

1. Report No. NASA TN D-8018		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle SPACE STATION INTERIOR DESIGN: RESULTS OF THE NASA/AIA SPACE STATION INTERIOR NATIONAL DESIGN COMPETITION				5. Report Date JULY 1975	
				6. Performing Organization Code	
7. Author(s) Richard F. Haines				8. Performing Organization Report No. A-5867	
				10. Work Unit No. 970-21-11-07	
9. Performing Organization Name and Address NASA Ames Research Center Moffett Field, Calif., 94035				11. Contract or Grant No.	
				13. Type of Report and Period Covered Technical Note	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D. C. 20546				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract <p>This report presents the results of the NASA/AIA Space Station Interior National Design Competition held during 1971. It has been prepared in order to make available to those who work in the architectural, engineering, and interior design fields the results of this design activity in which the interiors of several Space Shuttle-size modules were designed for optimal habitability. Each design entry also included a final configuration of all modules into a complete Space Station. A brief history of the competition is presented with the competition guidelines and constraints. The first place award entry is presented in detail, and specific features from other selected designs are discussed. This is followed by a discussion of how some of these design features might be applied to terrestrial as well as space situations. The report concludes with a list of all participants.</p>					
17. Key Words (Suggested by Author(s)) Spacecraft interior layout Space Shuttle module build-up sequence Habitability Architectural designs for living in space Student design competition				18. Distribution Statement Unclassified -- Unlimited STAR Category -- 51	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 135	
				22. Price* \$5.75	

**SPACE STATION INTERIOR DESIGN:
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SUMMARY

This report presents the results of the NASA/AIA Space Station Interior National Design Competition held during 1971. It has been prepared in order to make these results available to those who work in the architectural, engineering, and interior design fields. A brief history of the competition is presented with the competition guidelines and constraints. The first place award entry is presented in detail, and specific features from selected designs are discussed. This is followed by a discussion of how some of these design features might be applied to terrestrial as well as space situations. The report concludes with a list of all participants.

INTRODUCTION

Design Competition Background

The Space Station Interior National Design Competition came about as a result of a contract between NASA and the American Institute of Architects (AIA). This contract (NAS2-6305) specified that the AIA would provide NASA with a minimum of three fully developed designs of an advanced multimodule space station for which NASA would provide the basic specifications. As discussed elsewhere (ref. 1), the AIA chose to administer a nation-wide student-architect design competition in order to obtain these designs. Near the end of the competition a panel of judges would be formed from a number of specialties to select the top three entries. All entries were to be turned over to NASA for later study.

The AIA called upon members of its National Task Force on Aerospace and Hostile Environment Architecture to administer the competition. The task force established the various procedural guidelines and time table that were followed. Each participant could submit no more than three 30 in. by 40 in. display panels. All plan, elevation, perspective drawings, and text had to be located on one side of each panel. And, although scale models could be made and photographed as a part of this project, none could be entered. In order to help clarify various procedural matters related to the competition and/or provide further technical information specifically requested by participants, two separate question/answer periods were scheduled. Each period lasted approximately one month. These questions and answers were duplicated and mailed to every participant.

Purposes of the Competition

This design competition had the following objectives: (1) to obtain novel habitability designs that may be applicable to the design of future Space Shuttle delivered station modules, (2) to encourage research which will enhance the architectural profession's ability to deal with earth-bound habitability problems, (3) to locate and recognize design talent through excellence of design, and (4) to emphasize the attractiveness of the new field of space architecture as a potential career.

The emphasis upon habitability— This competition emphasized future space missions which will include longer durations than those previously achieved, larger crews than before, and other crew-selection factors that will set these missions apart from previous Soviet or American space missions. The design problem summarized here assumed that all of the major life support elements were already provided for and that the scientific and technological factors were not yet established to the point of including them in the space station's design. Thus, this competition emphasized the habitability aspects of the space station's interior.

This competition posed a situation where the living/working volumes were constricted, where options for variation were severely limited, where the exterior environment was hostile to life (without adequate protection), and where crew cooperation and recognition of interdependency were paramount to success. It was assumed that habitability designs directly affect human behavior, attitudes, and life style.

Because habitability has been defined in so many different ways (refs. 2, 3), it was necessary and important to define what the term "habitability" means in the present context. The following definition emphasizes the need to take into account the crew's individual differences (e.g., psychological, physiological, and intellectual needs) in the space station's interior design.

Habitability is the discipline that provides the space station's occupants with personally and collectively satisfying living and working accommodations throughout the mission.

Key design concepts for the present competition included flexibility and novelty of equipment and volume use, and safety. Each concept was to be incorporated into the final design. Other habitability-related design factors, listed later, were also to be emphasized in the competition.

COMPETITION GUIDELINES AND CONSTRAINTS

The following guidelines and constraints were sent to all those students indicating an interest in participating in the competition. They were included not to limit the creativity of the student's design in any way, but, rather, to emphasize the importance of dealing with those aspects of the space station that have to do with habitability. The supporting documents sent to all participants also made it clear that these guidelines and constraints did not necessarily represent actual mission-related parameters or flight hardware that might be used in future NASA missions.

Program

The program, as outlined to the design participants, contained the following elements:

(1) The Initial Space Station configuration is a semipermanent cluster of eight modules, each of which can be transported individually to Earth orbit inside the Space Shuttle Vehicle. The Advanced Space Station will be made up of a total of 11 modules by adding three more modules to the Initial Space Station.

(2) The Initial Space Station will be operational when fully manned by a crew of six persons, and the nominal mission duration will be six months. It will include a general purpose laboratory capability, as well as two Laboratory/Experiment modules, two Life Support/Power modules, one Command/Control module, and three Living/Habitability modules. Only the three Living/Habitability modules have to be fully detailed inside.

(3) The Advanced Space Station will be designed to accommodate a crew of 12 persons for a nominal mission duration of 12 months. It will have integral laboratory facilities, research support provisions (power, information management capabilities, etc.), appropriate docking ports, ingress/egress ports for crew extravehicular mobility, and windows. Habitability provisions will be adequate to house crews of both sexes and various nationalities. It will include three Laboratory/Experiment modules, four Life Support/Power modules, one Command/Control module, and three Living/Habitability modules.

(4) The Space Station will be placed in an orbit of 55° inclination at an altitude of 240–270 n.mi.

Safety

Safety is of prime importance to any mission, and participants received the following set of safety-related instructions:

(1) Safety is a mandatory consideration throughout the total program. As a goal, no single malfunction or foreseeable combination of malfunctions and/or accidents shall result in serious injury to personnel or to crew abandonment of the Space Station.

(2) Personnel escape routes shall be detailed to provide for any potentially hazardous situations. A design goal shall be to provide alternate escape routes that do not terminate into a common module area.

(3) The Space Station shall be divided into separate modules so that any damaged module can be pressure-isolated if necessary. Accessible modules will be equipped and provisioned so that the crew can safely continue a degraded mission and take corrective action to either repair or replace the damaged module.

(4) Access to extra-vehicular activity and inter-vehicular activity airlock suit stations shall be provided for all reasonable emergency conditions. At least two airlock chambers shall be provided

to permit crew access for ingress/egress operations. NOTE: The following three aspects of the Space Station's design should be considered by the student when possible; however, they will be considered to lie outside the scope of the competition for judging purposes.

(5) Provisions and habitable facilities shall be adequate to sustain the entire crew for a minimum of 48 hr during an emergency situation requiring Space Shuttle rescue from Earth.

(6) The capacity of atmospheric constituent stores shall be sufficient for one repressurization of the entire Space Station volume and shall be maintained on the Space Station during manned operations to independently supply each pressurized volume sufficiently to sustain the entire crew.

(7) At least two suited crewmen will participate in any pressure suit activity and rescue capacity.

Module Interface Requirements

Requirements included the following items:

(1) The maximum external dimensions of each module shall be 14 ft in diameter and 58 ft long. Mechanisms that are external but attached to the module, such as handling rings, attachments for deployment, storage fittings, thrusters, etc., shall be contained (at launch) within an envelope 15 ft in diameter and 60 ft long.

(2) The Space Station will rely on the Space Shuttle Vehicle for emergency removal of the crew within 48 hr of alert notification.

(3) The docking ports (minimum of three) and their latches shall provide a minimal inner diameter of 5 ft.

(4) There shall be a window or windows on the Space Station to enable visual contact with the Shuttle Vehicle or with free-flying modules during their terminal phases of rendezvous (last 5000 ft) with the Space Station and/or with an astronaut working outside the vehicle immediately after he has left the station. These windows should be located at the control station and at other areas where deemed necessary. A maximum of four windows per module will be allowed.

Configuration

The configuration restrictions were:

(1) The Initial Space Station will be designed to accommodate a crew of six persons. Provisions are to be made for temporary double occupancy during (second) relief crew overlap periods.

(2) The Space Station configuration may be designed either for zero-gravity operation or for artificial gravity.

(3) The Initial Space Station shall have the capacity for independent operation with the full crew of six for a period of approximately 180 days. It may be assumed that this life support capacity will be included in one of the two life support modules.

(4) Private quarters shall be provided each crew member on the Space Station. Other habitability provisions shall include facilities considered necessary to live with dignity and comfort for a period of occupation of up to six months duration.

(5) The following functional areas shall be included in the three Living/Habitability modules: dining and food preparation area, leisure, recreation (exercise) area, dispensary, chapel or meditation area, and laundry (personal effects maintenance) area.

Competition Judging Criteria

Included in the package of entry materials was the following list of judging criteria. They are *not* listed in order of their relative importance.

(1) Novelty of volume use. The degree to which novel approaches are used in designing the volume for optimal habitability.

(2) Presentation clarity. How well does the student present his design, emphasizing important design features through neat, clear graphic techniques?

(3) Realizability. The degree to which the design meets the basic Space Station constraints given in the Guidelines and Constraints document and in subsequent Question/Answer documents.

(4) Degree of equipment usage flexibility. How much flexibility of equipment usage does the design include for personal living needs and for those crew facilities which are shared by the entire crew?

(5) Manner of dealing with specific subjects. The following features of Space Station habitability are of primary concern and should be given special attention:

- (a) Personal privacy
- (b) Toilet and personal hygiene needs
- (c) Leisure time and entertainment needs
- (d) Psycho-social crew interaction

The following persons served on the judging panel: Mr. Jean-Michel Cousteau, the well known undersea explorer and architect; Mr. James Kachik, an architect who has completed detailed space station interior designs; Miss Margaret Lucas, an engineer and crew member on the undersea Tektite II mission; Mr. Wilfred E. Blessing, an architect and Task Force member who has had extensive design experience in both undersea and aerospace environments; and Dr. Edward Wortz, an aerospace psychologist who has developed habitability criteria for a wide range of environments.

In addition to the five jurors, three technical advisors were chosen to provide assistance on the realizability of each entry and to check on the conformity with competition constraints. These advisors were: Mr. Robert F. Lovelett, an aerospace engineer at NASA Headquarters, Mr. James B.

Aitken, an architect and chairman of the AIA Task Force, and Dr. Richard F. Haines, a research scientist in the Biotechnology Division at NASA Ames Research Center.

Additional Reference Materials

Included with the entry materials was a list of suggested references to which the student could turn for further technical information on both habitability-related subjects and aerospace vehicle design. These are listed as references 4–10 in the reference section.

SPACE STATION INTERIOR DESIGN ENTRIES

Twenty-seven students submitted designs. The reader may identify the participating student with his design entry by noting the small number located in the lower right-hand corner of each figure. The letter following each panel number indicates which of the three panels that illustration represents. All participants and their school affiliations are numbered in the appendix.

Analysis of First Place Award Entry

In order to make available to the reader the details of the first place award entry and other selected entries, the textual material has been transcribed directly from those panels that are difficult to read. The quoted text is coded by entry number and (panel) letter. In those cases where there are clearly identifiable sections of text within the larger panel, those sections that are quoted are coded by lower case Roman numerals beginning at the top-left corner of each panel and progressing to the right. They are referred to as figures. All underlined text has been added by the author for purposes of clarification.

(Entry 27a; figs. i–iv) “GOALS: NASA has defined the goals of the space station in several methods. These can best be described as follows: flexibility, compatibility, automation, diversity, versatility, modularity, efficiency, and redundancy. MODEL OF HABITABILITY: Besides these operational goals, there are many habitability requirements: provision for group interaction; habitable socio-economic environment; provision for sensory stimulation; diversity in communal/private spaces; provision for alteration of environment; provision for some method of orientation to physical surroundings; provision for total living cycle — rest, relaxation, exercise, work; provision for administrative organization to solve personal disputes and organizational problems; provision for adequate nutritional diets and good hygienic facilities; provision for complete recreational and relaxation facilities; as many changes of scale as possible to provide visual diversity; allowance for territoriality through provision of totally individual living spaces; allowance for greater allotment of slack time activities as the crew familiarizes themselves with their duties; provision for diversions to offset habituation.

“A systems approach must be taken in approaching the complex problem of designing a space station. All factors have an effect on the total functioning of the station. The organizational characteristics, personnel, and behavioral settings will all greatly affect the morale of the crew. In this design study I have tried to take a systems approach and look at all aspects of the station’s operation and habitability requirements.”

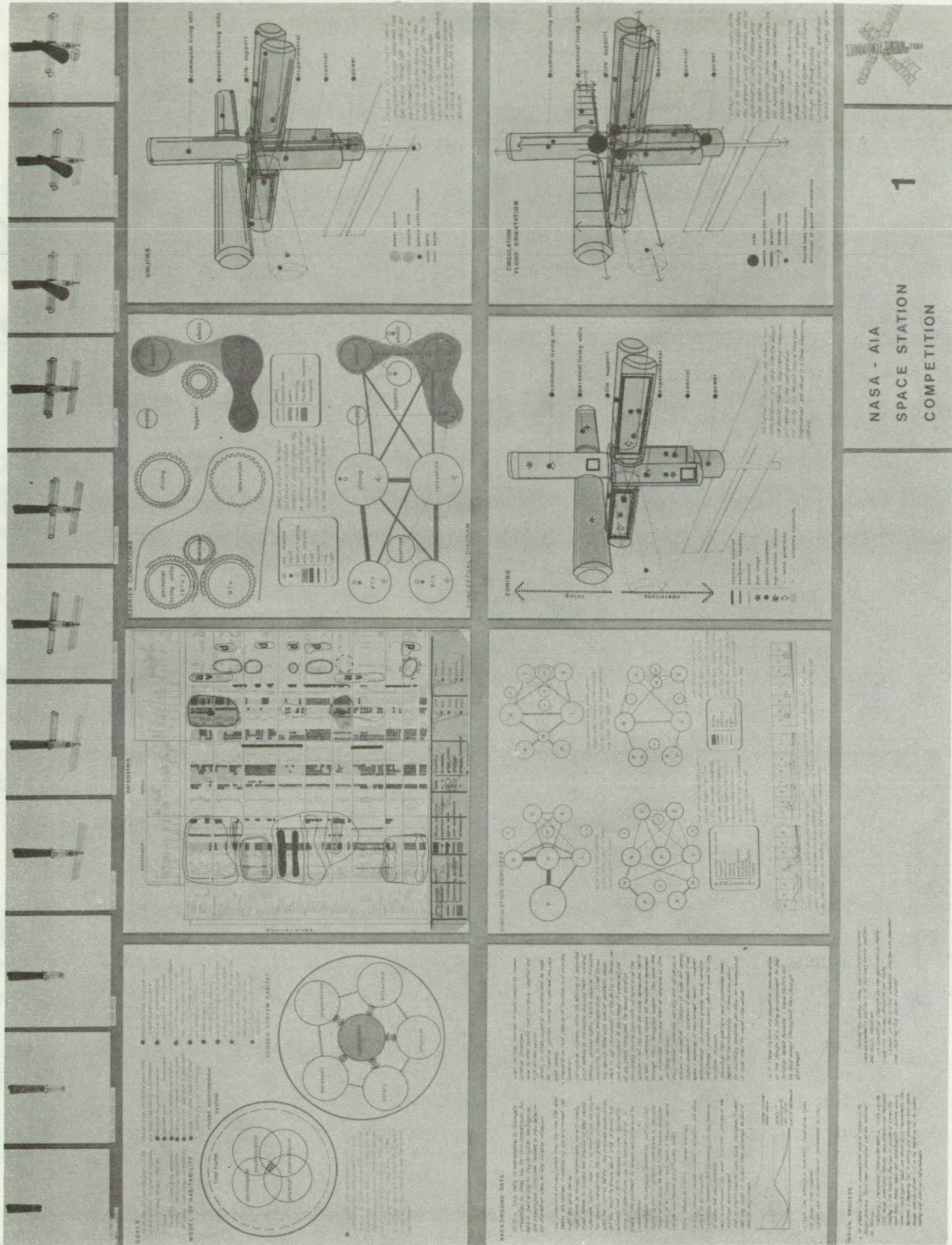


Figure 1.— Panel a of FIRST PLACE AWARD ENTRY (27a).

UTILITIES

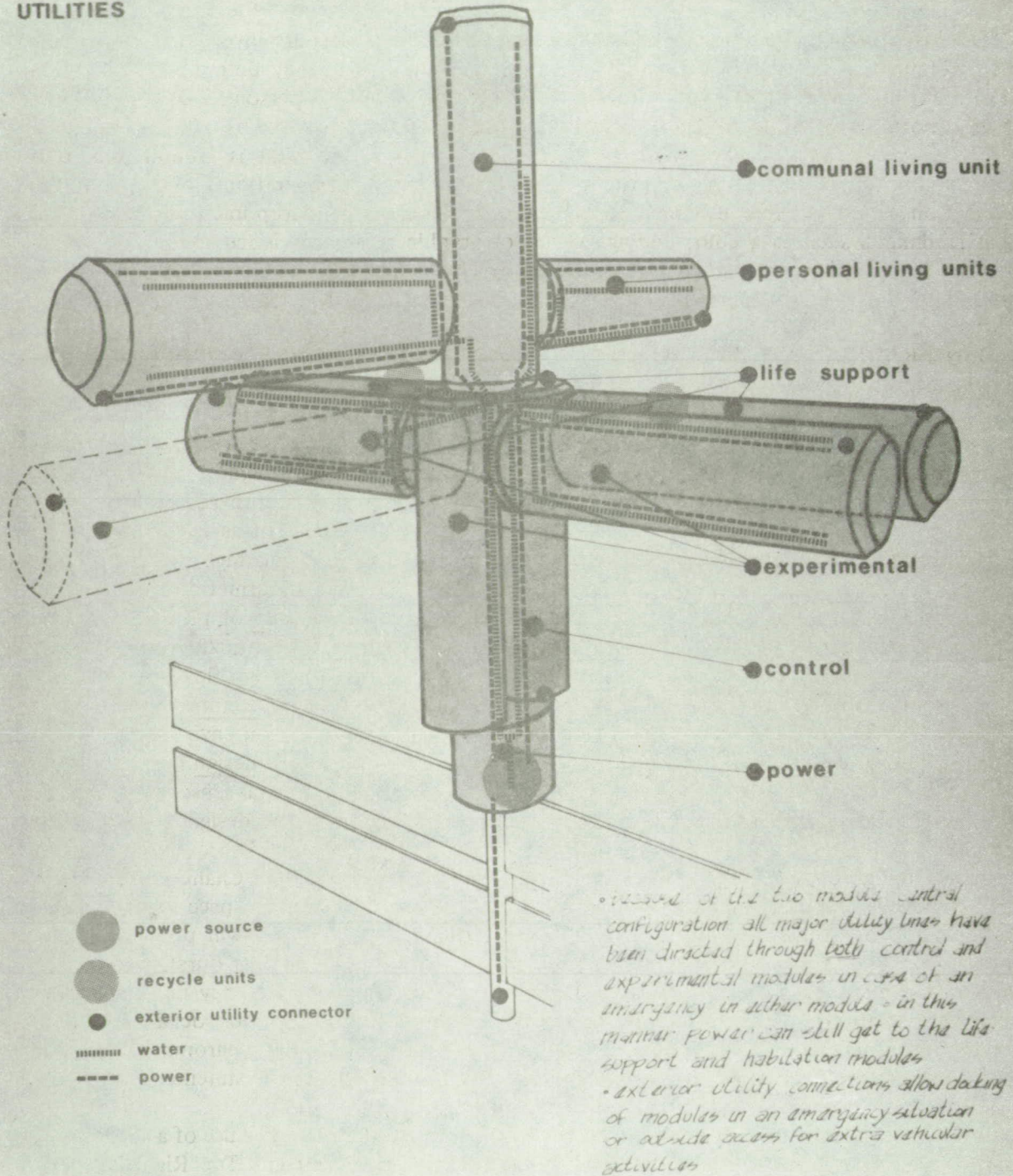


Figure 2.— Utility details of FIRST PLACE AWARD ENTRY (27a).

(Entry 27a; fig. v) "BACKGROUND DATA: Note: this data is supplemental to documents presented by NASA-AIA for this competition. All data pertains to psychological, sociological, and physiological conditions relevant to crew behavior and interaction while on long duration missions.

"The invasion of privacy comes from the idea that other people are involved in controlling your environment — not sight, and sound per se. Sight-sound, as privacy determinants, serve to directly orient humans to the distance and direction of other people. A person's mental image of a situation is not due only to his sensory perceptions but is greatly influenced by what has occurred before — his previous experiences and how much he knows about what is around him. It is estimated that a 50 per cent decrease in the time required to carry out operations occurs due to the familiarization. A greater time allotment for leisure activities must be incorporated. Orientation to physical landmarks such as a color coding system or graphic references is requisite. Habituation must be kept to the lowest possible levels at all times. Otherwise physical-mental fatigue and low morale and efficiency levels will result.

"BEN FRANKLIN STUDY — Space Analogy; As time passed, people worked-recreated-ate alone whenever possible. Increasing boredom and increasing privacy-seeking of individual crew members occurred. The need was expressed for relief from the confines of the enclosed environment. The level of psychological well being decreased toward the half-way point in the mission and then increased as the end of tour of duty approached. A rigid time schedule was hopelessly inoperative — as tasks were not always time oriented. A great deal of improvisation was implemented by crew. The available space per man became of more concern as mission duration increased. Noise from other people was the most irritating — laughter and high pitched sounds. Variety of meals was essential. Allowance must be made for "creative" gourmet cooking vs. continual pre-packaged cooking. Preparation and clean-up of facilities is also of primary concern. Perceptual richness allows for altering individual group spaces by the people utilizing them through the use of colored panels, colored lights, tactile material, and furniture. Design flexibility to allow change and alteration is important. Fixed forms only satisfy those crew members with similar aesthetic values. There is ego involvement in the ability to change one's own environment at any change of personnel and at any point in the mission. Another aspect of this design is to personally involve the crew with surfaces in all of the spaces, not only with the visual senses but with the tactile as well. The Japanese involve all muscles in movement through their designed spaces. This would tend to stimulate the crew and keep up their interest in these close confining spaces. Providing for the greatest possible variety and variation in spaces is essential. Changes of scale and sensory stimuli is essential. Sameness of environment is required if one space only is being inhabited, and monotony of environment will result; compartmentalization will produce greater visual variation and change and will produce stimuli which is good for long duration missions. Individual crew quarters must accommodate man's instinct for territoriality. They must also allow for voluntary isolation yet allow for accommodation of other crew members for social interaction. All of these factors are essential considerations in the design of a living environment for long duration space missions. These factors will be addressed throughout this design statement."

(Entry 27a; fig. vi) Top Left Diagram. "CIRCULATION CONCEPTS: The use of a single living area with separate hygienic area results in heavy concentrations of traffic." Top Right Diagram. "The use of two personal living areas with central hygienic area results in less crowding but still heavy traffic between personal living units and hygienic areas." Lower Left Diagram. The use of "two personal living units with separate hygienic facilities diminishes traffic considerably with less resulting congestion. The use of a separate communal space alleviates traffic problems still further

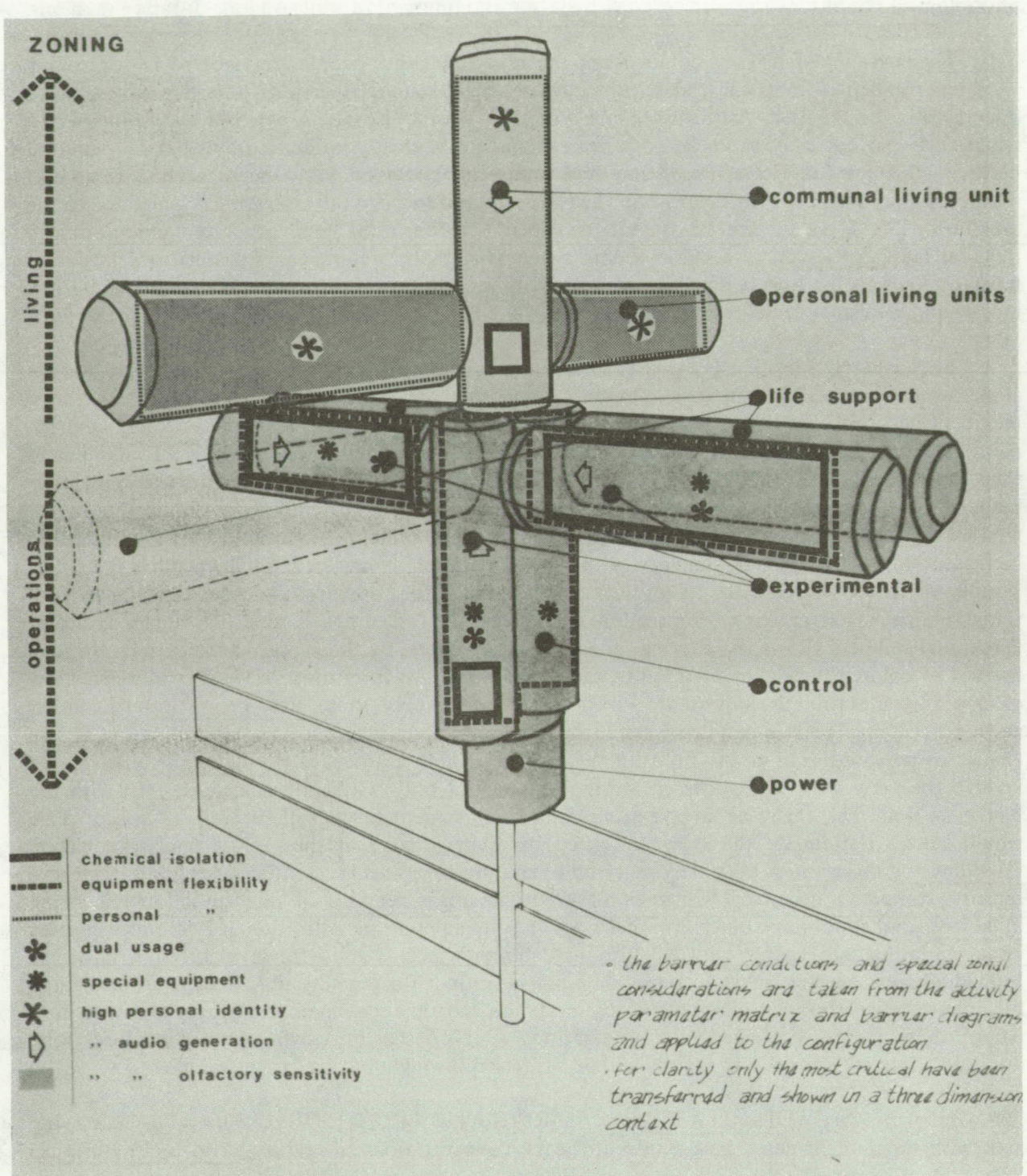


Figure 3.— Functional area designation (zoning) of FIRST PLACE AWARD ENTRY (27a).

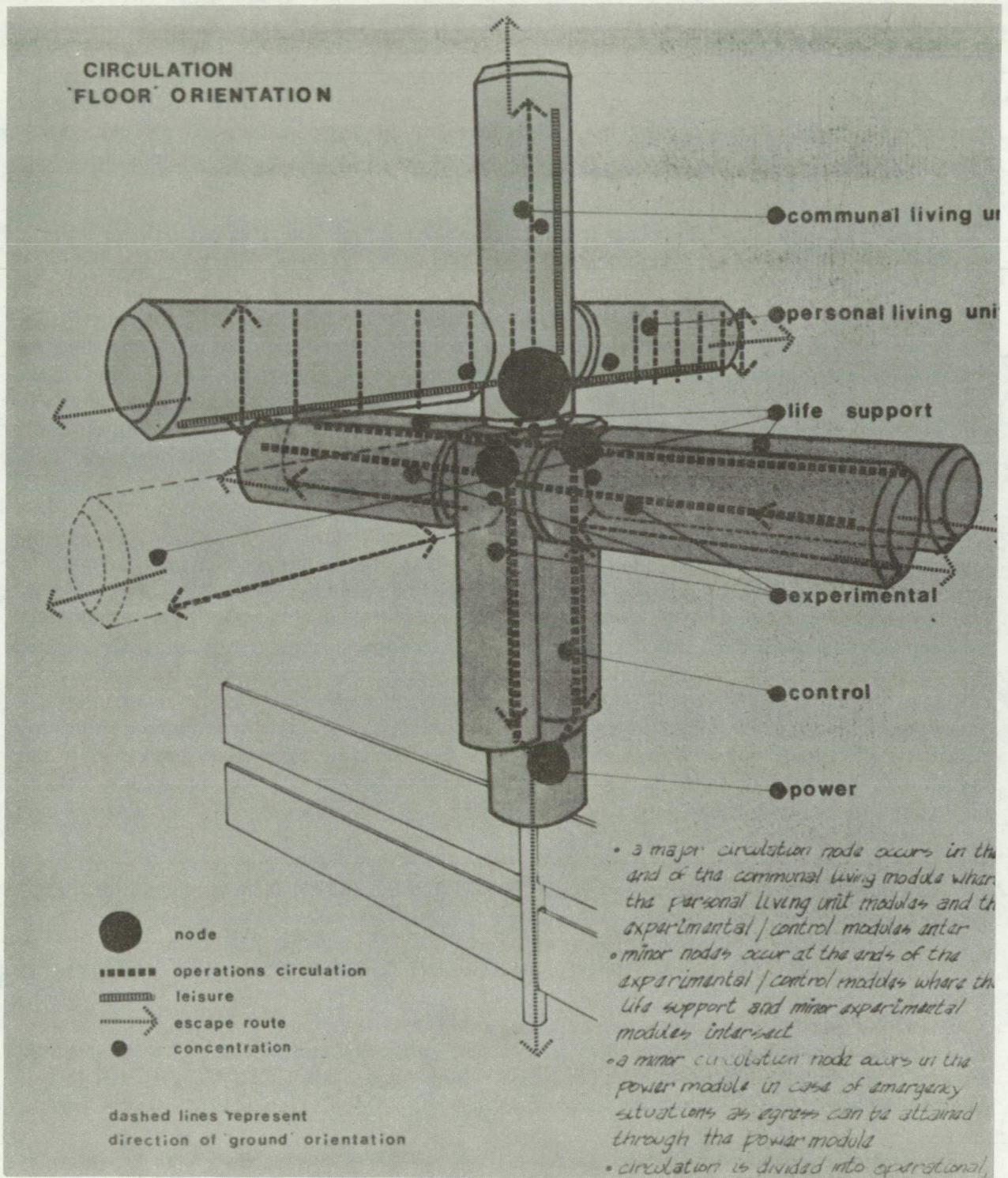


Figure 4.— Circulation and floor orientation of FIRST PLACE AWARD ENTRY (27a).

but the increase in weight, volume, and cost is unjustified." Lower Right Diagram. The use of a "personal living unit with private hygienic unit within it is analyzed. A separate hygienic facility is provided in both the laboratory and medical location. This approach is justified due to proximity to the photo lab and control area. Resulting traffic patterns are also reduced to a minimal level." Bottom Diagrams. Various "traffic patterns within personal living units are illustrated. A central hygienic unit produces great congestion. Use of two-man units provide acceptable circulation patterns. Individual one-man units provide maximum benefits if they can be justified in terms of cost and weight."

Figure 5 shows panel b of the first place award entry. Inset figure i labelled HYGENIC UNIT is enlarged in Figure 6.

(Entry 27b; fig. ii) "CLOTHING: All jump suits will be of stretchable material, snug fitting, yet porous enough to allow ease of air circulation. They must be lightweight, colorful, and allow for the most mixing and matching possible. The front panels of the jump-suits will contain various assorted pockets with velcro closing for storing various personal and duty-related material due to zero gravity. Velcro stripping and other "attachable" items will adorn the front panels for attaching small, often-used materials, pens, writing tablet, etc. EQUIPMENT: These clothing racks hold plastic garment bags in tension allowing clothes to remain flat i.e. not free floating. Zippers or velcro stripping allow easy sealing of bags. Clothing bags slide in and out of racks "fixed" in a furniture unit. JUMPSUIT COMBINATIONS: Due to the monotony of the environment and the long duration in confinement, it is felt that the crew will express individualism in any way possible, the most obvious being clothing. The desire to provide some solution for clothing in zero gravity resulted in several variations of jump suits for both men and women alike. GARMENT STORAGE: To keep personal wardrobes stored in zero gravity, yet visible, but not free floating, a system of racks in one of the personal living unit's furniture modules holds a transparent plastic container for clothing. WRITING TECHNIQUE: Due to the necessary generation of voluminous quantities of paper by a scientific crew, a method to avoid this kind of wastage is found in a modified child's toy "magic slate". This will allow a large amount of data, doodlings, etc. to be created in a sheaf of this material. It may then be taken to the personal living unit of various other microfilm cameras, photographed, and then erased by separating the pages and starting anew. A locking system would be necessary to prevent accidental erasures."

The inset figure iv of Figure 5 labelled POWER PANEL SYSTEM is enlarged and presented as Figure 7.

The inset figure v of Figure 5 labelled RESTRAINT SYSTEM is enlarged and presented as Figure 8.

Figure 9 shows panel c of the first place award entry. On the right is a view of the fully assembled Advanced Space Station in Earth orbit. Inset figure i labelled CONTROL MODULE is enlarged in Figure 10.

Inset figure ii labelled COMMUNAL LIVING MODULE is enlarged in Figure 11. Inset figures iv and v, labelled CENTRAL EXPERIMENT MODULE and PERSONAL LIVING UNIT are enlarged in Figures 12 and 13, respectively.

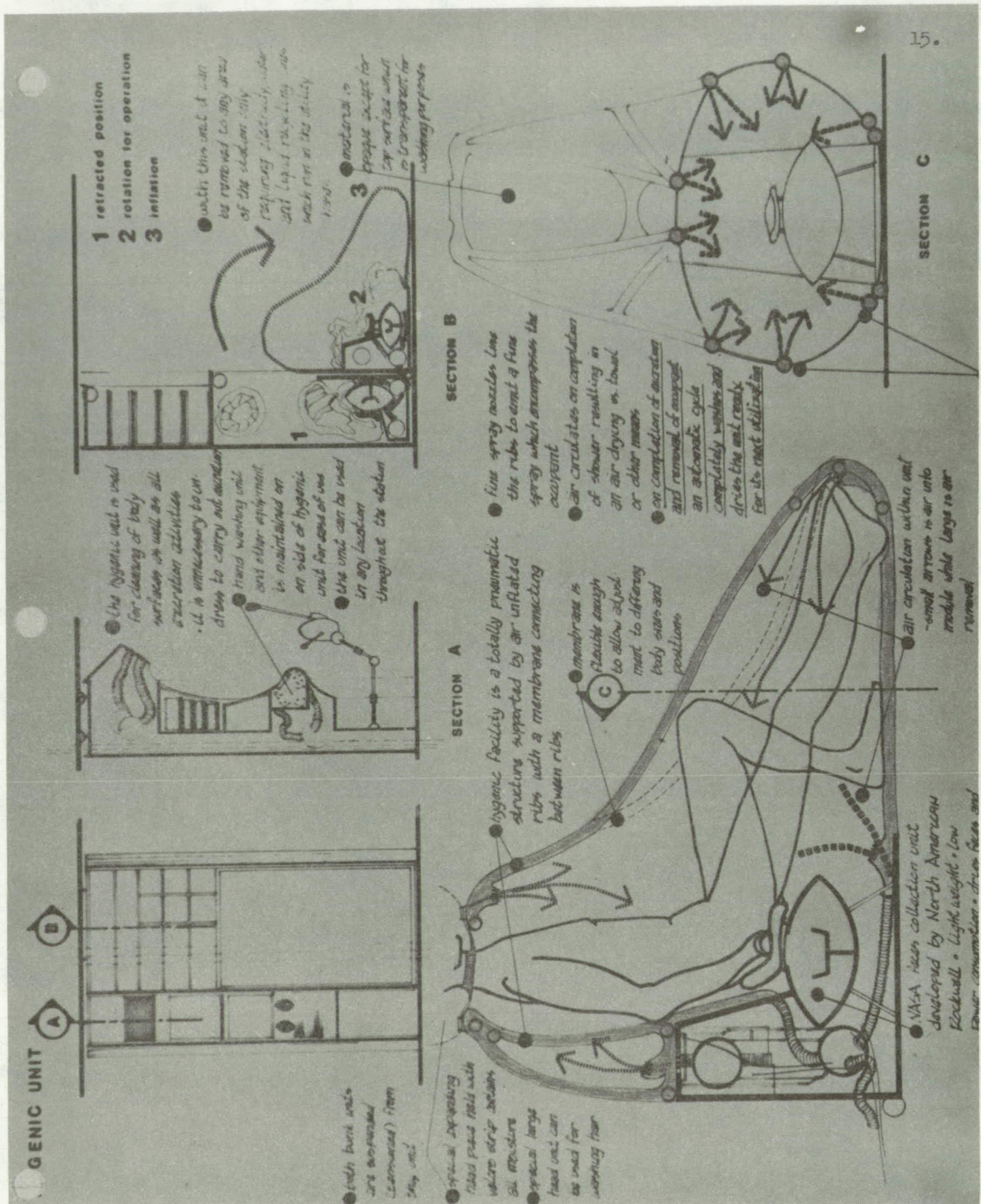


Figure 6.— Hygienic unit details of FIRST PLACE AWARD ENTRY (27b).

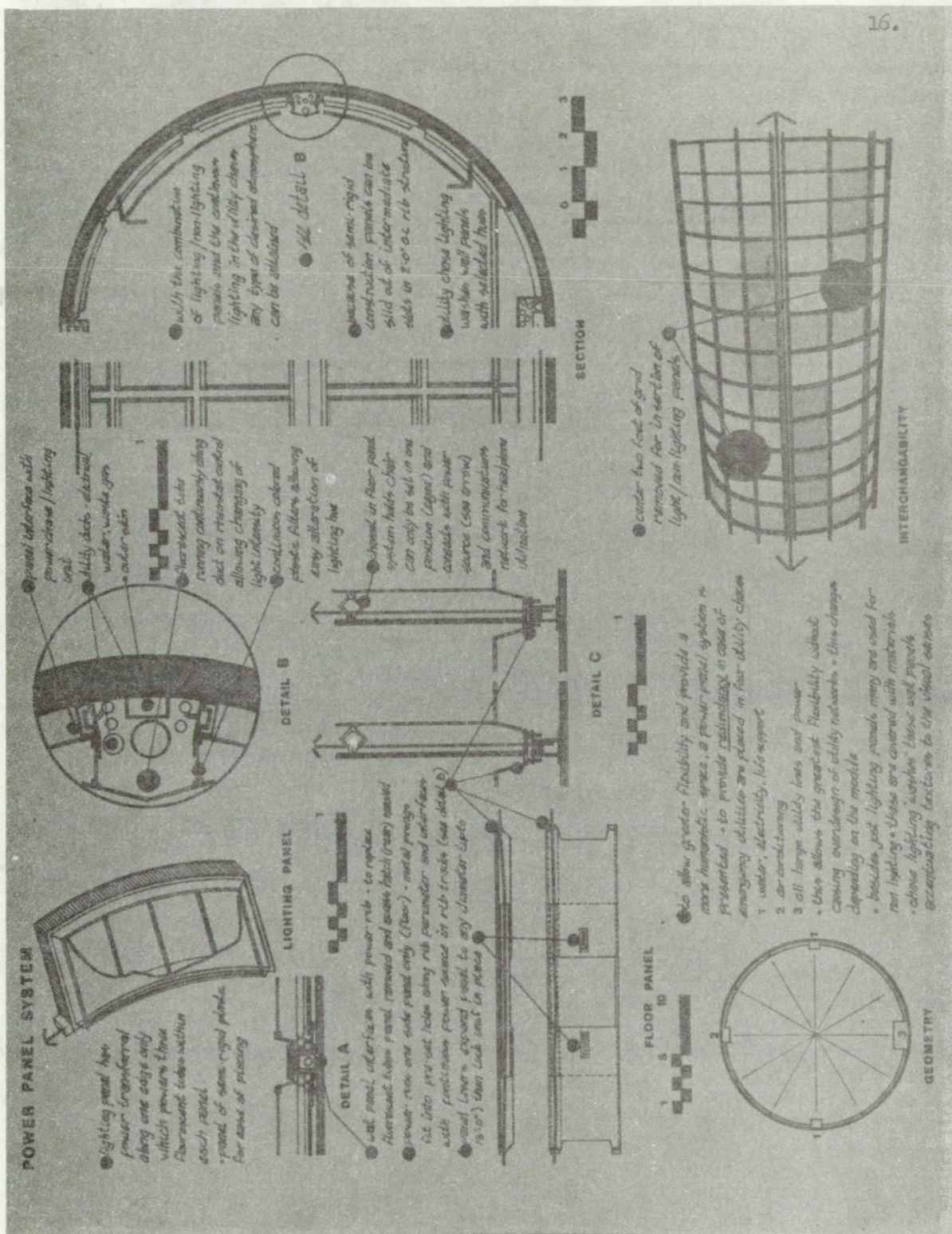
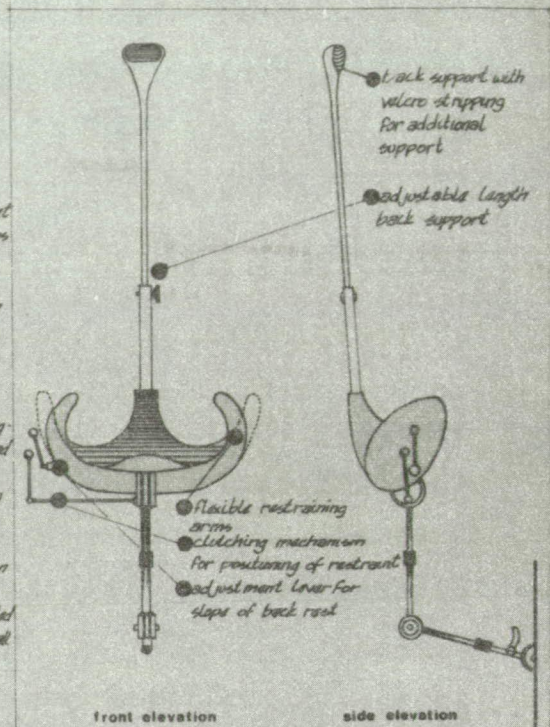
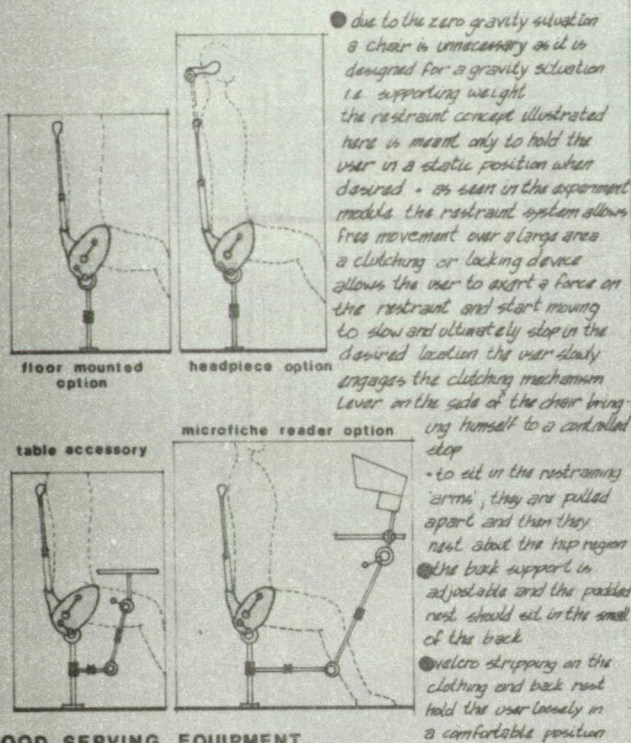
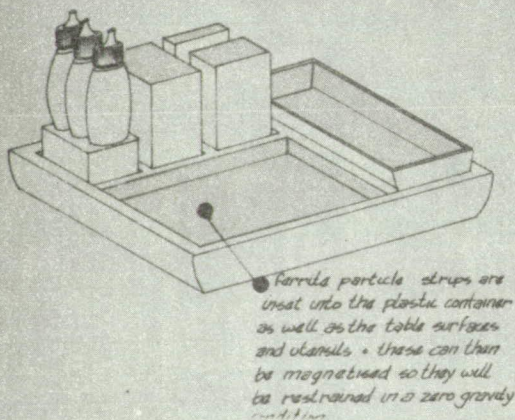


Figure 7.— Power panel system details of FIRST PLACE AWARD ENTRY (27b).

