

Space

The idea here is to build some structure that can be resistant to the space radiation in extreme conditions such a different orbital scenario and the highest temperature reached from the different scenario planet outputs. Radiation is one of the main problems and is important to point out in the context of possible habitats, technical architecture will be feasible at any radiation context with some support documentation/behavioral and architecture. Also Xilinx or altera the chip design for extreme radiation is a good topic to explore and the architecture for hardware behavior in extreme galactic boundaries as well as Quantum algorithms for circuits. This idea support the idea that the human interaction with galactic ecosystems is feasible because there are a bunch number of problems that may arise in a billion of years and so on

Atmosphere and Habitats/architecture:

4.2.1.1 Atmosphere Breathable atmosphere has to be provided within the habitat. Vacuum conditions in outer space, absence of atmosphere on the Moon surface, and hazardous atmospheric conditions on Mars and other planetary bodies cannot support human survival. NASA's standard for long-term habitation reflects sea-level conditions (Nitrogen 78 %, Oxygen 21 %, Argon 0.9 %, carbon dioxide 0.03 %), but atmosphere composition and total pressure values may vary somewhat due to specific operational and equipment requirements (e.g. EVAs, greenhouse, bio and technical labs etc.). Students should have a principal understanding of the composition of Earth's breathable atmosphere, and what dangers arise if oxygen or nitrogen levels are not in balance.

4.2.1.2 Thermal Environment and Humidity Structures in outer space experience high temperature fluctuations from extreme cold to extreme heat. Temperatures on the Moon, Mars, asteroids, or other celestial bodies are not suitable for human survival without proper protection. The habitat should provide a 'shirt-sleeve environment 3 in order for the crew to operate instruments and conduct experiments comfortably.

4.2.1.4 Hygiene and Waste Collection Astronauts and cosmonauts follow the same hygiene routines in space as they do on Earth but all hygiene procedures are different in microgravity and require special devices and techniques. They will be less different from Earth on the Moon or Mars, although partial gravity conditions will affect engineering design of devices and plumbing.

4.2.2.1 Micrometeoroids Micrometeoroids are very small meteoroids—tiny pieces of rock or debris—that can be very sharp and reach high velocity in deep space. Therefore they present a high threat to humans and systems. Students have to learn about the possible origins of micrometeoroids and know about their potential danger for humans and systems and possible countermeasures. Further Sources for Research:

- Book "Space Stations and Platforms" by Woodcock (1986, p. 70)
- Book "Introduction to Space: The Science of Spaceflight" by Damon (1995, p. 60, 208)

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4.2.2.3 Radiation Beyond the Earth’s magnetic shield and atmosphere, humans are exposed to ionizing and non-ionizing radiation. During deep space exploration, the crew will be exposed to Galactic Cosmic Rays (GCR) and Solar Particle Events (SPE). Both radiation types are extremely hazardous for the human body and may cause equipment failure or malfunctioning (see Appendix—Glossary). Students should understand the types of radiation that space travelers face, countermeasures that are currently available, and the dangers of insufficient countermeasures.

4.2.2.4 Other Specific Environmental Issues and Safety Hazards Hazards may include biological threats of potentially unknown nature, such as the chemical composition of soil (or dust), and its physical qualities such as electrostatics, particles sharpness, cohesiveness, etc. Students should understand what types of hazards, potential risks, and specific environmental issues they must include in planning for a particular mission destination. Sources for Further Research: • Book “Spacecraft Systems Design and Operations” by Peters (2004, p. 108)

4.2.3 Behavioral Implications A number of biological changes associated with space travel have implications for astronaut’s life and work performance. Examples are: changes in perception, alterations in the vestibular system, physiological deconditioning, lack of motivation, boredom, and depression. Other stressors include situational stressors such as isolation and confinement. Students should obtain a basic knowledge about the effects that a space environment can have upon the human body and mind of crewmembers. 4.2.3.1 Personal Space and Privacy The term ‘personal space’ was introduced by psychologist Robert Sommer in the 1960s and is defined as follows: “Personal space refers to an area invisible.

