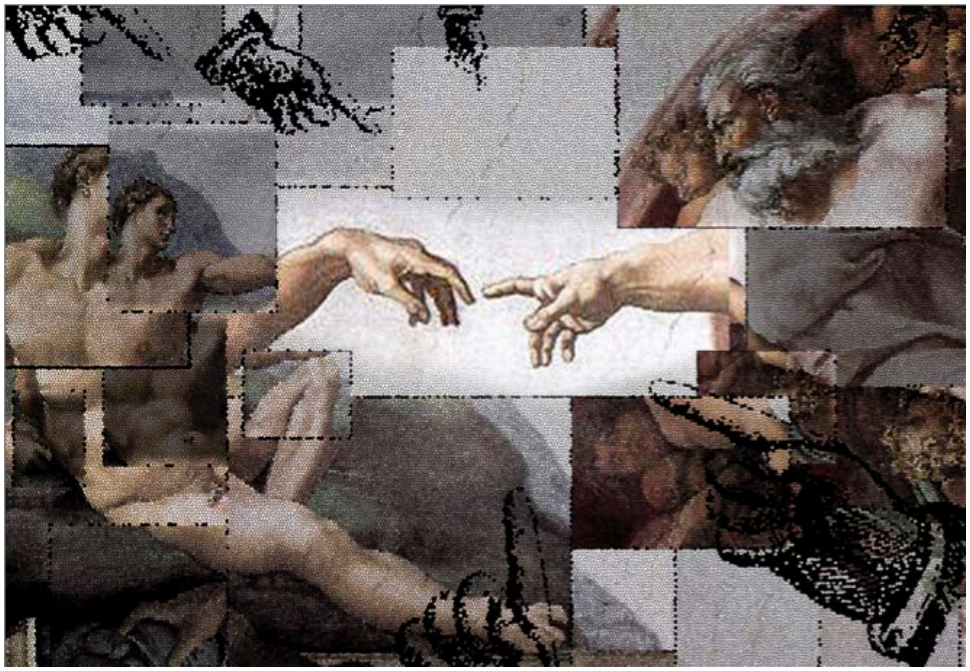
Future Space Architecture

By Ayse Oren



What is Architectural Imagination?
Imagination is the most individual and intense activity of design. It connects the space between the perception and understanding. It is different from other mental processes, because imagination does not need any reference. It creates its own image.

When we are talking about architectural imagination, we pay a lot of attention to form and how it is going to look, independent of materials, investment, and function. This is architectural imagination at work. This brings us to knowledge.

How is Architecture Science?
In the history of Architecture, there are two important moments: first, the invention of perspective by the Renaissance architect, Brunelleschi, in which all orthogonal lines converge to a point at infinity. That later influenced Immanuel Kant to conclude that the stars in the sky might be other galaxies.

The second invention is sensor technology and neuroscience, which have rationalized our senses and revealed the new paradigm of Neuro-Architecture. The information we gain has a greater potential to reveal the needs and preferences of individuals, which can make the difference in how we analyze consciousness or the subliminal responses of our brains and bodies to the environment, and how they affect our well-being and health.

Neuro-Architecture allows us to create places that align with our instincts and our human nature, and this knowledge will create an architectural revolution. We create places because we need to lean on them physically and emotionally.

Even though the standards of aviation are very strict – particularly in long-duration space travel – individualization is going to be a must. If scientists and architects are to unite to construct spaceships that can be integrated with living functions, they must learn to think, to deal with the needs of individuals, and to make the necessary changes to adapt to people's emotional states.

That makes people feel they belong more to the environment, which brings in transhumanism. It is important, since the environment should be like clothes that are comfortable and that provide for people's needs without making their presence felt. By all means, allow for integration with the crew and craft. The success of an extended mission on a space station depends on the crew being an integral part of the interior design.

Spaceships are half machine half architecture; infrastructure and construction need to occur together: the electrical system, ventilation, installation, lighting…. Architects and engineers also need to work together. To date, we have developed the typology of space architecture by learning from earlier space stations.

Typology is the essence of the building, defining a system that has nothing to do with the five senses. Skylab, MIR, and the ISS are forming a certain kind of developing typology. The key point is to systematize and to operate the typology so that we can create infinite variety. That keeps us on the road to serial production, which creates economy, and economy creates variety and competition as well.