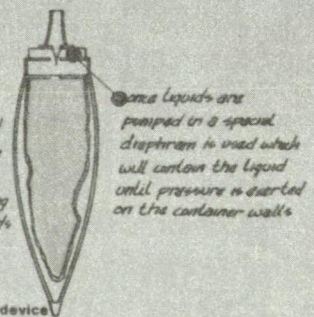
RESTRAINT SYSTEM



FOOD SERVING EQUIPMENT



● the liquid intake device works in conjunction with the liquid dispensing unit - it plugs in to the unit, is filled with hot or cold liquid and then removed for intake - it allow sterilization on completion thereby becoming a permanent fixture - liquids can then be brought up in bulk containers



liquid intake device

- the double stem allows gripping of the device even with hot liquids

- the inner liner allows better intake of liquids as well

Figure 8.— Restraint system details of FIRST PLACE AWARD ENTRY (27b).

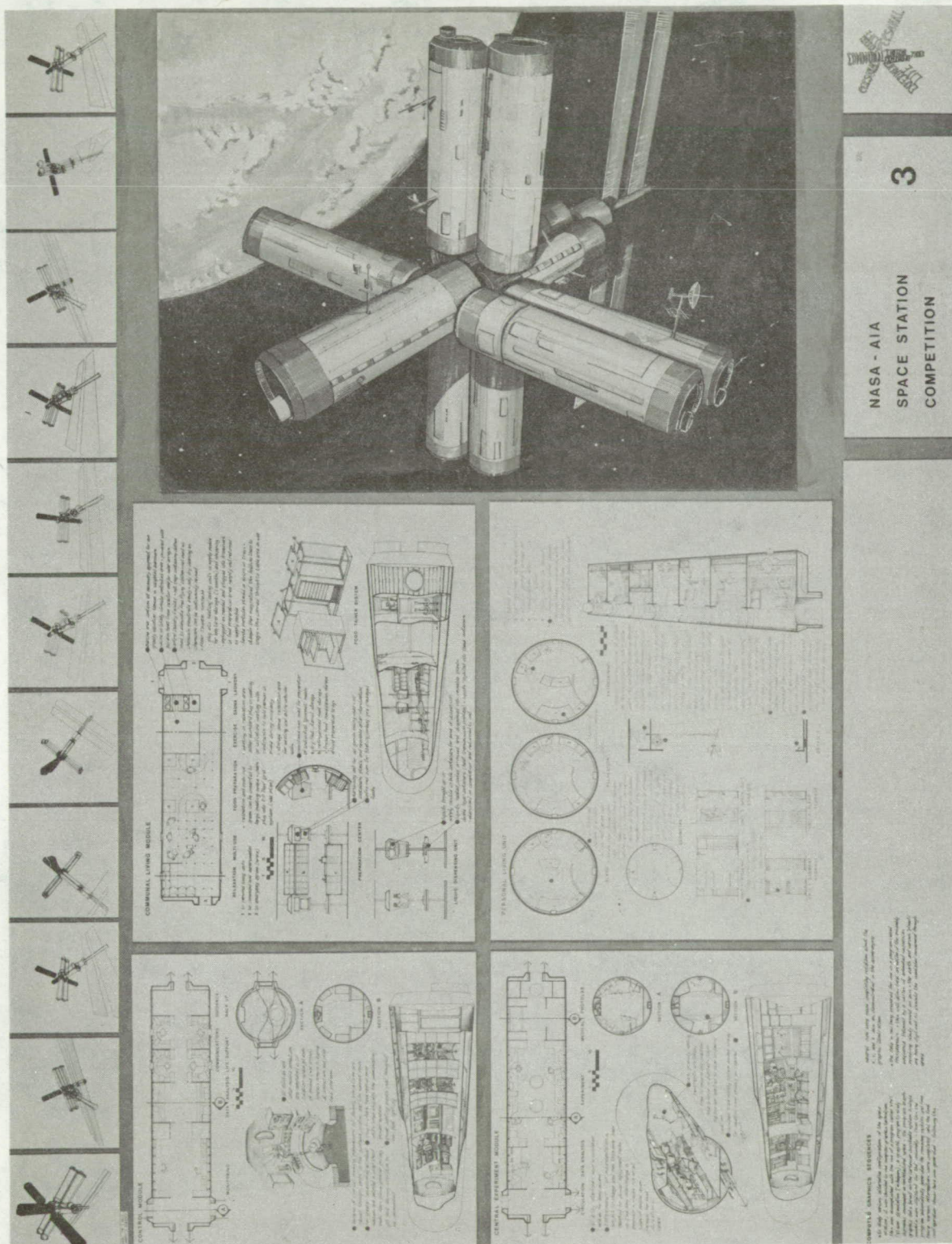


Figure 9.— Panel c of FIRST PLACE AWARD ENTRY (27c).

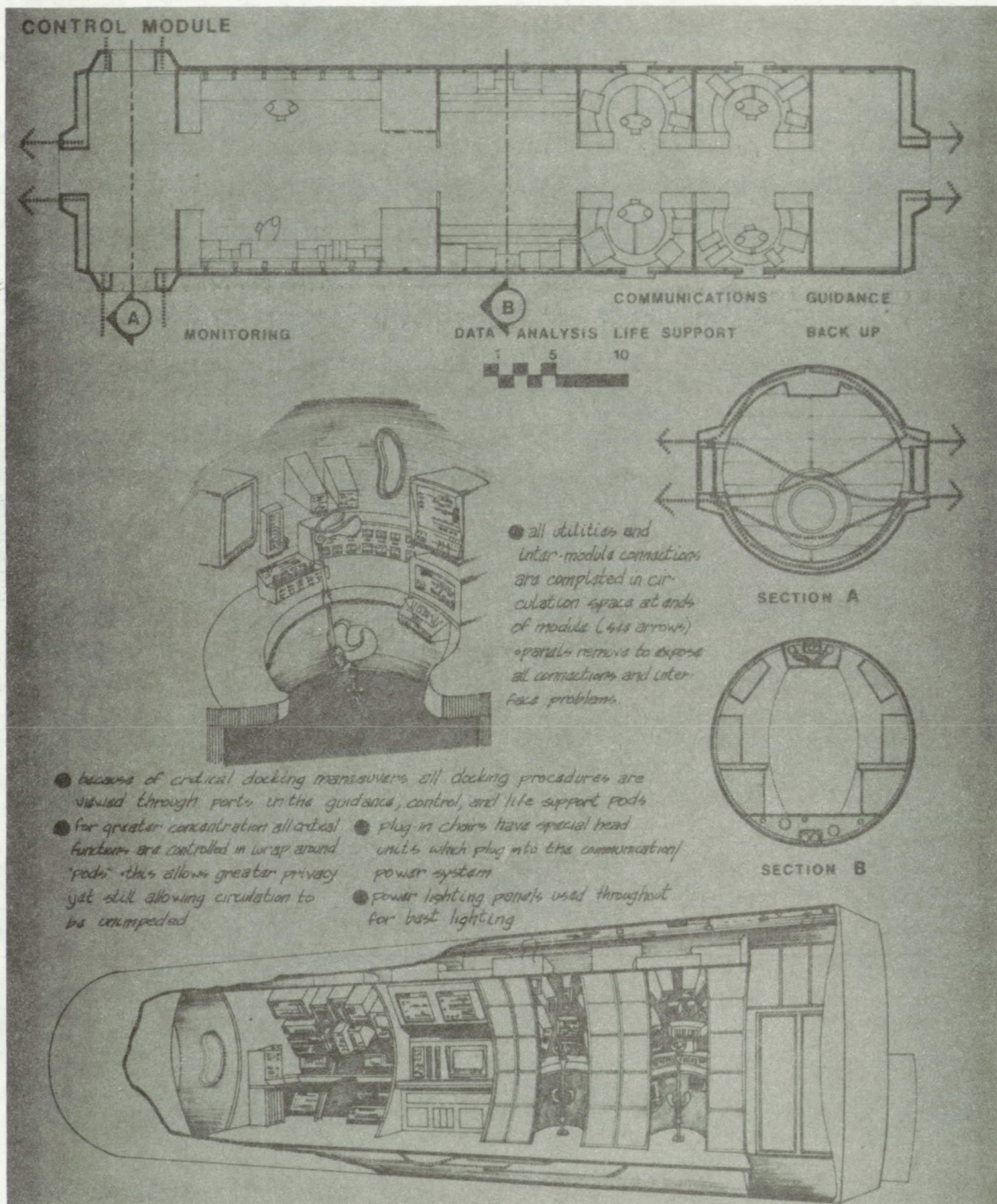


Figure 10.— Control module details of FIRST PLACE AWARD ENTRY (27c).

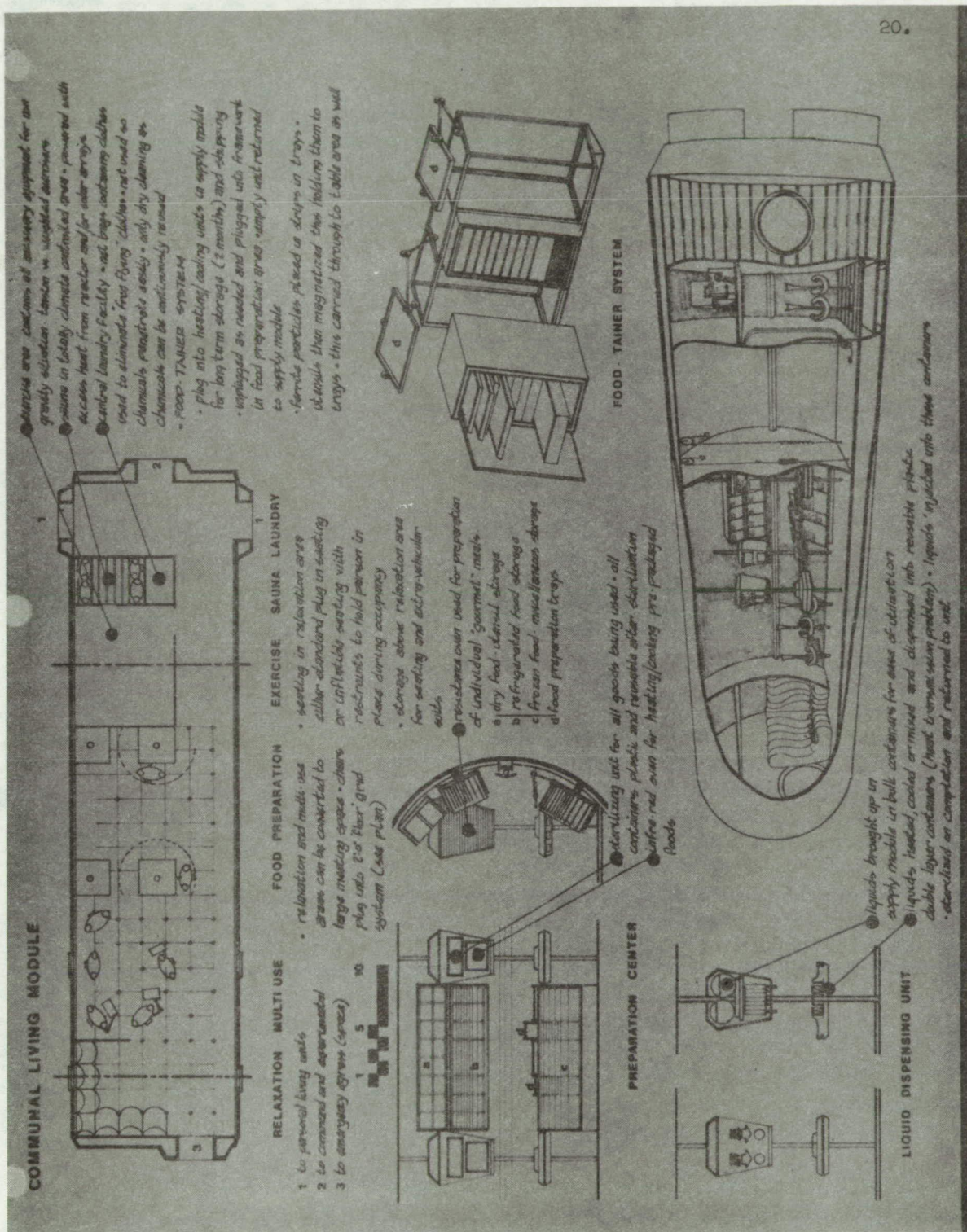


Figure 11.- Communal living module details of FIRST PLACE AWARD ENTRY (27c).

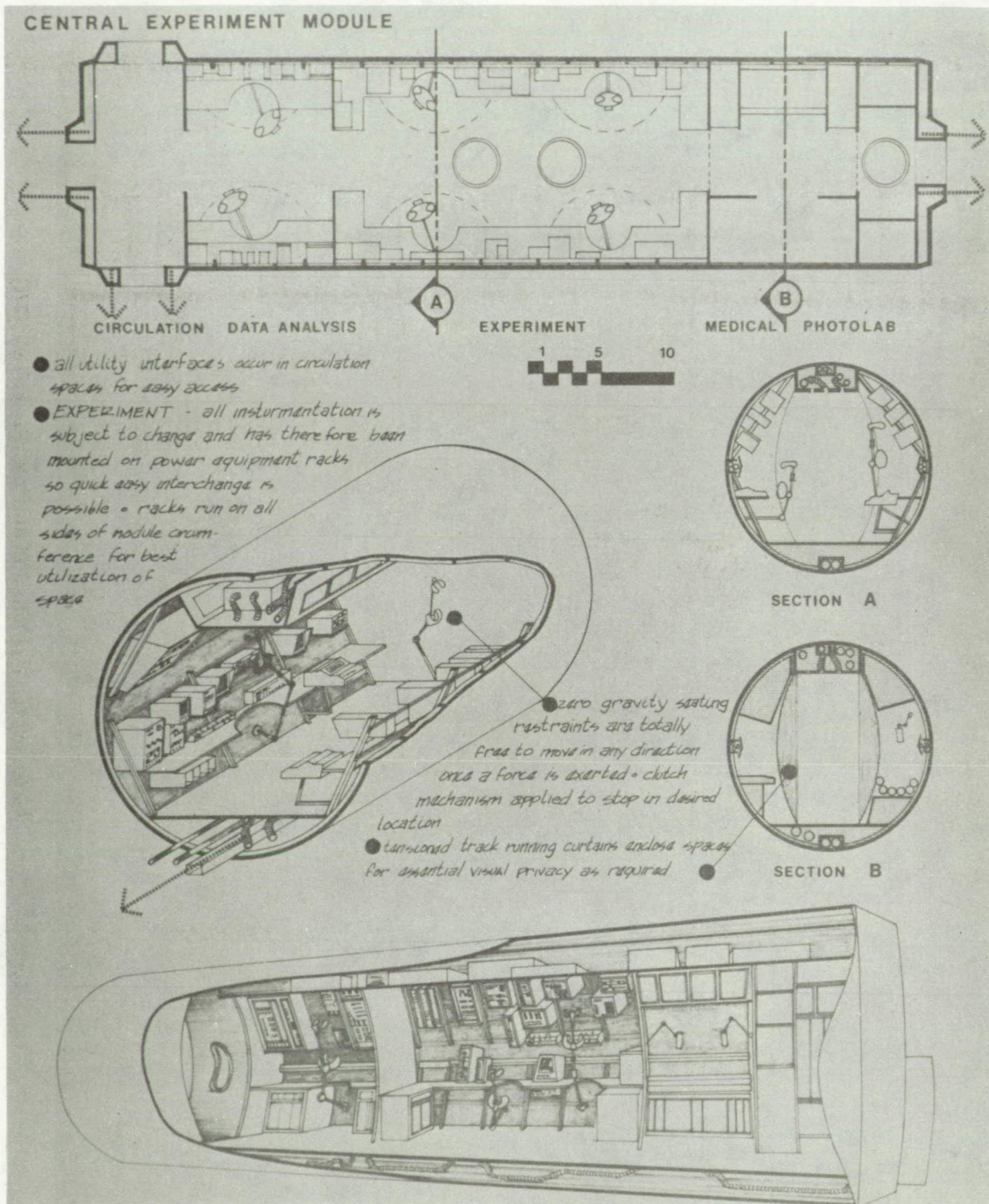


Figure 12.— Central experiment module details of FIRST PLACE AWARD ENTRY (27c).

Remaining Design Entries

It is not possible to comment on all features of every design. The general layout, floor plan, elevation, and perspective drawings are clearly visible in the following figures. In addition, selected text has been transcribed and located near the figure from which it has been taken.

Selected design features are discussed below because of their applicability to terrestrial as well as to the space environment. The entry from which the feature was taken is given in brackets. The following subjects are discussed: *Basic modular layout*; *Structural details and partitions*; *Illumination*; *Entertainment*; *Storage and station-keeping features*; *Miscellaneous features*.

Basic modular layout— Almost all design entries assumed a zero-gravity environment. This fact must be taken into account when attempting to apply these designs to the terrestrial environment. Nevertheless, the basic modular configurations and structural features should be of interest to architects and other designers.

Most entries used the “form-follows-function” precept. Thus, most entries compartmentalized specific living/working areas rather than leaving open volumes which could be partitioned off as necessary. Use of living/working volumes having common dimensions was suggested in several entries (2, 7, 10, 24, 26) for reasons of “interchangeability” and “crew familiarity.” Other entries suggested a variation of floor plans from one module to the next (11, 12, 14, 15, 18, 20, 21) in order to provide “sensory stimulation,” “visual variability,” and “environmental novelty.” Although most entries suggested flat floor, wall, and ceiling surfaces, entries 12 and 21 presented a complex assortment of interior surfaces which enclose functionally related volumes (e.g., within the central habitability hub area), as well as vaulted ceilings, to provide a sense of uplift and greater volume. Entry 9 suggested that the floor orientation should change from one living space to the next to help create a change in environment; entries 12 and 17 suggested a concave floor in certain areas of the space station. Entry 12 also suggested a dining area with completely encircling walls to enhance a sense of group unity. As one entry pointed out, “there must be an agreeable combination of the familiar and the unique, to promote security yet prevent boredom in a confined environment” (14). One entry provided an analysis of how a module might best be divided with floors and walls to optimize the available volume (18). In many entries, section drawings of a particular module showed that a rectangular area was used most often (ceiling height of approximately 7 ft) with utility ducts, storage, etc., located between the module’s outer shell and the four sides of this rectangle (11, 13, 16). Many other entries used the outer shell itself as the basic supporting surface for cabinets, furniture, and other equipment (2, 23, 24, 27).

Personal privacy was implemented in these designs in various ways. Several entries suggested the use of one-man pods within which a person could read, listen to music, watch TV, or sleep. These pods were attached to the wall, ceiling, or floor on an adjustable track (7, 11) or could be plugged into a grid network of floor holes (27) within various areas. The competition guidelines also required individual, private crew quarters without specifying a minimum cubic foot value. The entries which dealt with personal hygiene and toilet matters in detail suggested that one or more lavatories be included much as they are on commercial jet aircraft in order to reduce traffic congestion and to save weight and power.

A particularly novel design feature was the leisure time area of entry 12 where the crew could find a "low stress-low demand area" with "wrap-around space" that does not create social hierarchies but does create a background for leisure activities.

Structural details and partitions— Many different kinds of wall partitions were submitted. These included a folding fan (2), standard accordion fold (19, 23), corrugated padded walls (16), partitions that roll-up into the ceiling (11) or fold down into the floor cavity (19). Various inflatable structural members and surfaces were also suggested (6, 13, 26). Inflatable partitions have the advantage of helping to reduce sound volume and the disadvantage that they cannot (easily) be adapted to include interior lighting. Rigid but movable partitions were suggested in other entries (3, 12).

A dining table with interchangeable, plastic-laminated tops in different colors and textures was suggested (18) for novelty. Continuous electrical plug-in strips within the module's structural members were also suggested (2). Another entry suggested that floor sections be designed so that they could be raised and locked into position to serve as table(s) (11). Various telescoping rods and spring-loaded flex systems were also suggested (6).

Illumination— Many entries emphasized the importance of providing variable lighting. Most designs included both general diffuse-white and "tensor" spotlights with continuously adjustable controls (3, 8, 12), electroluminescent lamps (12), or diffuse light sources located behind translucent wall panels (10). "The reality of an unnaturally long narrow volume is resolved by the use of visual illusion through lighting. Small but important foci can become interesting by the use of high intensity lamps" (18).

Entertainment— Some architectural design concepts that were related to entertainment and leisure time activities included specified areas in which to perform various activities (2, 3, 11, 14, 15, 27). An exercise (gym) area was included in many entries. Other entries provided a storage area(s) for small games, etc. (2, 27) and special seating arrangements for small groups participating in these activities (7, 11). Entry 9 suggested the use of a 4-ft by 6-ft computer- and video tape-controlled TV screen, stereo, and other sound systems in an "entertainment room." This wall-sized screen could also be used to display outdoor nature scenes of Earth and to display slides, etc., during crew conferences. Entry 15 illustrated a hygiene/exercise area with air-inflated padded walls, punching bag which may be used to help relieve tensions, and other exercise equipment. It also included an eating/lounge area with theater and library areas. Entry 20 suggested that a fireplace (image) be created in the lounge by the holographic technique.

Most entries which dealt with entertainment included the usual range of American pasttimes and seemed to reflect this cultural factor in spite of a competition guideline which specified an international crew. Several entries commented on the necessity of microfilming books and other reading material to save weight and volume. Several entries also included the entertainment/leisure time area near or within the dining area.

Storage and station-keeping features— Storage of personal equipment and mission-related items will be extremely important on long duration missions. Care must be taken to provide unambiguous marking for their rapid access (e.g., during an emergency) and stowage. Entry 2 suggested a rotating drum storage concept built directly into the structural ribs of each module. This continuous compartment would have a cross section of about 100 sq in. and could be rotated on bearings to bring

the storage canister to the crew member rather than requiring him to go to the storage area and bring the item back. Vertically adjustable galley cabinets – which can be moved to other locations – were suggested to increase equipment interchangeability (9). A magnetic food shelf was suggested on which to hold a crew member's eating tray (22, 27). Entry 27 suggested a modularized "Food-tainer" system with plug-in heating/cooling units located in the Life Support module for long term storage. This unit would be transported into a similar framework/power supply unit in the galley area and the empty unit returned to the Life Support module for refilling (see fig. 11). Vacuum cleaning (suction) outlets (14) and air conditioning supply and return vents (15) should be built into structural members.

Miscellaneous features— Other design concepts ranged from the commonly used practice of color-coding walls, doors, cabinets, etc., according to their specific function, to the use of a slow, but continuously moving floor tread to move crew members from one location to another (11).

Entry 14 dealt with the important subject of visual path length within various modules. Maximizing both the length and variety of different "vistas" would seem to be an important design goal from the standpoint of habitability. Since man is accustomed to having access to windows in most buildings on Earth – which allow him to focus at (optical) infinity – his eye's accommodation mechanism can relax fully whenever he likes. Windows also provide a type of visually-mediated, psychological escape mechanism during periods of social or psychological stress. The space station's windows will also provide for this to some extent. Nevertheless, the relatively short visual path lengths within a typical space station module suggest the use of special illusory lighting techniques, mirrors, and surface texture to help optimize this visual factor. Provision for optimal visual variety that may be changed from time to time will also be very important.

General Observations and Comments

Each of the present entries seemed to be based upon one of two basic design philosophies: (1) either an Earth-like environment should be duplicated in the space station (presumably to help the crew maintain its ability to return to Earth after the mission is over), or (2) a relatively unrestrained, novel interior design should be planned to which the crew can adapt during preflight ground simulation training or the flight itself. The great majority of these entries favored the first philosophy.

Depending upon the degree of Earth-environment realism desired, many different techniques could be incorporated into the space station's interior design to help enhance habitability. For instance, barely audible nature sounds (e.g., wind, running water, rain, birds, moving tree branches, etc.) could be played over the intercom system when appropriate. The intensity, color, and direction of illumination could be slowly but continuously changed within a lounge area like that illustrated in figure 23 to simulate daily variations found on Earth. Various odors could even be used at certain times and locations when appropriate. Of course the suitability and acceptability of using any of these kinds of simulation techniques would depend upon a thorough analysis of their impact upon the crew's social, psychological, and mental well being, taking into account the cultural, age, and sex differences represented.

Little evidence was found in these entries that any serious consideration was given to cultural, nationality differences among the crew. Although it is difficult to design for such factors without knowing the exact cultural make-up of the crew beforehand, there was little obvious planning which would allow each new crew to configure the space station's interior environment to suit itself. Several entries did indicate that each crew member should be able to select and/or vary interior surface colors or hang pictures or other art work within his own stateroom or the lounge area. It might be suggested that each flight crew be permitted to configure the interior of a full scale ground-based space station simulator to suit itself before the flight in order to help it adapt more efficiently to the confined volumes, to assist it in establishing sensory cues for postural orientation when moving from one module to another, and to otherwise make the space station's interior more habitable.

Ames Research Center

National Aeronautics and Space Administration

Moffett Field, Calif. 94035, December 5, 1974

SPACE STATION CONCEPTS

CONFIGURATION

SAFETY: Module arrangement provides at least two routes of access or exit for each module. No module is cut off by failure of another. No escape routes terminate into a common area.

GROWTH: Phase 1 is based on two groups of two modules joined end to end with cross joined modules completing circuits of circulation. Circuits make alternate routes of circulation possible.

Phase 2 is achieved by addition of a laboratory and two life support modules in cross joined positions.

Future modules may be added — joined end to end with laboratory PI-6, command control PI-1, or sleeping modules PI-3 or PI-8.

SERVICE: Doors are located at ends of sleeping modules, command control and lab PI-6. A 5'0" diameter passage at all connections permits movement of delivered items through entire station.

EVA's take place primarily from command control (2 air lock suit stations); emergency EVA possible from living module (2 air lock suit stations).

TWO SLEEPING MODULES

LIVABILITY: Each module has its own hygiene area, dispensary and secondary food preparation and dining area.

PRIVACY: Normal occupancy provides private quarters for 6 persons in each module and 2400 cubic feet of semiprivate space.

EMERGENCY: Each module will house 12 inflated sleep units in an emergency or for crew overlap.

ONE LIVING MODULE

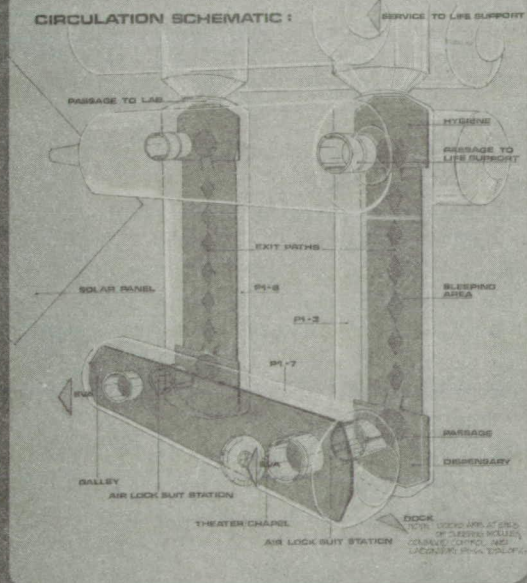
CONVERTIBLE: Fixed functions located at ends frees major spaces of module for interchangeable uses. Simple, open plan increases versatility.

COMMUNITY: Functions promote community activity — community dining, community entertainment, community lounge.

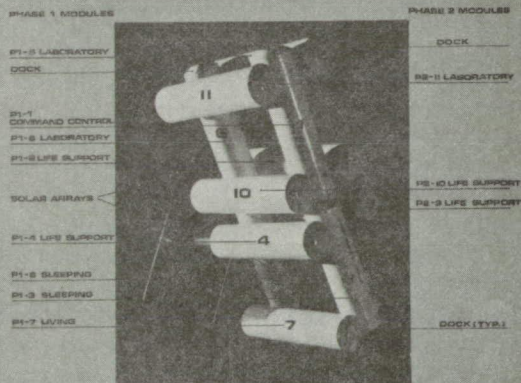
CONFIGURATION



CIRCULATION SCHEMATIC :



PHASE 1 MODULES



NASA/AIA COMPETITION: SPACE STATION DESIGN

Figure 14.—Panel a of SECOND PLACE AWARD ENTRY (13a).

SLEEPING MODULES: P1-3 & P1-8*

HYGIENE AREA: Primary function — hygiene, laundry, personal-maintenance. Allows 6 members of crew to use the facilities simultaneously.

- A. Sealable passage to command control
- B. Passage to life support module
- C. Laundry and cleaning facilities
- D. Dressing area
- E. Showering cabinet — air tight unit uses direct spray and air vacuum to control flow.
- F. Face and hand washer and toilet.

SLEEPING AREA: Primary function — provision of crews private and semi-private spaces. Each module, P1-3 and P1-8 normally houses 6 sleep/dress units which serve as individual crew quarters (see description below). Remaining space arranged to meet crew's needs and desires.

In an emergency both modules can house 12 such units for double crew capacity, or in event of failure of one of these modules. In the case of failure of living module P1-7, the overhead orientation of sleep units gives a large general living space.

- G. Sleep/dress unit in vertical orientation
- H. Sleep/dress unit in overhead orientation. Plan shows random arrangement of units.

DISPENSARY & AUXILIARY FOOD PREPARATION AREA: Primary functions — the dispensing of medical supplies, aid and observation of ill crew members. This area also provides an auxiliary food preparation and dining space for intermittent snacks or meals, or to serve the 6 members of each module in the event of failure of living module P1-7. Major food storage occurs in life support modules so that loss of P1-7 will not cut off food supply.

- J. Dispensary: Bed, medical stores, observation. This space can also serve as sleeping room in case of irreparable damage to a sleep unit.
- K. Dock — 5'0" nominal diameter. Adjacent passage permits service package transfer.
- L. Passage to P1-7
- M. Food preparation and dining

*Note: Module P1-3 and P1-8 are similar. Sleep/dress unit arrangement can vary.

SLEEP AREA CONCEPTS

INFLATABLE SLEEP/DRESS UNIT: The sleep/dress units are made of air inflated vinyl panels which form the exterior walls and doors. Two rigid panels in each unit provide stiffness and separate the sleeping and dressing area from the storage spaces. Air inflatable units offer several advantages over rigid structures, such as:

- The entire unit may be deflated and stored under the floor for launch, being inflated and positioned in orbit.
- The major barrier material is a light weight vinyl — reducing load.
- The air inflated panels offer soft rather than rigid barriers, increasing safety.
- Extra units for double occupancy can be stored easily and compactly, inflated when needed.
- In case of local air contamination the air of the sleep unit may be tapped and breathed until situation is corrected.

SUCTION SLEEPING SURFACE: The sleeping surface of each unit is a mat having many small perforations. Return air is drawn through the perforations creating suction which will hold person or blanket to the surface — a means of stability for sleeping without confining restraints.

OTHER INFLATABLES: Use of inflatable furniture and barrier panels is also advantageous as discussed above. Separate inflated panels provide further subdivision of spaces if desired.

PHOTOGRAPHS

1 & 2. Each sleep/dress unit provides a private space 4'6" X 6'6" X 7'6" or 220 cubic feet, allowing a person to lay out on the sleeping area for semi-private use. The units primary function is for sleeping and changing of clothes and provision of personal storage space.

Photographs show a unit in overhead position; clear plastic represents inflated panels.

FLEXIBILITY OF SPATIAL ORDER:

- 3. Arranged randomly, the sleep/dress units can provide many varieties of space, subject to the desires of the crew. Spaces can be altered by simply reorienting one or more units.
- 4. With all 6 units packaged into one end, 1/2 of the sleep area is left completely open for various functions. This arrangement permits 12 units inflated in each module for cases of crew overlap or loss of use of one sleep module.
- 5. With all 6 units in an overhead position the entire floor space is open for lounging and semi-private spaces. Divisions can be achieved by furnishings or separate individually inflated panels.

SLEEPING MODULES: P1-3 & P1-8

HYGIENE AREA

PRIMARY FUNCTION: WASH, SHOWER, TOILET, DRESS, ALONG WITH STORAGE OF PERSONAL BELONGINGS.

- A. COLORED WALLS TO DRAINAGE DRAIN.
- B. FLOOR TO THE SHOWER BATHS.
- C. LAYOUT AND LAYOUT FLOORING.
- D. DRESSING AREA.
- E. DRESSING AREA WITH SHOWER AND TOILET.
- F. FLOORING AND LAYOUT FLOORING.

SLEEPING AREA

PRIMARY FUNCTION: SLEEPING. THE SLEEPING AREA IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE. THE SLEEPING AREA IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE. THE SLEEPING AREA IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE.

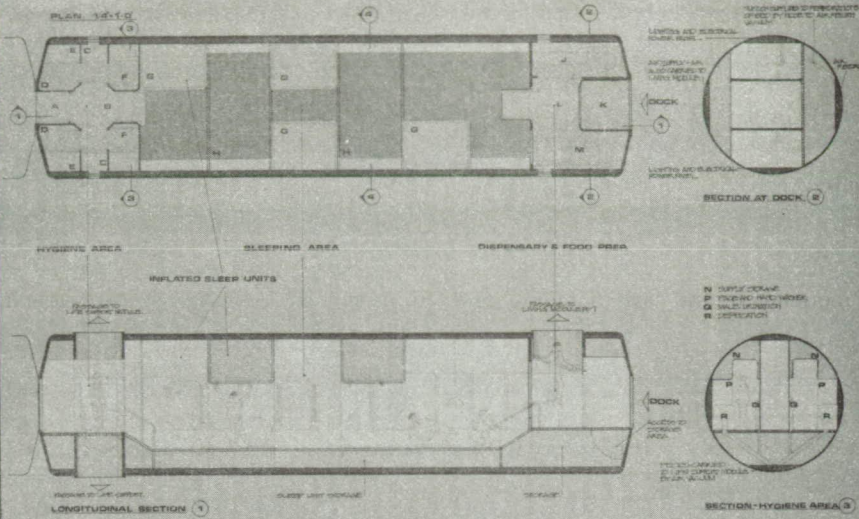
- A. SLEEPING AREA WITH SHOWER AND TOILET.
- B. SLEEPING AREA WITH SHOWER AND TOILET.
- C. SLEEPING AREA WITH SHOWER AND TOILET.
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- F. SLEEPING AREA WITH SHOWER AND TOILET.

DIETETARY & AUXILIARY FOOD PREPARATION AREA

PRIMARY FUNCTION: THE DIETETARY & AUXILIARY FOOD PREPARATION AREA IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE. THE DIETETARY & AUXILIARY FOOD PREPARATION AREA IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE.

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- F. DIETETARY & AUXILIARY FOOD PREPARATION AREA.

NOTE: SLEEPING AREA IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE.



SLEEP AREA CONCEPTS

INFLATABLE SLEEP-DRRESS UNIT

THE SLEEP-DRRESS UNIT IS A UNIT THAT IS USED FOR SLEEPING AND DRESSING. IT IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE. THE SLEEP-DRRESS UNIT IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE.

- A. SLEEP-DRRESS UNIT.
- B. SLEEP-DRRESS UNIT.
- C. SLEEP-DRRESS UNIT.
- D. SLEEP-DRRESS UNIT.
- E. SLEEP-DRRESS UNIT.
- F. SLEEP-DRRESS UNIT.

DICTIONARY SLEEPING SURFACE

THE DICTIONARY SLEEPING SURFACE IS A UNIT THAT IS USED FOR SLEEPING. IT IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE. THE DICTIONARY SLEEPING SURFACE IS THE MOST IMPORTANT PART OF THE SLEEPING MODULE.

OTHER INFLATABLES

THE OTHER INFLATABLES ARE THE MOST IMPORTANT PART OF THE SLEEPING MODULE. THE OTHER INFLATABLES ARE THE MOST IMPORTANT PART OF THE SLEEPING MODULE.

PHOTOGRAPHS

THE PHOTOGRAPHS SHOW THE SLEEPING MODULE IN USE. THE PHOTOGRAPHS SHOW THE SLEEPING MODULE IN USE. THE PHOTOGRAPHS SHOW THE SLEEPING MODULE IN USE.

RELIABILITY OF SPATIAL DESIGN

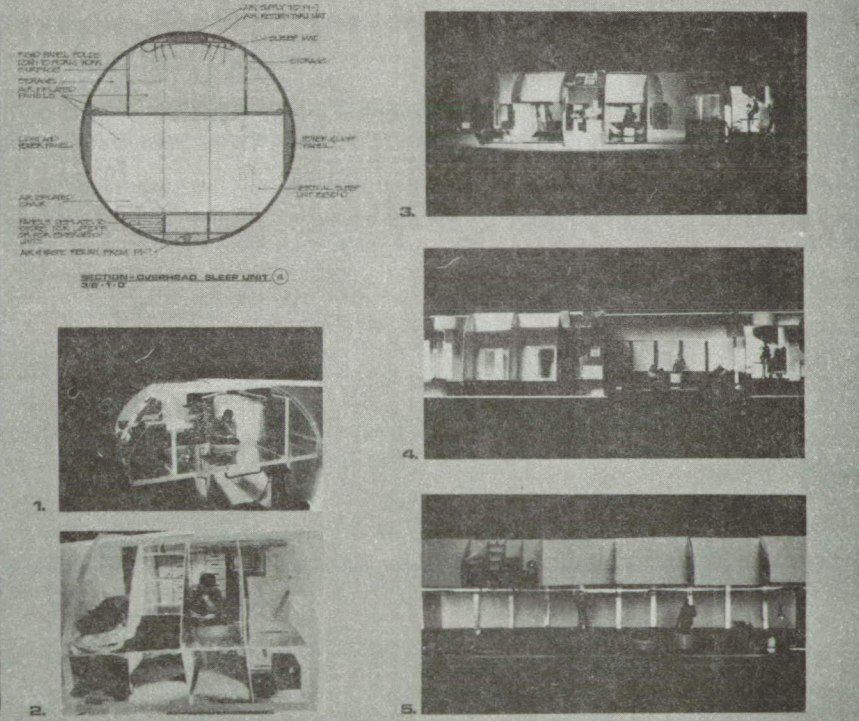
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2. INFLATABLE SLEEP UNITS FOR FLEXIBILITY, CONVENIENCE, SAFETY.

Figure 15.— Panel b of SECOND PLACE AWARD ENTRY (13b).