Quantum radiation: Quantum Radiation in the Context of Space

Quantum Radiation refers to the interaction of quantum particles and fields with radiation phenomena, especially under extreme conditions such as those found in space. In the context of space exploration, quantum radiation becomes a critical aspect when designing structures and systems capable of enduring extreme radiation environments, such as different orbital scenarios, high temperatures, and galactic events like collisions with Andromeda.

Challenges of Quantum Radiation in Space:

Extreme Radiation Exposure:

Space habitats and spacecraft are constantly bombarded with Galactic Cosmic Rays (GCR) and Solar Particle Events (SPE). These forms of radiation can cause severe damage to human tissue and electronic systems.

Quantum radiation introduces additional complexities as particles at quantum scales can behave unpredictably, especially when influenced by strong gravitational fields or near black holes.

Material Degradation:

- 1) Continuous exposure to high-energy radiation can degrade materials over time, leading to structural failures.
- 2) Quantum effects, such as tunneling and entanglement, could influence the behavior of materials at atomic and subatomic levels, necessitating the development of quantum-resistant materials.
- 3) Quantum Algorithms for Circuit Design:

Quantum algorithms can be used to design circuits that are more resilient to radiation-induced faults. Chips from companies like Xilinx or Altera (now part of Intel) can be enhanced with quantum principles to better handle high-radiation environments.

Potential Solutions:

Advanced Materials:

- 1) Research into high-entropy refractories, hafnium tantalate, and modified graphene can yield materials capable of withstanding quantum radiation and extreme temperatures.
- 2) Nanostructures and liquid metals could offer innovative ways to dissipate heat and resist radiation at quantum levels.
- 3) Quantum Simulations:
- 4) Using quantum computing to simulate the behavior of materials and systems under extreme radiation can help predict potential failures and guide the development of more robust designs.
- 5) Simulations can include the effects of quantum radiation, giving engineers a clearer picture of how materials will behave in deep space.
- 6) Radiation Shielding Technologies:

Developing multi-layered shielding that incorporates both classical and quantum-resistant materials could offer enhanced protection against various radiation types.

Exploring quantum field theory to understand and potentially manipulate radiation at a fundamental level could lead to breakthroughs in radiation shielding.

Quantum Communication and Navigation:

In high-radiation environments, traditional electronic systems may fail. Quantum communication offers a way to ensure reliable data transmission and system control, leveraging quantum entanglement for secure and error-resistant communication.

Behavioral and Structural Considerations:

Designing habitats that maintain a breathable atmosphere and a thermal environment suitable for human life is crucial.

Quantum radiation can also impact human health in ways that are not fully understood yet, such as influencing DNA at a quantum level, which requires further study to develop effective countermeasures. Hygiene and waste management systems must be adapted to account for potential quantum-level contamination from radiation exposure.