So, what is this typology that is creating space architecture?

Flexibility – Modularity – Changeability

After the industrial era, architects adopted the use of metal with its technical advantages. Joseph Paxton, who was a gardener and an entrepreneur, built the Lily House (a greenhouse) in the reign of Queen Victoria. He developed this building by drawing inspiration from the pattern of a lily. The pattern of a leaf is a fractal design. Accordingly, it can solve modularity problems, because by understanding the design principle of the system, one can solve the entire system.

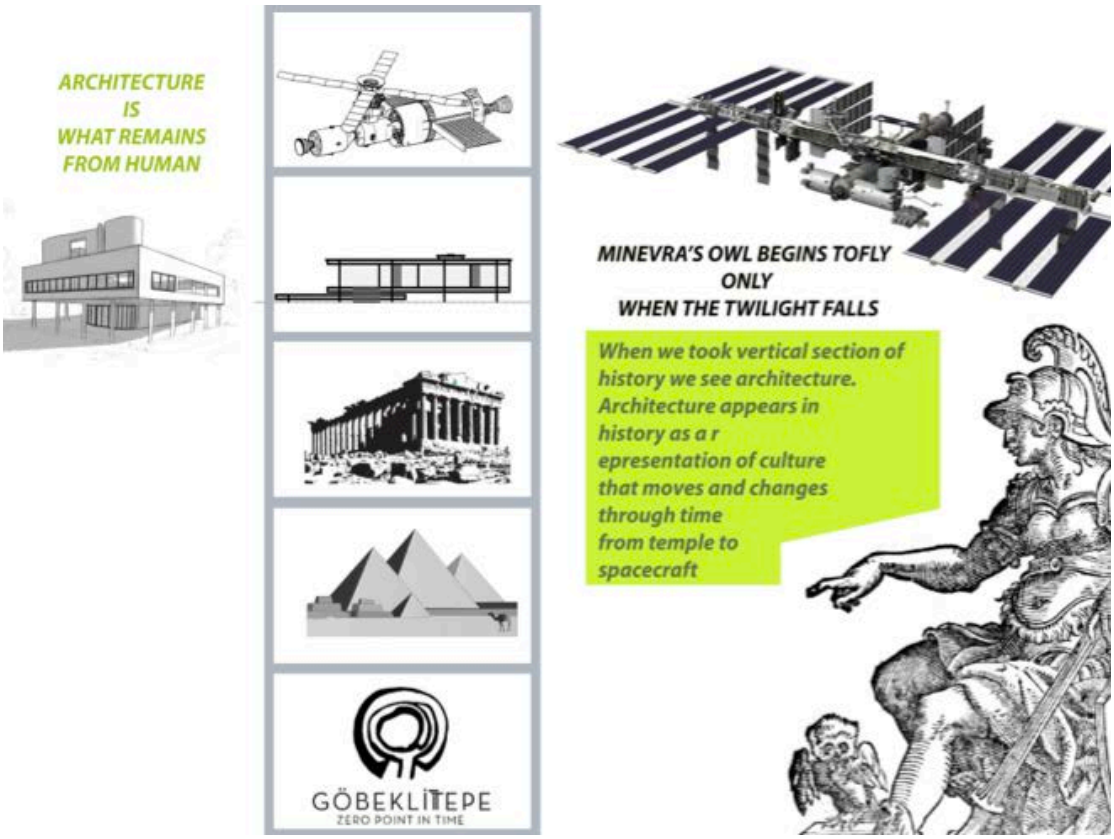
Being flexible and changeable means thinking about the process of recycling mechanical parts from the early stages of design. Development of production processes is a similar approach, in that each product will turn into another product after use.

Open plan is also an option where reshaping can be useful. Combining different metals can add structural flexibility and enable modularity. By contemporary means, nodes and connection details can act as ornaments in architecture. If we think more thoroughly about change in space, the module that lands on the surface of a planet can shift to another function after landing.

Slayt-Göbeklitepe to the ISS

If we are to understand space stations, we need to appreciate how they developed. When we take a vertical section of history we see architecture, because architecture is what remains from human occupation.

Look at these images:



You will probably start to compare them: one is stone, another is painted white, and the third is metal.