LIVING MODULE P1-7

GALLEY:

Primary function -- food preparation, clean-up.

A to B: Food tray taken from storage at "A," necessary cooking and preparation is accomplished, served at "B."

C to D: Food trays returned to counter at "C," clean-up is accomplished and trays are returned to storage at "D."

DINING:

Primary function -- dining for shifts of 6, or up to 12. Tables fold against wall to give additional meeting, conference or lounge space.

1. Prepare tray or place order.
2. Pick up prepared food.
3. Dine.
4. Return tray for clean-up.
5. Exit.

LOUNGE:

Primary function -- informal relaxation and entertainment. Inflated barrier between lounge and theater deflates to store under floor as does furniture (see photo). Resulting space may serve as large lounge or for lecture/conference space. In an emergency, lounge will house 6 sleep/dress units. Monitoring console is overhead.

THEATER/CHAPEL:

A multi-function space serving as a viewing theater/chapel or conference room. Tilting chairs allow use in two orientations; as a theater, chairs tilt to horizontal position and module wall acts as cinema type screen. Sound communication is via headset. Inflated barrier can be positioned to increase room size if desired.

EXERCISE ROOM:

Primary function -- use of exercise equipment. Ergometers and other equipment store in "floor" and "ceiling" cavities. Barrier between this and theater space can be deflated to provide a large exercise or large meeting space.

LIVING AREA CONCEPTS

ZERO GRAVITY GALLEY:

Zero gravity can be of service to areas like the galley to permit activities at two levels (see section). Upper level is primarily storage areas and freezers, lower level is work area. Further storage is provided in carrels over the dining area. Safety rail all around the galley facilitates maneuvering.

CLINGING CARPETING:

Certain synthetic materials such as "velcro" have the ability of adhesion to itself with substantial force. It can be pulled apart and readhered repeatedly and is used commercially as zippers, shoe straps, etc. Its soft, pliable quality makes it a potential carpeting material in areas where surface stability is required, in this module as well as throughout the station.

"Velcro" adheres with varying degrees of force depending on pressure applied. Thus it may be used for semi-permanent stabilizing, such as furniture, or transient stabilizing on paths of movement, securing tools or utensils on work surfaces.

INFLATED BARRIERS:

Barriers separating areas are inflated and may be deflated and stored under the flooring or positioned as desired. Therefore, the lounge, theater and dining area may become one large space or segmented as desired.

PHOTOGRAPHS

1. Overall view of living module. Storage carrels are over dining area, monitor and entertainment consoles in lounge "ceiling."
2. Dining area: Chair bases adhere to carpeting, tables are for storage.
3. Lounge-chapel: Space with inflatable barrier removed as might be set up for a chapel service or general meeting.
4. Cinema: Chairs tilt back and module surface becomes a cinema-type screen.
5. End view: Shows a typical passage which will close to become an air lock suit station. Passage design minimizes amount of space needed for circulation between modules.

Photographs 1 to 4 relate to longitudinal section; 5 relates to end section.

LIVING MODULE: P1-7

GALLERY

PRIMARY FUNCTION: SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION.

LOUNGE

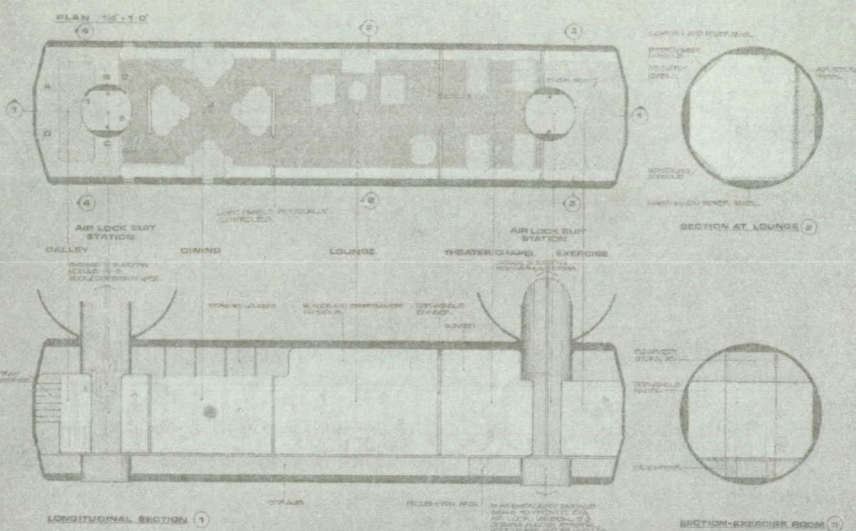
PRIMARY FUNCTION: SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION.

THEATER CHAMBER

PRIMARY FUNCTION: SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION.

EXERCISE ROOM

PRIMARY FUNCTION: SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION.



LIVING AREA CONCEPTS

ZERO GRAVITY BALLOON

PRIMARY FUNCTION: SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION.

CLIMBING CARPETING

PRIMARY FUNCTION: SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION.

PRIMARY FUNCTION: SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION. SPACE FOR COMMUNITY MEETING, RECREATION, AND INFORMATION.

INFLATED BARRIERS

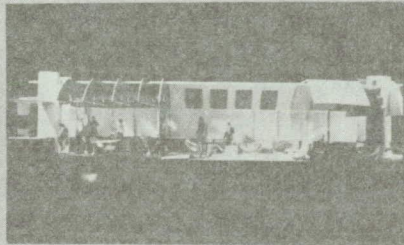
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PHOTODARKNESS

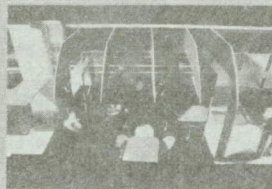
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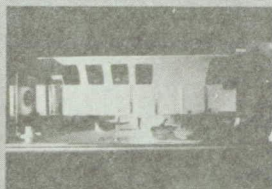
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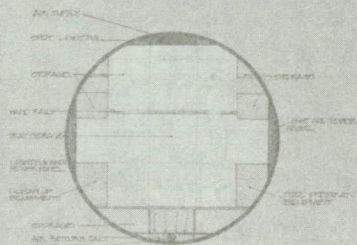
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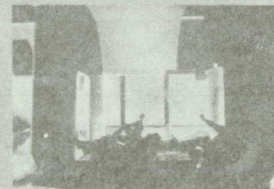
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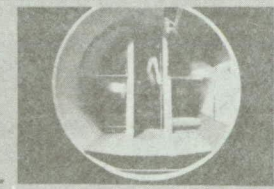
3.



SECTION AT GALLERY 4 PLAN 100'-0"



4.



5.

LIVING DESIGNED FOR COMFORT, CONVERTIBILITY, COMMUNITY. 3.

Figure 16.— Panel c of SECOND PLACE AWARD ENTRY (13c).

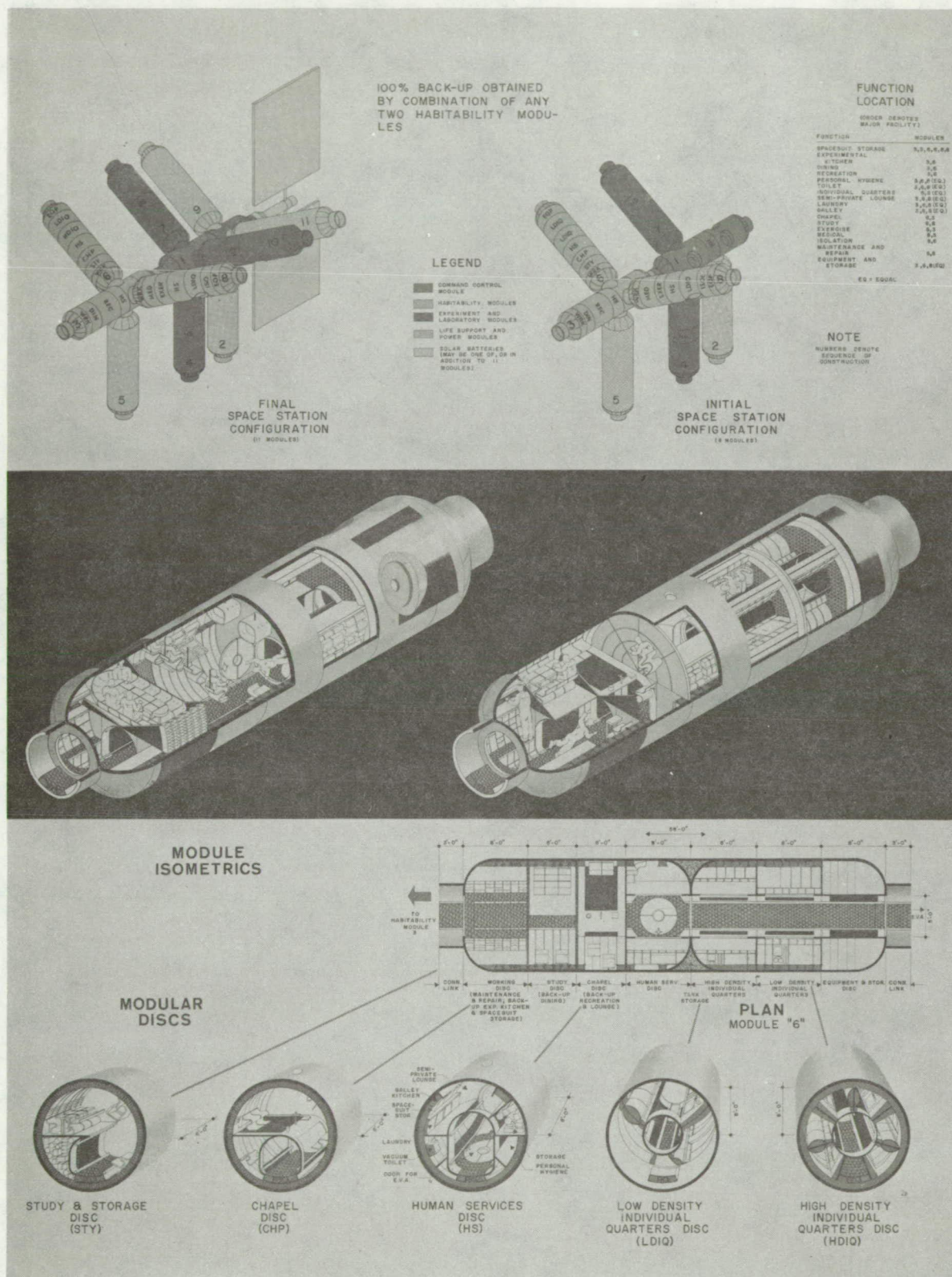


Figure 18.— Panel b of THIRD PLACE AWARD ENTRY (2b).

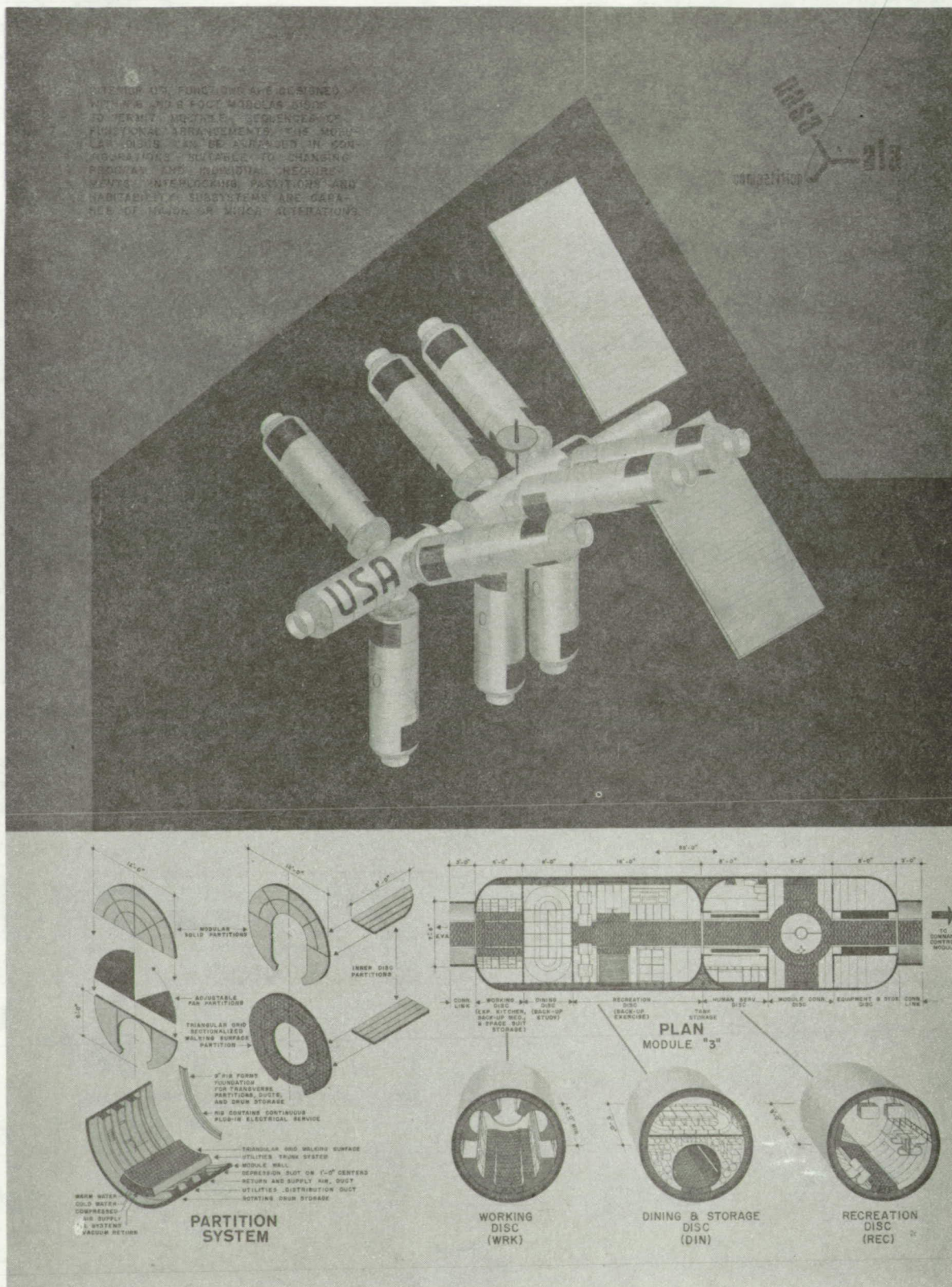


Figure 19.— Panel c of THIRD PLACE AWARD ENTRY (2c).

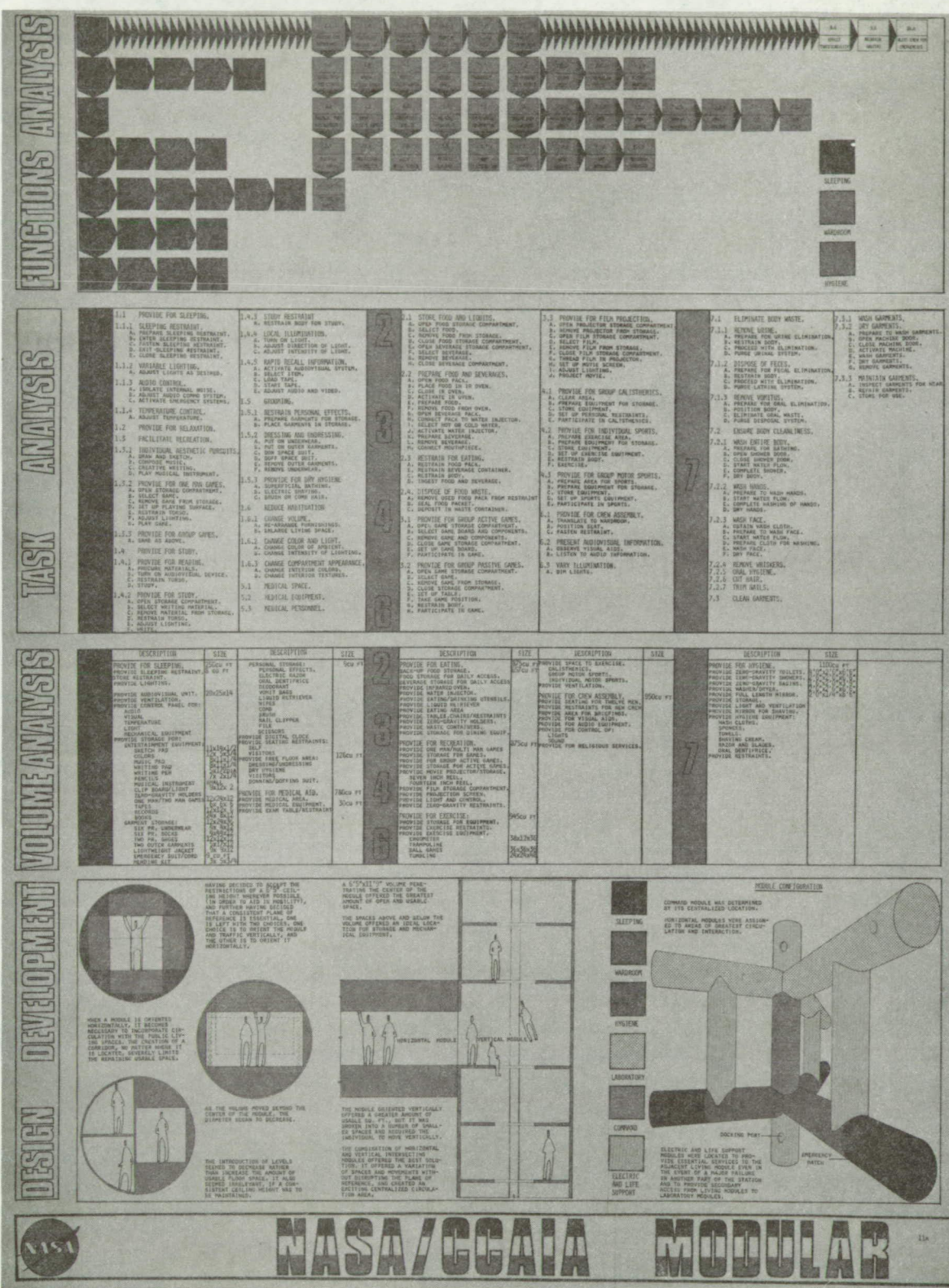


Figure 20.— Panel a of FIRST HONORABLE MENTION ENTRY (11a).

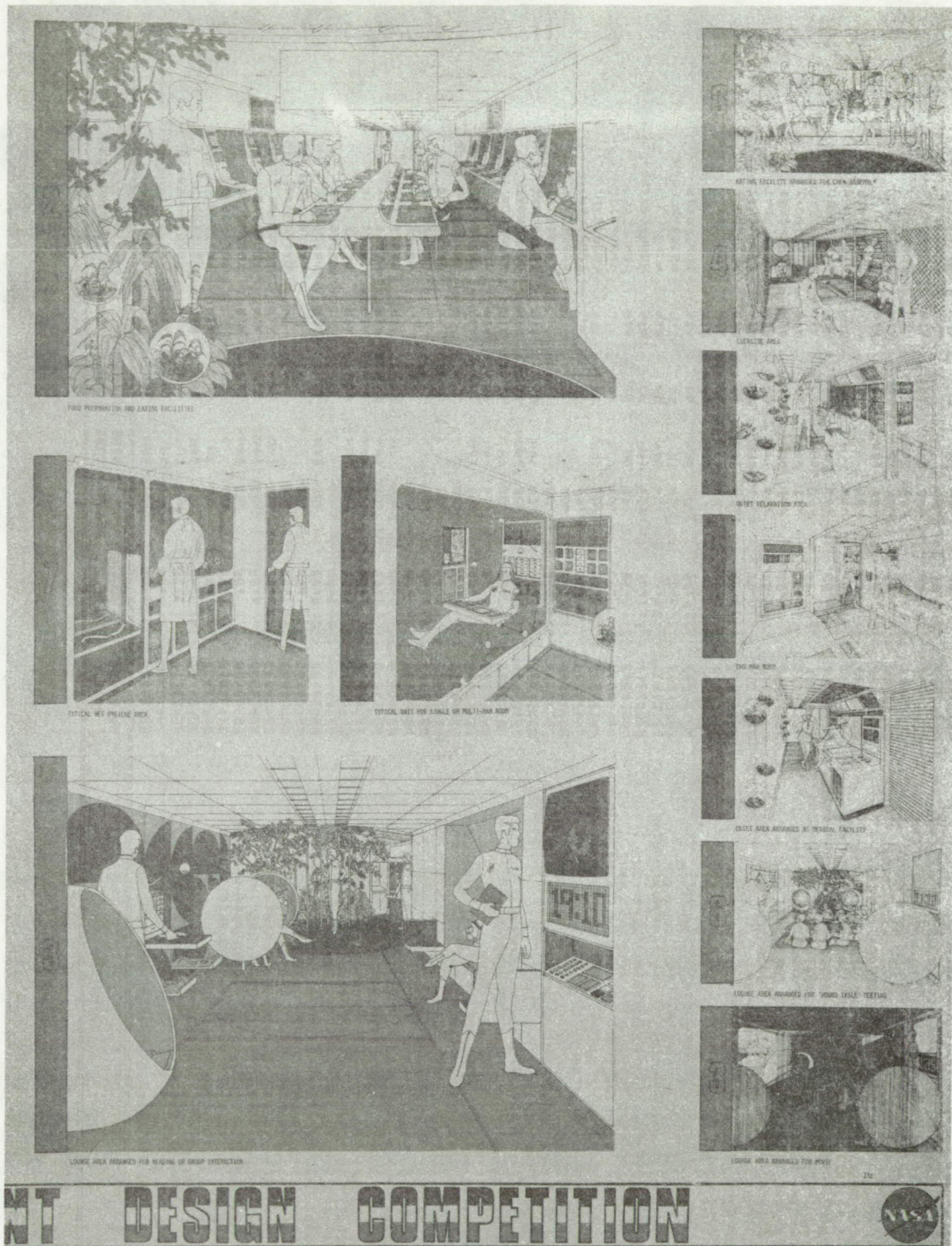


Figure 22.— Panel c of FIRST HONORABLE MENTION ENTRY (11c).

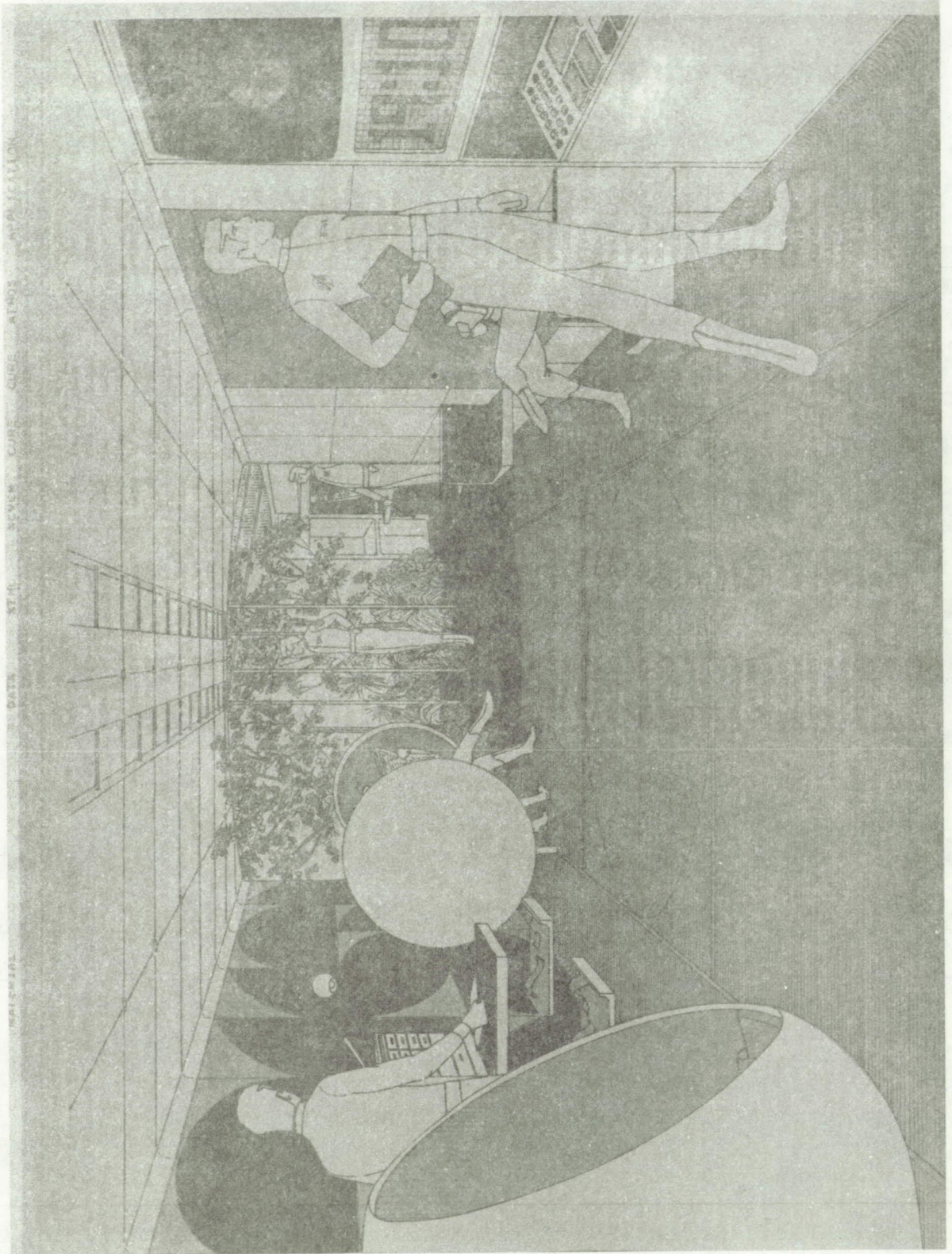
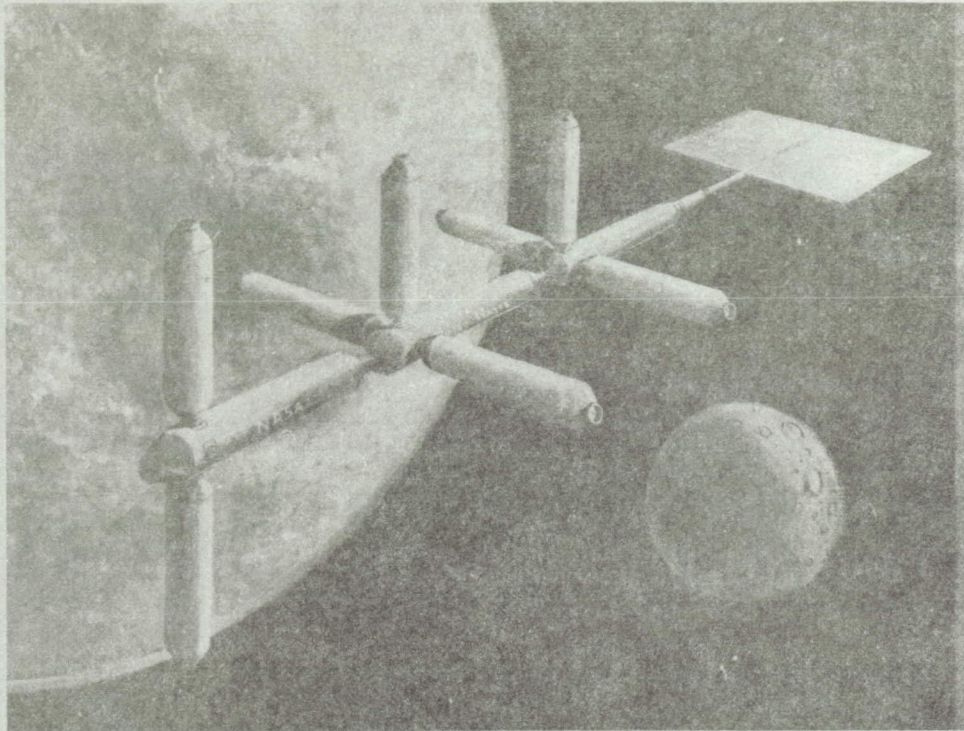
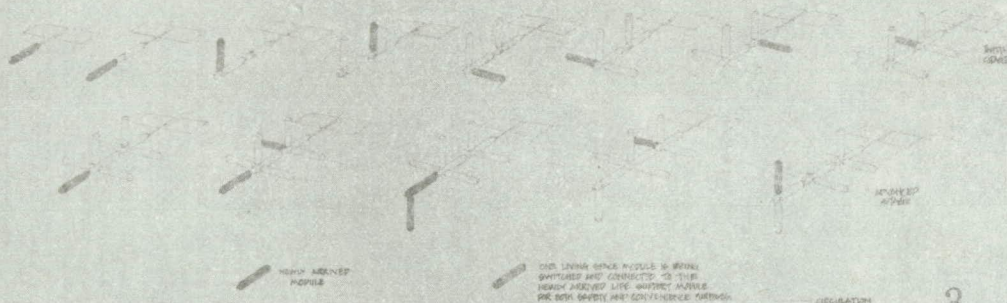


Figure 23.— Detail of module hub area of FIRST HONORABLE MENTION ENTRY (11c).

NASA/AIA SPACE STATION DESIGN



CONFIGURATION & GROWTH DEVELOPMENT



THE STRUCTURAL CONFIGURATION ASPECTS OF THE DESIGN IS BASED ON THE FOLLOWING REQUIREMENTS: CONSIDERATIONS, AND CRITERIA:

1. GROWTH CAPABILITIES
2. HABITABILITY PROVISIONS WHICH WILL BE ADEQUATE TO HOUSE CREWS OF MIXED SEX AND NATIONALITIES
3. SAFETY IN TERM OF: MODULAR ORGANIZATION AND/OR ARRANGEMENT, PERSONNELS' MOVEMENT AND HEALTH, SUBSYSTEMS TO MAINTAIN NORMAL STATION FUNCTIONS, AND ACTIVITIES DURING EMERGENCIES
4. EFFICIENT SPACES AND FACILITIES PROVIDE MAXIMUM PHYSICAL AND PSYCHOLOGICAL COMFORT FOR THE CREW
5. HABITABILITY PROVISIONS WHICH WILL ENSURE CREW MEMBERS TO INTERRELATE, COMMUNICATE AND PARTICIPATE IN OTHER SORTS OF SOCIAL ACTIVITIES, BUT AT THE SAME TIME PROVIDE

ADEQUATE PRIVATE PERSONAL SPACE & EQUIPMENT WITH FLEXIBILITY OF USE

THE SPACE STATION DESIGN IN THIS CASE IS BASICALLY DIVIDED INTO THREE SECTIONS, EACH SECTION CONSISTS OF MODULES WITH DIFFERENT FUNCTIONS AND IS CAPABLE OF MAINTAINING NORMAL ACTIVITIES IN CASE OF ANY DAMAGE OR IN CASE OF ISOLATION FROM OTHER SECTIONS MUST BE AFFECTED.

THE MODULAR STATION IS ARRANGED IN SUCH A WAY THAT THERE WILL BE ONE DOCKING PORT IN SECTION TWO AND THREE, AND THREE DOCKING PORTS IN SECTION ONE. WITH THIS END-TO-END CONNECTION SYSTEM, MODULES ARE INTERCHANGEABLE WITH A MINIMUM OF PROBLEMS IN ASSEMBLY.

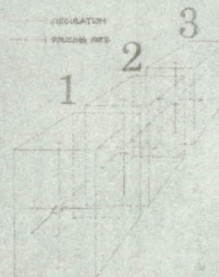


Figure 24.— Panel a of SECOND HONORABLE MENTION ENTRY (9a).

PLANS

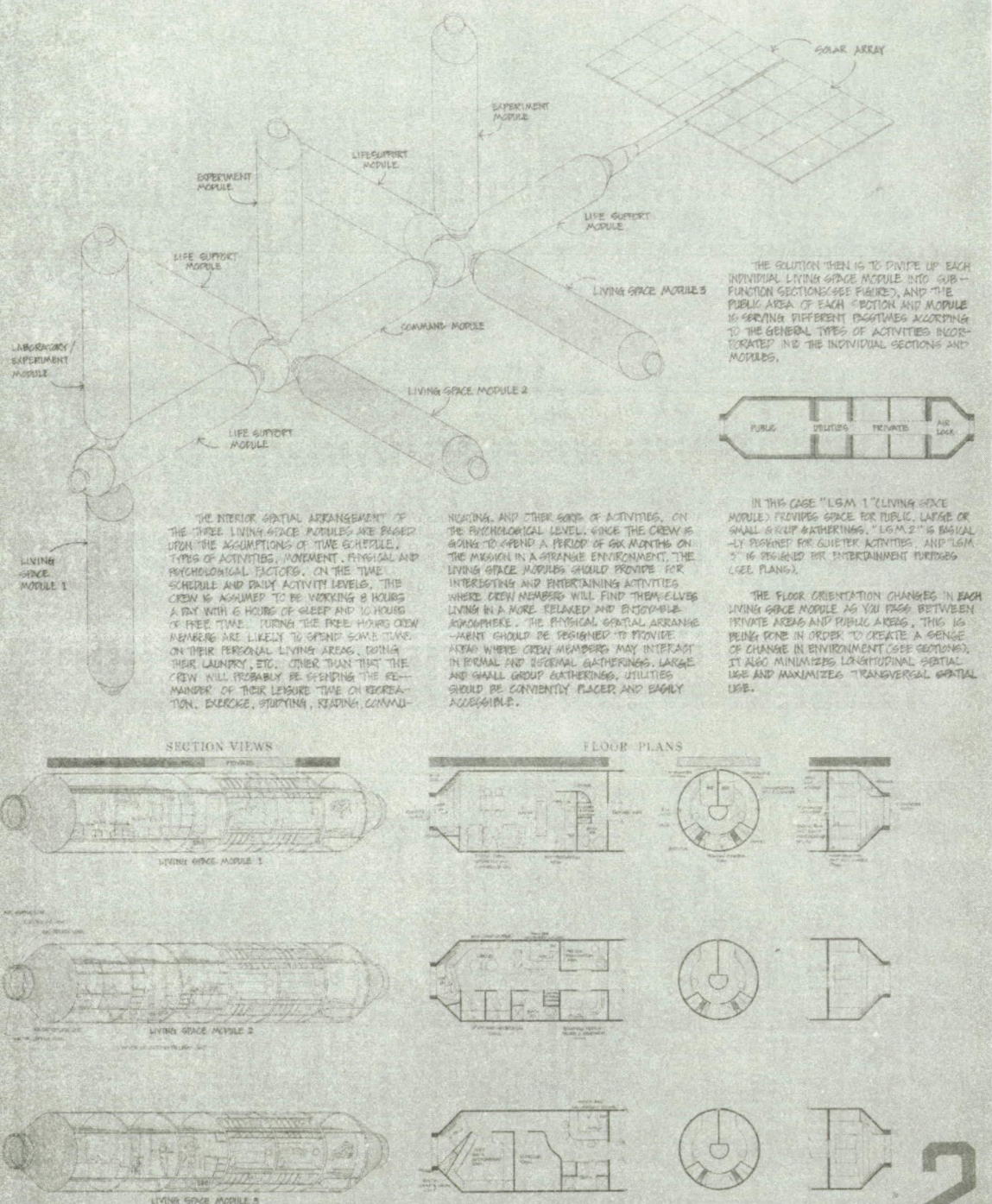


Figure 25.— Panel b of SECOND HONORABLE MENTION ENTRY (9b).

VERBAL ANALYSIS

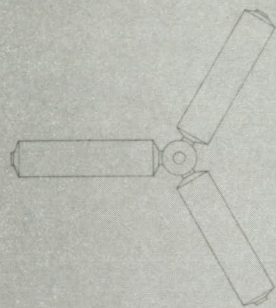
The Space Station exhibits radial geometry with six units radiating off the core module and three units radiating off the command module in the advanced configuration. Three docking ports are provided. One at the end of the laboratory and one at the indicated laboratory/experiment module. Three air lock chambers are provided. One each on the two indicated life support modules and one on the indicated laboratory module.

The Space Station interior has been designed with vertical decks with furnishings located on the floor facing the core module. This arrangement allows the Station to be rotated for artificial gravity, creating a multi-deck effect. Rail ladders and hand grips have been provided in the corridors for climbing under gravity and ease of maneuverability during zero gravity.

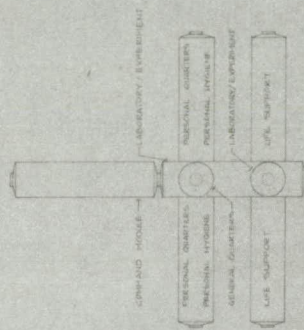
As required, three modules were designed and detailed per concept. One module has been designated as general quarters and the remaining are designated as personal quarters/personal hygiene. The general quarters module features a leisure compartment, dining facilities, galley, medical dispensary, laundry and personal maintenance and recreation/exercise decks. The leisure compartment features affixed lounges and chairs with stereo equipment (audio entertainment).

The dining facility area employs a curving table contouring to the walls with chairs on tracks to allow sliding in and out of eating position during zero gravity. Between the dining deck and galley is a food service elevator which conveys prepared food and dishes from the galley to the dining area. The galley features large storage areas with facilities for heating and refrigerating foodstuffs. The dispensary incorporates a lounge, shelves and preparation counter. The laundry area has storage space and cleaning units. The recreation/exercise deck is left open except for the partial reinforcing of the wall for the attachment of exercise equipment.

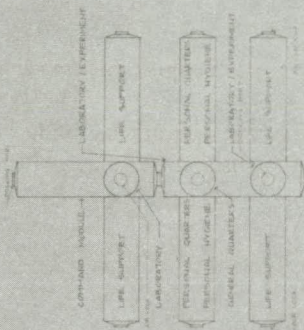
The personal quarters/personal hygiene modules contain six living quarters and one bathroom each. Low ceilings are used in the personal quarters for ease of maneuvering in zero gravity. A large bunk is provided along with an accordin-type net to restrain the body during zero gravity sleeping periods. A desk is provided for study or reading entertainment. A spacious 43.5 cubic foot closet is provided for personal storage. A lounge chair is furnished for personal use or for accommodation of guests. Shelves are also provided for placement of personal effects and storage. The personal hygiene deck facilitates linen shelves, lavatory basin, shower stall with an adjacent dressing alcove and two toilet compartments.



RADIAL GEOMETRY



INITIAL SPACE STATION



ADVANCED SPACE STATION

NASA / AIA

SPACE STATION

INTERIOR STUDENT

DESIGN COMPETITION

CONFIGURATION 1
VERBAL ANALYSIS

1 OF 3

Figure 27.— Panel a of Entry 1 (1a).

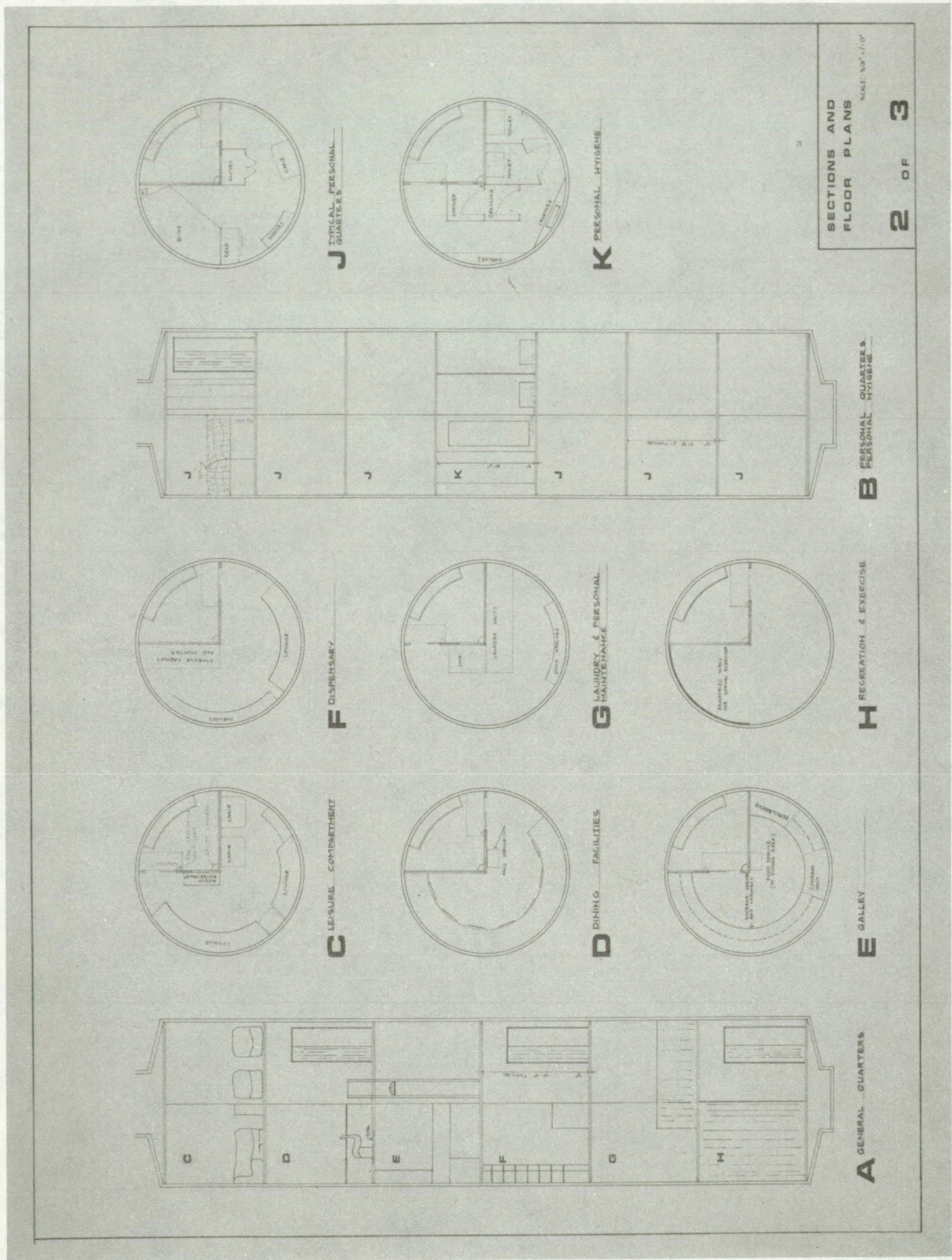
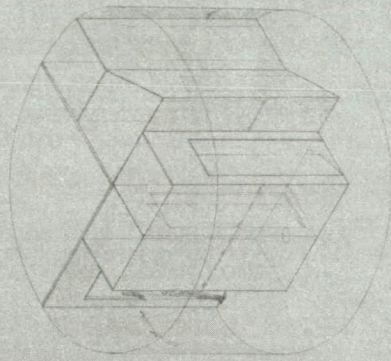
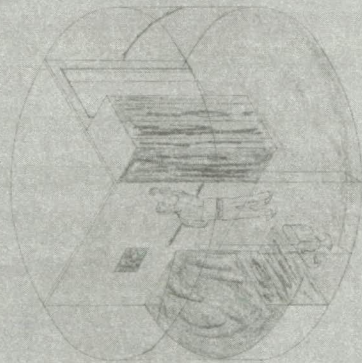


Figure 28.— Panel b of Entry 1 (1b).