Architecture/

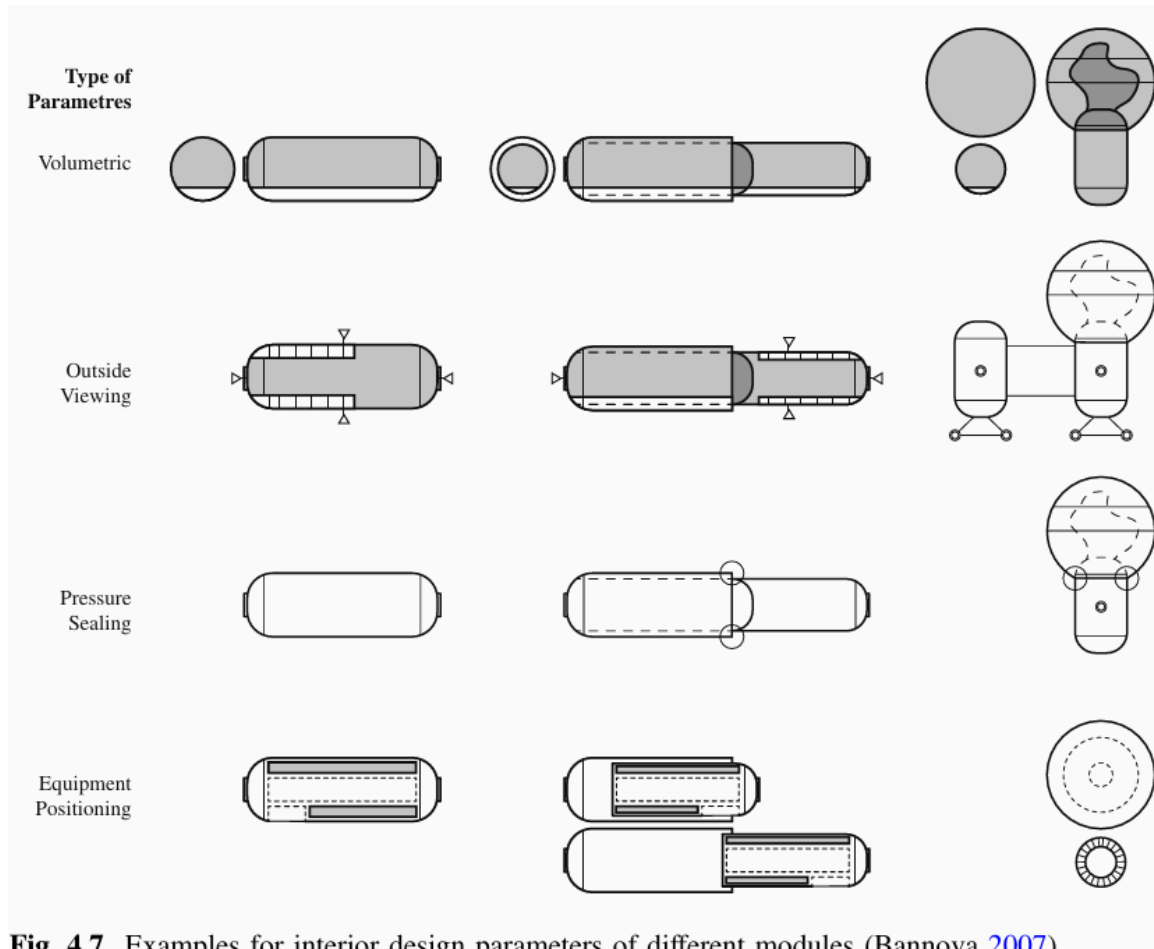


Fig. 4.7 Examples for interior design parameters of different modules (Bannova 2007)

Volumetric characteristics for different module types are important for surface module class selection: • In both types of conventional modules all equipment can be pre-integrated before launch.

• Floor area in telescopic modules can expand at an approximately 1:1 ratio with a smaller diameter of a telescoping section.

• Inflatable modules offer extra space for a crew's multi-functional activities, providing relief from a closed and cramped hard module confinement. This is vitally important for good crew morale and performance which significantly influences mission success and safety (see also Sect. 5.3.3: Inflatable Structures). In inflatable modules the area of the inflatable section expands rapidly with increased diameter as a function of r^2 . From a volume point of view, inflatable modules are the most efficient scheme. They should be designed to minimize deployment and equipment/utility integration requirements, and may be most practical to implement after crew operations have been established using conventional module(s)

Outside Viewing positioning options vary in different module types: • Conventional hard-shell modules may accommodate several viewports with the penalty of losing valuable real estate space along a module's walls where equipment racks and other elements can be located. • Telescopic hard-shell modules may be equipped with viewports in the ends of the deployable part of the structure. Same real estate concerns apply here as in conventional modules.

- Although there is a possibility to integrate a viewport structure into the soft-shell of an inflatable module, it will increase module weight and risk a pressure leakage. Therefore, outside viewing might best be located in a hard-shell structure combined with an inflatable or in conjunction with the airlock. Pressurization/ Safety is a very important issue to secure the modules' pressurization, which depends on the sealing characteristics between sections, modules, and interfaces.

- Telescopic module requires a hard seal at the mating connection between the two module sections.

- Vertical inflatable modules require only one seal attachment between hard and soft sections to minimize leak and maintenance problems.

- Both types of conventional modules use standard module construction, which guarantees no pressurization complications. Equipment positioning: • Conventional "hard" modules afford good pre-integrated equipment capacity along with design simplicity using proven systems. This will be of particular interest.

