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COLOR DESIGN REQUIREMENT IN MICROGRAVITY LONG DURATION MISSIONS

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ABSTRACT

This paper presents an investigation on the rules of color in the design of space habitats, in particular on the color design purpose of a hypothetical 'Space Inflatable Unit'.

The design of colors in an isolate and confined space habitat has a strong influence on the physical and psychological comfort of its users as on the worthiness of the environment.

The feeling of being confined causes unavoidable changes in an astronaut's psychophysical conditions. However, the well-being, particularly in the case of long duration missions, can be considerably increased through sensorial and psychological stimulations such as light, colors, changes in wind direction, hot and cold temperature, which are characteristic of earth's environment and are able to activate vital processes that are implicit in any human being (1).

However the color, exalted from the correct light, has psychological positive effects: an attractive place reduces the hard work, improves the interpersonal rendering, productivity and relationships (2).

Color takes part in the cortical activity, in the functions of the independent nervous system and in the hormonal activity; moreover it stimulates aesthetic and emotional associations.(3)

From these premises I would like to underline the importance of a structured planning of the colors, to answer to the demand of productivity and of psycho-physiological well-being correlated to it.

INTRODUCTION

In the design of long duration missions, the reliability of the man becomes the successful key of the mission characterized by a confined and isolated extreme environment. The hypothetical 'Space Inflatable Unit', that I will investigate, is an outer space habitat developed in order to test this type of reliability.

Colors and interior decor influence well being, create physiological reactions and modify the perception of reality.

In a confined environment like a 'Space Inflatable Unit', that is isolated from natural environment, these reactions are amplified.

In the design of colors and interior decor is therefore necessary, in order to enhance the efficiency and well being of the crew, to recall the normal physical and psychical conditions, whose characteristics are variety and variability in time (4).

COLOR DESIGN OBJECTIVES

To create a color design of long duration space mission habitats I have developed three objectives to follow, based on the NASA Standards Requirements (ISS Interior Color Scheme NASA 2001) (5)(6).

These objectives are studied to create a color design with the aim of a 'Human centered philosophy' and to promote the wellbeing and the productivity of the user.

1. Psycho-physiological well-being:

the light and the colors have psycho-physiological influences on the person, therefore they must be considered in the project, in order to maximize well-being, to increase the efficiency and to guarantee the reliability of the person.

2. Orientation:

the sense of direction in microgravity after 3/5 days is totally entrusted to the visual perception, for this reason it is necessary to use an immediate visual configuration, created accordingly to instinctive replies to natural signals to which we are accustomed on Earth life, like "sky" up and "earth" down. According to NASA Standard 3,000, 8.4.2, 8.4.3-b: The orientation comes first of all through visual input like color.

3. Activities supports:

the colors and the light should respect the needs of the several activities carried out in the areas and increase the comfort, facilitating functions and needs like, for instance, privacy...

COLOR DESIGN REQUIREMENTS

In order to reach the purposes of well being, orientation and activities supports, the following key requirements have been identified to develop the color design of a space isolated environment. They have been studied from the NASA and ESA requirements.

A. Safety:

color and decor should respect the safety requirements

B. Visibility:

color and decor should answer to every need of vision.

C. Flexibility:

color and decor should be planned considering their physical-psychological influence and multi functionality. They should facilitate both daily life and acknowledgment of the various activities and needs (3).

D. Variation:

The environment must be variable in time, must be able to stimulate senses like in natural conditions, so as to maintain a normal status of conscience, perception, attention, concentration and intellectual activity (7).

E. Variety:

color and decor should create a variable environment, in order to obtain a psycho-physiological positive environment.

F. Customization:

colors and the light should be changeable according to personal requirements both for work needs and aesthetic taste, particularly in the personal areas like the crew quarters.

G. Naturalistic evocation:

decorated elements, materials, references to natural landscapes (photographs, pictures, video or colors compositions) should be arranged, with the aim of providing direction references, relaxing, reducing stress, resting eyes from the computer work.

The image 1. shows an example of requirement applications, through a 'human centered design' realized by I-Guzzini's Italian group.

It represents a habitat isolated from 'terrestrial sun-light cycle' and illuminates with 'Sivra' biodynamic artificial light.

In particular the project will respect the following requirements:

- Requirement E Variety: The habitat is an isolate and confined space decorated with various colors.

- Requirement G Naturalistic evocation: The 'Sivra' artificial light recalls the natural sun-light effects.

- Requirement D Variation: The artificial light will re-create the natural color variations during the course of a whole day.



Figure 1. 'Sivra' by I-Guzzini.

AESTHETIC PURPOSES

With the respect of the objective and the requirements that I have studied, I have designed a project about a scheme of internal

color and décor to apply on the structure of a possible 'Space Inflatable Unit'.