PERSONAL HYGIENE DECK



TYPICAL LIVING QUARTERS

RENDERINGS

3 OF 3

Figure 29.— Panel c of Entry 1 (1c).

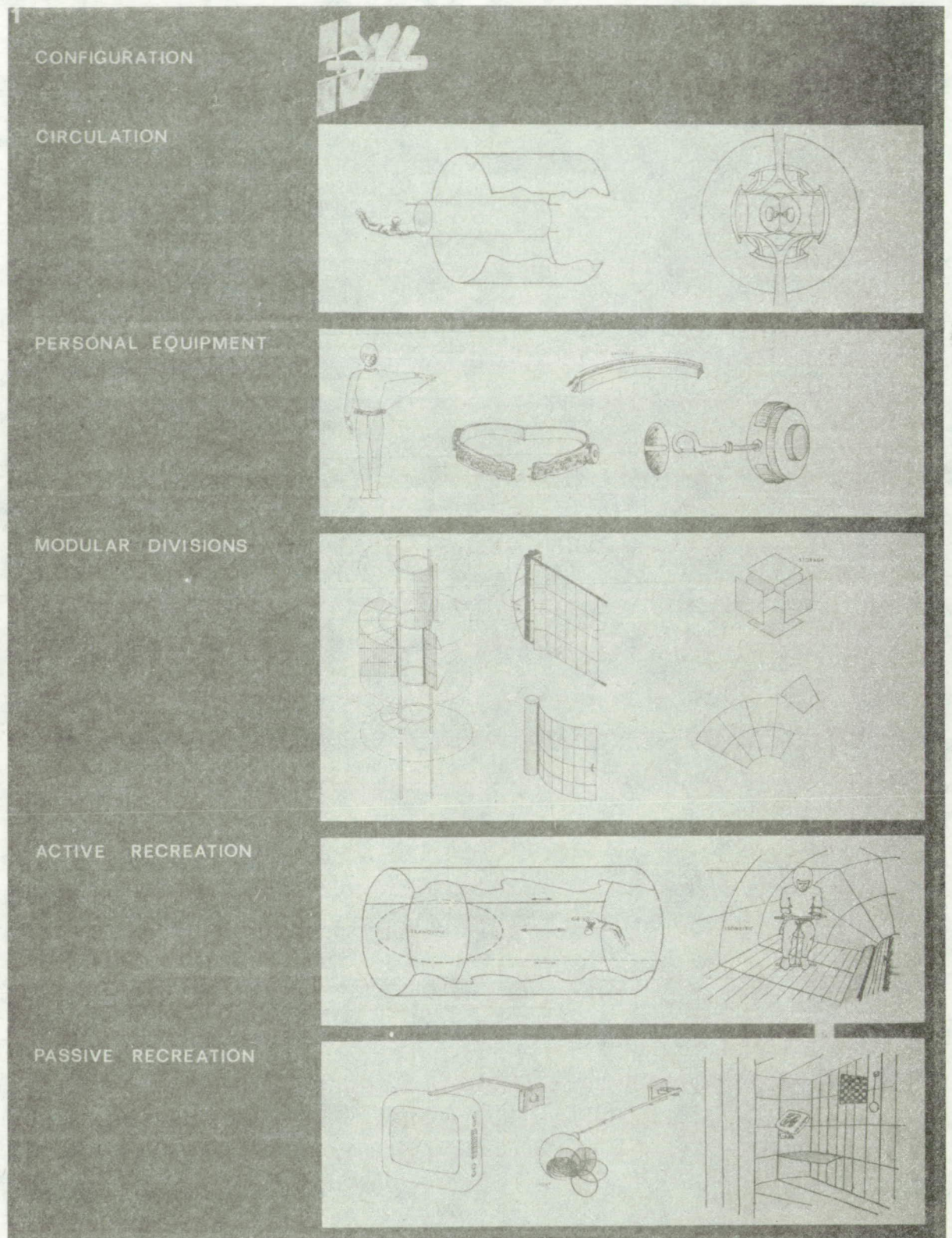


Figure 30.— Panel a of Entry 3 (3a).

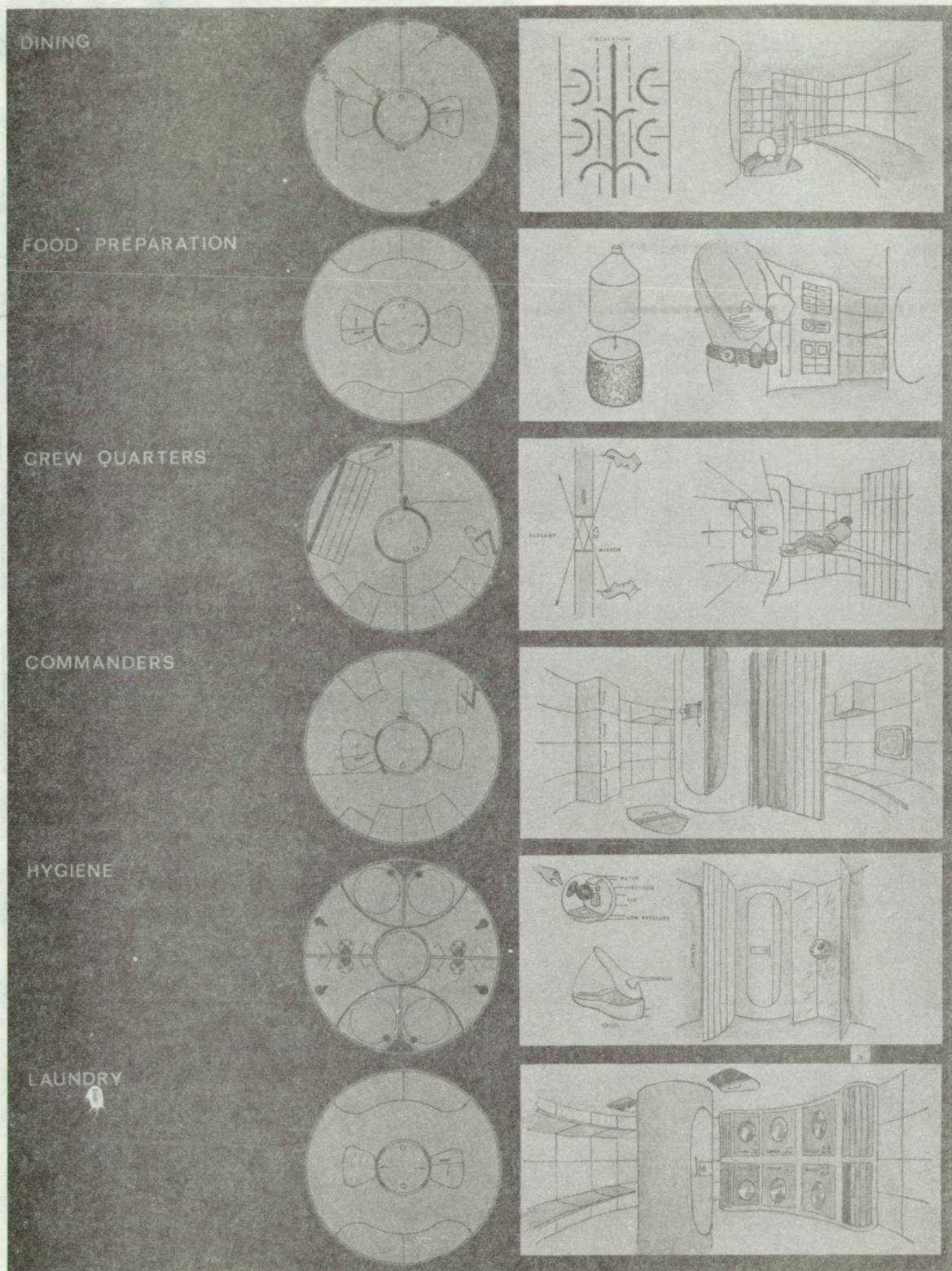


Figure 31.— Panel b of Entry 3 (3b).

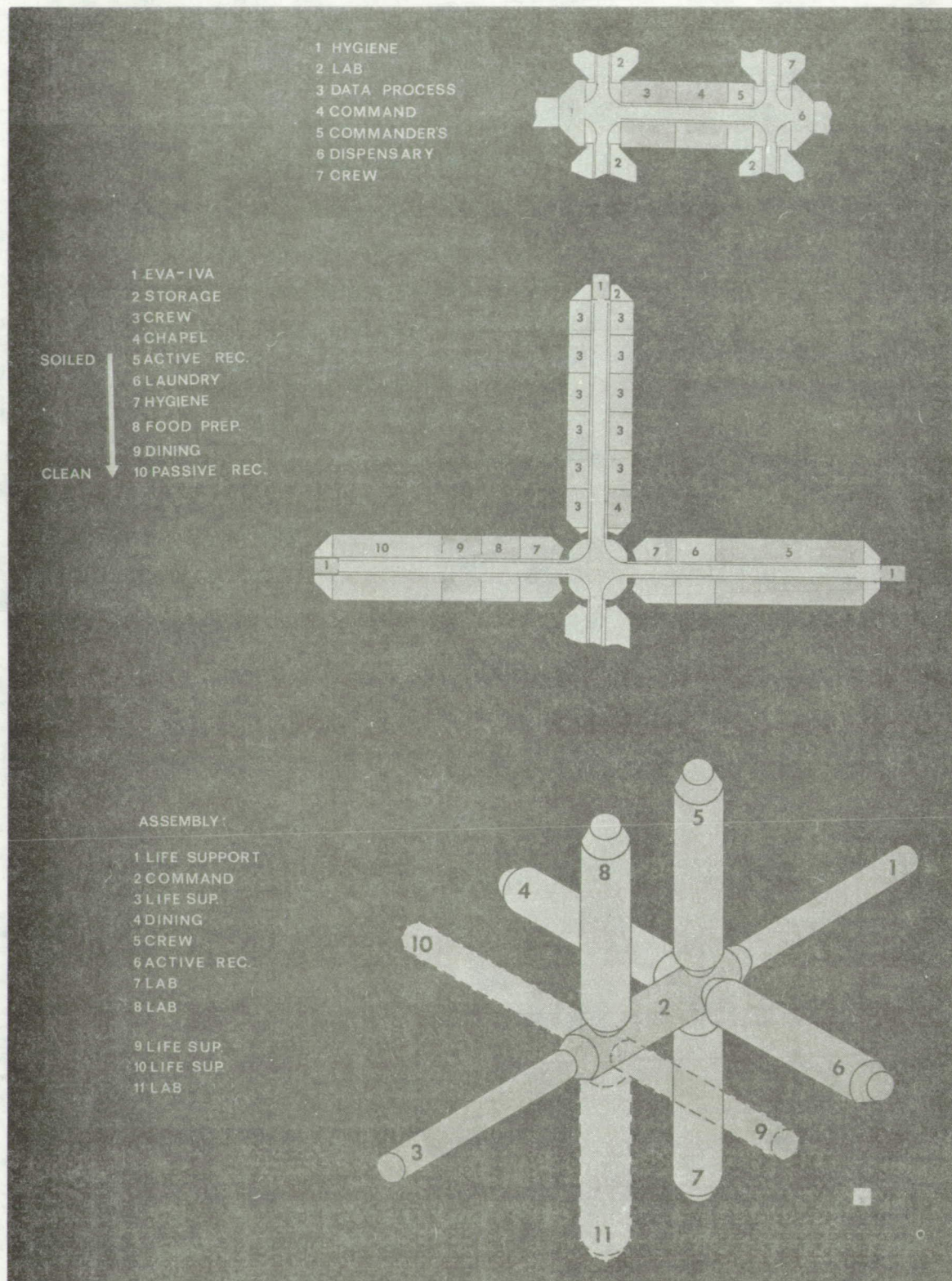


Figure 32.— Panel c of Entry 3 (3c).

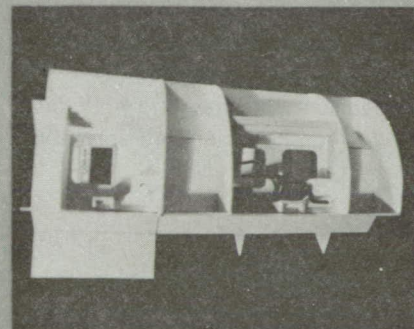
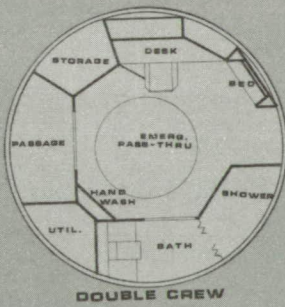
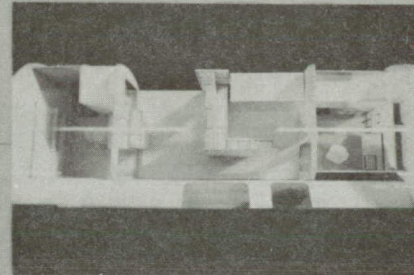
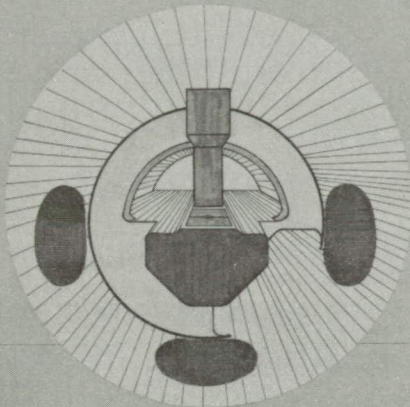
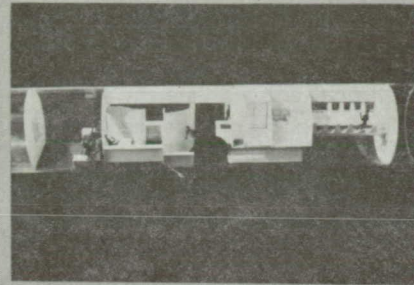
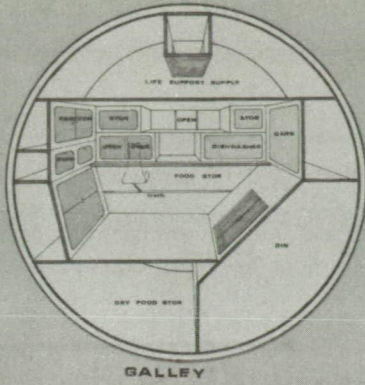


Figure 33.— Panel a of Entry 4 (4a).

GENERAL DESIGN CONSIDERATIONS:

- 1/ Promote feeling of equality of possessions.
- 2/ Minimize travel distance within station.
- 3/ Minimize travel within tunnel passages.
- 4/ Maintain "up" and "down" orientation within any one area or areas openly connected.
- 5/ Change orientation in different sections of the ship to accent a change in function.
- 6/ Be able to isolate and evacuate any area.
- 7/ Any single life support module can operate the entire station because of interconnecting utility lines.
- 8/ In stage I six people are using the entire habitability sector. This is done to prepare the station for permanent occupancy and maximum efficiency.
- 9/ Zero gravity station

INDIVIDUAL DESIGN CONSIDERATIONS:

CREW QUARTERS

- maximum privacy and individuality
- equal representation
- Minimum and equal distance to public services
- leave and enter in private
- use room for work office as well as relaxation and rest
- separate work and lounge areas within room
- two chair restraints: one for desk work the other for clothes change or visitor
- windows should be provided in double crew quarters (double crew quarters refers to sharing one bathroom)

HYGIENE

- maximum privacy and efficiency of use
- individual personal hygiene supplies, i.e., hand washing, shave, grooming aids, etc.
- a public bath provided for the lounge and dining area as well as one for the gym and dispensary
- single crew quarters and bath provided for commander or leaders also in case of female crew
- single crew and bath are also provided for the physician and possible patients or lab technician

LAUNDRY

- equally accessible from all crew areas and waiting areas, i.e., lounge, gym, library

DISPENSARY

GYM

- the two areas are together because the exercise equipment can also be used to measure physical condition
- equally accessible from the entire station
- EVA is provided directly overhead to facilitate transfer of equipment and patients to shuttle

LOUNGE

- buffer zone between crew and work areas, accessible to both
- relaxing atmosphere therefore isolated from busy traffic

THEATER

- also can be used as chapel
- extension of lounge but separate due to noise levels and contrasting activities

LIBRARY

STUDY

- "call for" tape storage system
- can get print out from tapes and study them in crew room or lounge
- tapes stored below library floor and possibility of EVA over as in dispensary, depending on EVA requirements of NASA

DINING

CONFERENCE

- equal access from entire station but isolated
- enter and leave without disturbing operations
- food ordered from seat and sent to cook in galley
- everyone should eat together since this is the only time they could associate

GALLEY

- one man prepares and delivers food via a pass-thru window on a cart and cleans waste returned after the meal the same way
- food stored in galley for 1 to 7 days and resupplied from adjacent food storage life support module
- emergency life support facilities are stored above galley

SNACK

- separate from galley because of a need to be in specific areas, i.e., work, lounge
- resupplied daily from food supply module

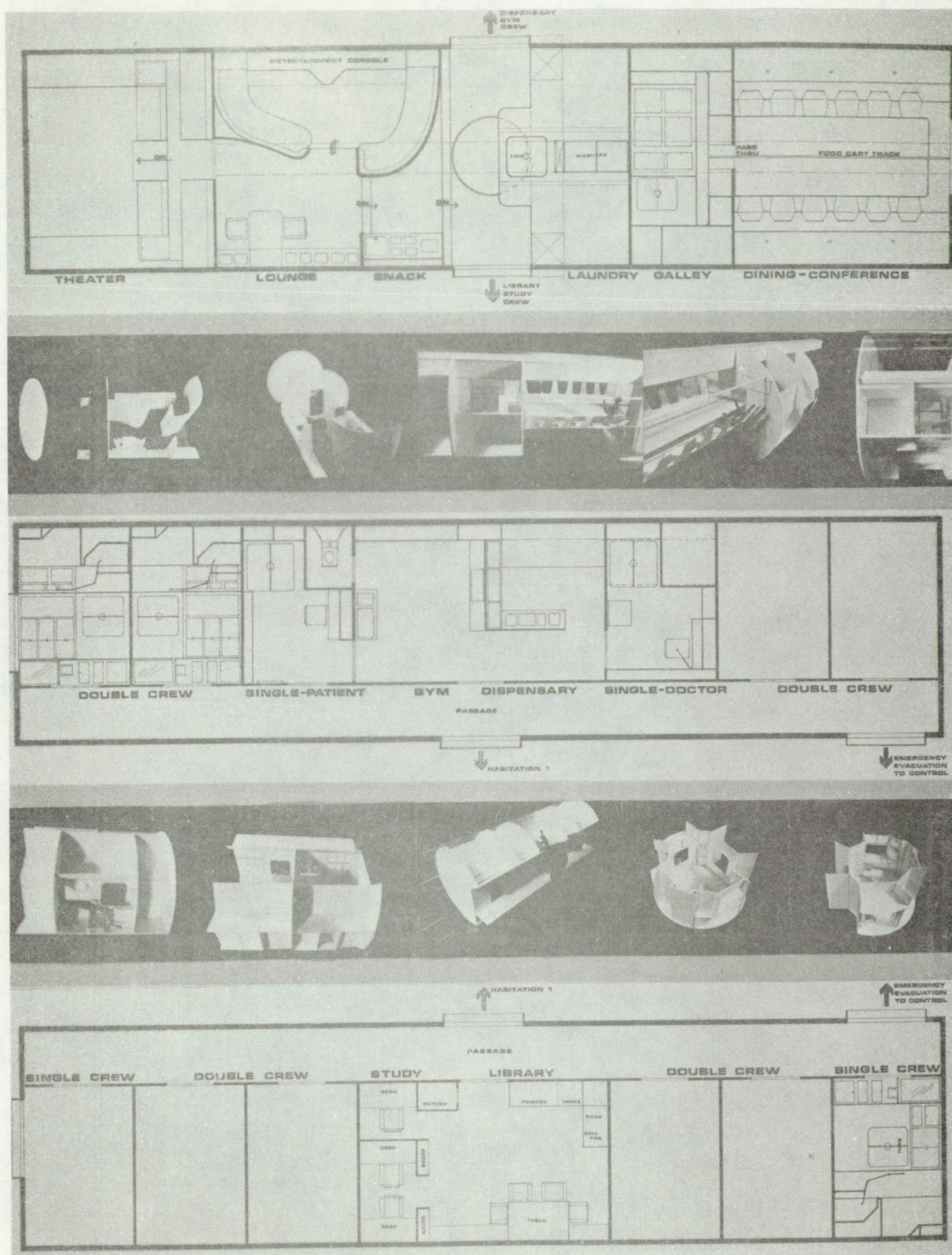


Figure 35.— Panel c of Entry 4 (4c).

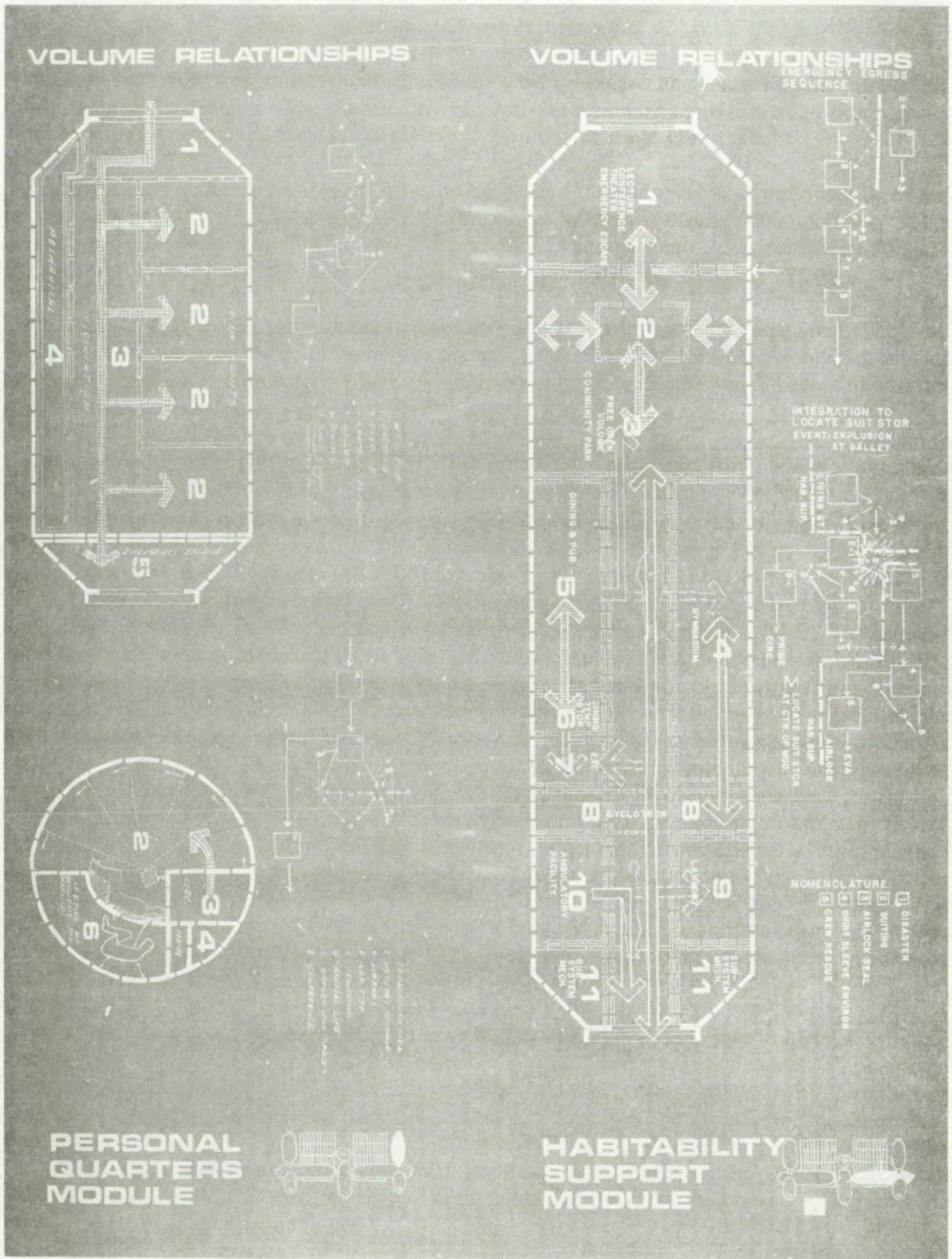


Figure 36.— Panel a of Entry 5 (5a).

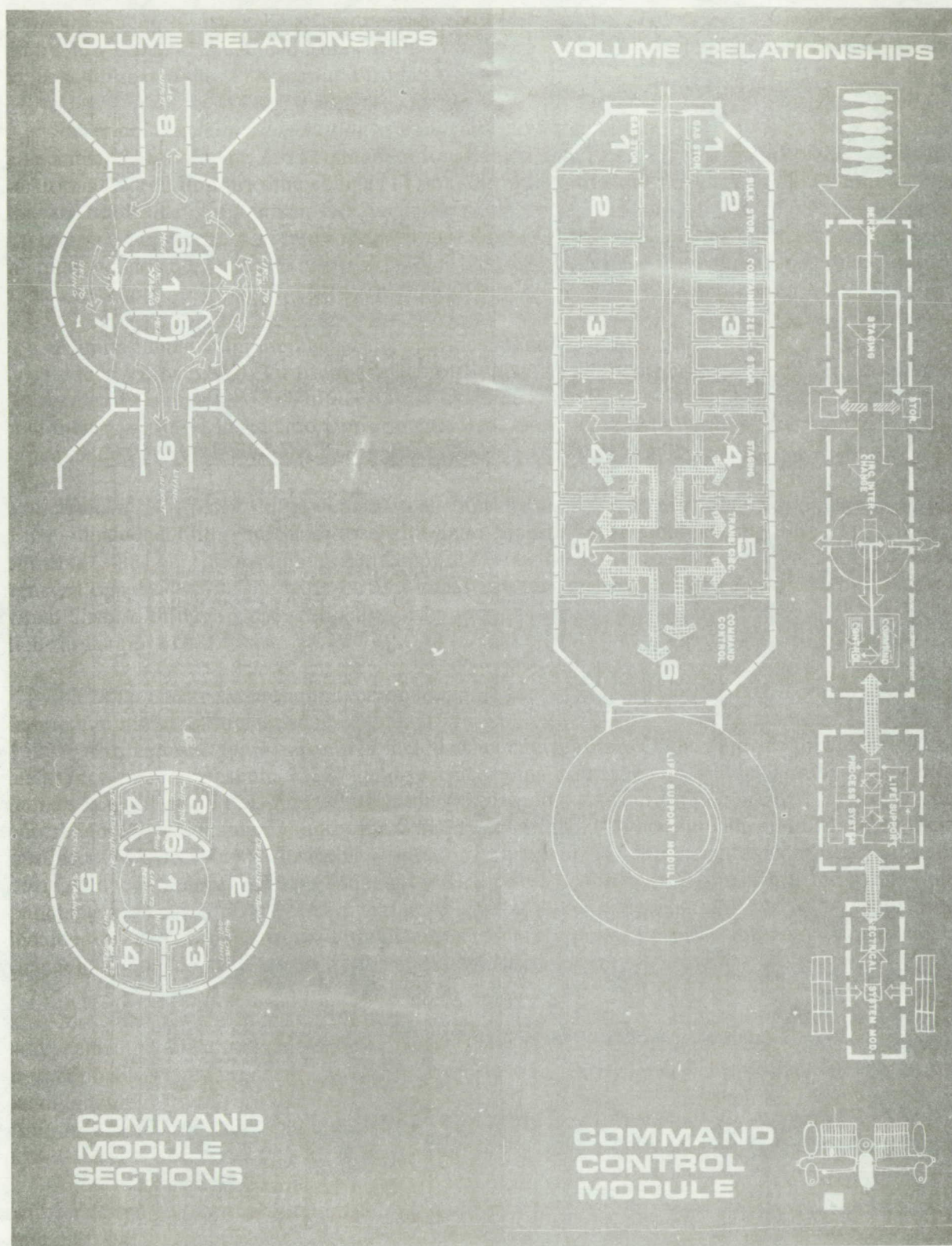


Figure 37.— Panel b of Entry 5 (5b).

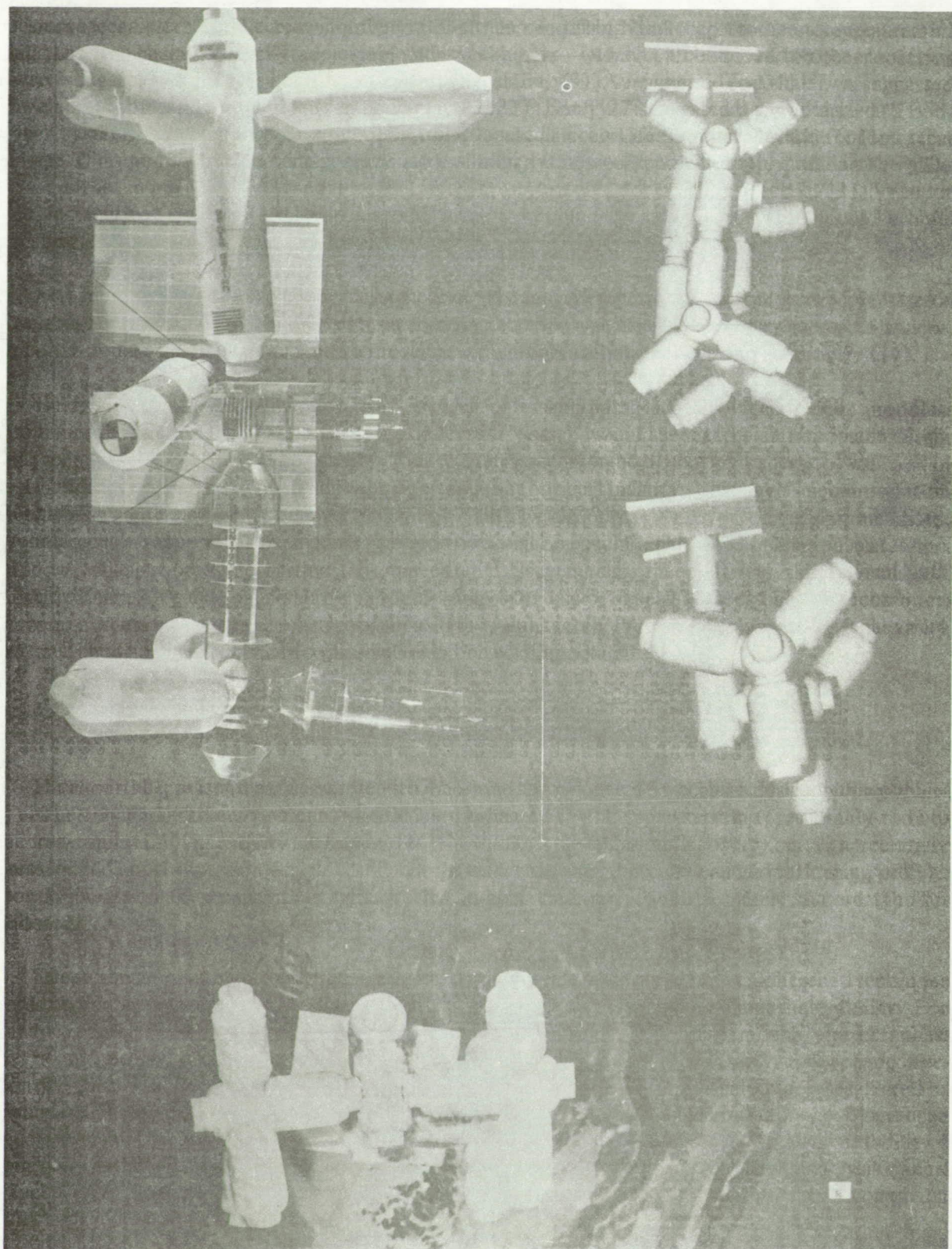
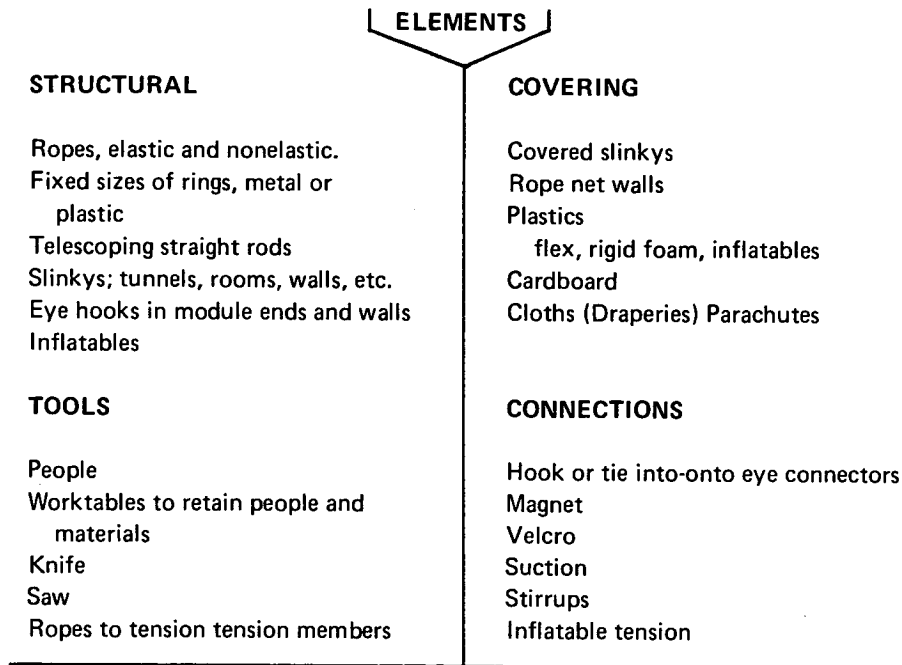


Figure 38.— Panel c of Entry 5 (5c).

FLEX SYSTEM -- AN ADULT TINKER TOY ENVIRONMENT CREATOR

Main concept of flex system is changeability through involvement; alternatives, choice. Flex volume system plus choice of travel paths (safety). Total choice system.



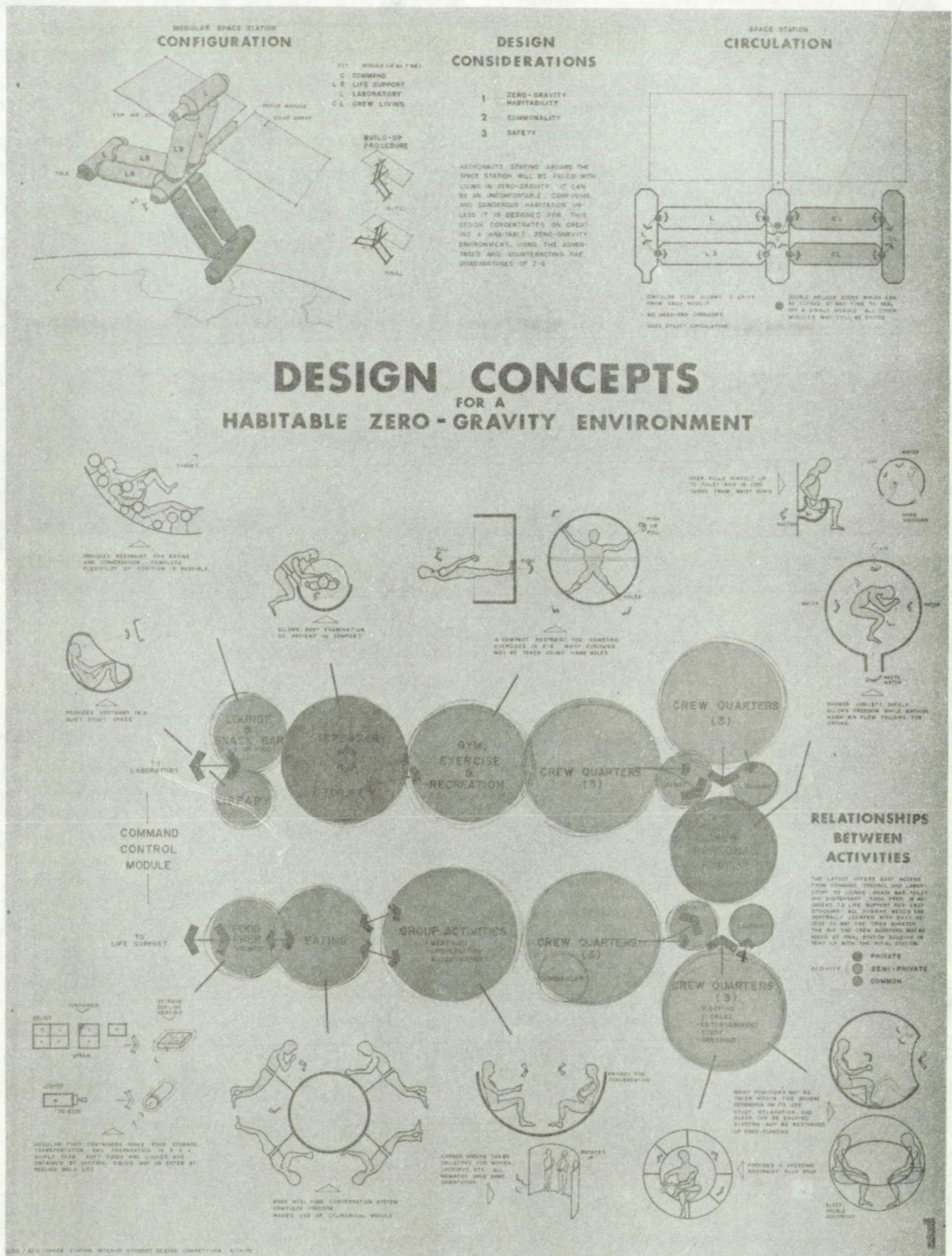
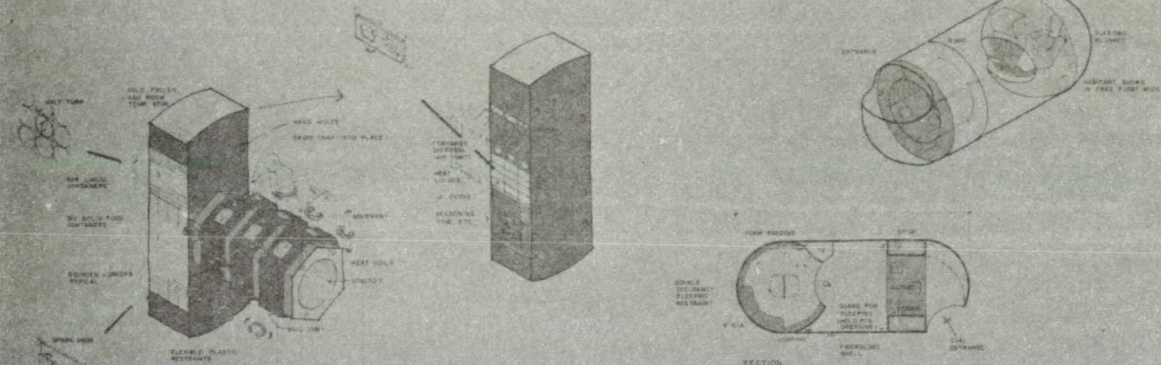


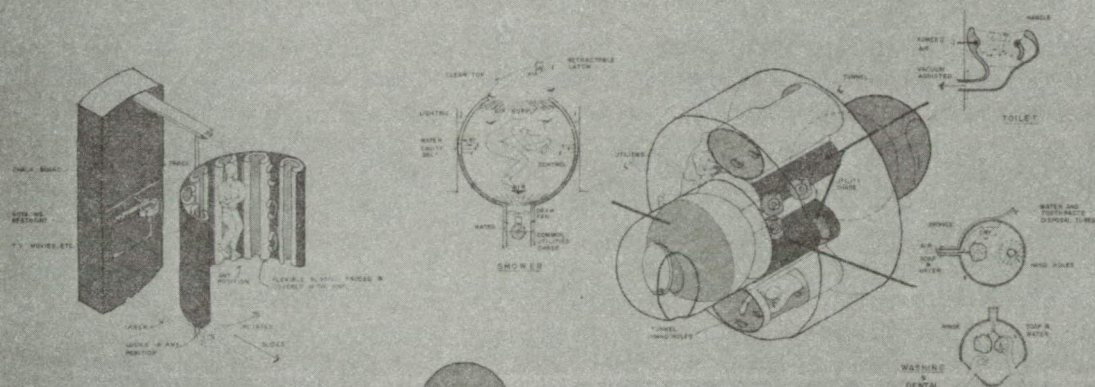
Figure 42.— Panel a of Entry 7 (7a).