Let us start with the first one – Göbeklitepe. See how it meets the ground. It almost seems to be emerging from the earth like a mountain.

The second one is Mies van der Rohe's Farnsworth House. It is lifted off the Earth. It kind of perches on the Earth, but it is still in contact with the landscape.

When we came to the architecture of space stations, they are free from the Earth's surface, elevated from the ground, and conceptualized.

Slayt: Skylab-Mir-ISS

Space Stations

Due to the technical aspects of space travel, the architecture of space stations is still very primitive. But it will develop despite the restrictions. The important thing is to understand what you can do and what you cannot do in space, and to be creative in this restricted zone.

When we compare Skylab, Mir, and ISS, it is clear that they are going through their own evolution process: The earlier stations provided references for the subsequent ones. For example, the Mir space station had crew quarters designed using information from Skylab. They included visual barriers to provide a little privacy. Skylab had no openings at all, while MIR had a 20 cm window. The ISS has a better window size that enables astronauts to observe the planet Earth and space.

The interior architecture of space stations is messed up with cables, poor acoustics, and ventilation problems, and they all have poor lighting. The ISS can accommodate six people for 90 days at a time. For the first time, human well-being, human psychology, and maximizing efficiency became subjects for a space station. We experience change and see apparently fixed objects in continuous free-fall.

These initiatives are developing a space industry and an infrastructure that allows for larger and more complex structures.

Triz

A method called Triz came out when architects were looking for a way to expand interior spaces. Triz is a technique of producing systematic ideas for engineers. I decided to use it for evaluation and development of systems and interiors so that we can optimize ideas. I have a team at Istanbul Technical University, and we have begun to hold workshops on designing more effective spaces.

Triz was used in building the Cassini-Huygens Probe (which is a cooperative project of NASA, ESA, and the Italian Space Agency). Nowadays Cassini is very famous due to its the successful analysis of Saturn's atmosphere.

The radiation in space is harmful to some of the digital and electronic devices in the spacecraft, so the design team divided the equipment and elements into two separate

layers: an inner and an outer layer. The pieces that were less affected by radiation went on the outside of the structure, and thus served as armor for the components that the radiation was likely to affect.

Delta Airlines used another method to improve the seating areas for passengers and to increase the volume of cabin at the same time. An asymmetric seat arrangement solved the problem, by increasing the interior volume and the seat volume at the same time. The same problem exists in space stations. That is why I want to create systematic solutions that will enlarge the interior space, so I created a team that can produce ideas for the enlargement and efficiency of the interiors of modules or stations.

Sensory Inputs

Color, light level, sound, and odor are not just surface effects and they are not intangible. They are very real, very strong, powerful tools, and they have a real, physical presence. For example, even if you design the most beautiful place in the universe, if it smells bad, people will not go there.

A View Through Space – Windows and the Use of Glass (Apollo-Soyuz-Piramitler)

Windows have a very important function and effect in architecture. Architects have learned how to design windows only comparatively recently. This is true of building spaceships as well. Engineers first deemed windows unnecessary, yet the results were worth it.

The small module with windows in the ISS was named the cupola. Windows have a very positive impact. The size and the shape of windows is another important consideration. In their free time, what astronauts enjoy most is to gaze at the planet Earth. A window is more than just a form; it can enable escapism. It allows humans to form connections with the outside world.

The Capability of Obtaining and Sharing Information on Our Surroundings and Nature

We are awed by life in our lives, even watching the sunset, the phases of the moon, or the tide. Our interactions and bonds with nature are very important for us to make sense of life. The philosophy of *anima mundi* suggests that the universe has a soul as well, which makes us one with nature and its events. However, for safety reasons, we must be able to take shelter against external impacts.

Light – Integrating Light

The light that enables us to see has a significant impact on our mental state, cognitive function, behavior, and physical health. Light has effects on melatonin, endocrine, and cortisol levels, which prepare the body for activity and satisfaction.

In fact, the amount of light in nature constantly changes, minute by minute. Light and humidity may vary at any location (color, shadows, brightness contrast, sun angle; thermal/haptic sensations associated with direct sun, wind, and humidity). The light design project and the organization of light, especially on long-duration missions, is of critical importance.

