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Genius Loci in the Space-Age

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Abstract:

In Roman mythology a Genius loci was the protective spirit of a place. In contemporary usage, "genius loci" usually refers to a location's distinctive atmosphere, or a "spirit of place". The concept of "genius loci" has been discussed in modern architecture, but still is much underestimated. When it comes to extreme environment, the situation is even worse. The problem of sensory deprivation in extreme environments should even result in putting more emphasis on the concept of genius loci. An important part of the 'spirits' of a place are the environmental energies. In space habitats the 'Life Support System' becomes an intrinsic part of the 'atmosphere' of the habitat. On Earth, the use of these energies, not only to make buildings self-sufficient, should enhance the quality of the architecture and our built environment.

Humans differently than the other entities of life on our planet are capable to force large-scale devastative change on the environment. The need to save our environment for future generations is one of the greatest challenges that humankind must address today.

Our buildings are essentially enclosures to protect us from the impact of weather and allow specific activities like residential, office, manufacturing, etc. to take place. Ecologically, a building is a high concentration of materials, manufactured often using non-renewable energy resources, from some distant place and transported to a particular location and assembled into a built form or an infrastructure whose subsequent operations create further environmental consequences.

Environmental energies have actively or passively been used through all the building history. Technology today offers a range of energy converters such as solar collectors, photovoltaic cells, wind generators, biological recycling systems and more. Increasing ressource costs of the public infrastructure make the use of these decentralized systems more and more attractive for home owners. Our vision for future buildings is that they will 'live' on local ressources only, and even more help to improve the local environment in terms of air quality, water quality as well as aesthetical quality. The building should be one system within the natural environment, a “Genius Loci”.

We believe that designs with limited ressources in extreme environments leads to a much higher respect of nature and the human being and thus is generating a strong drive to improve life on Earth.

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1 Introduction

"The earth is like a spaceship that didn't come with an operating manual"

Buckminster Fuller

Figure 1. Human facing the Earth: Human Spaceflight makes us realize the value of the most basic resources our planet is providing: water, air, food, balanced temperature and radiation protection. (source: NASA)

Since the beginning of the space age in the late 1950s there is an increasing understanding of our planet as an extraordinary cradle of life in the vast dark universe. But we also learn to see the limits of the system, the fragility of the atmosphere and influence the human population has on this closed-loop system, which receives it's main driving energy from the sun (Figure 1).

Yet, we exploit the planet with an unappeasable hunger: 20% of the wealthiest people account for 86% of the world's total private consumption. A recent study suggests that, if every person alive today, consumed at the rate of an average person in the United States, three more planets would be required to fulfil these demands. This as such should be alarming. However, what is appalling is, that with the accelerating wealth the industrial societies are accumulating, it seems not to be possible on a planet, where news are distributed real-time and people travel in airplanes and high-speed trains, to prevent people from dying from hunger or polluted water. The State of the World report is stating the balance of population growth against poverty as the number one challenge of our world (Starke, 2003). 1.2 billion people, almost a quarter of the planets population are classed by the World Bank as living in "absolute poverty". This means living on less than 1 USD a day! It is not necessarily, that our planet cannot provide enough resources to feed all of us, but the way we treat the resources turns out to be much too wasteful. We leave the problems we create by our current life-style to others: in other geographic and/or temporal locations.

On the other hand we are flying to space and we are realizing how valuable life's most basic resources are. To fly 1 kg of water or air into low Earth orbit costs about 20'000 EUR. For longer missions like going to Mars, it would even be illusionary to transport all supplies for a 2 year mission. To realize these missions, systems have to be developed, which reuse and recycle air, water, food and energy, eventually arriving at a fully closed loop system, only powered by the sun, just like our mother ship 'Earth' (Figure 2).

Kenneth Boulding (1966) stresses the need to change from a 'cowboy economy' to a 'spaceman economy'. He describes the 'cowboy economy' as an open system with plenty of world. Its measure of success is a high through-put. The 'spaceman economy' is more of a closed system in a narrow world. Its measure of success is quality and complexity of stock (i.e. human bodies and minds).