CONCEPT DEVELOPMENT



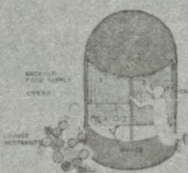
Individual Quarters

Food Prep. and Eating

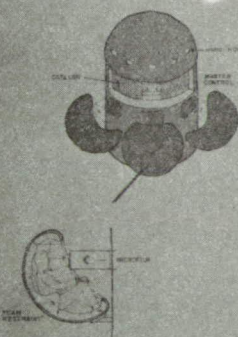


Group Activities

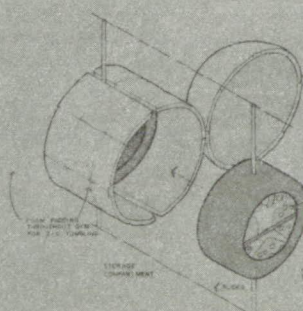
Personal Hygiene



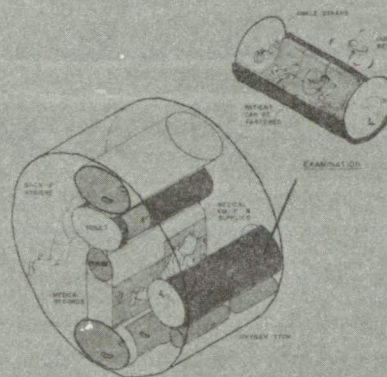
Lounge • Snack Bar



Library



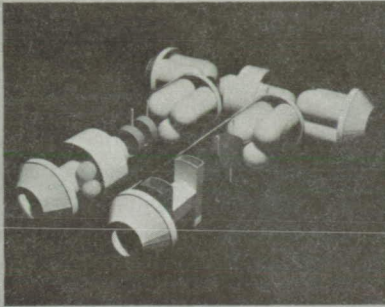
Gym • Exercise



Dispensary

Figure 43.— Panel b of Entry 7 (7b).

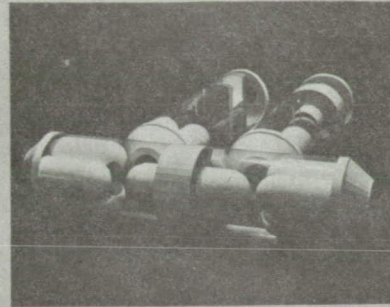
THE TOTAL ENVIRONMENT



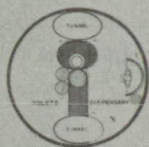
COMMONALITY

MANY COMMON ITEMS ARE INCORPORATED WITHIN THE TOTAL DESIGN WHICH REDUCES MANUFACTURING COSTS AND ADDS TO THE INTERIOR AESTHETIC QUALITY. INTERCHANGEABLE PARTS ARE ALSO HELPFUL WITH THE LIMITED STORAGE SPACE ON THE STATION.

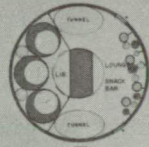
MODULES — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8
CREW QUARTERS — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8
COMMON EQUIPMENT — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8
HYGIENE FIXTURES — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8
FOOD CONTAINERS — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8



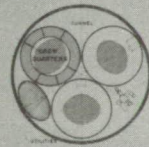
SECTIONS



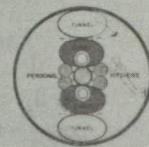
4



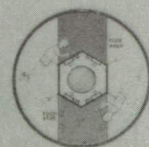
5



6



7



8

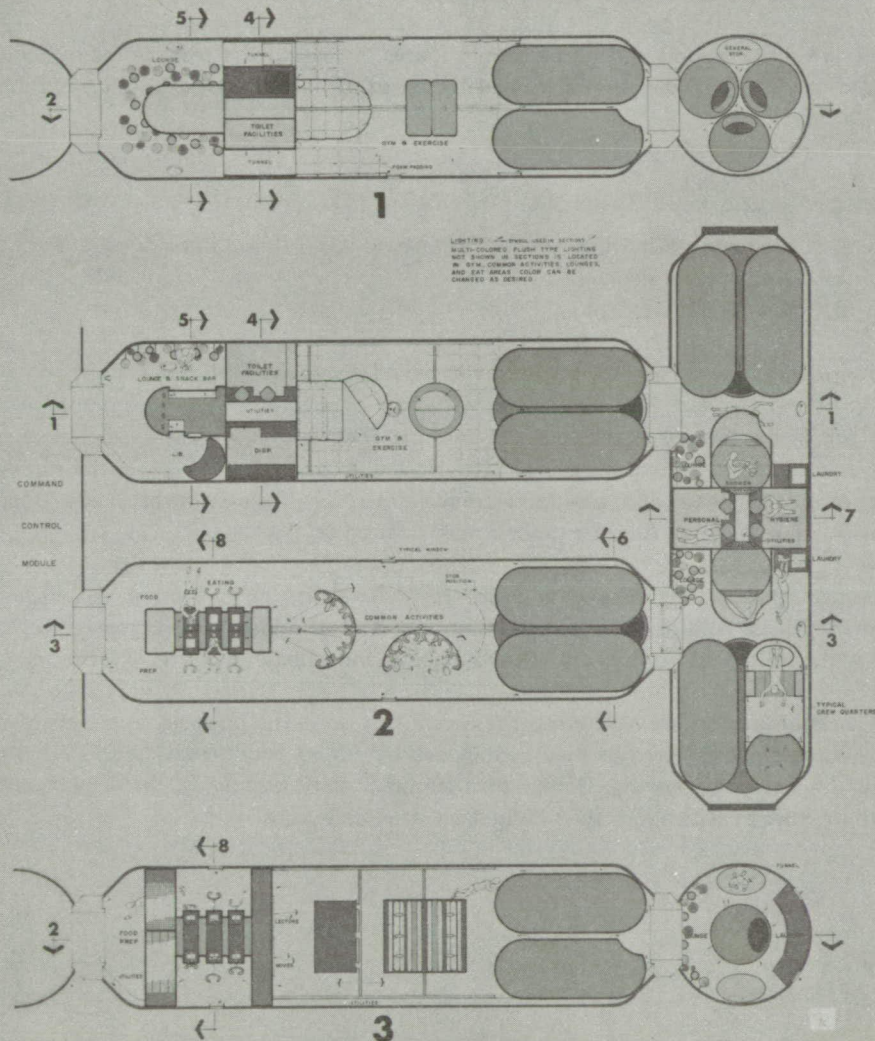


Figure 44.— Panel c of Entry 7 (7c).

The basic structural elements of the interior of the modules are tubular rings which are fastened around the interior diameter of the module at 32" intervals. All horizontal and vertical partitions as well as lighting equipment, storage cabinets, and electronic equipment are in 32" wide sections which clip on to the 1" diameter mounting rings. In construction of partitions for a single 8' bedroom, slotted beams, in the shape of the segments which remain after a hexagon is inscribed in a circle, are placed around the diameter of the interior on a mounting ring. Wall panels or movable wall tracks fit into the slots in the six beams. The bottom hexagon side supports the floor and allows space for plumbing and electrical wires beneath the floor. A large upper floor area is determined by a horizontal plane passing through the center of the cylindrical module. The upper floor is broken at one side by a downward access to the lower floor. The upper floor determines a space below which is divided vertically into a corridor, a bathroom area, and an entrance into the bedroom which allows a space for two individuals to pass each other in the narrow corridor. At the side of the upper floor is the individual's personal communication and entertainment panel which also contains the ventilation equipment for his room. On the opposite wall, there is a storage panel for his personal items and clothing. All remaining cylindrical wall space is covered with standard width rigid foam panels with a fabric or plastic coating. A 1" space behind the foam panels provides space for electrical wiring, and a hole in the center of the panel provides a hand hold for drifting crew members.

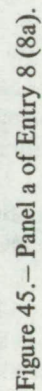
There are six bedrooms and six bathroom spaces in each of the two bedroom modules. The decentralization of bathroom facilities provides greater privacy for crews of mixed sexes. The six bathroom spaces have the following specializations:

1. Female toilet
2. Male toilet
3. Shower
4. Washing and shaving
5. Washing and shaving
6. Laundry equipment

Showering in the weightless environment would be accomplished by means of a water tight suit which fits securely around the neck and is equipped with hose connections at various points. A crew member could don his shower suit in the privacy of his bedroom and then proceed to the shower room, connect the hoses, and a cleansing fluid would circulate around his body. After rinsing, a sponge foam lining in the suit would be compressed by the application of a slight vacuum, and upon removal of the suit, the crew member would be clean and sponged dry with the exception of his head. Another process must be used on the head.

Movement through the weightless environment is facilitated by built-in hand rails in the corridors and around equipment panels. Additional aids to locomotion may be added by the crew in the form of adhesive flanges and elbows with tubular rails, or by adhesive tying points and a length of cord.

The lack of gravity will have a most serious effect upon the physical condition of the crew. In addition to the exercise room, physical exercise may be included by adding friction devices to all doors or by requiring the crew to pump water before showering. Rather than simple push-button living, the crew should exert reasonable muscular strength in order to accomplish their desired activities and needs.



CONFIGURATION OF SPACE STATION

The configuration of modules in a modular space station is related to the desirable proximities of activities and equipment. In this proposal, the life support modules are grouped at one end of the cluster, control and experiment modules at the opposite end of the cluster, and living modules in the center. Frequent travel through a life support module is eliminated and traveling distances are shortened. The command control module is centered among the individual experiment laboratories, while the crew community module is between the two bedroom modules.

The modules are connected in a "barbell configuration" for one outstanding reason. It is essential that the interiors of the modules establish a distinct, relative, up and down orientation for the crew. The location of all of the modules in the same plane allows for continuity of an established up and down orientation from one module to the next.

Rather than requiring the fabrication of a unique central core module, this proposal includes a module coupler with six docking ports allowing all modules to be identical in construction. The coupler permits movement from one module to another, even in the event that one of the central modules were to be damaged.

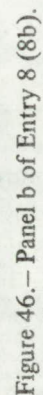
CREW COMMUNITY MODULE

The interior of the crew community module is constructed of standard interior parts and includes: local food storage, kitchen equipment, food waste storage, an exercise room with separate thermal control, audio and visual entertainment equipment and media storage, a large group area, library and game equipment storage, medical dispensary, lockers in the entrance corridor, a dining room which may be isolated from or included in the large group area, a small group area or chapel which also may be opened into the large group area, and emergency equipment storage lockers in the entrance corridor.

By means of the movable walls, an effective floor space of from 8' X 13' to 40' X 13' is possible in the crew community module.

Chairs are included for restraining a crew member in an upright position for any community activity and include a table surface for eating, writing and etc. which folds into the sides of the chair when not needed. The chairs are sufficiently close to the floor that an individual may maintain an upright position by means of body contact with the floor, the chair, and the lap belt.

Lighting is available in three types and may be easily altered by the crew in order to suit their specific needs. Ceiling mounted general lighting may be used in the dining or exercise area, while wall mounted indirect lighting may be more appropriate for relaxed areas and viewing a video screen. Small, directable spot lights provide additional light where the other types are inadequate.



THE TUNNEL

The basic modules contain a 5 foot diameter tunnel which is structurally separate from the module itself.

The 5 foot diameter of the tunnel allows for two-way traffic of crew and movement of moderate size cargo inside the tunnel, under normal conditions; and the passage of two crew members in full pressure suits, under emergency conditions.

The tunnel is offset to one wall of the basic module to allow for more usable floor area when the module has transverse floors, and to give more usable volume when longitudinal floors are used.

THE INTERFACE

With the use of the offset tunnel in the case of living modules, the three modules may be positioned in a triangular arrangement, with the three offset tunnels to the center falling within the designated 13-1/2 foot interior diameter of a basic module.

The capability of longitudinally combining three modules with one module in this way, means the ability exists to eliminate the need for a core module, with its attendant problem of difficult circulation pattern — room use relationships within such a small space.

To replace the need for a core module, the three-in-one module interface allows for the existence of two "node stations," one at each end, interfacing with the three living modules. Each node station is a multi-directional circulation hub.

THE CONFIGURATION

The three living modules in triangular arrangement are the center of the station.

At the two ends of the station are the command/control module and the power supply module. They connect to either end of the living modules through the three-in-one interfaces at the two node stations. At the command/control node station a crew member may enter the command/control compartment, any of the three radial experiment modules, or any of the three living modules.

At the power supply node station, a crew member may enter any of the three radial life support modules or any of the three living modules. Docking ports for the shuttle are located at each node station and at the free end of the command control module.

2 airlocks for EVA activity will be located in each node station, with one airlock station at the free end of each experiment module.

THE CIRCULATION SYSTEM

The primary circulation in the station is longitudinally between the two node stations through the ward/recreation module, and radially into the experiment modules or life support modules from either node station. Under emergency conditions the two node stations function as emergency exits and the self-contained tunnels as passages to those exits.

Every module in the station has a node station at one of its interfaces so no point in the living or working area is more than 30 feet from an emergency exit airlock.

Due to the fact that the three living modules connect the two node stations, a triple loop system exists between the two node stations providing continuous access if one or even two of the living modules must be sealed off.

The circulation system for the entire station is set up in a way that any module may be isolated due to malfunction without disrupting the functions in the station, under normal or emergency conditions.

THE ASSEMBLY

The initial station will be composed of modules (8) linked end to end. The command/control module and power supply module will be linked together by the three living modules. The necessary life support and experiment modules will connect to the station at the respective node stations.

Necessary life support and experiment modules will be added at the empty ports in the respective node stations. This will give a final station configuration of 11 modules.

THE CREW QUARTERS MODULES (2)

Two identical crew quarters modules are used, each with enough quarters and hygiene facilities to support half the crew (6) under normal conditions, or an entire crew (12) during crew changeover, or in the event one entire crew quarters module becomes unusable.

The tunnel is continuous through the crew quarters module to provide maximum privacy in each compartment and ease of circulation within each module.

All floors in the crew quarters module are transverse to heighten the sense of territorial space by providing all crew members with their own "floor."

All compartments within the crew quarters modules are designated "personal space," so all floor to ceiling heights are set at 6'6" (198 cm) for ease of mobility within the space (compression walking) and to make the spaces intimate in scale.

The crew quarters are grouped into two sets of three compartments separated by a separate hygiene compartment. This hygiene compartment provides all the hygiene facilities necessary for the 6 crew members of the module; 3 lavatory/water closet cubicles and 2 shower/dressing cubicles.

The end hygiene compartment provides overflow hygiene facilities for the crew in the module and convenient hygiene facilities for crew in the work and ward areas. In addition, there are laundry and storage cubicles.

THE WARD/RECREATION MODULE (1)

One ward/recreation module will provide the necessary services for an entire crew of 12 under normal conditions, or a crew of 24 during changeover periods.

The tunnel is discontinuous through the ward/recreation module. It terminates at both ends of the ward compartment but because the tunnel is offset, circulation through the ward remains channeled away from areas of activity.

All compartments within the ward/recreation module are designated "Communal Space," so to give the compartments more uninterrupted volume, an average ceiling height of 7'6" (228 cm) is used.

Adjacent to the command control node station is the crew lounge which can be used for briefing small groups in privacy.

The ward compartment is to provide food preparation and dining facilities for the normal crew of 12 or a crew of 24 during changeover periods. The seating design will also allow the ward to function as a lounge, an area for light recreation (games, films) or a briefing area for the entire crew.

The tunnel terminates at both ends of the ward compartment to provide an overall ceiling height of 9'0" (274 cm). The large amount of free volume will make the ward/compartment comfortable for large numbers of crew members and will provide visual relief from the smaller spaces in the station.

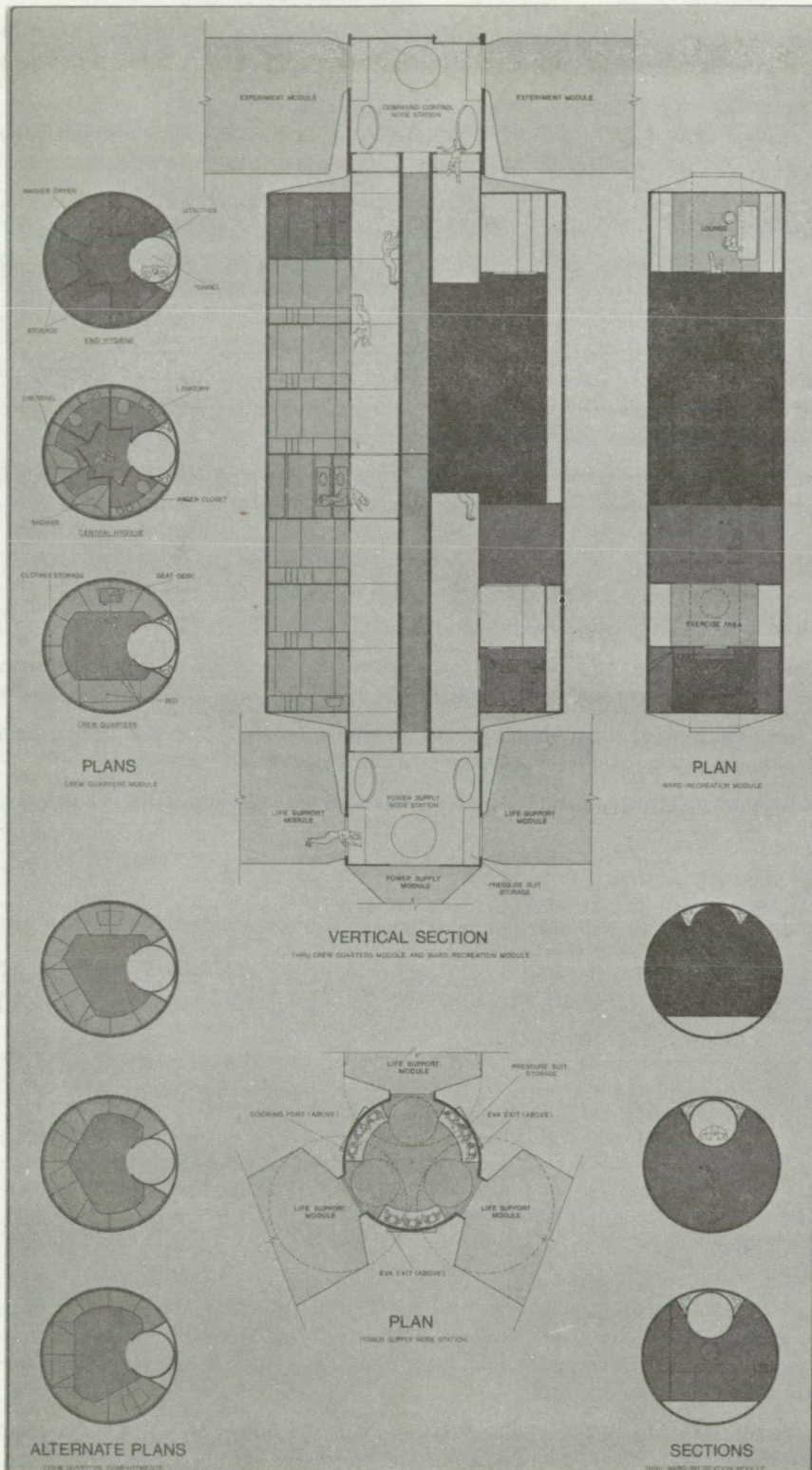
The exercise/recreation compartment is for the physical fitness of the crew. The exercise area has storage for equipment, and isometric type exercise space. The larger recreation space has no floor, thus providing more free volume for the group type zero gravity sports. The dispensary compartment is adjacent to the exercise/recreation compartment. It will provide an area for individual crew examination and the equipment can be used to monitor any crew exercising in the adjacent area.

The location of the dispensary compartment places it near needed support systems in the life support module and yet the isolation of the dispensary from areas of heavy circulation or activity makes it easy to quarantine.

The location of the dispensary adjacent to the power supply node station means that any crew member who is ill or incapacitated can be moved easily and quickly to an emergency exit in the node.

NODE STATIONS (2)

Each node station is to provide storage for pressure suits which will be used for emergency exit from the station and other normal EVA activity. 2 EVA airlocks and 1 shuttle docking port shall be provided in each node station.



THE CREW QUARTERS MODULE

TWO IDENTICAL CREW QUARTERS MODULES ARE USED, EACH WITH TWO CHAMBERS AND HYDRO FACILITIES TO THE FRONT HALF OF THE CREW QUARTERS MODULES. DURING NORMAL CONDITIONS, ONE OF THE CREW QUARTERS MODULES IS USED FOR THE CREW QUARTERS MODULES DURING CHANGEOVER.

THE TUNNEL IS 1.50 M (5 FT) THROUGH THE CREW QUARTERS MODULES TO PROVIDE A PASSAGEWAY TO THE CREW QUARTERS MODULES DURING CHANGEOVER.

ALL STORIES IN THE CREW QUARTERS MODULES ARE DESIGNED TO PROVIDE THE SPACE FOR PERSONAL SPACE BY PROVIDING ALL CREW MEMBERS WITH THEIR OWN PERSONAL SPACE.

ALL COMPARTMENTS WITHIN THE CREW QUARTERS MODULES ARE DESIGNATED PERSONAL SPACE. TO ALL PERSONAL SPACE, PERSONAL SPACE IS SET AT A 1.50 M (5 FT) PERSONAL SPACE WITHIN THE SPACE. PERSONAL SPACE IS SET AT A 1.50 M (5 FT) PERSONAL SPACE WITHIN THE SPACE.

THE CREW QUARTERS MODULES ARE DESIGNED TO PROVIDE THE SPACE FOR PERSONAL SPACE BY PROVIDING ALL CREW MEMBERS WITH THEIR OWN PERSONAL SPACE. THE CREW QUARTERS MODULES ARE DESIGNED TO PROVIDE THE SPACE FOR PERSONAL SPACE BY PROVIDING ALL CREW MEMBERS WITH THEIR OWN PERSONAL SPACE.

THE CREW QUARTERS MODULES ARE DESIGNED TO PROVIDE THE SPACE FOR PERSONAL SPACE BY PROVIDING ALL CREW MEMBERS WITH THEIR OWN PERSONAL SPACE. THE CREW QUARTERS MODULES ARE DESIGNED TO PROVIDE THE SPACE FOR PERSONAL SPACE BY PROVIDING ALL CREW MEMBERS WITH THEIR OWN PERSONAL SPACE.

THE WARD RECREATION MODULE

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Figure 48.— Panel b of Entry 10 (10b).

THE WARD COMPARTMENT

The ward compartment is composed of two areas, food preparation and dining. Main entry into the ward compartment is from the hatch at the tunnel terminus above the food preparation area.

FOOD PREPARATION — All food preparation will be from the two units at the sides of the food preparation area. One unit is for meal preparation, including storage for frozen or dehydrated food, and hot and cold running water. The second unit will be primarily used to prepare dehydrated food for snacks or work breaks. All waste disposal will be at the second unit.

SEATING — All seating will be to the sides of the dining area. Built-in bench seating will be placed along the module wall with fixed individual seats placed across the tables to the center of the dining area. All seating surfaces will be carpeted to accept the velcro strips on crew members' outfits: this will allow crew to sit anywhere along benches or in individual seats without the need for straps or harness.

CIRCULATION — Crew members just passing through the ward compartment space will travel with the aid of parallel rails on the ceiling. Crew members wishing to use the ward space can follow the inclined rails down to the floor where they can propel themselves through the ward to a desired activity area by pushing off either end wall of the compartment. All circulation will be down the center of the ward compartment space.

UTILITIES — Lighting and ventilation will be from overhead in the utility channels on each side of the overhead circulation route. Space under the continuous floor will give room for food storage and storage of recreation and hobby supplies.

THE TUNNEL

The tunnel contains sufficient cross-sectional area for two way circulation.

CIRCULATION — Circulation will take place along the tunnel on opposite sides by the use of recessed handholds. These recessed handholds can be used from two directions.

SAFETY — The interior of the tunnel should be of a soft, durable material. Hatches shall be placed at both ends of tunnel runs to prevent any fire from running through the entire station, and to provide sound isolation.

LIGHTING — Lighting for the tunnel is to be recessed inside the handholds and should be on its own emergency circuit.

THE HYGIENE COMPARTMENT

The hygiene compartments are based on a hexagonal modular plan with hygiene cubicles enclosed in five spaces and the tunnel space in the sixth.

CIRCULATION — All circulation is by compression walking from the center circulation space to any of the hygiene cubicles at the perimeter.

FURNISHINGS — All walls in the hygiene compartment are to be of a hard, smooth texture for easy cleaning; and white in color for lightness of the space. The hygiene fixtures are to be of bright colors for accent in the white space, and to emphasize their individual functions.

THE CREW QUARTERS COMPARTMENT

Each crew quarters compartment is for the private use of one crew member for such activities as sleeping, dressing, grooming, reading and hobbies. In addition, there is ample space for the socializing of a small group of crew members.

FURNISHINGS — All furnishings are based on the hexagonal modular plan and are placed at the perimeter of the space. Flexibility is possible by changing the arrangement of the modular bench sections and wall components to fit the preferences of the different crew members. Bench and wall components which support a common function form a station: such as a sleep station, desk station, storage and dressing station.

UTILITIES — General lighting will be of a diffuse type from behind the perimeter wall panels. Colored bulbs can be used for different color variations in the space or to emphasize specific activity stations. Local lighting for specific tasks will be from the specific wall component furnishings.

EATING AREA

The eating area design contains two parts: (1) it is not in a major circulation path but it is (2) circular to save space and to create a good crew arrangement. Lighting is by high intensity spots over each place with an overhead diffused lighting for meetings. Use of the spots help keep the space from feeling too confined. Colors are bright, textures are fairly smooth except for the wall which is rough. Tube type foods were chosen for easy preparation and storage.

LIBRARY

The library has low-level illumination with high intensity spots for personal areas. Colors are dark and textures are rough. Seating in the library is solitary type but seats can be moved (locked to floor with a pin socket arrangement). The library would provide microfilm, tape or films, and standard books and would be for leisure as well as for technical/reference use.

The hydroponics adjoining the library are for decoration, texture, visual relief, fresh air supply and fresh smells.

CHAPEL/MEDITATION

The chapel/meditation space is designed as a simple, warm toned, dark area for quiet introspection. Surfaces are resilient with a carpet covering.

EXERCISE AREA

The exercise area provides a series of varied surfaces to exercise upon or by. Solitary exercise of the isometric type is the standard with a larger section left open for team or dual type of activity (space handball, etc.). Lighting is average diffused type, colors are cool, textures are medium rough (carpeting).

CLINIC/LAB

In the clinic/lab area functional aspects were given prime consideration. Lighting is, for the most part, a diffused general type. Surfaces are plain for easy cleaning, colors and textures neutral. There are two spaces — one for lab work and physiological experimentation and the other for emergency and general dispensary.

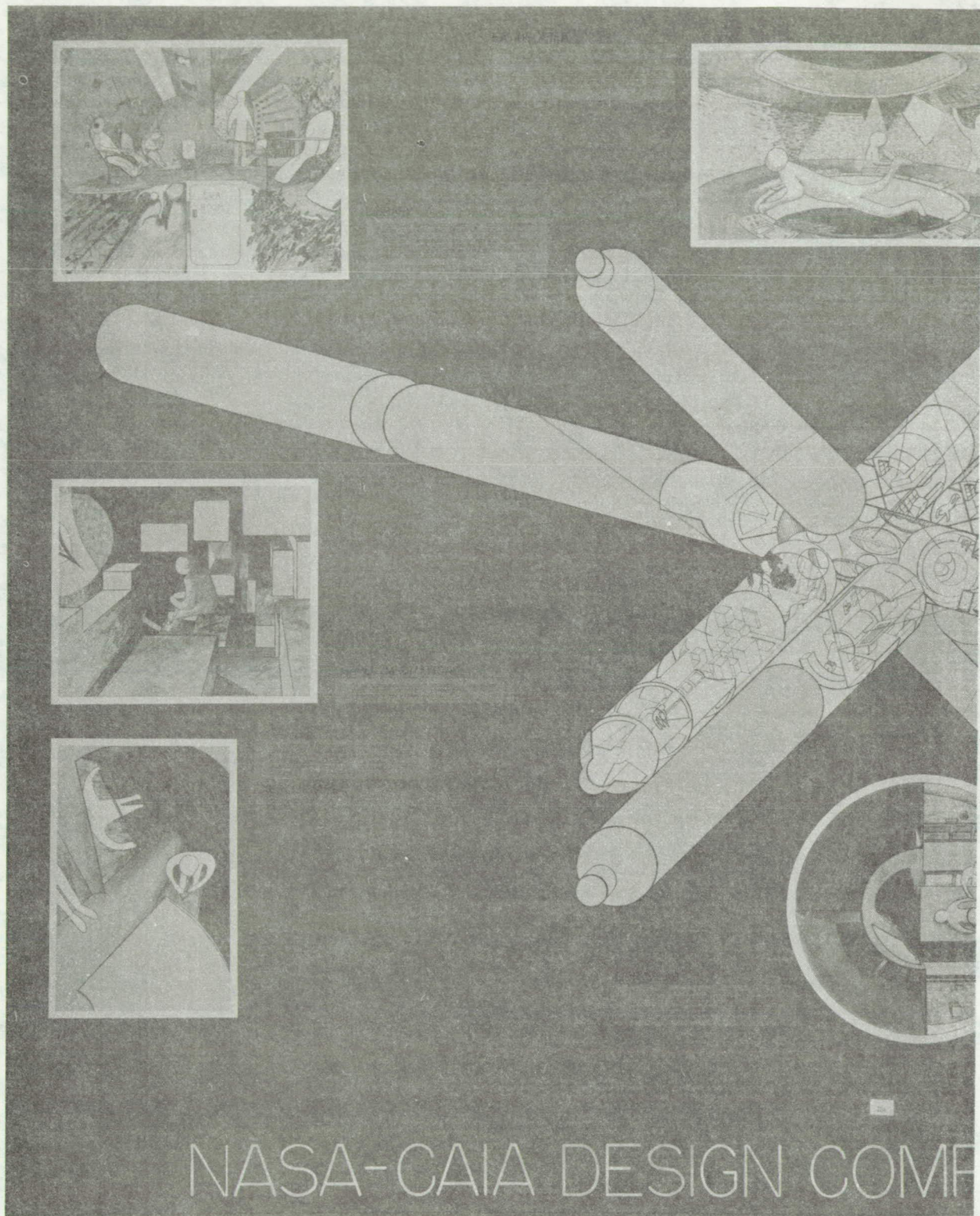


Figure 50.— Panel a of Entry 12 (12a).

HUB

The hub is designed as the major activity area. General lighting is dim, being provided by electroluminescent panels around each entrance in such a way as to provide a code identification for that module. Tensor spots would light pods. Each pod is designed for a general function, but can be multi-purpose. Designed functions include: television watching; listening to music; games; discussion groups, with a terrarium for a focal point — like a fireplace; a darkened area with three grouped portholes for stargazing and a couple of all purpose pods.

LIVING QUARTERS

The living quarters are designed so that each person has their own room, sharing bathroom facilities. The bed has an air mattress type of cover which would push down on the sleeper, providing a sense of cover pressure and maximizing surface contact for a feeling of stability during sleep. Throw away clothes and linens should be used to eliminate the need for laundry facilities. Each living module has its own galley with microwave range, sink and freezer/refrigerator. The galley would usually be used during extra-station missions with food being stored in the main dining room (in packaged units) and brought to the living module before missions.

The individual rooms would have cool colors with spot lighting to create an enlarged space feeling. Textures would be smooth to rough, with many patterns to lessen visual boredom. The M.E. to these living units would be a two-way system type. The main M.E. would run the length of the living/lab modules so that when connected to the station the normal power module would provide service. During a mission an auxiliary power module would service the unit.

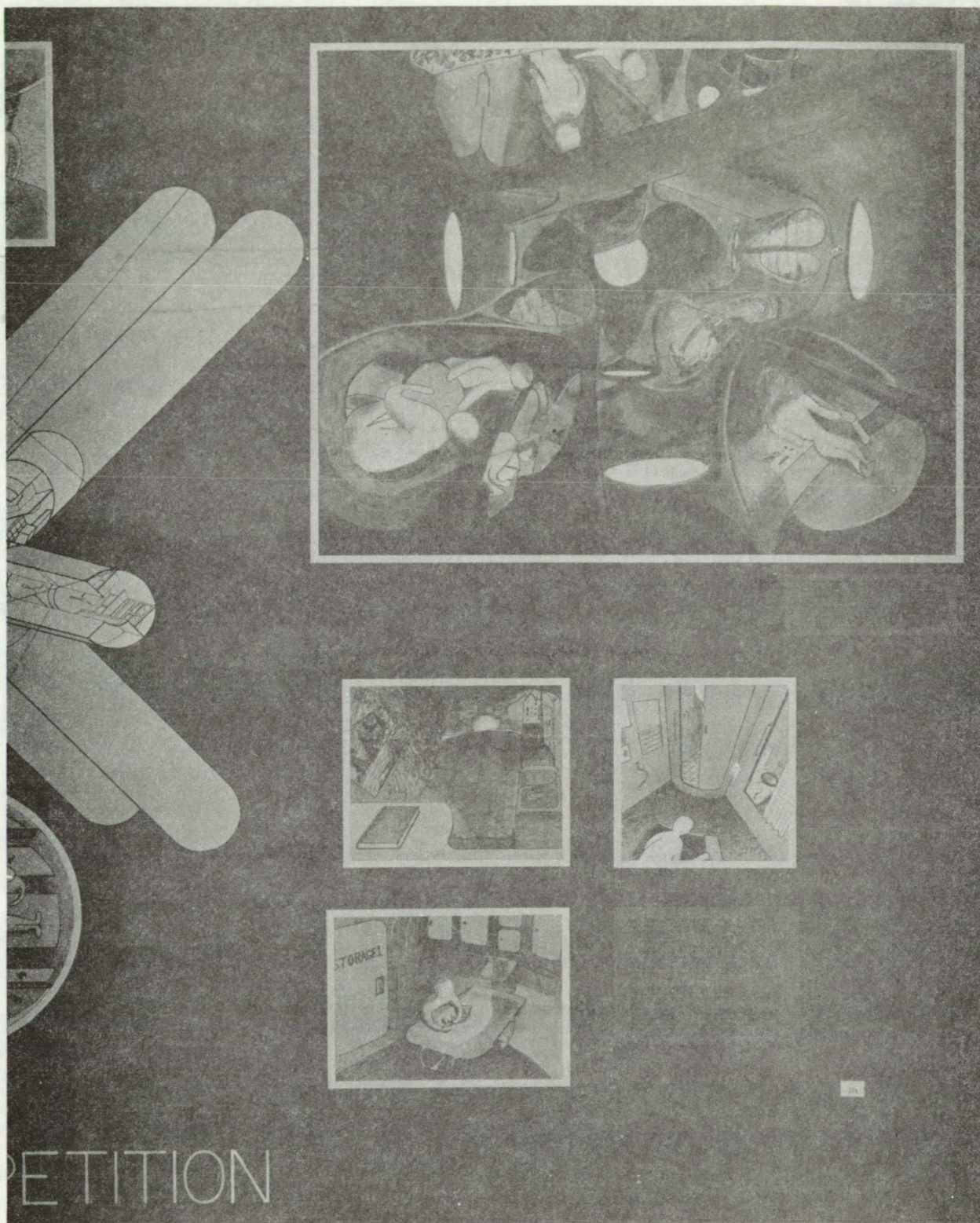


Figure 51.— Panel b of Entry 12 (12b).

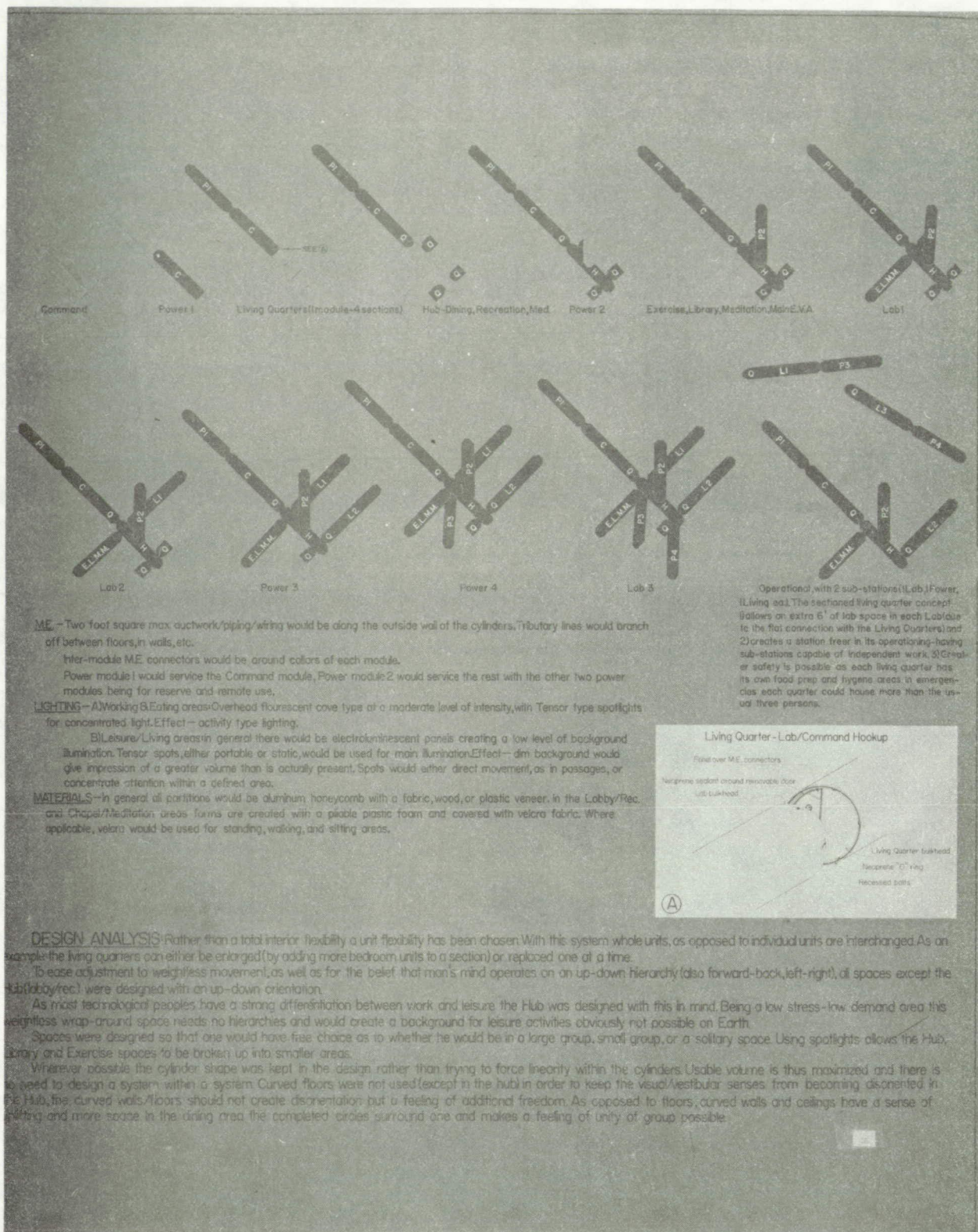


Figure 52.— Panel c of Entry 12 (12c).