- COLOR SELECTIONS:

Colors have been chosen considering their psycho-physiological influences, in order to provide orientation in space and to support the activities going on. In the colors choice it has been considered also that in absence of gravity, due to a minor oxygen contribution, eyes perceive colors in a more subdued way.

- COLOR IN ORIENTATION:

With the aim of making orientation easier, all pavements are grey and all ceilings are white, to give the idea of stability below and open space above. Every dominant color has been linked to each internal and external floor, in the same order we can find in nature, so that lower floors have colors linked with earth, while top floors have sky colors.

The crew quarters, even if situated in the central part, are blue, in order to evidence the chromatic sequence of the way; in fact from the crew quarters one can only go to the 3rd floor from which it is possible to come down, chromatically as well, to the 1st floor.

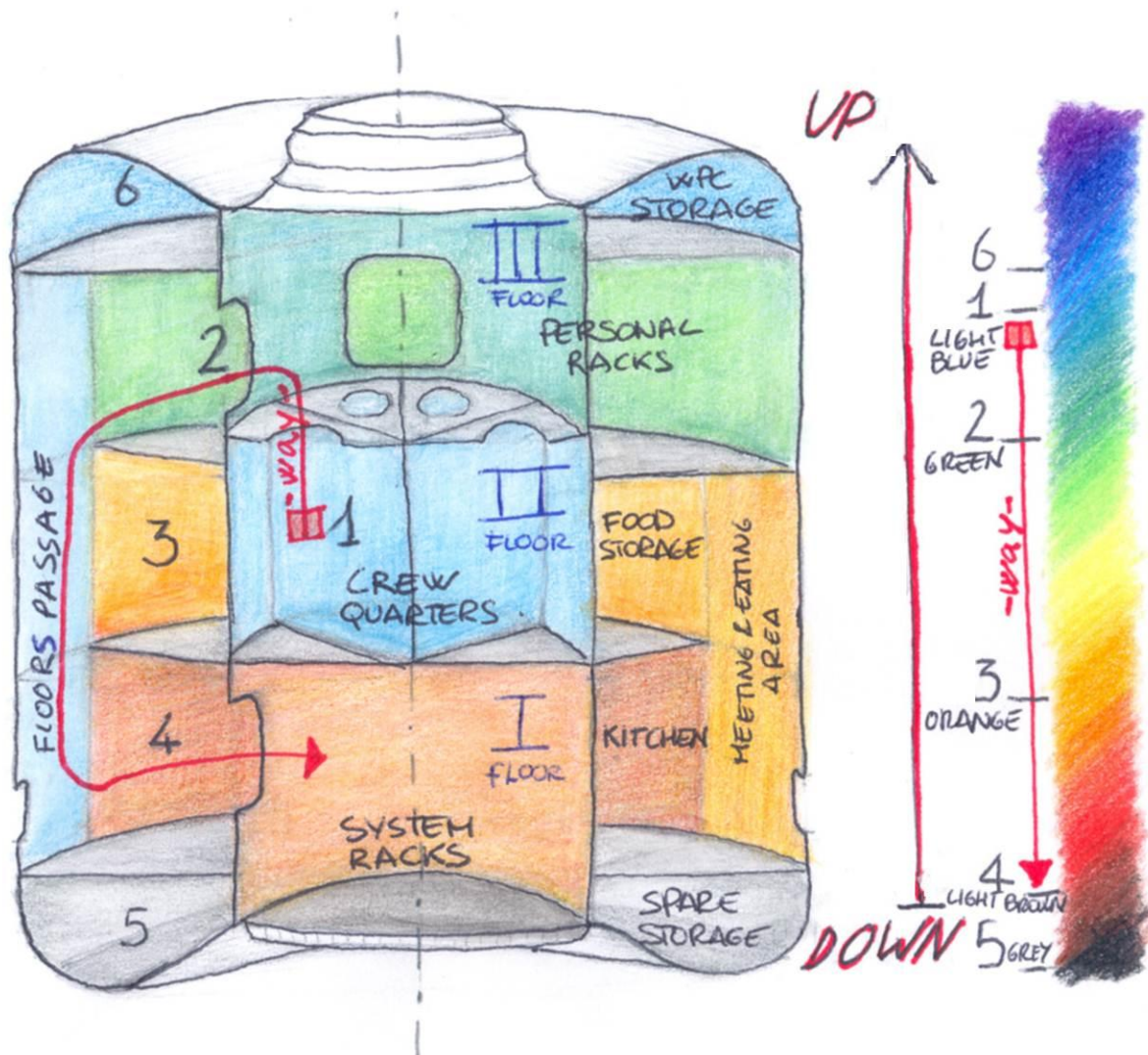
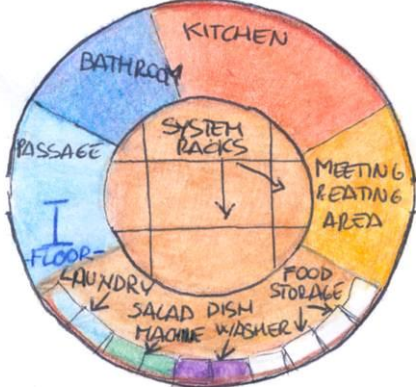
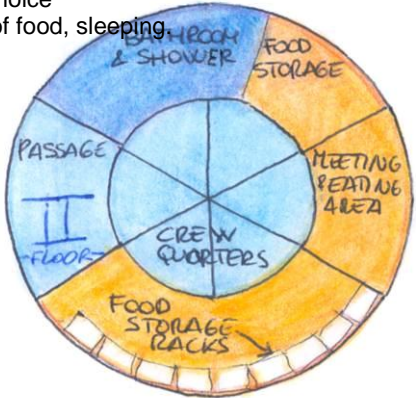
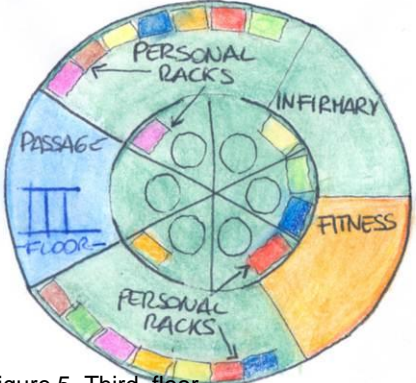