Station	Sleep	Hygiene	Food	Work	Leisure and Exercise
Apollo	In the main module	In the main module	In the main module	In the main module	Outside on the lunar surface (EVAs)
Salyut	In the main module	Deployable shower and personal hygiene in the work area, toilet close to the work area	Wardrobe with table in the work area	Instrument area could be partitioned from the living area	EVAs, exercise and recreation in the main module
Skylab	Spatially separated in private crew quarters	Collapsible shower in the work area, spatially separated hygiene area	Spatially separated wardroom for food preparation and eating	Experiment area and Dome in the OWS	EVAs, dedicated area for exercise in the work area, private crew quarters

Shuttle	Depending on the mission; in the main module (sleeping bags) or dedicated spatially separated area (sleep boxes)	No dedicated area for advanced personal hygiene, separate toilet area	No dedicated area to eat; galley rack for food preparation	In the main volume	EVAs, exercise and recreation in the work area (Middeck, Flight Deck)
Mir	Spatially separated in individual cabins	Permanent shower in Kosmos, toilet with curtain in the core module	Food cabinet with table in the work area	In the core module and dedicated science modules	EVAs, exercise in the work area, but in different modules; recreation in individual cabins, other modules
ISS	Spatially separated in individual crew quarters	No shower, two toilet compartments	Food cabinet with table for all astronauts	Dedicated modules and rack system	EVAs, exercise in the work area, but in different modules; recreation in crew quarters