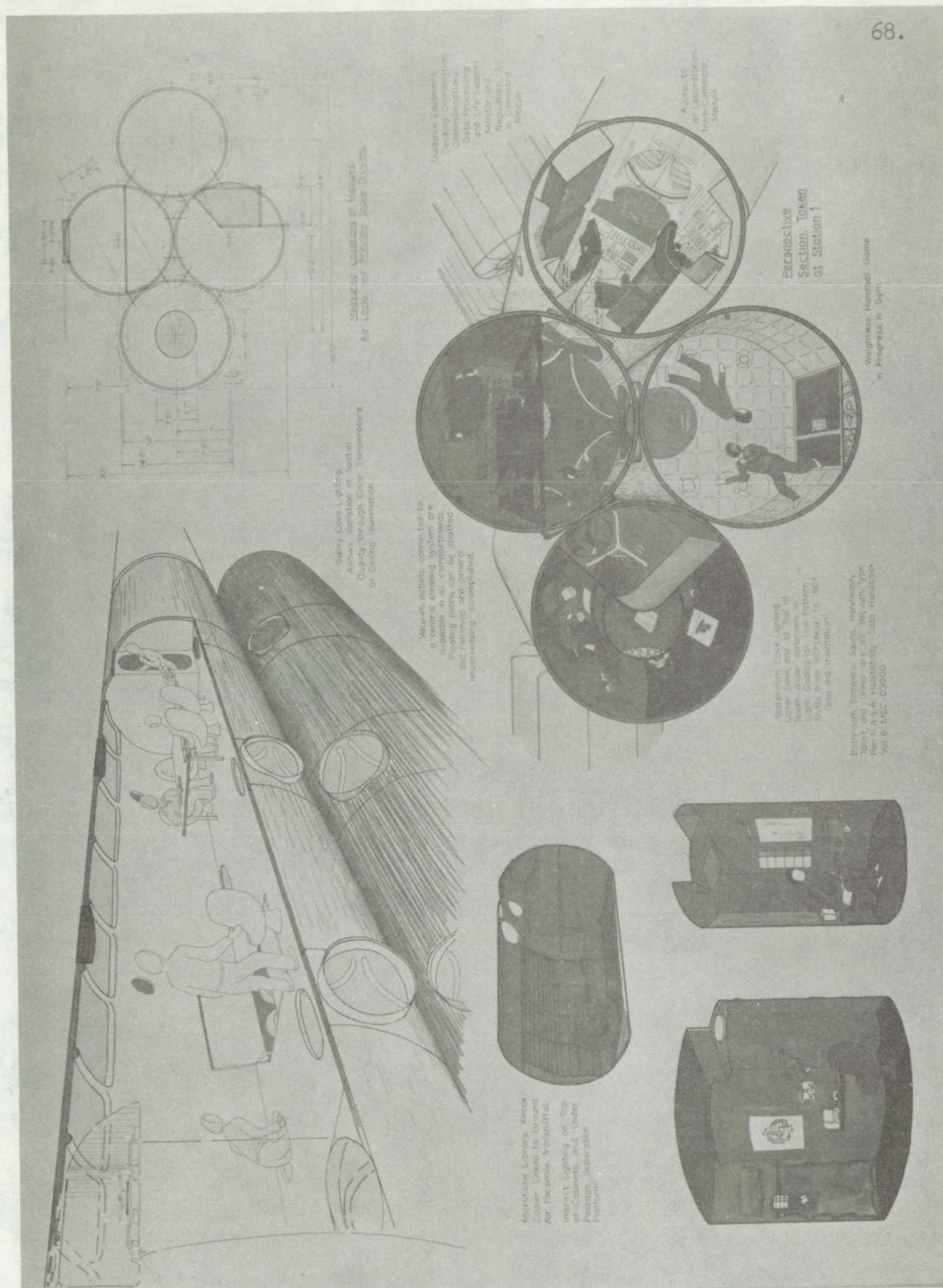
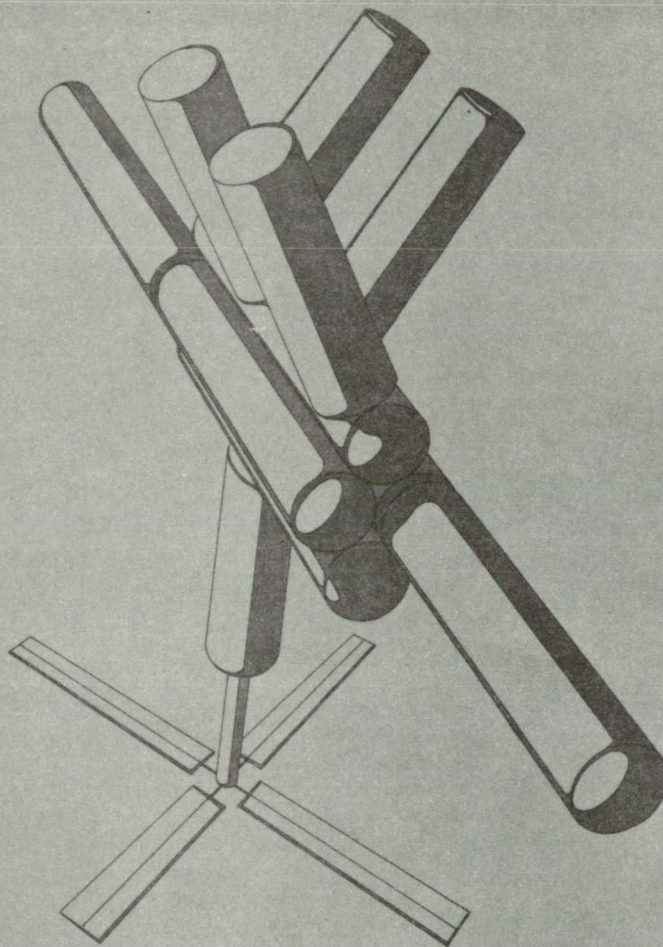


Figure 53.— Panel a of Entry 14 (14a).

Figure 54.— Panel b of Entry 14 (14b).

MAINTAINING The station will not be able to generate artificial gravity. Differences in apparent gravity and coriolis effects would severely disrupt the illusion on as small a craft as this. Various experiments require zero gravity. The expense and increased complexity do not seem justified.

Alan Shepherd and Marshall McLuhan both agree that weight where the feet happen to be is more important in a visually dominated environment. Textures and colors are more noticeable; noise and odor can become more intense; it dominates the feeling. "Down" is no longer always sensitivity and reliability. Visuals combination of the familiar and mutations might evolve how get past answers to bad questions



but those programs, non-specialized spaces and functions will give answers and allow new questions to be generated as well. Parallel arrangement of the three permanent living and one command module offers optimal arrangement of spaces, variety of vistas and minimal circulation corridors. Other alternatives

Stage I is illustrated in the large drawing. All labs join the side of air locks and four data ports. The command module, its supporting structure provides illumination and occupies the remaining positions well color in gully and storage. Windows are placed in the gully rooms. The all-white gym allows concentration on games. Habitat to allow observation of the two walls from the draw to devise

such games as free-fall handball or surfaces on shoes, trousers, etc. four-wall pingpong, vigorous body movement and jiggling around are more beneficial than isometric tension. Bath "card room" and library are it is better to provide seaable available for meditation and study bars and microwave and infrared Earth and wood colors give a quiet library mood. All wall surfaces are covered with an extraterrestrial cuisine, and loop pile woven carpet. Visitors book writing the first wayfaring cookbook

Figure 55.— Panel c of Entry 14 (14c).

MAN IN SPACE

PROBLEM:

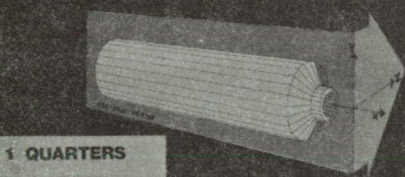
THE PROBLEMS THAT WILL CONFRONT MAN IN HIS NEW ALIEN ENVIRONMENT ARE THOSE OF BORDOM, INDIVIDUAL CONFINEMENT, GROUP CONFINEMENT, LACK OF VARIETY OF HUMAN EXPERIENCE, LACK OF MENTAL ACTIVITY, LACK OF SEXUAL ACTIVITY, ETC. THIS STATION INTERIOR MUST RELIEVE THESE PROBLEMS.

SOLUTION:

AN ATMOSPHERE STRENGTH AND SOLIDITY, A FEELING OF LUXURY AND VARIETY IS PROVIDED THROUGH THE USE OF RICH MATERIALS, VARIABLE LIGHTING TO SET MOODS, PLUSH PADDING, AND SPACIAL VARIATION. THESE ELEMENTS COMBINE TO CREATE FEELINGS OF STIMULATION, REST, SOLITUDE, OR ACTIVITY.

VARIETY OF ACTIVITY AND ENTERTAINMENT ON THE SOCIAL AND PRIVATE LEVEL IS FURNISHED THROUGH VARIED FACILITIES IN THE LIVING QUARTERS AND GROUP AREAS.

A FEELING OF SAFTY AND SECURITY IN THIS HOSTILE ENVIRONMENT IS IMPERATIVE.

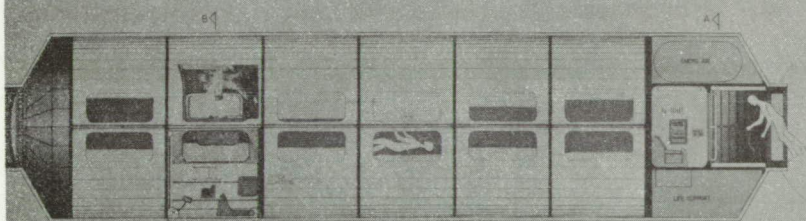


DESCRIPTION:

The quarters module is designed to provide a comfortable and secure environment for the crew. It features a central living area with a large window, a sleeping area with two bunks, and a private area with a shower and toilet. The module is equipped with a variety of amenities, including a television, a radio, and a small kitchenette. The design is intended to be both functional and aesthetically pleasing, providing a sense of home in a hostile environment.

MODULE 58x4

SCALE 1"=10'



SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

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SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

SECTION B-B

LIGHTING:

Low intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

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Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

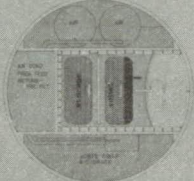
Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma

High intensity, cool, glaucoma

Medium intensity, warm, glaucoma



SECTION A-A

SECTION A-A

SECTION A-A

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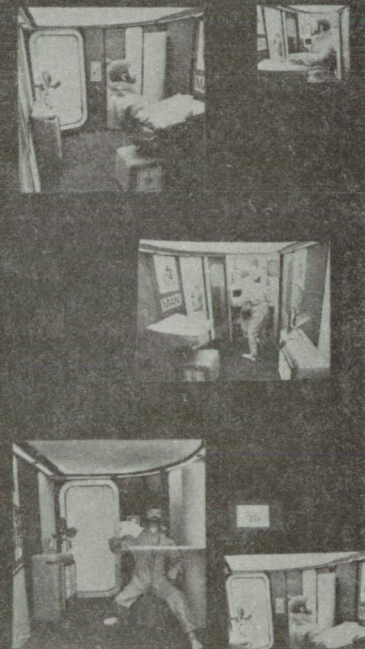


Figure 56.— Panel a of Entry 15 (15a).

DESCRIPTION:

The module contains areas for personal hygiene, exercise, and a dispensary.

The hygiene area contains three private grooming areas which contain a shower, hand washer, and other equipment needed for body cleanliness and dental care. This area also has two of the three toilets, a washer and drier, and areas for storage of cleaning materials. Access is provided to the areas above and below the hygiene equipment for service and repair. All walls are of formed plastic with corners and edges rounded for easy cleaning. The floor has velcro attached for use with velcro slippers.

The exercise area is designed to provide more than just muscle exercise. The room is lined with clear plastic air cushions to absorb body impact. Nets are provided to partition the room for different forms of physical activity such as three-dimensional trampoline, volley ball, or acrobatics. The idea is that aggressions require forms of physical release other than exercise machines and it is desirable to have a place to "let it out" without hurting oneself. Normal exercising machines have been provided to fill the need of exercising muscles that would not normally be exercised in other ways.

The dispensary has been provided to treat unexpected medical problems as well as provide routine checkups. This area has been isolated from normal station traffic to provide quiet and separation for anyone requiring intensive care or observation. It is also possible to isolate anyone contracting a communicable disease until rescue can arrive.

DESCRIPTION:

The module contains a kitchen-eating area and a lounge area.

The kitchen has long term and short term food storage areas, a preparation area, and disposal equipment. The two tables push down to floor level and the area can be used to hold 24 people for briefings. There are two windows in this area over each table. Lighting is provided by high intensity direct lights over the food preparation and eating areas and variable reflective from the ceiling. Passage to the lounge area is thru a light sculpture made of lighted colored transparent plexiglass shapes. This serves as a pleasant transition to the quiet lounge area.

The lounge area is the largest space in the station. It is designed for group social gatherings, reading, and visual entertainment. A theatre partitionable from the rest of the space is provided where movies, slides, or video tapes may be shown. The padding throughout the entire space is covered with a deep colored velvet to provide a feeling of luxury and softness. Lighting is by variable warm intensity panels set between padding ribs around the interior. Two windows are provided in this area.

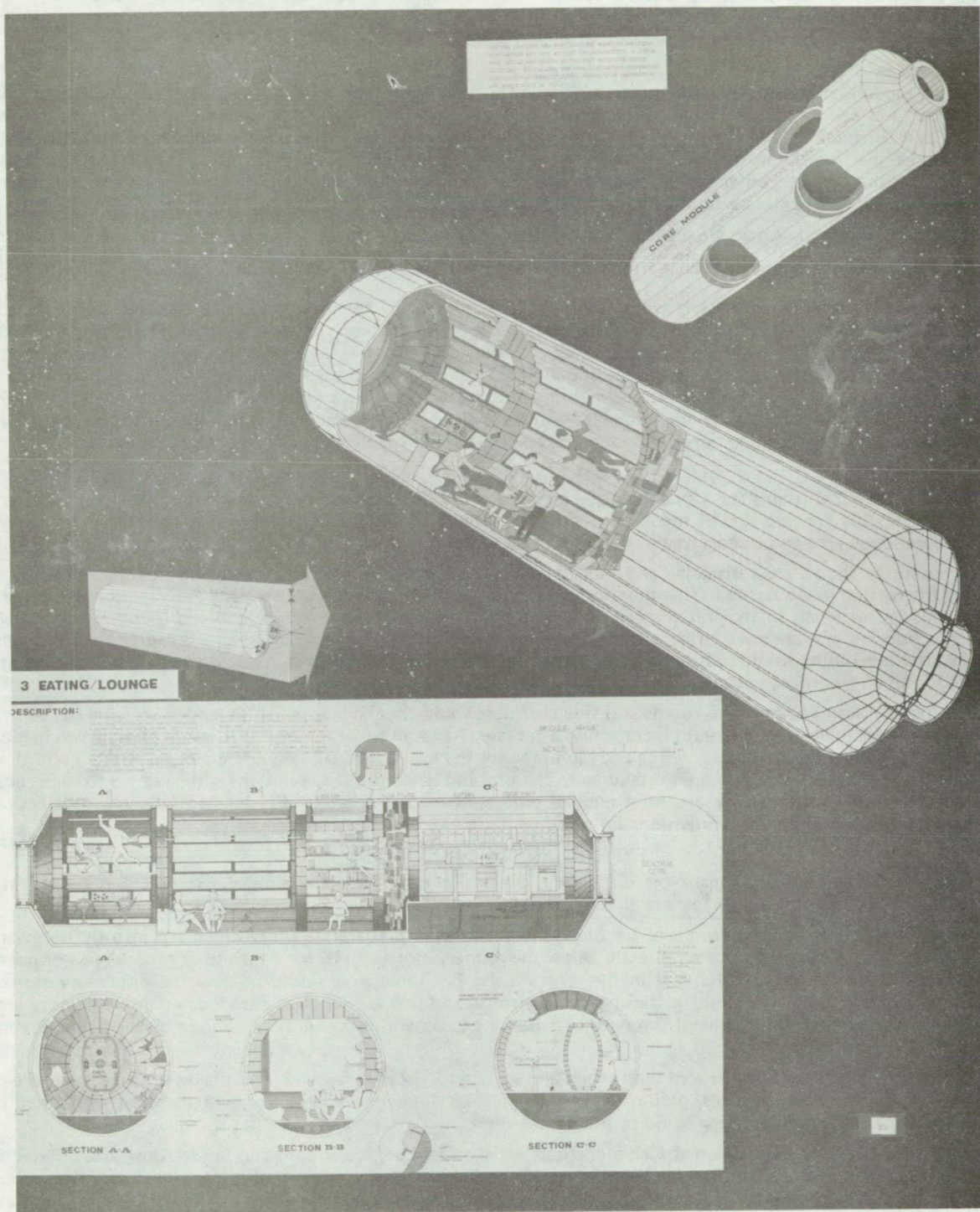


Figure 58.— Panel c of Entry 15 (15c).

DESIGN ANALYSIS

As seen from the illustration on this panel, the station configuration could take the form of a one level, single direction, layout. Because of the severe limitations of the module dimensions I felt it may be better to design in this direction and to make the best applicable usage of the remaining volumes.

Advantages of the single plane orientation are several. A one level floor longitudinally located towards the center of a module allows for the largest volume usage for habitation. The remaining volumes created beyond the "false" floor and ceiling of the living volume could best be used for storage and special equipment. (See panels Type A, Type B, modules.) The routing of all life support hardware (air, fluids, electrical, etc.) could take place directly under the flooring in the form of a service core panel that runs the length of the module. From this panel, walls wherever they are needed, could be erected carrying various conduits and ducts. Such is the case with the crew living quarters and to an extent with the living facilities module.

Lighting and special devices are located in the smaller volume above the ceiling and a larger beneath the flooring becomes a service aisle (17" minimum clearance) for access to the life support systems, mechanical equipment, and storage.

The one level floor scheme I feel would be better psychologically for those people (physicians, scientists, and engineers) aboard the craft who might not adapt so quickly to the zero-gravity environment. Therefore, provision should be made for special grip carpeting and shoes. Working on a cohesive bonding principle (e.g., "Velcro" cloth) an individual could "walk" with the assistance of hand-holds and railings through the living areas much like on Earth but without feeling any weight. Of course, something like this would have to be carefully engineered but it might make adapting to the "weightless environment" a little easier. At the same time total weightlessness would be experienced through the docking ports, airlock areas, and possibly in the life support, experiment modules.

TYPE A LIVING QUARTERS

Separate identical rooms for 12 people total are provided for in two modules dedicated to crew living quarters. Within each module are two sets of three rooms grouped about a centrally located bath area. The remaining volume serves as a common area and passageway in the form of an offset corridor.

Between the rooms are corrugated and padded wall partitions that retract into the ceiling creating an open area for crew interaction when desired. This therefore allows for usage of certain room sections as recreation and general multipurpose areas when in the initial stage of a 4 to 5 man crew. Space couches (bed and lounge) also retract below the flooring and are covered by a sliding panel that could take the form of a padded exercise mat. A crew member after awakening would press a button to lower his bed out of the way and in its place a gym mat for doing a restricted form of "morning exercises."

Serving as a wall between the rooms and side corridor would be a service panel (extended up from the central service core). Part of this panel would incorporate a recessed handrail while the rest of it would contain mechanical equipment for sliding doors, various wiring and plumbing for the toilet area. Directly off the panel within each room would be audiovisual sets for taped entertainment. These would be controlled, as are the sliding doors to each room and the retractable partitions, by a central control unit built into a closet facility located by each space couch. Complementary color keying and provisions for personal items give variety to each room.

TYPE B LIVING FACILITIES

The crew living facilities consist of: dispensary, dining, food preparation, laundry, exercise, and leisure time areas. A library storage unit and chapel are all located within a single module.

About the central service core panel are the laundry and food preparation units which tap into the necessary fluid and electrical plumbing. Located directly below the primary storage units for cold and dry foods are secondary storage units which are out of the way in the service aisle. The same would hold true for the dispensary storage locker, if the above floor unit is not sufficient for all medical and first aid supplies. Also located in the laundry area would be a storage locker for general station maintenance equipment in the form of vacuum cleaners and dusting devices of various sorts.

In the dining area sufficient room with tables and seating for 12 are provided. This makes possible the usage of this area for full crew conferences, group meetings, and entertainment. A large audiovisual screen with taped or transmitted shows and programming could be provided.

Located away from and down the side corridor are the exercise, recreation, and leisure time areas. Exercise apparatus fitted for the weightless environment would be located in a large area that could also serve for group recreation, in the form of handball games, tennis, etc. since the larger exercise apparatus could be folded up and retracted below the floor using the same type mechanical equipment as the space couch.

Located beyond and partitioned from the exercise area would be small but adequate chapel with a library storage facility situated in this room. Outside would be a seating area for reading and general lounging.

NASA / AIA SPACE STATION INTERIOR DESIGN PROPOSAL

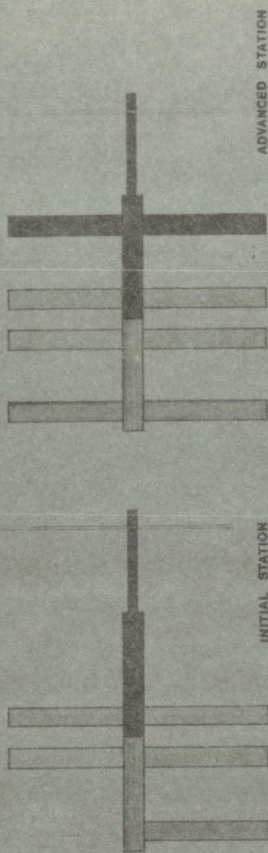
DESIGN ANALYSIS

As part of the competition for the design of the space station, NASA has invited a number of design firms to submit proposals. The design of the space station is a complex task, and the design of the interior is a critical part of the overall design. The design of the interior must take into account the needs of the crew, the needs of the station, and the needs of the mission. The design of the interior must also take into account the needs of the future, as the space station will be a permanent presence in space.

The design of the interior must be functional, efficient, and comfortable. It must provide a safe and secure environment for the crew, and it must be able to support the needs of the station and the mission. The design of the interior must also be aesthetically pleasing, as the space station will be a permanent presence in space.

The design of the interior must be flexible, as the needs of the crew and the station will change over time. The design of the interior must be able to adapt to these changes, and it must be able to support the needs of the future.

The design of the interior must be a team effort, as the needs of the crew, the needs of the station, and the needs of the mission are all interconnected. The design of the interior must be a team effort, and it must be a team effort that is focused on the needs of the future.



STATION CONFIGURATION

TYPE A LIVING QUARTERS

The Type A living quarters module is designed to provide a comfortable and secure environment for the crew. It features a large sleeping area, a dining area, and a living area. The module is also equipped with a bathroom and a kitchen. The Type A living quarters module is designed to be flexible, as the needs of the crew will change over time. The module is able to adapt to these changes, and it is able to support the needs of the future.

TYPE B LIVING FACILITIES

The Type B living facilities module is designed to provide a comfortable and secure environment for the crew. It features a large sleeping area, a dining area, and a living area. The module is also equipped with a bathroom and a kitchen. The Type B living facilities module is designed to be flexible, as the needs of the crew will change over time. The module is able to adapt to these changes, and it is able to support the needs of the future.

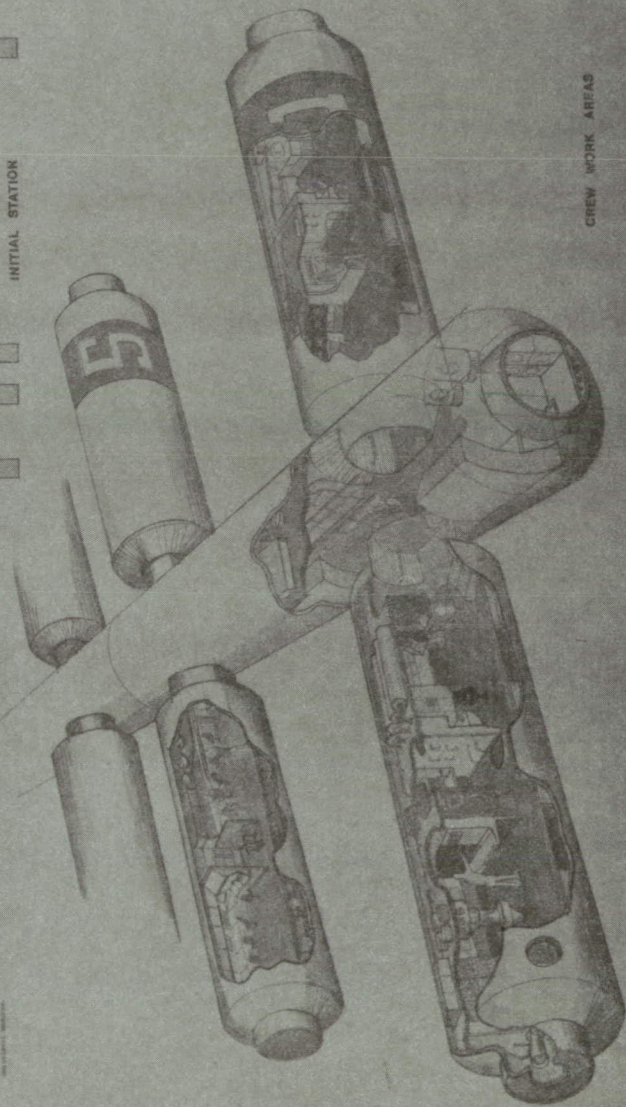


Figure 59.— Panel a of Entry 16 (16a).

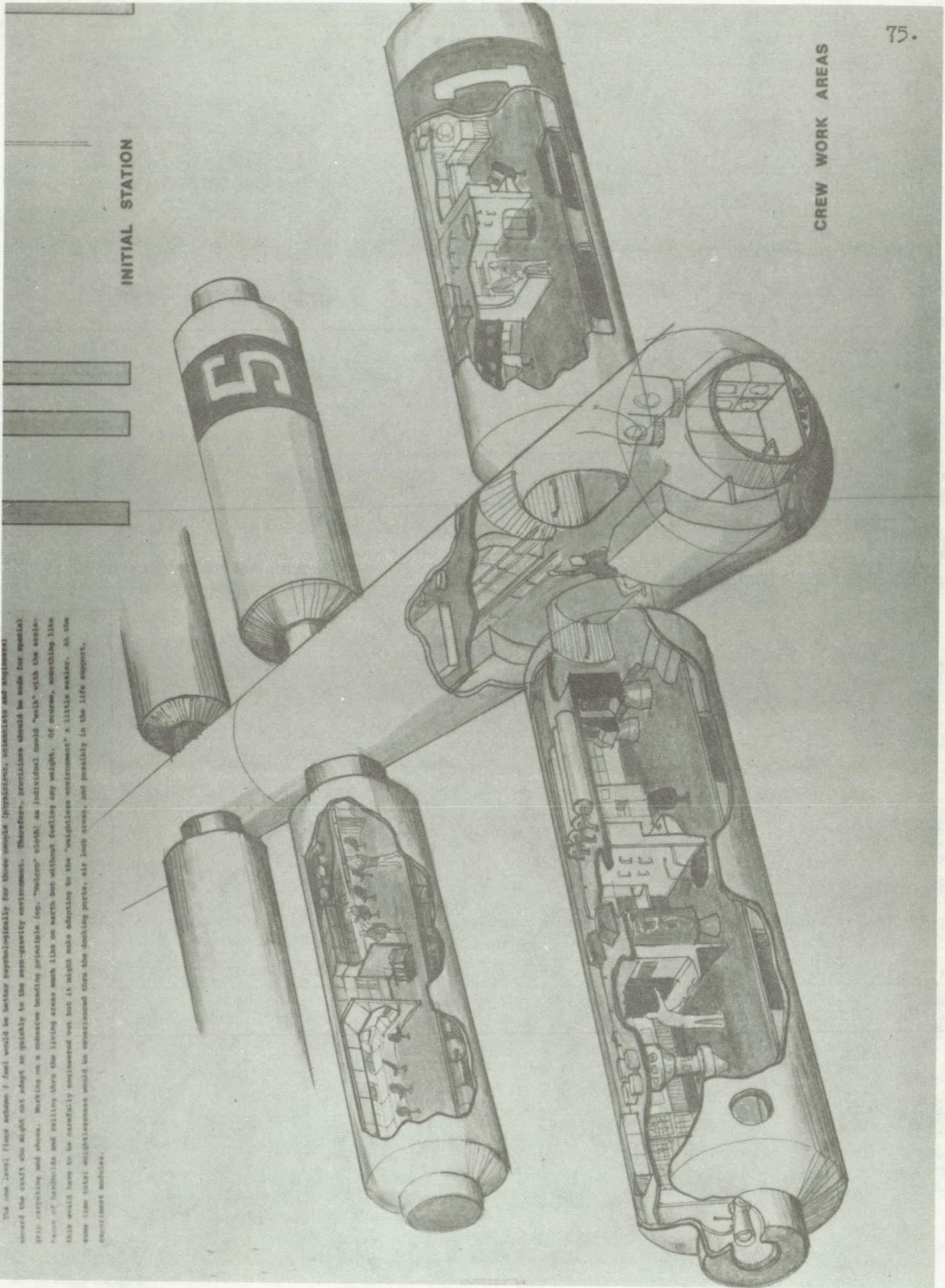
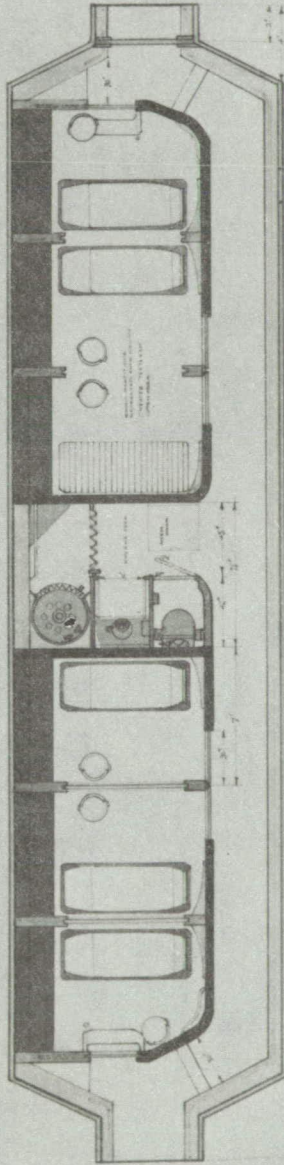


Figure 60.— Detail view of crew work area of Entry 16 (16a).

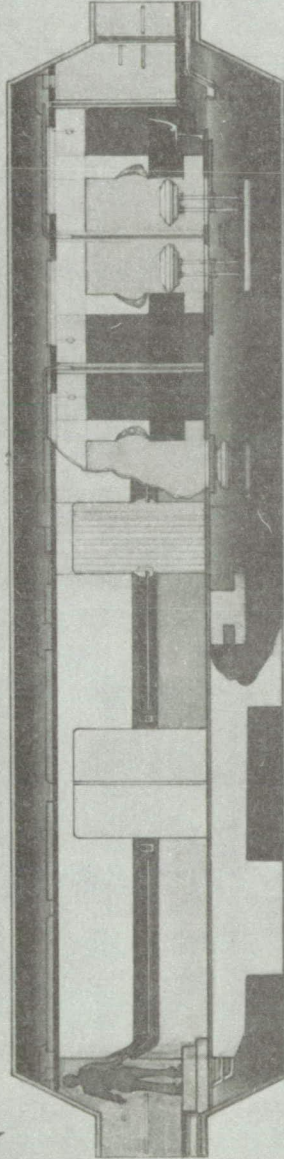
TYPE A MODULE

CREW LIVING QUARTERS

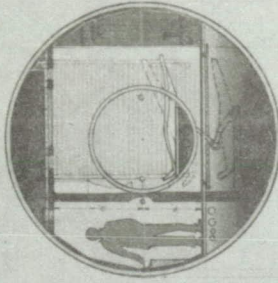
FLOOR PLAN / TOP HALF SECTION



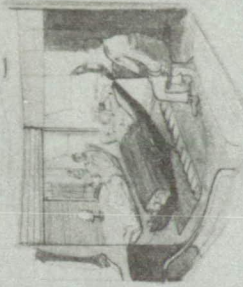
SIDE VIEW / SECTION CUTAWAY



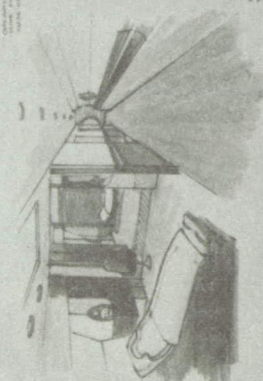
END VIEW / SECTIONAL



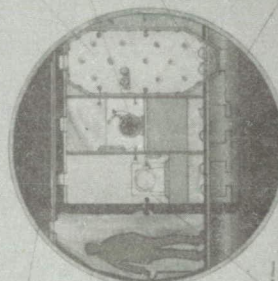
ROOM ENVIRONMENT



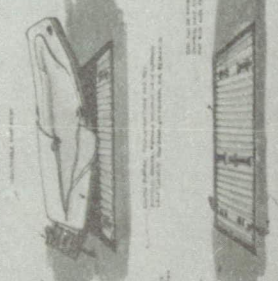
TWO MODULES



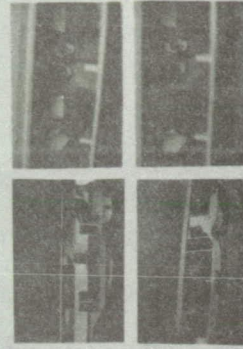
SIDE CORRIDOR PERSPECTIVE



PERSONAL HYGIENE AREA CROSS SECTION



SPACE COUCH / EXERCISE MAT



MODEL PHOTOGRAPHS

Figure 61.- Panel b of Entry 16 (16b).

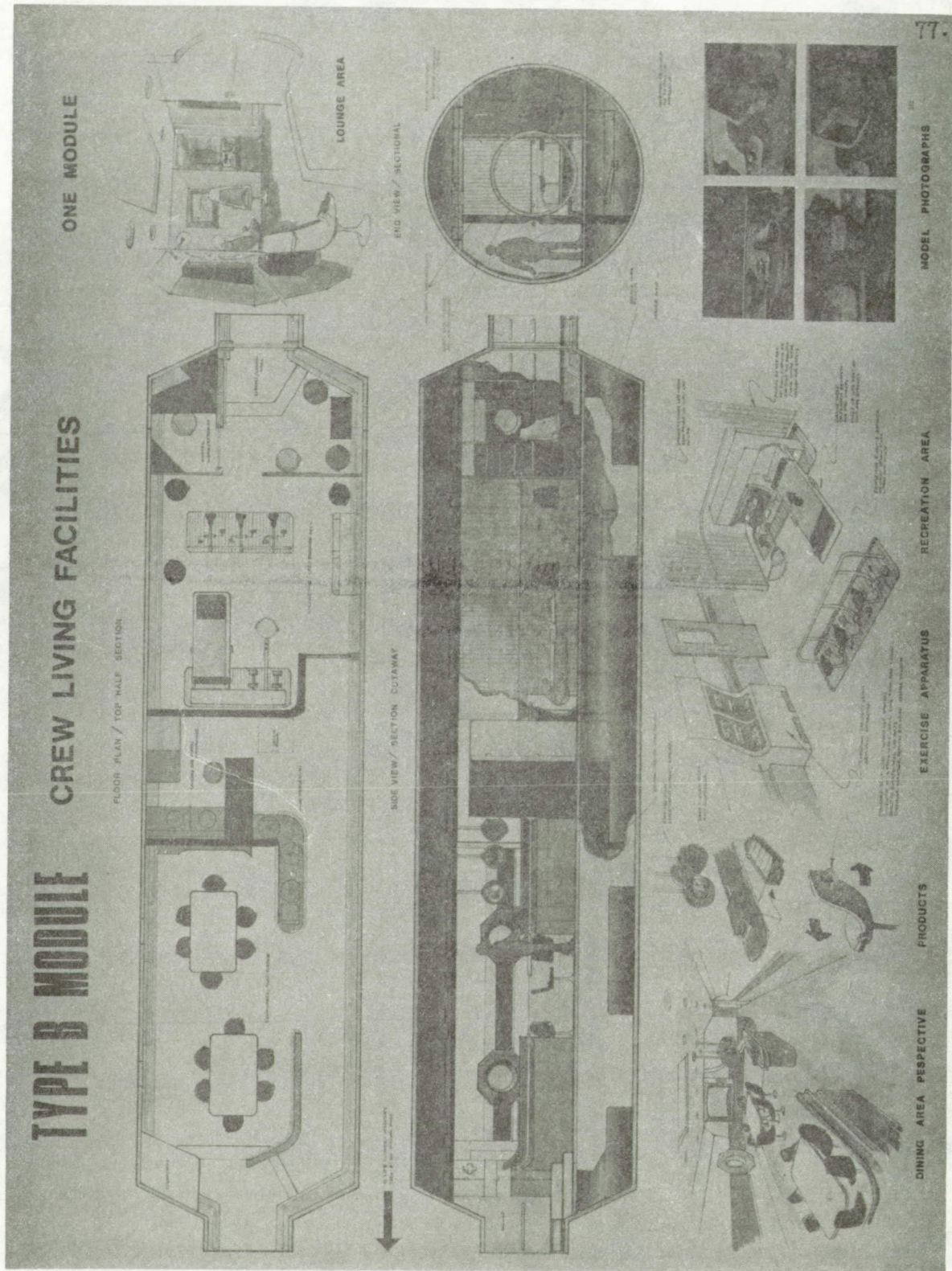
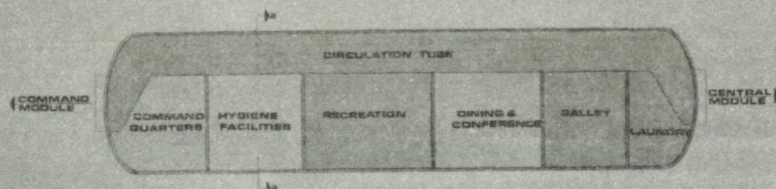
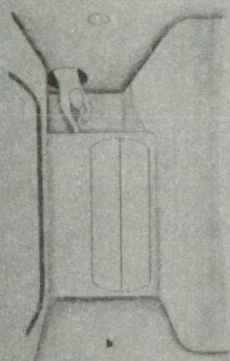


Figure 62.— Panel c of Entry 16 (16c).

module 1

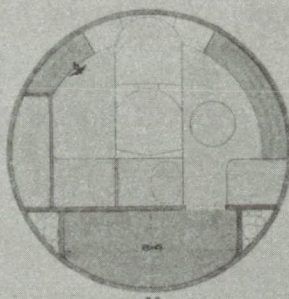


SCALE: 1/2"



hygiene facility

THIS HYGIENE FACILITY HAS TWO SECTIONS. ONE FOR THE COMMANDERS WITH DIRECT ACCESS TO THEIR QUARTERS & ONE TO SERVE AS A LOCKER ROOM FOR THE REC. AREA. ALONG WITH THE HYGIENE AREAS BY THE LABS & LOUNGE, IT ISN'T VERY FAR FROM ANY PLACE IN THE STATION TO A HYGIENE FACILITY.

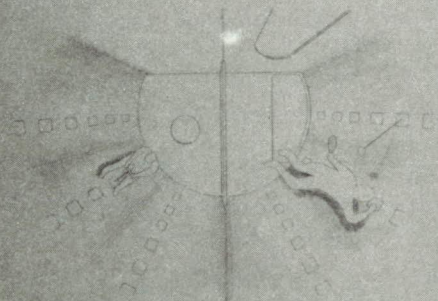


- CIRCULATION TUBE
- UTILADOR
- SHOWER
- WASTE FACILITY
- CLEANSING UNITS
- STORAGE
- STORAGE FOR REC.



galley

THE FOOD IS COOKED, THEN PUT INTO TRAY-LIKE UNITS. THE FUNCTION & DESIGN OF THE GALLEY IS CENTERED AROUND THIS UNIT, WHICH CONSISTS OF A PART FOR SOLIDS, A TUBE FOR LIQUIDS & WASTE DISPOSAL AREA.



recreational area

THE RECREATIONAL AREA CAN BE DIVIDED INTO TWO AREAS FOR FLEXIBLE USE. THE AREA UTILIZES A COMBINATION LIGHT-ING-EQUIPMENT MOUNT UNITS. ISOMETRIC EXERCISES, HANDBALL, RADDLEBALL AND TRAMPOLINE ARE A FEW OF THEIR ACTIVITIES.

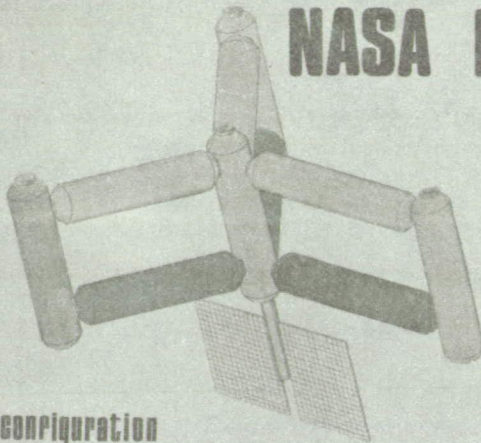


dining area & conference

TRAY IS USED AS A RESTRAINT DURING DINING AND CONFERENCE, ALSO A WRITING SURFACE. THERE ARE RESTRAINT PLACES FOR SPEAKERS IN FRONT, ALSO A SCREEN FOR PRESENTATIONS AND VISUAL ENTERTAINMENT DURING MEALS.

Figure 63.— Panel a of Entry 17 (17a).

NASA DESIGN PROJECT



configuration

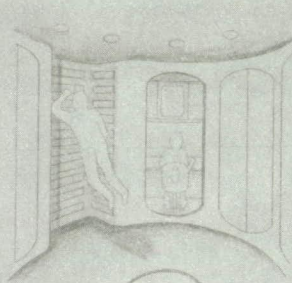
- LIVING
- COMMAND
- LABS
- LIFE SUPPORT
- FINAL 3 MODULES

THE CONFIGURATION IS SYMMETRICAL IN THE ADVANCED STATION AND CLOSE TO SYMMETRICAL IN THE INITIAL STATION FOR LESS DRAG WHILE IN ORBIT. THE 3 LIVING MODULES FORM A T AS DO THE LABORATORY MODULES. THIS IS FOR CLOSENESS OF FUNCTION AND MEANS LESS UNNECESSARY TRAVELING ABOUT THE STATION AND LESS DISTURBANCE. THE COMMAND MODULE IS PLACED, SO THAT IT HAS A VIEW OF ALL MODULES AND DOCKING PORTS. FOR SAFETY, ALL MODULES HAVE 2 MEANS OF EGRESS AND CAN BE SEALED OFF FROM THE OTHERS WITHOUT PREVENTING CIRCULATION THRU THE STATION.

ORIENTATION IS 'UP' AND 'DOWN' TO SIMULATE FAMILIAR EARTH-LIKE ENVIRONMENT. THIS PROMOTES A SENSE OF SECURITY AND PROVIDES FOR EASY FACE-TO-FACE COMMUNICATION AND READABLE FACIAL EXPRESSIONS. ZERO-GRAVITY IS USED AS A BENEFICIAL FACTOR THROUGHOUT THE STATION BY TAKING FULL ADVANTAGE OF ALL SPACES.