Figure 2. Color design

COLOR FUNCTIONS FOR EACH ACTIVITY

DOMINANTS FOR EACH FLOOR The colors in the scheme are the dominant colors for each functional area and racks	LOCATION	DOMINANT COLOR	COLORS FUNCTIONS:	
FIRST , SECOND, THIRD FLOOR:	FLOOR	Grey	Sense of stability, it orients towards the bottom.	
	CEILING	White	It widens the space and it orients towards high.	
FIRST FLOOR: Activity: meals preparation, post-meal activities.	WALL:	Ocra (or texture: wood)	WELL BEING: It creates a feeling of safety. ORIENTATION: color recalling earth, connected to the lower floor. ACTIVITIES: useful for social activities.	
	AREAS:			
	Passage	Light blue	It widens the space and it maintains continuity between the plans	
	Meeting&eating	Orange	It stimulates social life and appetite	
	Kitchen	Red/ orange	Biological color of the kitchen, recalls the fire, should be linked to cold colors items otherwise has iperstimulating effect.	
	Bathroom	Light blue	It recalls the water and the cleanliness	
	RACKS:			
	Laundry	Light blue	It recalls the water and the cleanliness	
	Salad machine	Light green	Recalls the vegetation	
	Dish washer	Light purple	Color linked to sterilization of ultraviolet rays	
	Food storage	White	It does not alter food color	
	System racks	Ochre	It recalls dominant color	
	 <p>Figure 3. First Floor</p>			
	SECONDO FLOOR: Activity: eating, meeting, storage and choice of food, sleeping	WALLS:	Orange /yellow	WELLBEING it stimulates social life and appetite. ORIENTATION: colors biologically linked to earth and fire; placed on ochre they help to perceive 2 nd floor over 1 st floor. ACTIVITIES: fit for social activities.
AREAS:				
Passage		Light blue	It widens space and maintains continuity between floors	
Meeting&eating		Orange	It stimulates social activities and appetite	
Bathroom & shower		Light blue	Recalls water and cleanliness	
Food storage		Orange/ White	Orange for the meeting point and white not to alter food colors	
Crew quarters		Light blue	Relaxing, it widens space, follows green color for orientation; it is possible to approach this area only after 3 rd floor whose dominant color is green	
RACKS:				
Food storage,		white	Does not alter food colors	
 <p>Figure 4. Second floor</p>				
THIRD FLOOR: Activity: management of personal thing	WALL:	green/blue	WELL BEING: help concentration and thinking. ORIENTATION biologically placed on top of orange, let 3rd floor to be perceived above 2nd. ACTIVITIES: fit for personal activities	
	AREAS:			
	Passage	Light blue	Widens space and maintains continuity between floors	
	Fitness	Orange	It stimulates activities but since it is hyperstimulating must not be linked to other cold colors as blue and green, which are in the floor walls	
	RACKS			
Personal	multicolored	It is possible to customize colors of personal racks with different color shades so as to create an easy acknowledgment and a direct link with the person		
 <p>Figure 5. Third floor</p>				