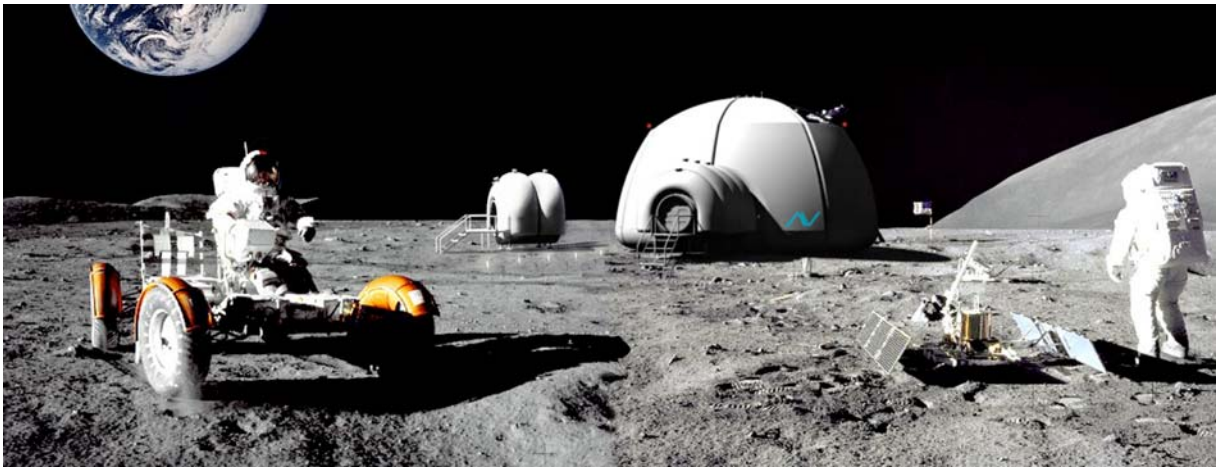


Figure 2. No other planet in our solar system has such favourable conditions for life. Already on the moon we hardly find any of it. Everything has to be transported from Earth to maintain our lifes. The inflatable MoonBase is powered by solar energy and is using an advanced life support system to recycle all resources needed for living (source: Architecture and Vision).

The industrial societies rely on costly infrastructure, which bring us fresh water, electricity, heating, telephone and internet right into our apartments and houses and take our waste away seemingly easy. However, there is no such thing as a municipal water supplier in a spaceship. The concept of waste is completely redundant on future long-duration spaceships: just like in nature, there are system resources in different states of processing. Low-energy and light-weight systems are needed to keep these systems going and make potable water from liquid waste and food from solid waste. These systems do not yet fully exist, but research is going into this direction. However, systems like this will initially be costly, but their spin-off is hitting one of the largest markets of the world: the private housing market. The Fraunhofer Institute forecasted a strongly growing market for autonomous systems in private housing, where people are willing to invest into independence from municipal infrastructure and its ever-growing prices for water, waste and energy. Amortisation times of up to 15 years are well in the scope of a private house owner. This competitive market would make the systems cheap and will eventually enable a technology jump also for developing countries, which could leapfrog the whole process of investing and maintaining an expensive centralized infrastructure. A remarkable example for such a technology jump is already existing with the mobile phone, which is currently successfully

spreading in developing countries. It allows leaving out the development of landlines completely as it happens currently in rural areas of China, but also in Ghana and India.

The underlying thesis of this paper is, that once we think in terms of decentralized, autonomous and recycling space systems, which are only dependent of solar energy, these technology jumps will easily be possible in our brains. And once they are possible and obvious there, they are likely to happen. The often heard argument, that technology is too expensive and that there is no money in these markets has disproved by many examples. Also, we live in a time, when never ever so much money was available, yet we are completely unimaginative, how to use this money to help poor people leading a decent live and how to prevent our own lives to become much more miserable by the effects of the destruction of our environment.

This train of thought can also be seen along the line of Alvin Toffler's (1981) 'Third Wave' society, where highly infrastructure dependent consumers become eventually self-producing and independent 'prosumers', who not just consume their environment, but also help to produce and maintain a clean and healthy environment. By easy access to communication they will identify ad-hoc business opportunities and information will substitute a big part of material resources as the mobile phone and internet potentially does today.