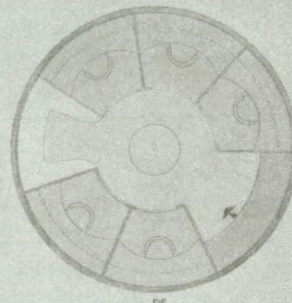
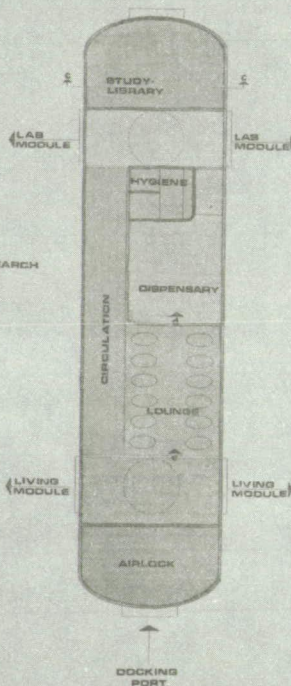
A LARGE OPEN LOUNGE IS LOCATED IN THE CENTER OF THE 3 LIVING MODULES. THE LOUNGE IS PLACED IN THE CENTER OF CIRCULATION, SO IT IS EASILY ACCESSIBLE TO ALL LIVING & WORKING AREAS. PEOPLE CAN STOP OFF HERE BETWEEN ACTIVITIES FOR ENTERTAINMENT AND SOCIALIZING. OFF ONE SIDE OF THE LOUNGE IS THE PASSAGEWAY LEADING TO THE PRIVATE CREW QUARTERS & HYGIENE FACILITIES. CIRCULATION TUBES ARE USED TO PREVENT DISTURBANCE OF ACTIVITIES. OFF THE OTHER SIDE OF THE LOUNGE IS THE PASSAGEWAY LEADING TO THE DINING-CONFERENCE AREA. NEXT TO THAT IS THE RECREATIONAL AREA WITH A HYGIENE AREA. AT THE END OF THE MODULE IS THE COMMAND QUARTERS. PLACED NEXT TO THE COMMAND MODULE IN CASE OF EMERGENCIES. THE CENTRAL MODULE ALSO CONTAINS THE MAIN DOCKING PORT & AIRLOCK, THE DISPENSARY, AND ALSO THE LIBRARY-STUDY & A HYGIENE AREA, WHICH ARE CENTRAL TO THE LABORATORY MODULES.

module II

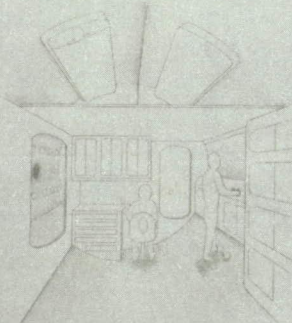


study — library

THE STUDY-LIBRARY CONTAINS 5 STUDY-RESEARCH CUBICLES, A MICRO-FILM LIBRARY, MICRO-FILM COPIER, AND A SITTING AREA. THE WALLS BETWEEN CUBICLES OPEN FOR CONFERENCATION.

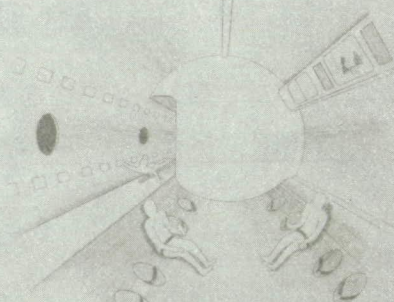


- STUDY CUBICLES
- MICRO-FILM LIBRARY
- SITTING AREA



dispensary

THE DISPENSARY CONTAINS A HYGIENE AREA, ADEQUATE STORAGE FOR FIRST AID, PHARMACEUTICAL & DENTAL SUPPLIES, A DESK WITH MEDICAL RECORDS STORAGE, AN EXAMINATION & OPERATING AREA, AND SLEEPING UNITS FOR THOSE SICK AND QUARANTINED.

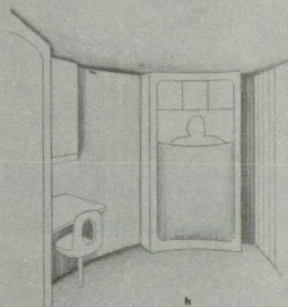
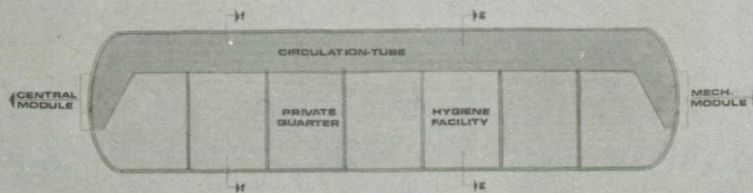


lounge

THE LOUNGE IS THE CENTER OF CIRCULATION FOR THE THREE LIVING MODULES. IT IS A LARGE OPEN AREA FOR SOCIALIZING AND ENTERTAINMENT. THE LOUNGE IS AN AREA FOR TELEVISION, MUSIC, MOVIES, READING AND OTHER PASSIVE RECREATION.

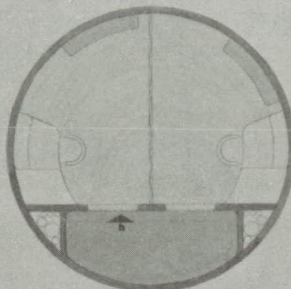
Figure 64.— Panel b of Entry 17 (17b).

module III



private quarters

THE SLEEPING UNIT CONTAINS STORAGE & CONTROL PANEL. THE SLEEPING RESTRAINT IS ELASTIC TYPE SHEETS. THE SLEEPING UNIT IS MOVABLE & WHEN THE FOLDING WALL IS BACK TO CREATE A SUITE, A DOUBLE BED CAN BE CREATED.

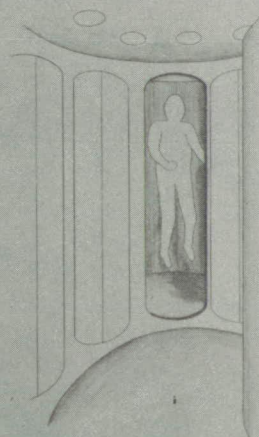


■ SLEEPING UNIT
■ STUDY-WORK AREA
■ CLOTHES STORAGE

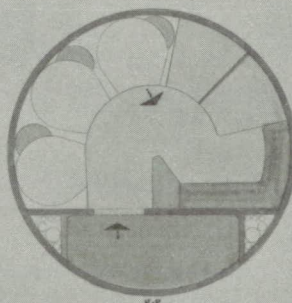


circulation tube

THE CIRCULATION TUBE CONTAINS A COMBINATION HANDHELD LIGHTING SYSTEM AND EMERGENCY FIRST AID STATIONS.

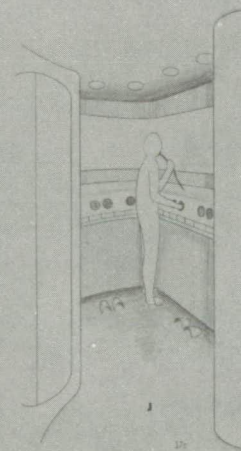


SHOWERS CONTAIN CLOTHES STORAGE, SO YOU CAN UNDRESS, SHOWER, DRY OFF IN PRIVACY.



hygiene facility

■ CIRCULATION TUBE
■ UTILIDOR
■ SHOWER
■ WASTE FACILITY
■ CLEANSING UNITS
■ STORAGE



THE CLEANSING UNIT CONTAINS HAND CLEANSING, TOWELS, DISPOSAL, TUBE TO DRINK AND WASH MOUTH OUT WITH.

Figure 65.— Panel c of Entry 17 (17c).

the man

0 1 2 3 4 5 6 7 8 9
 10 11 12 13 14 15 16 17 18 19
 20 21 22 23 24 25 26 27 28 29
 30 31 32 33 34 35 36 37 38 39
 40 41 42 43 44 45 46 47 48 49
 50 51 52 53 54 55 56 57 58 59
 60 61 62 63 64 65 66 67 68 69
 70 71 72 73 74 75 76 77 78 79
 80 81 82 83 84 85 86 87 88 89
 90 91 92 93 94 95 96 97 98 99

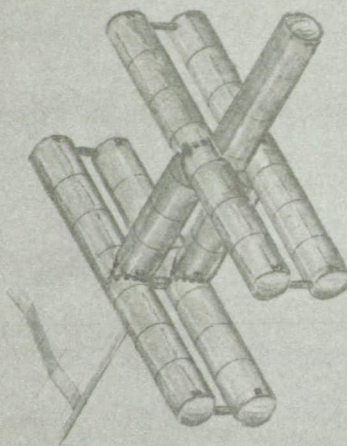
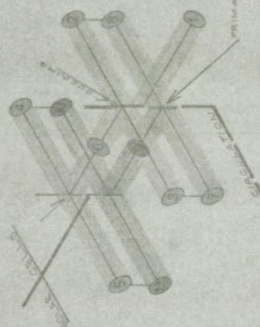
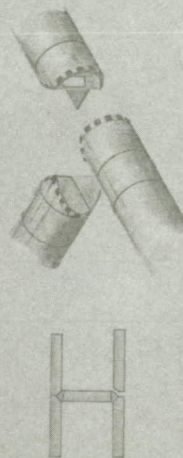
configuration

[Faint vertical text from bleed-through]

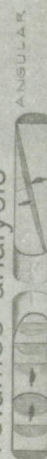
modules

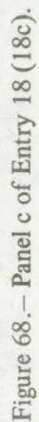
[illegible]

advanced configuration



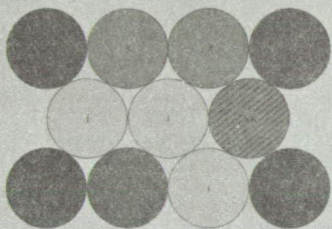
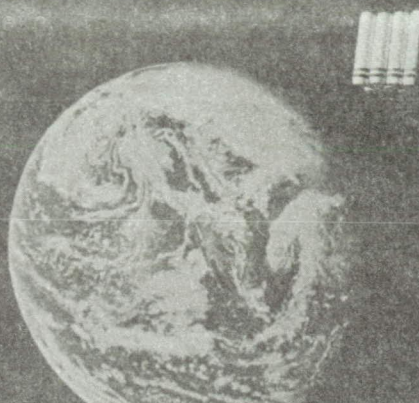
volumes analysis

[illegible][illegible]



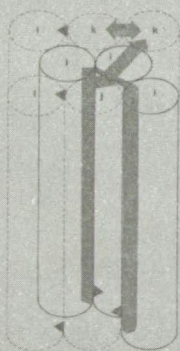
CAPSULE CONFIGURATION

NASA SPACE LAB DESIGN



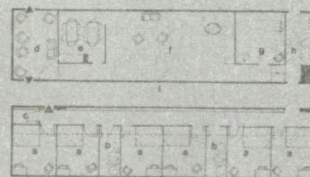
- l. living module
- c. command
- k. laboratory
- i. life support
- sh. advanced lab.
- sh. advanced life sup.

MODULE ARRANGEMENT



- major circulation
- emergency exit
- l. living module
- c. command
- k. laboratory
- i. life support

CIRCULATION

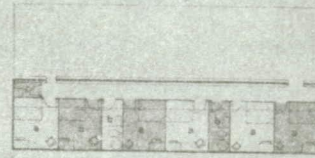


- escape route
- emergency equip.

EMERGENCY ROUTES
SCALE: 1/8" = 1'-0"

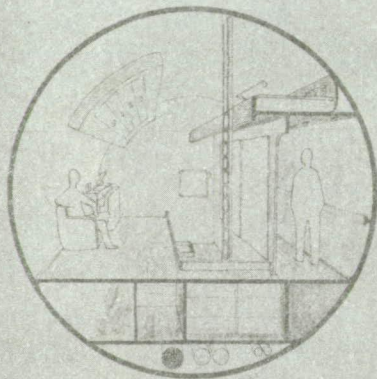
Figure 69.— Panel a of Entry 19 (19a).

BEDROOM CAPSULE NASA SPACE LAB DESIGN

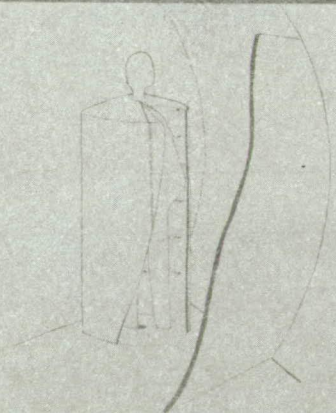


a. bedroom
b. bathroom
c. laundry

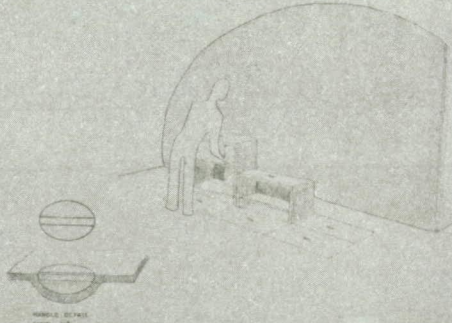
FLOOR PLAN
scale: 1/8" = 1'-0"



BEDROOM



SHOWER

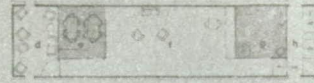


STORAGE

Figure 70.— Panel b of Entry 19 (19b).

COMMUNITY CAPSULE

NASA SPACE LAB DESIGN



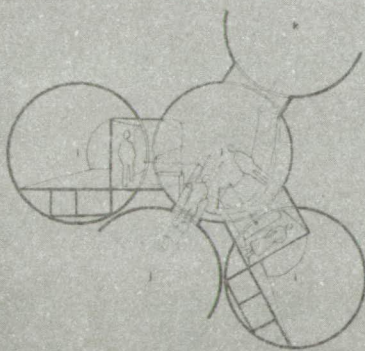
- d - reading rm.
- a - dining rm.
- f - multipurpose rm.
- g - exercise rm.
- c - circulation core

FLOOR PLAN
scale: 1/8" = 1'-0"

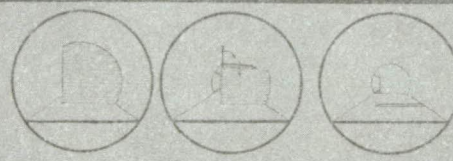


m - meditation rm.

SECTION AA
scale: 1/8" = 1'-0"



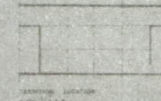
CIRCULATION CORE
scale: 1/4" = 1'-0"



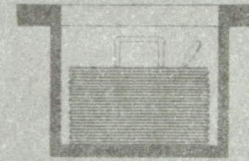
N. WALL
scale: 1/4" = 1'-0"

E. WALL

S. WALL



MOVABLE PARTITION
scale: 1/4" = 1'-0"



STORAGE UNIT
WALL UNIT

Figure 71.— Panel c of Entry 19 (19c).

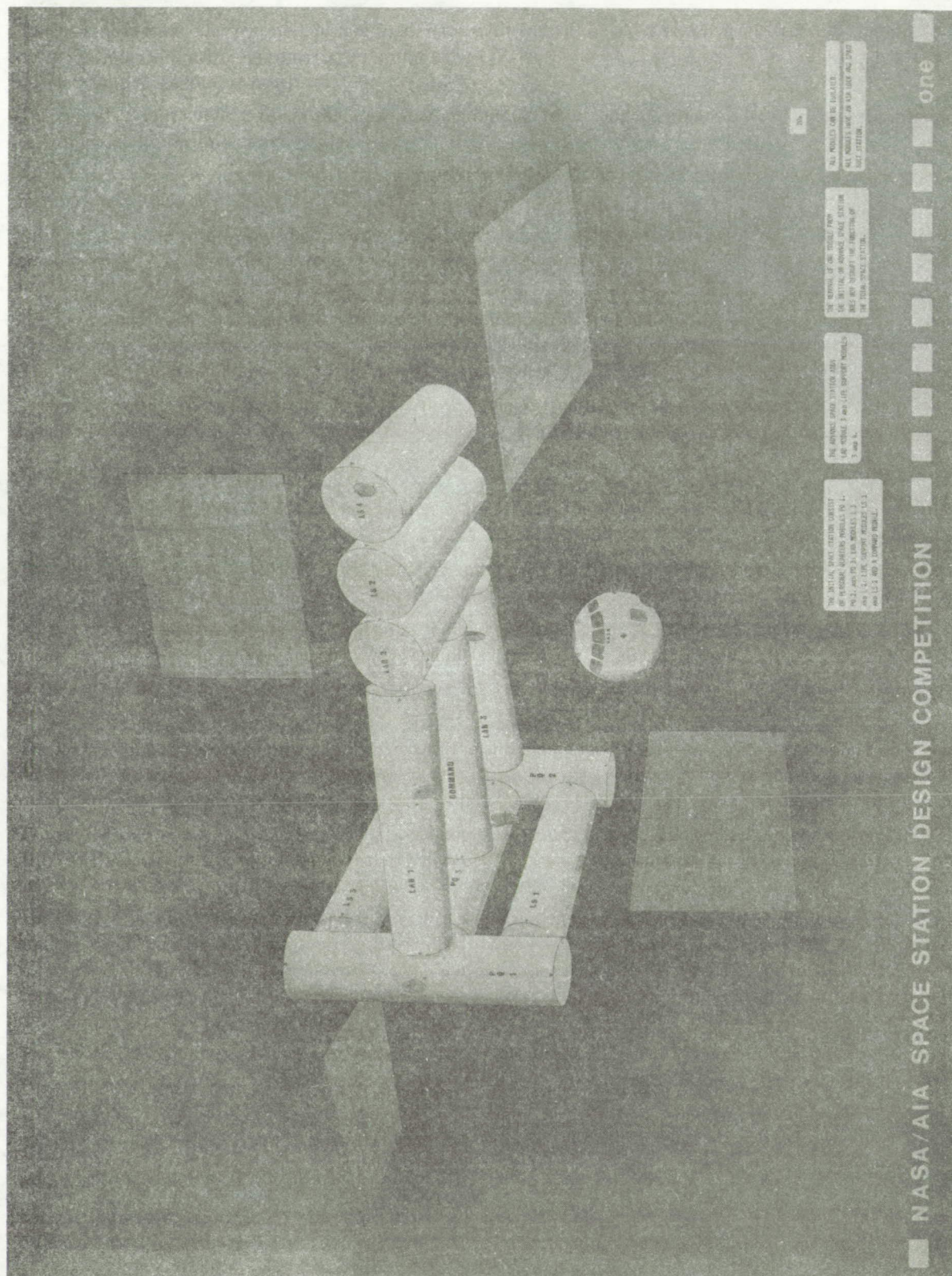


Figure 72.— Panel a of Entry 20 (20a).

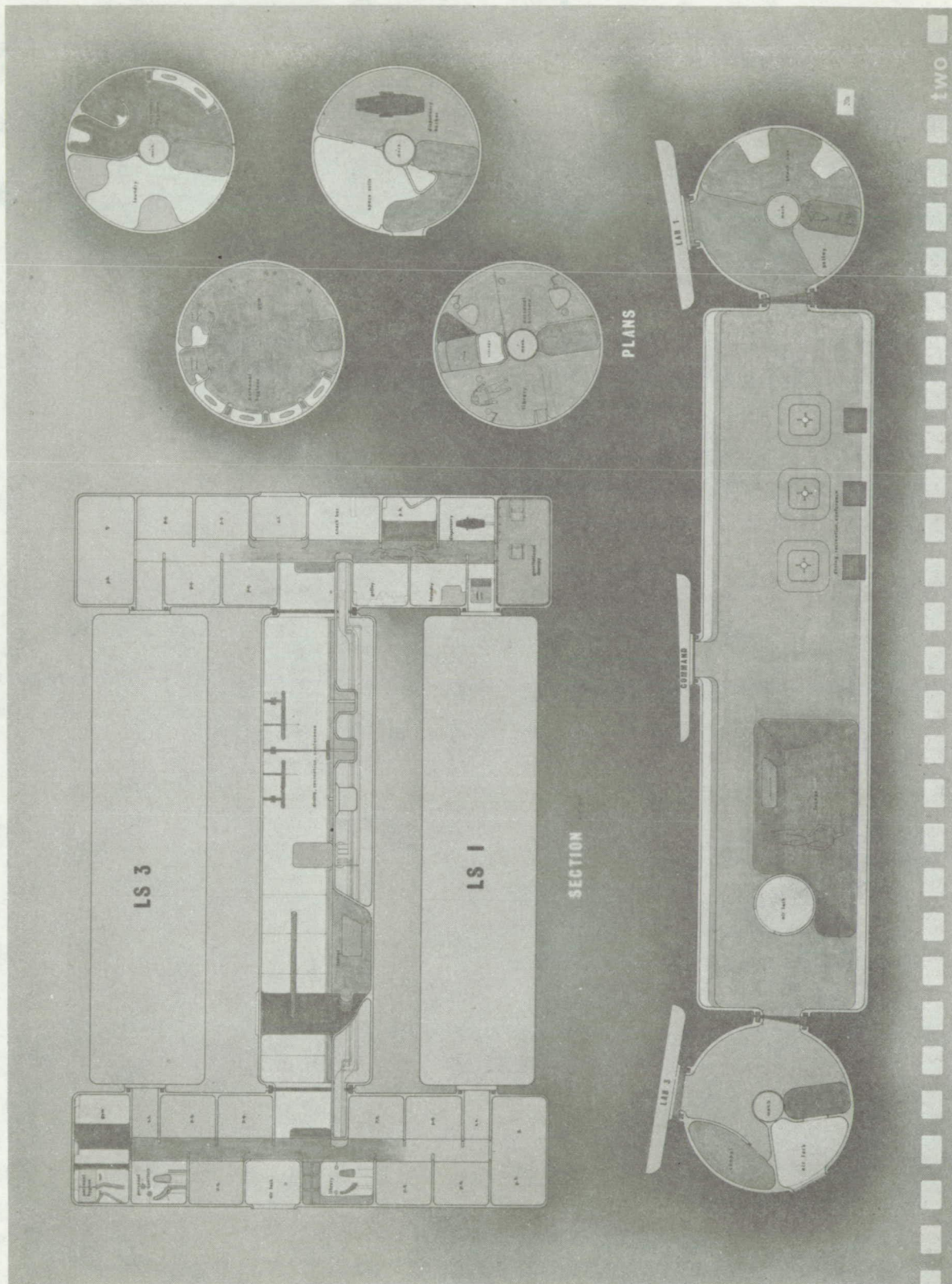


Figure 73.— Panel b of Entry 20 (20b).

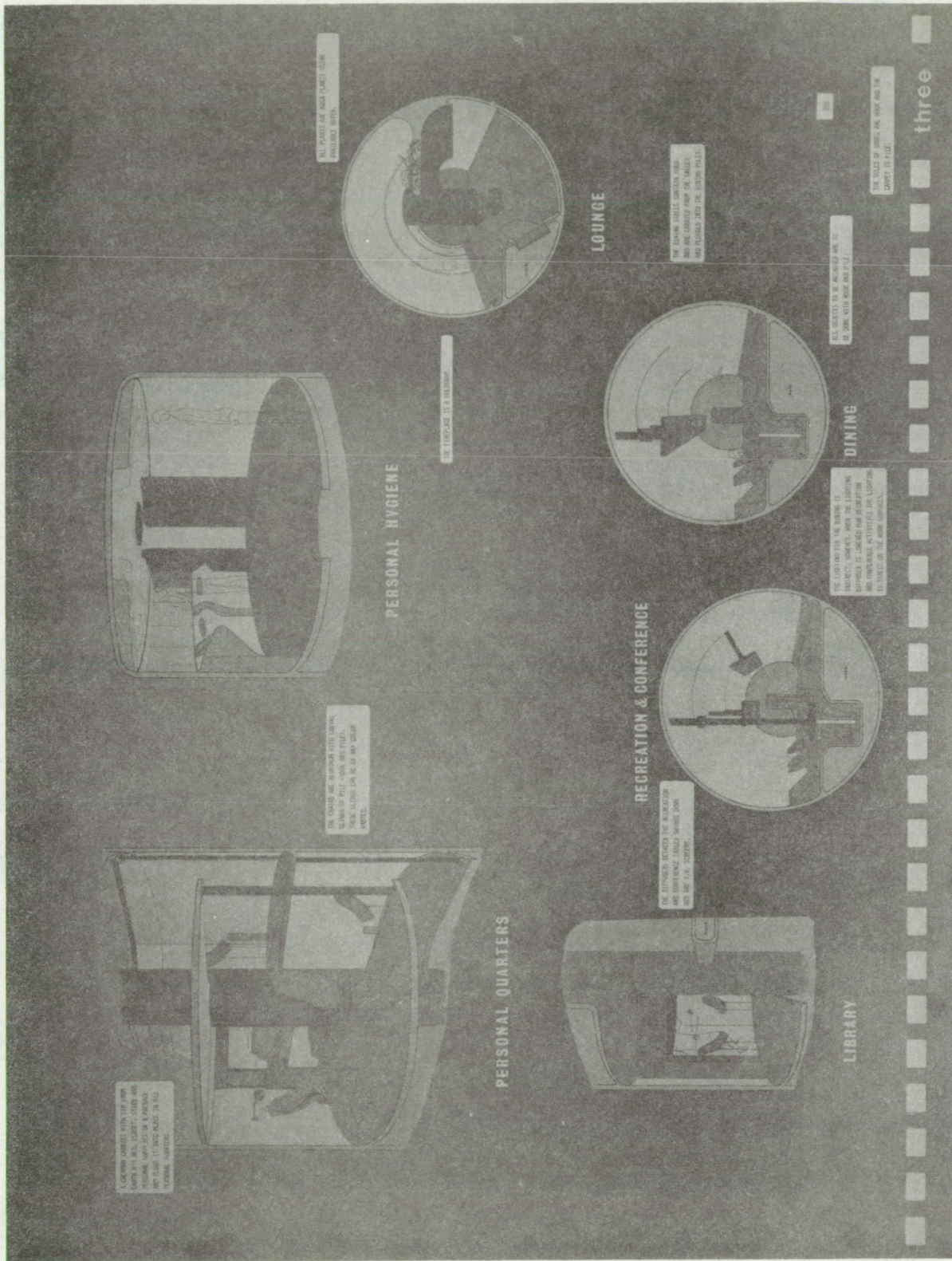


Figure 74.- Panel c of Entry 20 (20c).

CONCEPT:

The module organization plan is characteristic of compactness, balance, unity, order, structure, logic and function. It is possible to transfer from any one module to another if its neighboring module must be sealed, without necessity for EVA. Each module has immediate access to a life support system.

Any one module may be removed from the system without disturbing the order of the others. Each module has a minimum of two EVA exits for any project or emergency. All modules studied contain self-supporting emergency survival energy facilities.

Dining module contains food storage bin which may be removed and resupplied. Also a replaceable dispose recycle unit is included. Every module with hygiene facilities contain a recycle waste compactor unit which may be removed when filled and in each instance replaced by a new empty unit.

Double occupancy and extra sleeping facilities are provided throughout the arrangement. Extra may be set up in dining and recreation areas. Dining and recreation areas activities may be interchanged within modules. Interior design provides maximum conveniences decent of the cosmic environment. Living modules provide maximum security and closeness of crew, maintaining the maximum individual privacy. Dining module, includes food preparation facilities, disposal units, dining facilities, hygiene units, energy quadrants. Dining module is located as to conveniently interact and serve with recreation, living, command, lab, and life support modules.

Living module conserves its independent privacy linked to life supports. It also interacts with dining, recreational, and lab facilities. The recreation module serves, the dining, living, a lab and 3 life supports. After dining one may enter the recreation area. You do not have to go thru dining area from living in order to get to recreation. After lab work, one may enter recreation module for relaxation.

Each module may become independent of any other module at any given time without obliterating the interior communication patterns. The overall design emphasizes maximum availability to each module from any module to provide organic aspects within, demonstrating flow and unity.

Efforts include extracting maximum efficiency from zero gravity conditions intermingling functionally with any activity, conserving energy, minimizing waste and utilizing all spaces within a three-dimensional aspect.

Miniaturization of space has been maximized to provide the best efficiency and, through balance, a sense of constant flow and free space has been achieved thus eliminating psychological factors concerning tightness.

The vividness of the color patterns express a mellifluous transition of moods, environment, and a constant flux within interior activities. The colors not only transmit a sense of movement and life, but excite mentally in relation to the cosmic spectrum of outer space and mankind.

MODULE NUMBER CODE	
COMPLETED PHASE 1 Dining 2 Living 3 Life Support 4 Life Support 5 Laboratory 6 Life Support 7 Recreation 8 Life Support 9 Laboratory 10 Command 11 Laboratory	INITIAL PHASE 1 Dining 2 Living 5 Laboratory 6 Life Support 7 Recreation 8 Life Support 10 Command 11 Laboratory
CONNECTORS	
MODULE 1 2 3 4 5 6 7 8 9 10 11	ATTACHED TO 2, 7, 8, 9, 10 1, 3, 7, 8, 9 2, 7, 8, 9 5, 7, 8, 9 4, 6, 7, 8, 9 5, 7, 8, 9, 11 1, 2, 3, 4, 5, 6, 8 1, 2, 3, 4, 5, 6, 7, 9, 10, 11 1, 2, 3, 4, 5, 6, 8 1, 8 6, 8

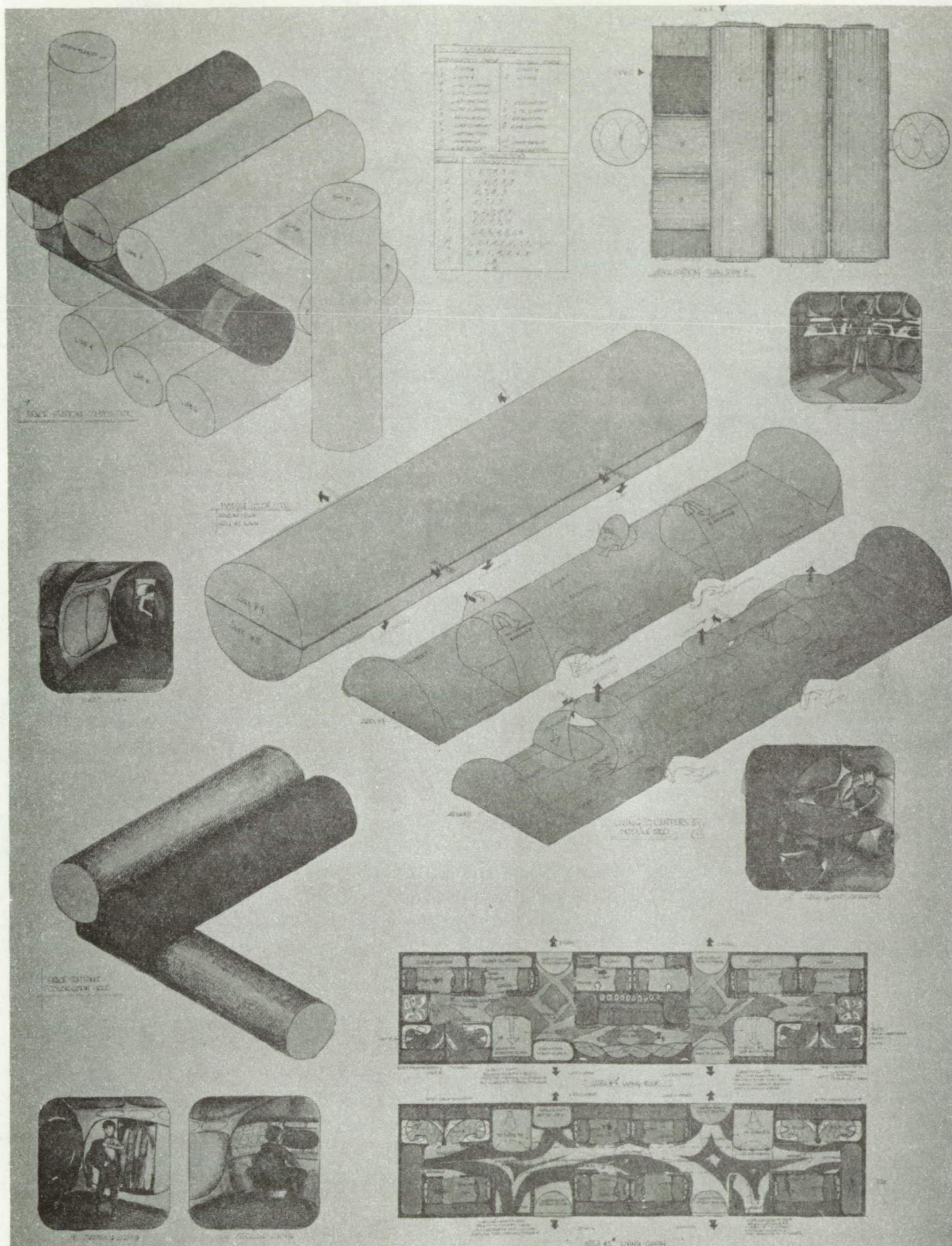


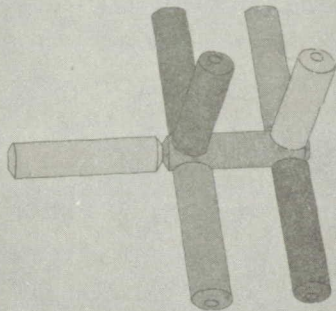
Figure 76.— Panel b of Entry 21 (21b).



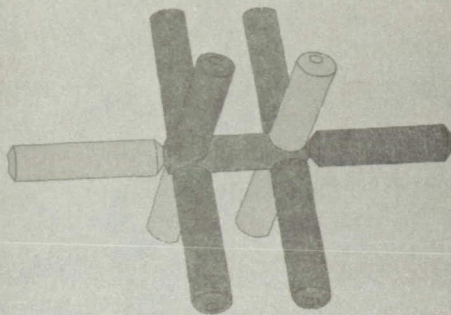
CONFIGURATION 1



CONFIGURATION 2



INITIAL STATION



ADVANCED STATION



INTRODUCTION:

THE INITIAL MODULAR SPACE STATION WILL CONSIST OF EIGHT MODULAR UNITS, EACH MEASURING 14 BY 28 FT. THE ADVANCED MODULAR SPACE STATION WILL GROW FROM THE INITIAL SPACE STATION WITH THE ADDITION OF 85 MODULES. THUS THE FINAL STATION WILL INCLUDE 93 MODULES. THE INITIAL STAGE WILL PROVIDE FOR A CREW OF 16 MEMBERS WITH PROVISIONS FOR OCCUPANCY BY 20. THE ADVANCED STATION WILL PROVIDE FOR 120 MEMBERS.

THROUGHOUT THE PROGRAM VARIOUS INCONSISTENCIES HAVE DEVELOPED. ORBIT PERTAINING TO THE SPACE MODULES AND THEIR CONFIGURATION, CLUSTERING OF THE SPACE MODULES, BECAUSE THEY CONTAIN THE MAIN POWER AND LIFE SUPPORT SYSTEMS, AND THE NUMBER OF ASSUMPTIONS

IN CONFIGURATION ONE OF THE SPACE STATION ONE CORE MODULES WOULD BE USED TO MAINTAIN THE RELATIONSHIP WITH EACH OTHER. IT WAS THE DEVELOPMENT OF THE SPACE STATION MODULE THAT LED TO THE DEVELOPMENT OF THE SPACE STATION WITH ONLY END TO END AND END TO WALL CONNECTIONS.

IN CONFIGURATION TWO OF THE SPACE STATION MULTIPLE CORE MODULES WOULD BE USED TO MAINTAIN THE RELATIONSHIP WITH THE MEMBERS OF THE THREE L2. IT WAS FELT THAT THE RELATIONSHIP OF THE THREE L2S LIVING UNITS IN NORTH STATION CONFIGURATIONS WOULD REMAIN THE SAME AND ONLY THE RELATIONSHIP OF THE OTHER MODULES WOULD BE CHANGED.

Figure 78.—Panel a of Entry 22 (22a).

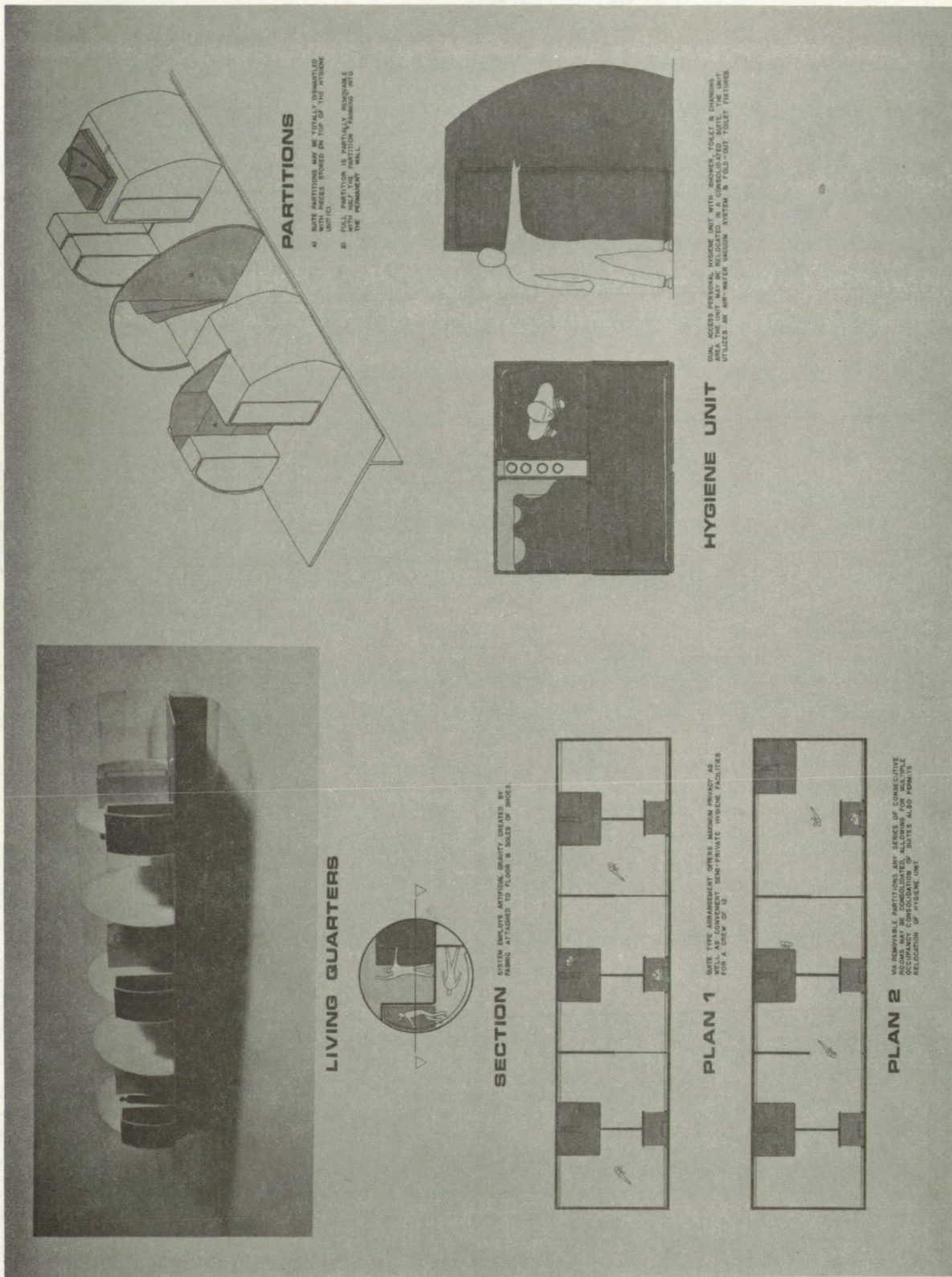


Figure 79.— Panel b of Entry 22 (22b).

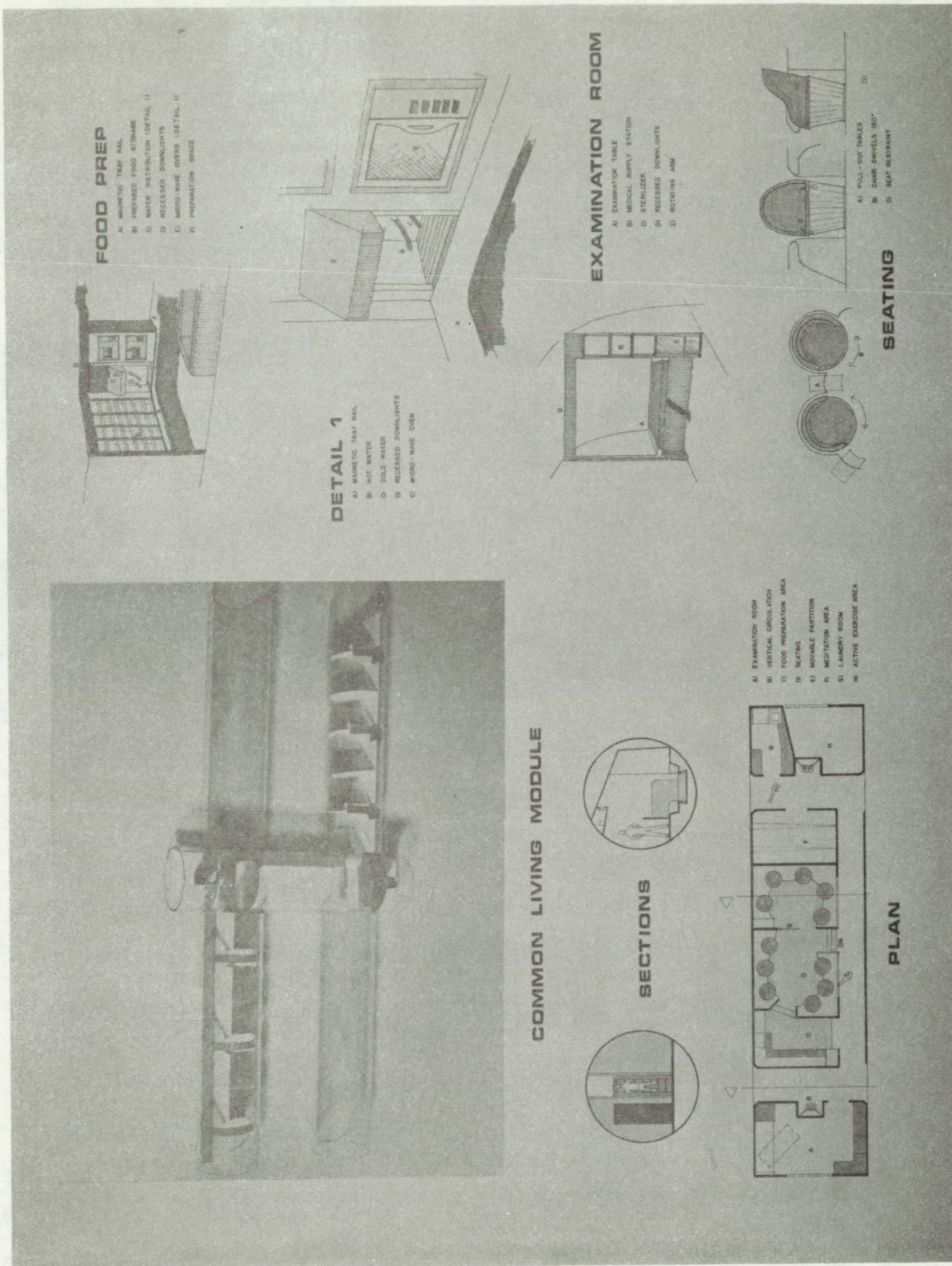


Figure 80.— Panel c of Entry 22 (22c).