Color

Light creates colors that allow visual experience. We use light to make the world meaningful. Architecturally, in the 1970s, there was a jump to another level in the use of color (for example, the Pompidou Center in Paris). Color has many uses for technical purposes beyond taste and culture. It may be highly useful, especially on long-term space missions.

1. In a place where there is no direction, color can create perceptions and give information about the building. Color schema can be used for way finding, defining up and down, etc.

2. It can be useful for communication and automation purposes: giving distinct colors to building systems – the electrical system, heating, ventilating, air conditioning, and cooling (HVAC), and plumbing.

Memory in Reality – Augmented Reality and Virtual Reality.

Virtual reality and augmented reality can provide a significant advantage in coping with special moments, having visual experiences and dealing with homesickness. As we move away from the world, the relationship between people and reality is unclear. We still do not know how people will react to this situation. These two kinds of realities can create ambiance without adding extra load to the structure.

Ambiance is the theme about which architects really care. We can create cozy atmospheres in social and private places. The sounds of nature, and even its smells, can be provided in any room. However, one criticism of virtual reality tools is that they do not capture the full multisensory experience of humans in the built environment, but they are still better than lacking everything to which people are used.

Sound Design – Ventilation, Acoustics, Noise

We are getting smarter, but we are still far away from the wisdom of nature; we need to understand what nature means. Nature does not leave waste behind. It does not create pollution, so it is essential to observe nature. One must be aware of hidden knowledge and pull out of it. Nature is noiseless (nature is not soundless, but it is noiseless: we take noise as the mechanical sounds that human-made machines create), and what makes spacecraft unbearable is the noise and buzzing inside.

Today's spacecraft, tools, computers, and machines make a lot of noise. However, nature has solved this problem. For example, spiral seashells provide both ventilation and cooling efficiently and with little noise.

Yes, we have developed, but we still have a long way to go.

Solutions like this need to be investigated. If this information proves useful, it may be possible to solve energy efficiency and acoustic problems.

Simple Solutions

Even though space travel is very expensive, sometimes it leads to inexpensive solutions to terrestrial problems. For example, Velcro was designed to help astronauts to walk in

zero gravity, but it has had endless applications on Earth. Simple ideas like this can provide unexpected solutions.

The Importance of Play in Architecture

We finish with the importance of play in architecture.

LEGO-like solutions may also work well, as we are not only *homo sapiens*, but also *homo ludens*, meaning play-loving. The element of play and the satisfaction of playfulness can be achieved by attaching materials to a grid and the changing them around to satisfy playfulness. Games are often underestimated. We should not forget that we all have a child within. This is most important.

My focus is on simple and lean thinking. We may design starships with artificial intelligence, we may laugh at absurd things, we may be interested in meaningless things, but that will always be the case. In space, it does not matter how old we are; in essence, we are all little children.

This child needs games and stories. Building a spaceship is a serious and technical topic; we are going to develop a system that also meets the need for entertainment of the child within.

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About the Author: **Ms. Ayse Oren** is a brilliant, successful entrepreneur, architect, sculptor and design artist in Turkey. She is a nationally and internationally awarded designer developing projects focusing on electronics and design, positioning human and life in the center. As an artist, honored by Republic of French as "Future Leader," she was also the first designer to be accepted into a Technopark (Boğaziçi University) by the ministry of Science Technology and Industry in 2010.

She is an active member of Kepler Space Institute. At the International Space Development Conference 2017, in St. Louis, she presented on the history of the influence of architecture and the environment on human progress as a model for future Space architecture. She will represent KSI at the International Moonbase Summit in Hawaii in October 2017. See her web site at: www.ayseoren.com

Editors' Notes: We were pleased to have Ayse presenting in the *Living in Space* Track at the International Space Development Conference 2017 in St. Louis and to write this article for the Journal of Space Philosophy. Her reasons for working in the Space Architecture field are well summarized in her following quote:

> If we are going on a different direction in the course of the *homo sapiens* evolution, we can do this with designs addressing not only our needs, but also our senses. The well-being of humanity can be achieved by creating environments supporting the cognitive and social stages in the evolution process.

Ms. Oren is destined to be a creative and productive member of Kepler Space Institute. *Bob Krone and Gordon Arthur*.