If the house can be understood in technological and architectural terms as a device or machine 'producing' environment and not just consuming it, it enters a new relationship with the location. If we can generate a holistic architecture, from the place seen as a very specific part of our planet, there is a chance we can generate a 'genius loci'.

In the last century, modern architecture focused in solving social and hygienic issues in our cities. These problems are far from being solved in the majority of cities on our planet and stay key issues. To solve the environmental issues may at least bring people closer to live more in harmony with their natural environment and in conflict.

2 The concept of Genius Loci

Architecture is a thing of art, a phenomenon of the emotions, lying outside questions of construction and beyond them. The purpose of construction is to make things hold together; of architecture to move us. Architectural emotion exists when the work rings within us in tune with a universe whose laws we obey, recognize and respect. When certain harmonies have been attained, the work captures us. Architecture is a mater of "harmonies," it is a "pure creation of the spirit."

Le Corbusier, Vers une architecture

Human culture is very strongly linked to places. Indeed, the inseparableness of the human being and the world, at least from the human being's point of view, has been one of the main discussions of philosophy. We are and we ‚take place'. In *Being and Time*, Heidegger (1962) argued that, in conventional philosophy and psychology, the relationship between person and world has been reduced to either an idealist or realist perspective. In an idealist view, the world is a function of a person who acts on the world through consciousness and, therefore, actively knows and shapes his or her world. In contrast, a realist view sees the person as a function of the world in that the world acts on the person and he or she reacts. Heidegger claimed that both perspectives are out of touch with the nature of human life because they assume a separation and directional relationship between person and world that does not exist in the world of actual lived experience.

Instead, Heidegger argued that people do not exist apart from the world but, rather, are intimately caught up in and immersed. There is, in other words, an unsolvable unity between people and the world. This situation – always given, never escapable – is what Heidegger called *Dasein*, or *being-in-the-world*. It is impossible to ask whether person makes world or world makes person because both exist always together and can only be correctly interpreted in terms of the holistic relationship, being-in-world.

On a less philosophical level, our relationship and direct exchange with the environment is even more apparent. Our metabolism has a daily input and output of about 5kg mass, consisting of food, water and oxygen (Reed & Coulter, 1999). An average human being is thus processing about 140 tons of 'world' during a life time.

Eliade (1961) is pointing out, that in all cultures, places have had a deeply mythological meaning. The foundation of a house, a settlement or a town has been a religious act, which is still reminiscence today. Architecture has an eminent role as a key interface and definition of our *being-in-the-world*. Where natural environment is more and more lost, architecture takes a key role in creating places and in the best case a 'genius loci'.

In Roman mythology a genius loci was the protective spirit of a place. It was often depicted as a snake. With the dawn of rationalism, this spiritual meaning of a place has been more and more negated. The modern movement in architecture tried to analyse the site based on scientific parameters and their optimization like sun angles and circulation distances. The fast growth of cities in the last century, which is still continuing today, and the application of the ‚modern formula' quickly resulted in sterile and faceless neighbourhoods. First social problems resulted in high-density poor city quarters, but in fact, also the fast growth of the

single family houses in the agglomeration results in places with no identity. The genius loci, which was found in medieval and renaissance cities has been lost!

In contemporary usage, "genius loci" usually refers to a location's distinctive atmosphere, or a "spirit of place", rather than necessarily a guardian spirit. It has been Norberg-Schulz (1982) who re-introduced this topic in the modern context, but the attempts of the postmodernists to reintroduce it into actually built architecture, did not go beyond a naive an formalistic repetition of long surpassed historic concepts. History can never be revived, it can only be understood and be taken as a base of knowledge for future developments.

Most people are charmed by the specific atmosphere of places, which developed over centuries or have been very well planned and seem to convey a unity, a rightness and an atmosphere. A harmony with Human culture and nature. These places cannot be reproduced, since their making was a complex cultural process.

2.1 How can the genius loci – the spirit of place – been found and created today?

Many great buildings and places have been measured and analysed to learn about their proportions, dimensions and materials. Efforts to rebuilt these places in a different context, usually fail, expecially in the modern environment. There is more to a place, than its physical dimensions. The understanding of a place, sensibility, due respect to it's nature and the courage to design something new is probably an approach to generate new meaningful places. Places are complex systems and we are still very weak in understanding and dealing with complex systems and their phenomena.