IMPLEMENTATIONS

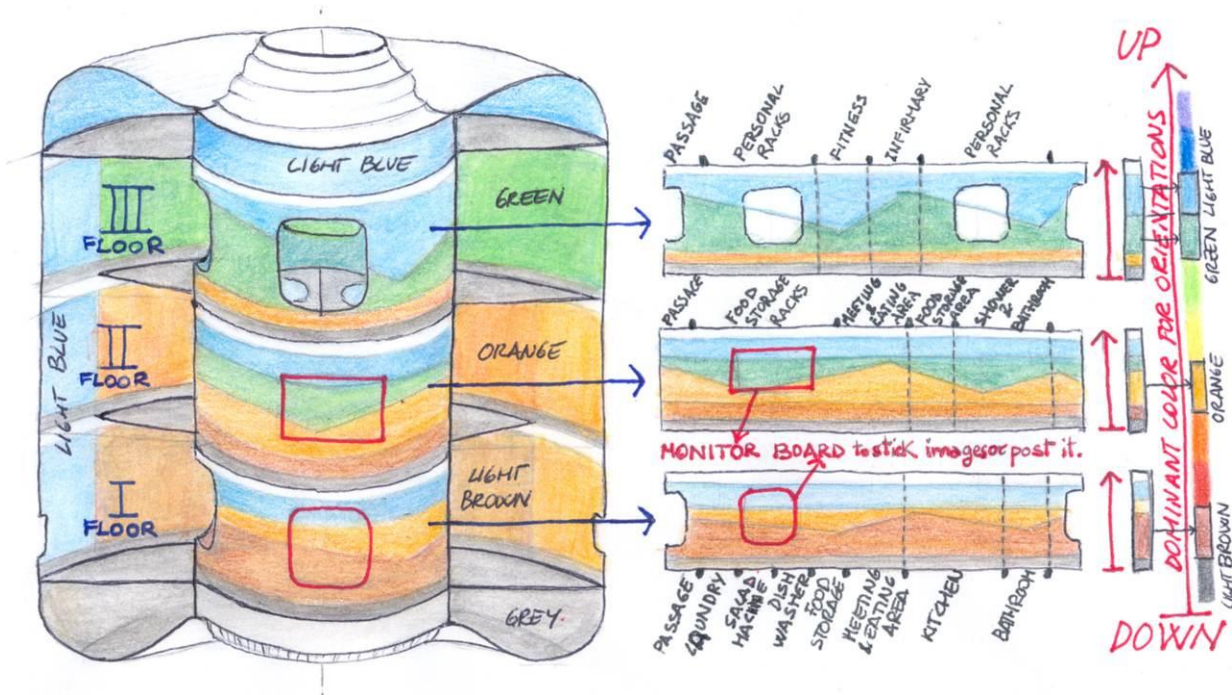


Figure 6. Implementations

In confined space environments, the use of images or decors showing landscapes reduce stress, balances heart pulses and rests eyes.

In order to meet the above requisitions, the following implements have been considered:

- Decors landscape-oriented: placed in the external wall of the inner cylinder, where racks are not previewed; they increase the global orientation and maintain the chromatic dominance of the floors, while singularly they re-propose the natural chromatic scale.

Accomplished objectives: all

Accomplished requirements: flexibility, variation, variability, customization, natural recalls.

- Monitors: communication, relax, enjoyment functions (i.e. screening water)

Accomplished objectives: psycho-physiological well being, support to activities

Accomplished requirements: all

- Boards: used to pin images, post-it and as a meeting point.

Accomplished objectives: support to activities

Accomplished requirements : visibility, flexibility, variety, variation

- Biodynamical light: variable lighting recalling the natural light effects in the course of a whole day, through automatic changes in intensity, direction, brightness and

predominant wavelength. It creates space, provides a sense of time passing, and varies colors perception. It includes the positive part of the ultraviolet beams, so as to make crew to benefit from the exposure to the solar light: in particular the lessening of viruses in the air. It is placed "on top" increasing up and down orientation, and it has adjustable intensity

Accomplished objectives: psycho-physiological well being, orientation.

Accomplished requirements : all.

CONCLUSIONS

Following Human centered design logic, in long duration space mission's colors and interiors decors must have among their purposes: psycho-physiological well being, orientation, and support to activities. It is therefore necessary to recall, through stimulating elements, the "normality" physical and psychical conditions featuring variety and natural variations occurring in time. (2)(3)(4)

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Images

Figure 1. 'Sivra' by I-Guzzini.
(<http://www.automa.cz/svetlo/2005/sv020546.htm>)

Figure 2. Color design of a 'Space Inflatable Unit', Irene Schlacht 2005.

Figure 3. First Floor color scheme of a 'Space Inflatable Unit', Irene Schlacht 2005.

Figure 4. Second floor color scheme of a 'Space Inflatable Unit', Irene Schlacht 2005.

Figure 5. Third floor color scheme of a 'Space Inflatable Unit', Irene Schlacht 2005.

Figure 6. Implementations of a 'Space Inflatable Unit', Irene Schlacht 2005.

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