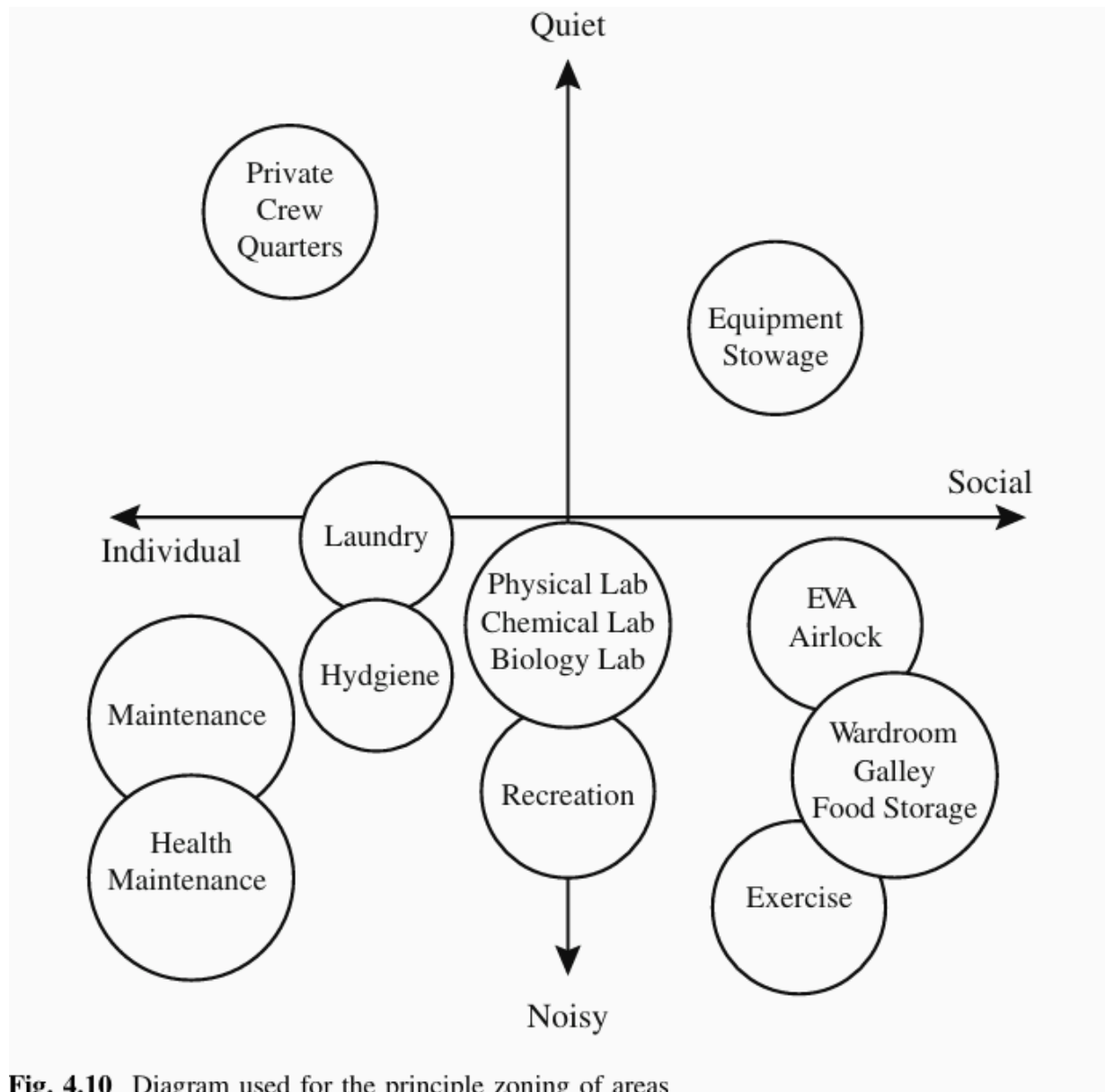


Fig. 4.10 Diagram used for the principle zoning of areas

Arq; • Resupply Stowage Rack (RSR) has a capacity of 1.1 m³ (37.5 ft³) and stores small items and lockers of various sizes.

• The Resupply Stowage Platform (RSP) is a carrier system for transporting cargo to and from the station.

4.4.3.2 Example: Eating and Dining in Space Having dinner is a social activity shared by many cultures and is one of the habitual social customs that people carry into space. Those customs inherit social rules that influence the requirements and design. Astronauts generally dislike talking to a colleague who is upside-down while having dinner together. On Skylab missions, crews refused to 'float' over the table, as it was seen as inappropriate behavior. They had, for the first time, a large dedicated area for food

preparation and dining and were eating together on a specially designed table, eating with knives, forks and spoons (Fig. 3.7a, Chap. 3). From then on, a table for having meals together has been considered to be of importance by the crew and became a requirement (Table 4.9). Still, having dinner together is an important social activity in space. “At dinner at night, we have time, even if you are busy; you set this time to make jokes and to have fun.”

Fig. 4.10 Diagram used for the principle zoning of areas

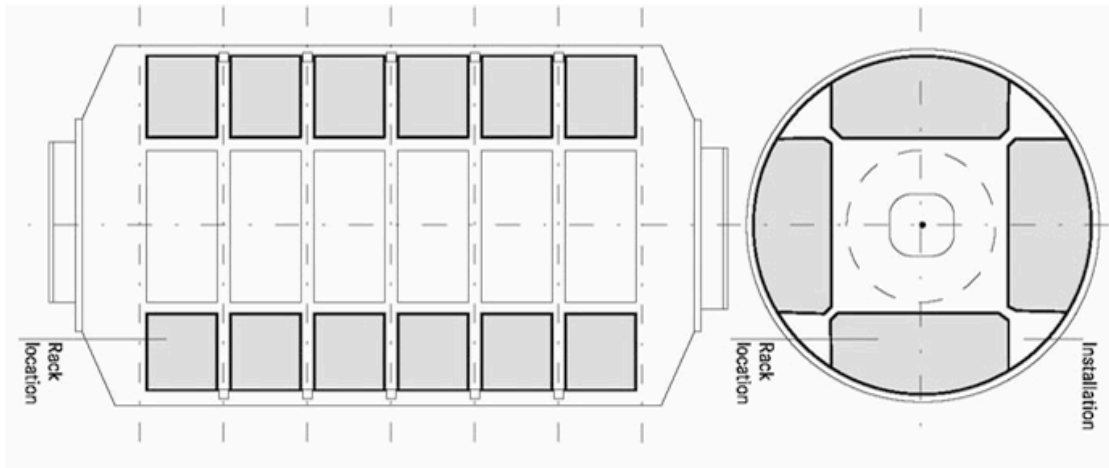


Fig. 4.11 International space station rack configuration (as published in architecture for astronauts, Springer, 2011; based on NASA documentation)