Norberg-Schulz (1982) was advocating for a ‚phenomenology of architecture'. Seamon (2002) defines phenomenology as the exploration and description of phenomena, where phenomena refer to things or experiences as human beings experience them. Any object, event, situation or experience that a person can see, hear, touch, smell, taste, feel, perceive intuitively, know, understand, or live through is a legitimate topic for phenomenological investigation. There can be a phenomenology of light, of colour, of architecture, of landscape, of place, of home, of travel, of seeing, of learning, of blindness, of jealousy, of change, of relationship, of friendship, of power, of economy, of sociability, and so forth. All of these things are phenomena because human beings can experience, encounter, or live through them in some way.

The ultimate aim of phenomenological research, however, is not idiosyncratic descriptions of the phenomenon, though such descriptions are often an important starting point for existential phenomenology. Rather, the aim is to use these descriptions as a foundation stone from which to discover underlying commonalities that mark the essential core of the phenomenon.

In other words, the phenomenologist pays attention to specific instances of the phenomenon with the hope that these instances, in time, will point toward more general qualities and characteristics that accurately describe the essential nature of the phenomenon as it has presence and meaning in the concrete lives and experiences of human beings.

The architect has to take into account the multitude of these phenomena to be able to create architecture with meaning. Architecture can neither be only an aesthetical exercise nor a

technological construction to be able to create a ‚genius loci'. For this, like in a spaceship, the complexity of these phenomena have to be taken into account.

One often used method of architects is to study and personally visit many important places and buildings to be able to synthesise new designs from the scientific investigation of these places, but also from the intuitive and personal experience of them. In this the method is very similar to the one of phenomenologists described before. A few examples of places with a specific genius loci shall be described here.

2.2 Sassi di Matera

The UNESCO World heritage is describing the Sassi di Matera (Figure 3) in the South of Italy as the most outstanding, intact example of a troglodyte settlement in the Mediterranean region, perfectly adapted to its terrain and ecosystem. The first inhabited zone dates from the Palaeolithic, while later settlements illustrate a number of significant stages in human history.

Figure 3. Matera. (source: www.???????)

Matera has gained international fame for its ancient town, the so-called "Sassi di Matera" (meaning "stones of Matera"). The Sassi originate from a prehistorical (troglodyte) settlement, and are suspected to be some of the first human settlements in Italy. According to the English Fober's guide Matera is „the only place in the world where people can boast to be still living in the same houses of their ancestors of 9,000 years ago."

The "Sassi" are houses dug into the rock itself, known as "Tuffo", which is characteristic of the regions Basilicata and Puglia. Many of these "houses" are really only caverns, and the streets in some parts of the "Sassi" often are located on the rooftops of other houses. The ancient town grew in height on one slope of the ravine created by a river that is now all but a small stream. The ravine is known locally as, "la Gravina". It was the source of live and water, which slowly degraded with changing agricultural practice and industrialisation taking place during the last 200 years. Before the city prospered by the agricultural use of the clay plateau above and the water management of the river. Through a complex watering system, water was led into cisterns usually in courtyards. These courtyards gave access to a group of dwellings, which not only shared access to water and light, but also evolved into a social structure called la 'vicinato' (Figure 4).

The slow, progressive and inexorable destruction of the ecosystem caused a breakup of the natural equilibrium of the environment. The old city of Matera became poor and the hygenic situation unbearable.

In the 1950s, the government of Italy forcefully relocated most of the population of the Sassi to areas of the developing modern city. After the old city has been nearly abandoned for decades, it became a UNESCO World Heritage. Since then, a new kind of activation of the Sassi happened by tourism, theatre and music groups and even high-tech companies, who run their server-farms in the naturally cool caves (Sandford, 2006, January 20).

The genius loci of Matera derives from the symbosis of Human culture with the geologic and topographic characteristics of the place. The source of live was the fertile fields above the town and the river flowing through it. Both formed a unity in infrastructure and landscape.