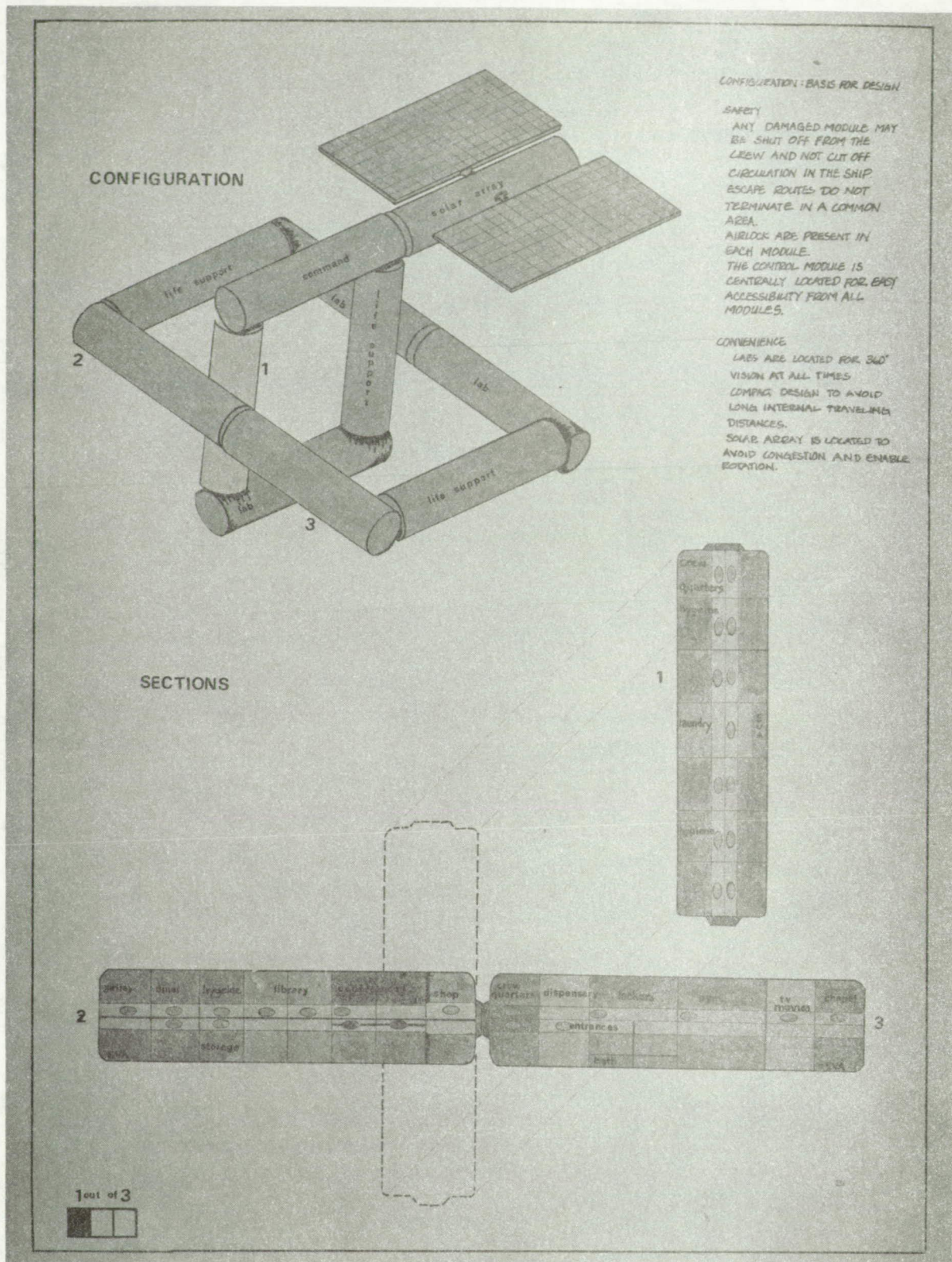
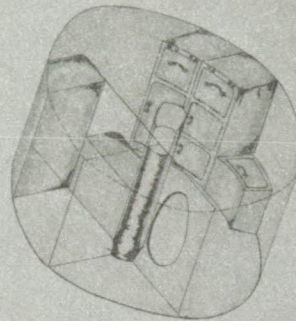


Figure 81.— Panel a of Entry 23 (23a).

NASA DESIGN COMPETITION

GALLEY

THE GALLEY WAS DESIGNED FOR PREPARING PRE-MADE, FROZEN DINNERS, SIMILAR TO TV DINNERS. THE OVEN IS MICROWAVE FOR QUICK COOKING. AFTER BEING COOKED THE DINNER IS PLACED IN A CONTAINER, WHICH ALSO HOLDS A LIQUID. THESE ARE THEN PLACED IN A LARGE TUBE WHICH CARRIES IT TO THE DINNING AREA. THE REUSABLE EATING UTENSILS ARE RETURNED TO THE TUBE AND TAKEN BACK TO THE GALLEY. THEY ARE PUT IN THE DISHWASHER AND LATER STORED. A LARGE REFRIGERATOR, UTENSIL AND FOOD STORAGE, FIRST AID AND A FIRE EXTINGUISHER ARE ALSO LOCATED IN THE GALLEY.

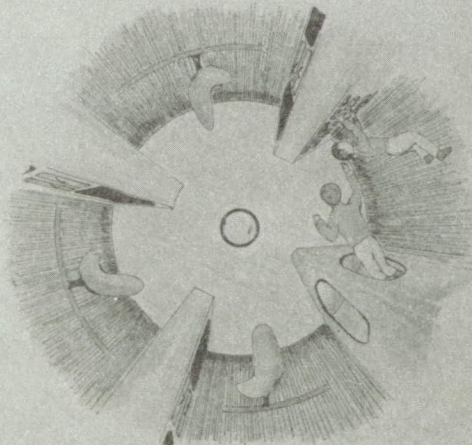


DINING AREA

THE DINING AREA IS DESIGNED FOR SIX PEOPLE PER MEAL, BUT ADDITIONAL SEATING RESTRAINTS CAN BE EASILY ACCOMMODATED. THE ROOM IS CONNECTED DIRECTLY TO THE GALLEY BY WAY OF ELEVATOR SERVICE. THIS TUBE CARRIES HOT MEALS AND DIRTY DISHES TO AND FROM THE ROOMS. THE TUBE REMAINING OPENING IS CENTRALLY LOCATED AND SURROUNDED BY MOVABLE CHAIRS LOCATED ON TRACKS. A TAPE DECK IS ALSO LOCATED IN THE ROOM. THIS ROOM DOUBLES AS A MEETING AREA DURING NON-MEAL HOURS.

LIBRARY

THE LIBRARY CONTAINS MICROFILM TO CUT DOWN THE WEIGHT AND VOLUME PROBLEM OF BOOKS. THE LARGE LIBRARY ROOM (PICTURED) CONTAINS SIX FILM SCREENS AND SIX CORRESPONDING SEATING RESTRAINTS. ALSO A CARD CATALOG IS LOCATED IN THE ROOM FOR FILM REFERENCE AND STORAGE.

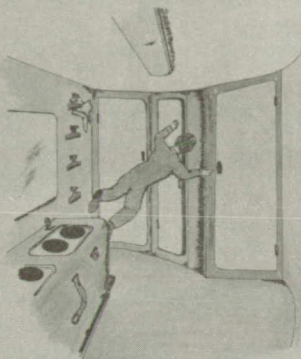


2 out of 3



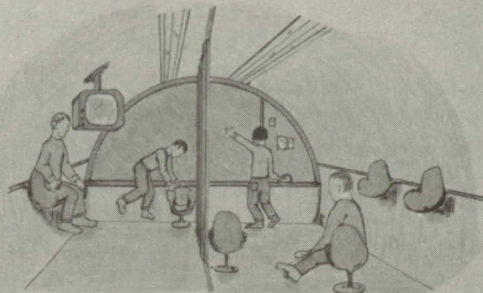
Figure 82.— Panel b of Entry 23 (23b).

PERSONAL HYGIENE AREA



TWO SINKS, A SHOWER, AND TWO TOILETS ARE SHARED BY FIVE MEN. THE SHOWER AND TOILETS WORK ON A SUCTION PRINCIPLE, WHILE THE SINKS ARE COVERED BY SOFT RUBBER AND THE HANDS ARE PUSHED THROUGH THE HOLES. WATER CAN BE CONTROLLED BY THE HANDS WHEN THEY ARE UNDER THE COVER. TEETH MAY BE BRUSHED BY USE OF A WATER HOSE LOCATED ON THE SINK.

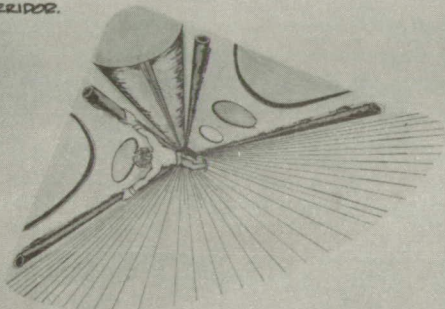
CONFERENCE AREA



THIS MULTIPURPOSE ROOM IS A COMBINATION TV-LOUNGE AND A CONFERENCE ROOM. A SLIDING SCREEN SPLITS THE ROOM IF MORE THAN ONE GROUP NEEDS THE ROOM. MOBILE CHAIRS ON TRACKS, AND OTHER TYPES THAT ARE SECURED BY A VELCRO PAD, ARE FURNISHED. A CHALKBOARD/BULLETIN BOARD COVERS ONE END OF THE ROOM AND CAN BE USED FOR BRIEFINGS.

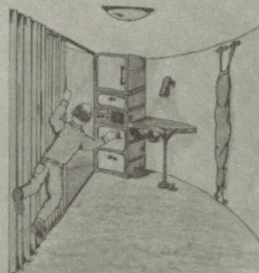
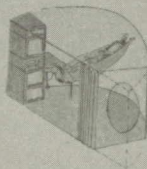
CIRCULATION

A THREE-SIDED PASSAGEWAY PASSES THROUGHOUT THE MODULES. THIS STRAIGHT CORRIDOR CONTAINS TWO CONTINUOUS HAND RAILS RUNNING APPROXIMATELY ARMS WIDTH ON THE TWO SIDES WHICH RUN BY ROOM ENTRANCES. THE THIRD SIDE CONTAINS LIGHTING FOR THE CORRIDOR.



CREW QUARTERS

THE CREW QUARTERS CONTAIN MOVABLE FURNISHINGS SO THAT THE OCCUPANT MAY BE ABLE TO CHANGE HIS SURROUNDINGS. THE SLIDING GREEN PARTITIONS DIVIDE THE TWO ROOMS. A TAPE DECK, REFRIGERATOR, CLOTHES STORAGE, WRITING SPACE, AND SLEEPING RESTRAINT ARE THE BASIC FURNISHINGS.



3 out of 3

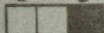


Figure 83.— Panel c of Entry 23 (23c).

SPACE STATION CONFIGURATION

Initial space station is centered around the command/control module-D and the three living modules-A, B, and C are connected directly to it. This provides access to the living modules in a direct route or not more than three modules. This configuration provides easy docking and connection of the three modules used to form the advanced space station. All modules are inter-connected at two points and each also has an air-lock at both ends to provide for E.V.A. operations.

List of Modules:

- A** Dining/food preparation, crew hygiene, leisure, recreation, exercise.
- B** Dispensary, living quarters, personal hygiene, chapel.
- C** Laundry, living quarters, personal hygiene, library.
- D** Command/control module.
- E** Laboratory/experiment module.
- F** Laboratory/experiment module.
- G** Life support.
- H** Life support (advanced).
- I** Laboratory/experiment (advanced).
- J** Life support (advanced).
- K** Electrical power.

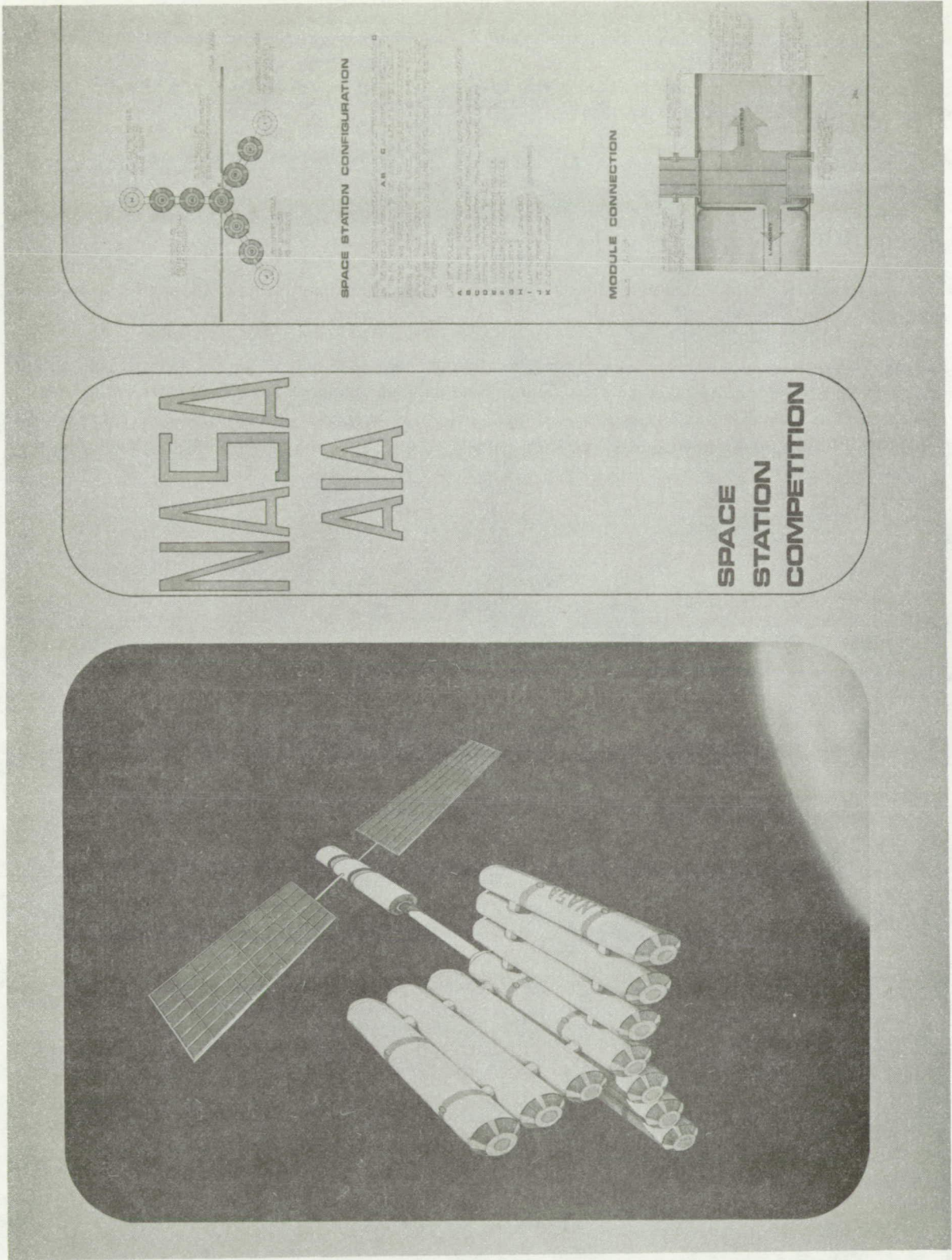


Figure 84.— Panel a of Entry 24 (24a).

Dining hall serves double purpose for eating and leisure space such as movies, chess, conversation and reading.

Gym supplies space for physical exercise with isometrics and bicycle riding. Special air handling unit below floor.

Individual quarters designed for a maximum of twelve people. Crew changes will take place over a period of twenty-four hours, so no extra sleeping spaces required.

Dispensary self-sufficient. Contains medical supplies and test equipment. Chair swivels and folds out into a table for various uses. Isolation bed supplied for any emergency that may arise.

Recessed lighting used along with spot lighting for work areas.

Chapel carpeted and swivel chairs used natural earth landscape murals painted on the individual walls to enlarge the space and create a relaxed mood.

Airlocks gray in color with recessed lighting fixtures. Laundry light blue with blue carpeting, recessed lighting and spot lighting over work areas. Individual quarters carpeted and painted various restful colors. Intercom located in ceiling. Chair folds out from used clothes storage. Cove lighting. Hygiene areas sealed from passages. Storage units for personal use. Storage for water and waste recycling. Library carpeted and wall panels in blue, recessed and cove lighting used. Swivel chairs used.

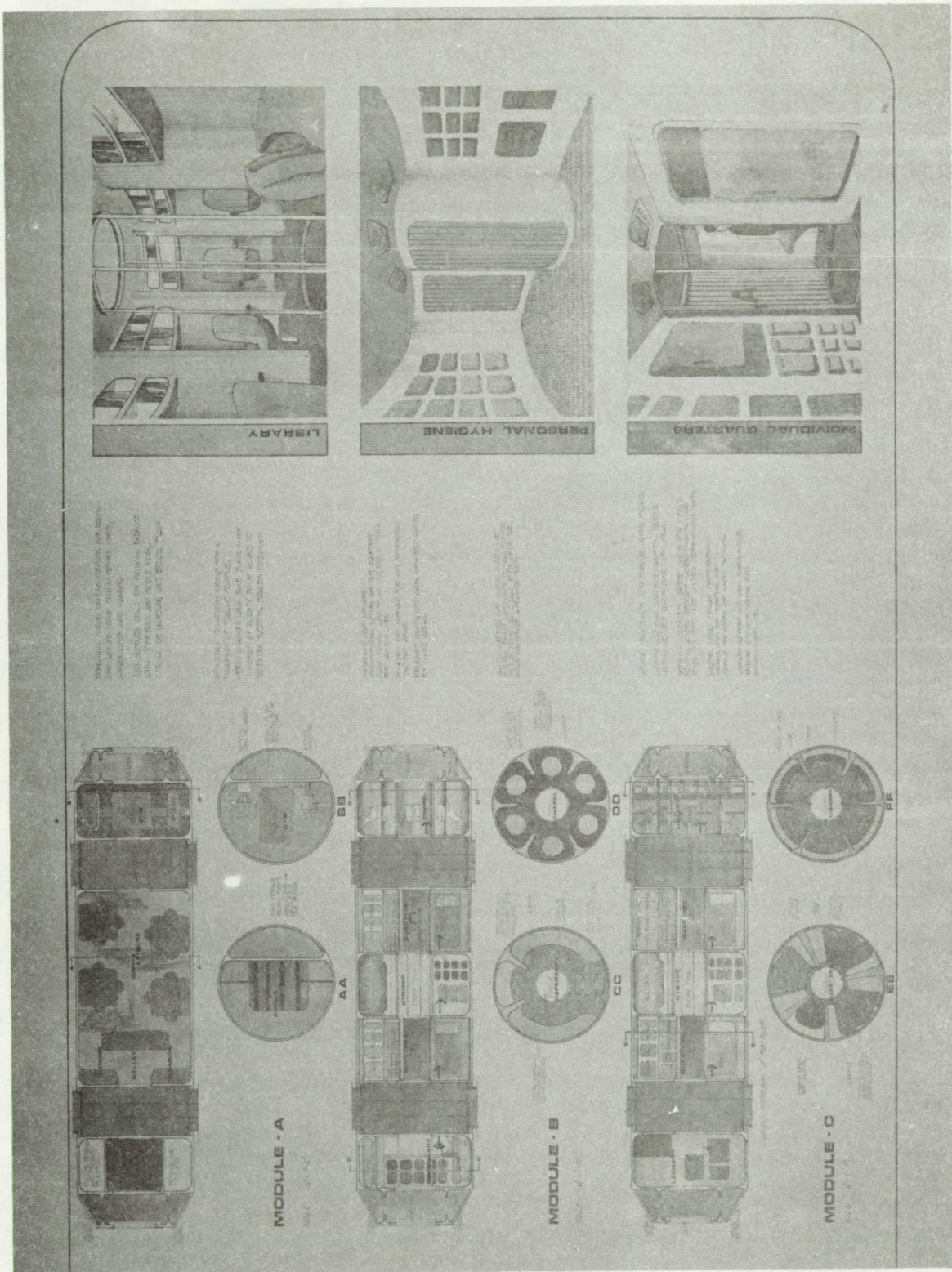


Figure 85.— Panel b of Entry 24 (24b).

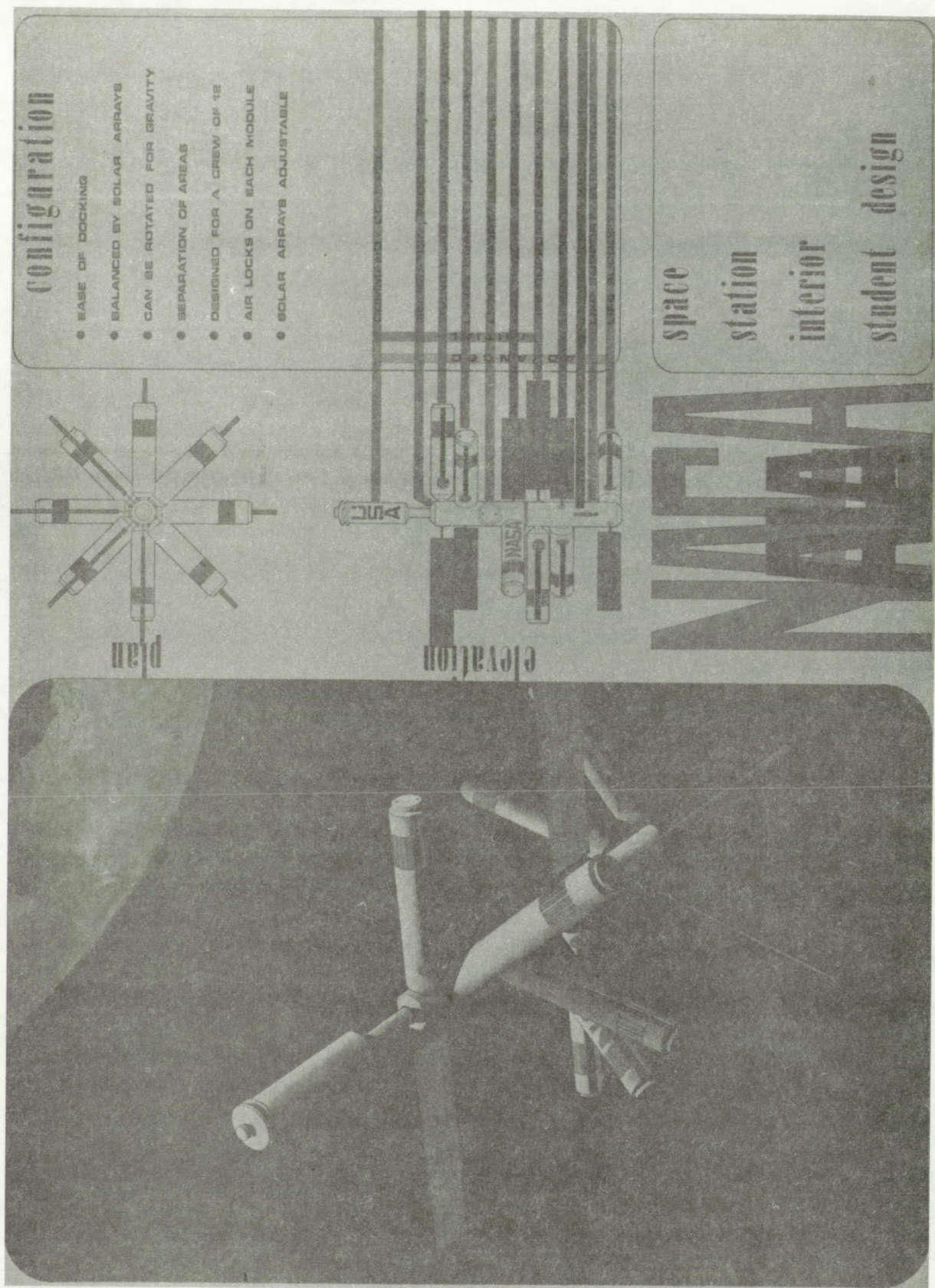


Figure 86.— Panel a of Entry 25 (25a).

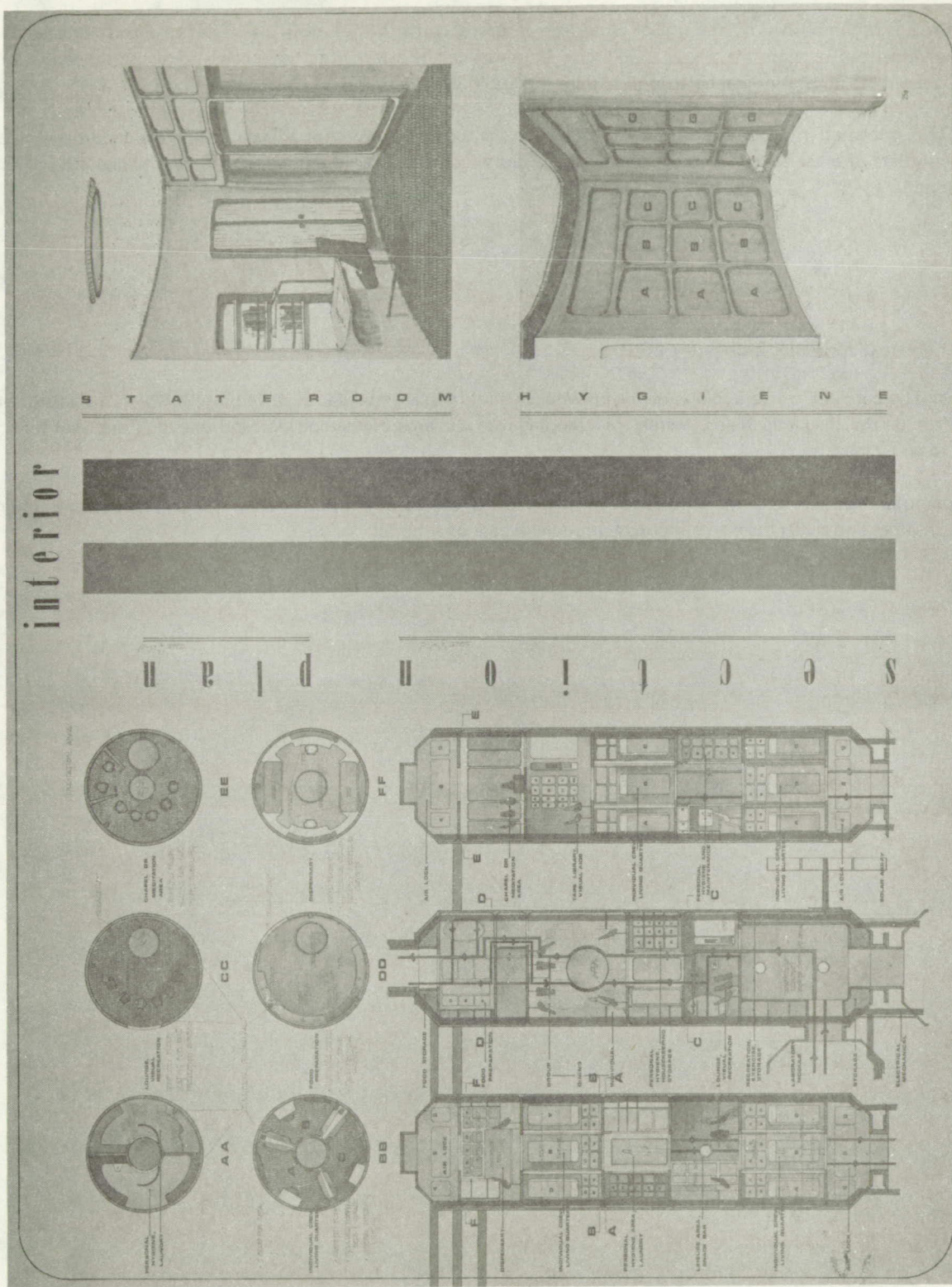


Figure 87.— Panel b of Entry 25 (25b).

Upper right text for Panel 1 of Entry 26 (Fig. 88):

EXERCISE is accomplished by the use of either set of elastic cords in the utility bar. The tension is adjustable so each individual can regulate the degree of exercise. Monitors can be attached to these cords to record the amount of energy burned off in calories and balance this to his dietary intake.

LIGHTING is located in two places: in the utility bar: in the top and bottom for adjustable lighting conditions much like the outlets of a car air conditioner, and on the sides which produces illumination through the pneumatic floor and ceiling.

Lower right text for Panel 2 of Entry 26 (Fig. 89):

mc: The corridor is like a solenoid: the crewman's uniform has metal bands woven into it which are sensitive to the effect of the magnetic fields. Merely by stepping into the area of the corridor and selecting the level that he wants to go to the c.m.

The computer than activates the field sending the person to the desired spot. It also prevents persons from running into each other and sends them to either core module in case of a module failure.

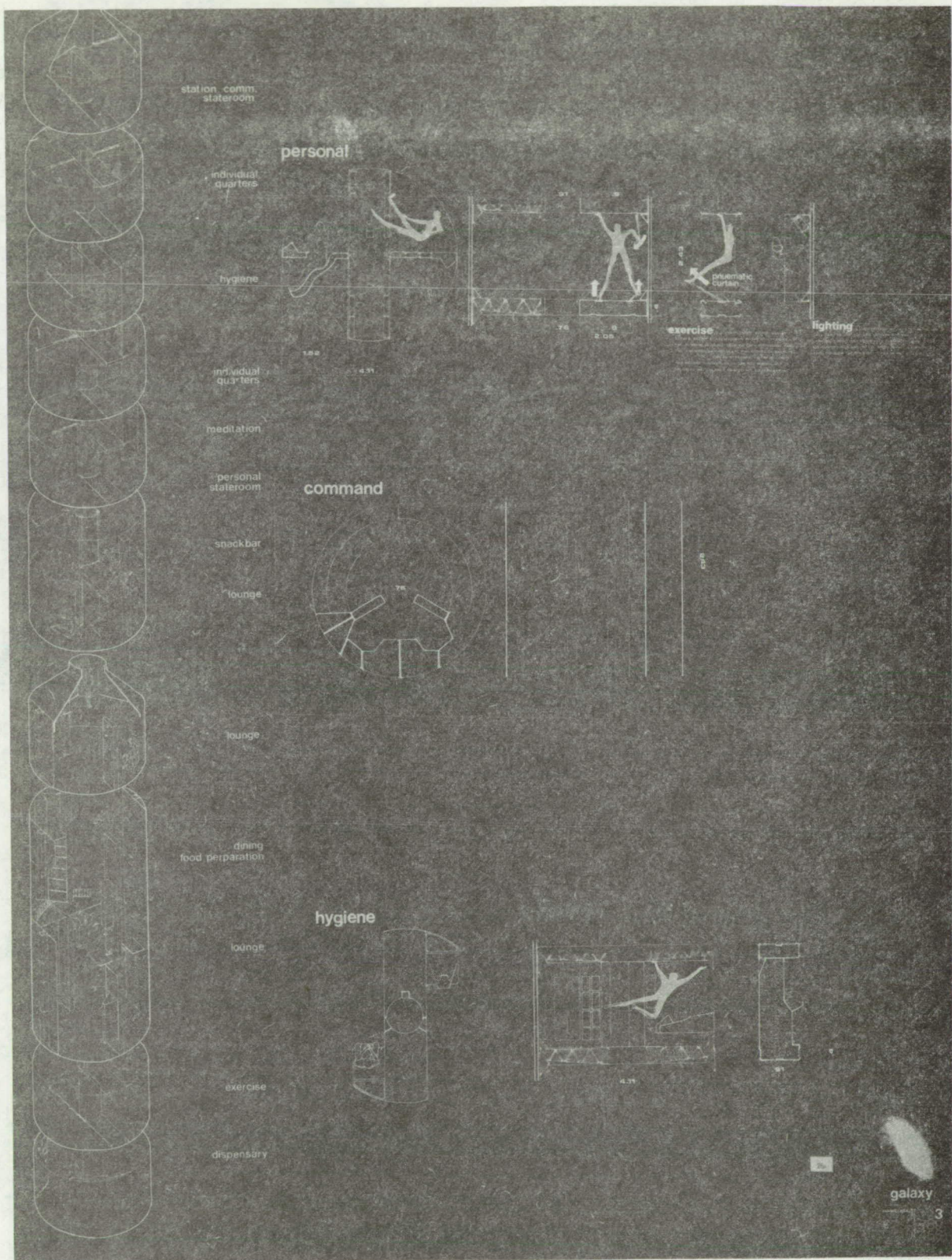


Figure 88.— Panel a of Entry 26 (26a).

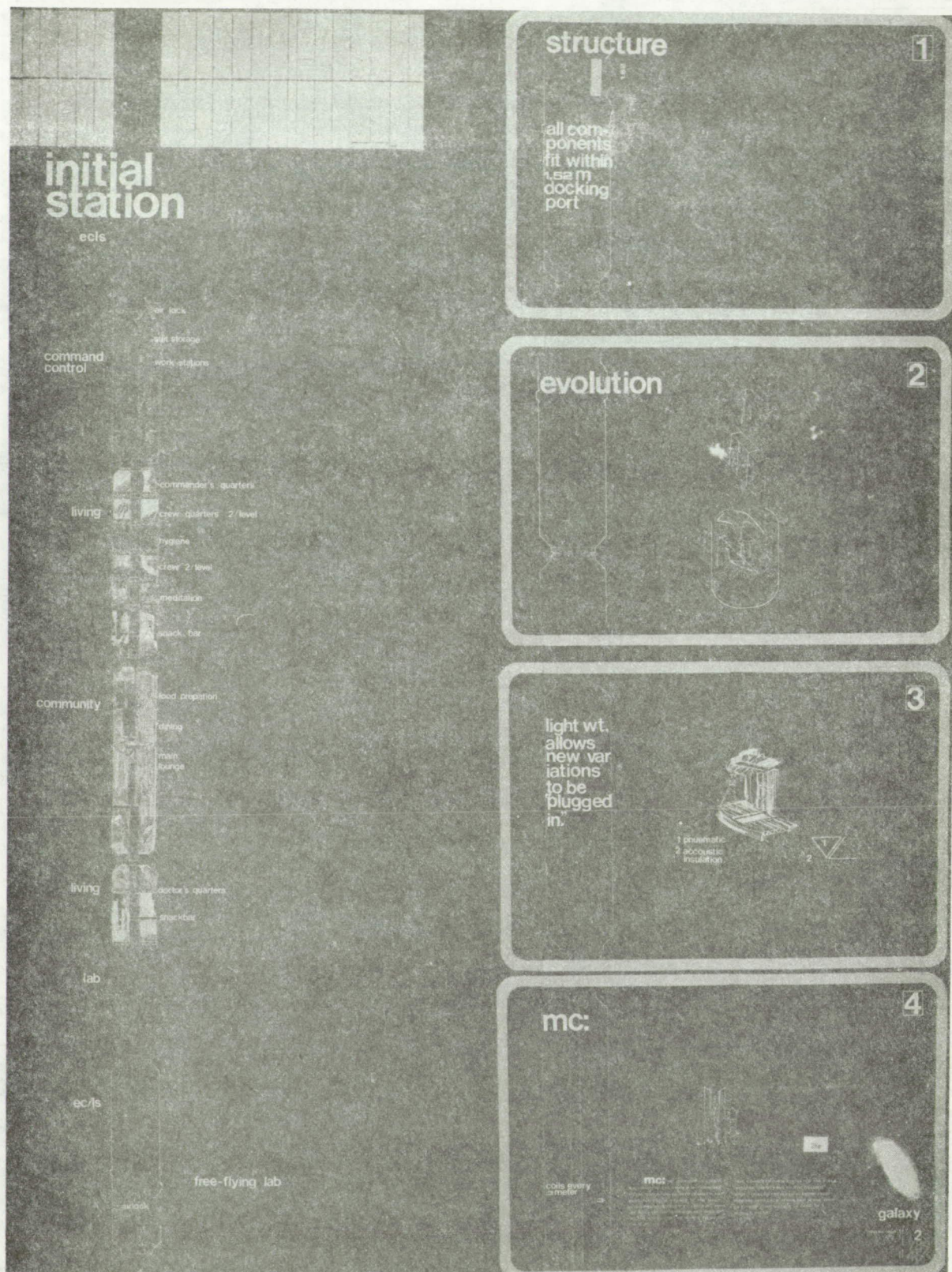


Figure 89.— Panel b of Entry 26 (26b).

concept: a linear magnetic corridor

utilizing the effect of a linear electric motor as the system for controlling movement of personnel and equipment in the station

circulation: linear like an elevator the corridor may be used to reach any level in the station

zero gravity: lack of gravity provided by an orbital situation allows the use of this concept

emergency: in case a dangerous condition arises crewmen are sent to a place of safety automatically

structure: provides an internal framework from which the floor and wall system can evolve

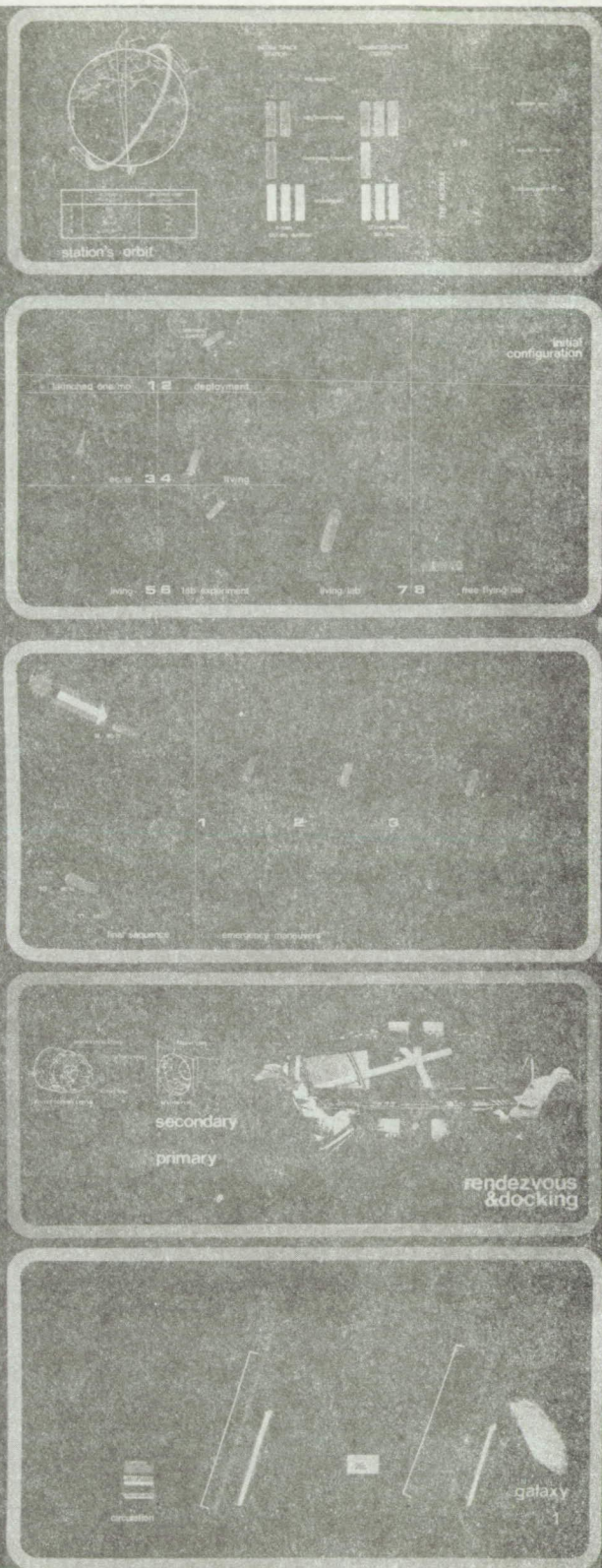


Figure 90.— Panel c of Entry 26 (26c).

APPENDIX

STUDENT PARTICIPANTS IN THE NASA/AIA SPACE STATION INTERIOR DESIGN COMPETITION

Entry Number

- | | | |
|-----|---|--------------------------|
| 27. | R. Dunning Roberts
Department of Architecture
University of Washington
Seattle, Washington 98105 | First Place Winner |
| 13. | James E. Calhoun
School of Architecture
The Ohio State University
190 West 17th Street
Columbus, Ohio 43201 | Second Place Winner |
| 2. | David A. Block
Department of Architecture
Iowa State University
Ames, Iowa 50010 | Third Place Winner |
| 11. | Philip F. Farrell, Jr.
Environmental Design Department
Pratt Institute
Brooklyn, New York 11205 | First Honorable Mention |
| 9. | Raymond K. Deer
School of Architecture and Allied Arts
University of Oregon
Eugene, Oregon 97403 | Second Honorable Mention |
| 1. | Timothy R. Brower
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| 3. | Glen Rosander
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Entry Number

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Minneapolis, Minnesota 55414



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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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