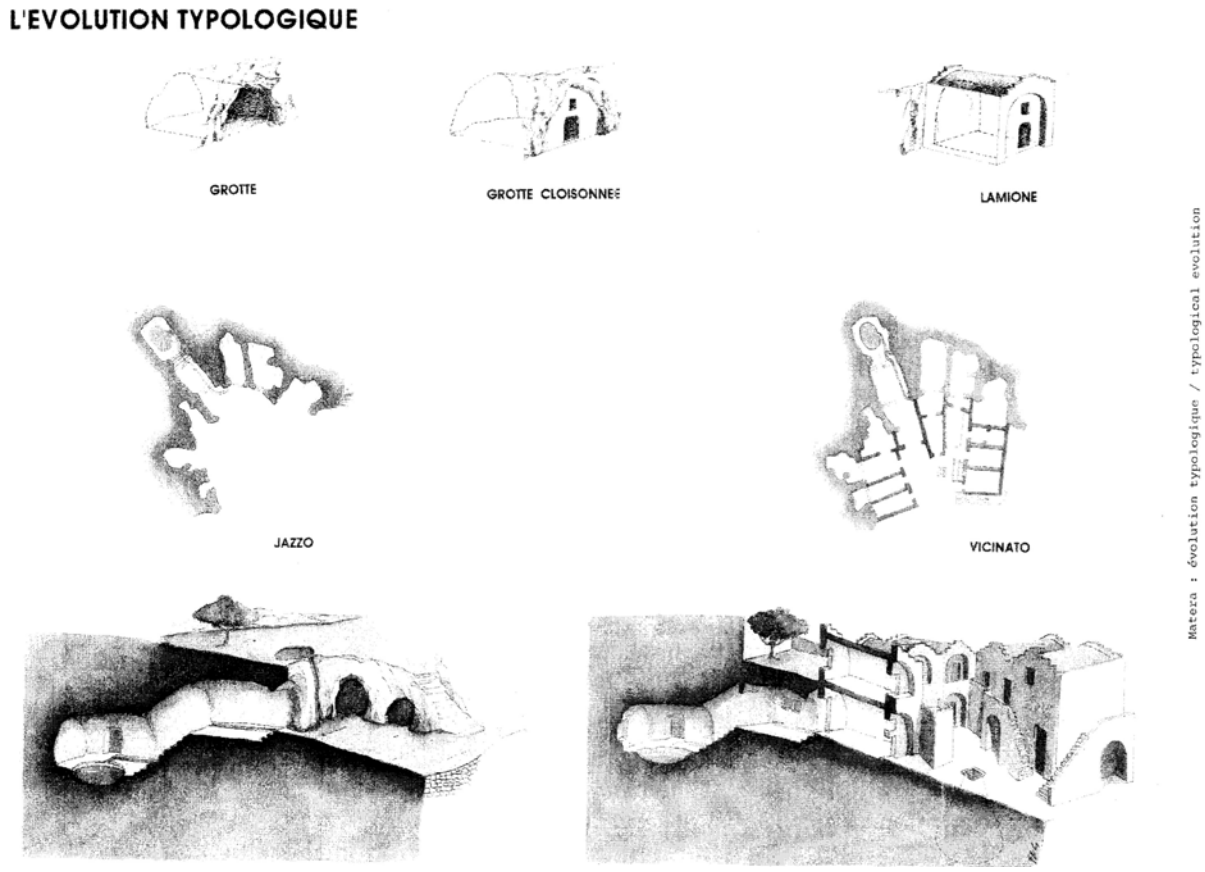


Figure 4. The Sassi are served by a complex water management system and developed from simple caves to more complex architectural and social structures as the ‘vicinatos’ (source: UNESCO)

2.3 Town Squares in Venice

Venice is one of the most admirable examples of a town built in the extreme environment of the salt water lagoons. The city's location on the Adriatic made it an important trading center as early as the A.D. 800's. Venice became a strong sea power and gradually built a colonial empire that extended throughout much of the eastern Mediterranean area. It was nearly impossible for enemies not knowing the lagoon to invade Venice. At the height of its power,

Venice was known as the "Queen of the Adriatic." Through the centuries, Venice lost much of its economic and political strength. But the city's art treasures helped it keep its place as a cultural center of the world. Today, floods and polluted air and water threaten to slowly destroy the city.

However, Venice lived on a permanent battle against the sea and the salt water, which creeps up the masonery. Venice also was sinking an average of about 1/5 inch (5 millimeters) yearly until the mid-1970's. A number of scientists believe that the sinking resulted partly from the removal of underground water for use by industries. The Italian government restricted the use of water from the city's underground wells. Water pressure then built up under the islands, and the city stopped sinking.

For our case, one of the most remarkable items are the town squares of Venice. These piazzas are not only the focus of urban and social life, but also served over centuries to ensure access to potable water for its inhabitants. Potable water was not available in the salty lagoon and the transport from the mainland was difficult and impossible during war times. Thus, rainwater was collected over the town squares, which was filtered by sand and accessible by fountains in the centre of the square. This combination of urban square and actual life support for the inhabitants, gives the piazza special meaning, often overseen by the casual visitor of this city. These squares, which are not used anymore today, since potable water comes in duct from the mainlain, formed a unity of urban design and a clever water collection system.

2.4 Syrian Adobe Houses

People have used adobe to build houses and other structures in desert regions for thousands of years. The ancient Egyptians and Babylonians used adobe. Traditional building methods survived in Syria (Figure 5 & Figure 6). The charm of these houses is in the unity of material and colour with the landscape and the specific shape the adobe construction produced. Traditional adobe houses are covered with mud. Adobe houses are cooler than uninsulated homes made of wood or stone, but adobe is not suitable for use in cold or damp regions. The bricks will crumble if they are exposed to rain or to periods of freezing temperatures followed by thaws.

Today these houses, which served people to live for thousands of years are only inhabited by very poor people and ‘aid’ programmes are replacing these huts for prefabricated concrete huts. There is this approach, which takes the whole character away from the place has it happened to many modern places. This happens in a time, where in the rich Western world adobe houses are built for the healthy climate. Unfortunately, there was no other concept seen to raise the hygienic standard of the disturbed ecosystems, than relocating the inhabitants into concrete boxes.

Figure 5. An adobe village in syria

Figure 6. The village Jabal-al-Hoss in Syria.

Figure 7. The rehabitation programme for poor people from Jabal-al-Hoss may ease the daily life, but definitely destroy the genius loci of the place.

2.5 Harmony with the Environment as an Incentive of a Genius Loci

The special conditions of the Sassi di Matera created a special place as well as in Venice and Syria. Over centuries human settlements lived on the basis of an ecological footprint, which allowed them to maintain the balance of a local food production (agriculture) and settlements from the size of farmhouses up to towns. Only with the industrial revolution this balance changed. The complete globalisation of markets, which is based on the concept of near free transportation costs, is creating a strong concentration, but also a distortion of markets. Especially the complete disconnection of a majority of people from the production of their own food and their most basic life-support ressources, and thus a direct relation to nature and its principles is causing dramatic effects. The all-year round production of tomatoes in greenhouses in Andalucia South of Spain serves as an example. The greenhouse production allows the formerly poor region a regular source of income. However, the use of water is in complete inbalance with nature and turned the region within years into

a desert. Many farmers face the end of their production, if the rain is getting less and less as it happened during the last years.

Even more bizarre is the fact, that tomatoes from Andalucia are underpricing locally grown vegetable on African markets, where even the poorest farmers can't beat the prices with their hand-grown vegetable. So, the effect of this mass production is not only affecting the ecosystem in Andalucia, but even more severe, in Africa. It is a process which is hard to reverse, but which may suddenly collapse with a steep increase of energy and utility prices, or the sudden lack of it by collapsing infrastructure.

In fact, the strong dependency of our whole industries and also personal lives from centralised infrastructure and low energy prices, make our societies very vulnerable. The building up of a centralized infrastructure has been a powerful tool for growth and still is, but we are constantly threaded by energy prices, resource shortage, wars and terrorism, which has an easy play to attack centralized systems.

Houseowners know the increasing prices of utilities costs. They ask themselves questions like:

Why should I pay for energy for electricity and heat, if some 550 Watts per square meter reach my ground from the sun? Why should I pay for water, if it rains on my roof? Why should I pay for sewage, if I could fertilize my plants? Why should I pay for fresh food, if I could grow it in my garden?

Well, we know, that people are occupied with other things, than maintaining all the facilities necessary to do that. The facilities even are available, but costly and labour intensive. The question is: Can we employ modern technology to make these systems cheap and easy to use? This will be a challenge for our future.

Most of today's houses are passive envelopes supported by the consumption of energy to protect the inhabitants against the energies and elements of nature. On the other hand it is exactly these elements we live from.

The goal would be to make houses, that live 'with' nature and not against it. This would radically change the concept of architecture, moving it away from its shelter and protection function to an open receptive one, which is more like an intelligent interface, that filters and processes the utilities.

Houses would become like plants, who specifically react on the environment and the availability of resources. Maybe the beginning of a new architecture, which is based on a more profound understanding of the human interaction and relationship with nature and the place. Maybe the architecture as the starting point of the generation of the "genius loci"?

3 The House as the Genius Loci

Houses and apartement buildings are fairly dispersed over the planet and usually concentrated, where the highest degree of environmental pollution is generated on a daily basis: in and around the cities. They probably provided the highest amount of envelope surface of all man made stucture. Surface, which can be used to collect rainwater, clean the air and collect energy from the sun in a fairly decentralized manner. On the other hand

housing is responsible for 50 percent of the world's energy use, not to mention the pollution created by heating, air condition, household waste etc. To turn houses from energy consuming, polluting entities into energy producing, cleaning ones seems an obvious idea.

3.1 The ecological footprint

Ecological footprint analysis approximates the amount of ecologically productive land and sea area required to sustain a population, manufacture a product, or undertake certain activities, by accounting the use of energy, food, water, building material and other consumables. The calculations used, typically convert this into a measure of land area expressed in 'global hectares' (gha) per capita.

It is a way of determining relative consumption for the purpose of educating people about their resource use and, sometimes, triggering them to alter their consumption. Ecological footprints have been used to argue that current lifestyles are not sustainable. For example, the average "earthshare" available to each human citizen is approximately 1.9 gha per capita. The US average footprint is 9.5 gha per capita, and that of Switzerland 4 gha, whilst China's is circa 1.5 gha per head (Rees, 1992).

If, let's say a 4-person Swiss family in a single family house with a footprint of 100 square metre would have to provide this area for a self-sustaining live, they would have to live in a 1600-storey, 4800m high skyscraper.

But it is not only surface area which is a problem, also the time natural processes need. Contrary to many assumptions, it is the human use of renewable resources, not of non-renewable ones, that poses the real sustainability crisis. Nature can restore renewable resources at a certain rate. Humans consistently and increasingly consume renewables faster than ecosystems can restore them.

This state of excessive ecological burden eventually threatens those very ecosystems by not allowing them sufficient time to "recharge." Furthermore, humans can clearly live without nonrenewable resources such as metals or fossil fuels, as we have done in the not-so-distant past. It is the renewable resource base on which we and all species depend. The ecological footprint approach can introduce the concept of resource recharge and the rate at which we use resources as key elements in more sustainable human societies. This time element helps us understand that it's not just what we use, or even how much, but how fast, and over what period of time.

3.2 The ecological accelerator

Today environmental problems, which we face cannot be defeated with large scale interventions. Artificially ventilating the Smog out of Mexico City would require tremendous jet engines, which would create noise and high turbulences. Naturally, the destruction must be stopped at the very source. But even, if by tomorrow all cars, industries and power plants would be emission free, we still may suffer the environmental effects caused 50 years ago.

Starting to use the tremendously dispersed stock of houses on our planet, not only to stop polluting our environment, but to actively clean it, may have a positive effect on the long term.

Today houses are consuming devices, connected to an costly infrastructure (Figure 8). They mostly exclude the freely available in-situ resources. Their intake are clean processed resources and their outlet is usually waste and sewage, which need treatment. There are no advanced processes of these resources happening in the house. They are merely diluted and mixed together and reach an inferior process state.

The understanding of the house as a processing and producing machine, would allow us to make the house an active part of the environment like a tree (Figure 9). Technology would allow that the house converts the intake of dirty air and polluted water into clean air and potable water, being powered by wind and solar energy. Even excess energy could be produced, which can be used for personal mobility. This would give the house a considerable added value. Currently houses consume 50% of the world's energy. If they would produce at the same rate, no power plants would be needed.

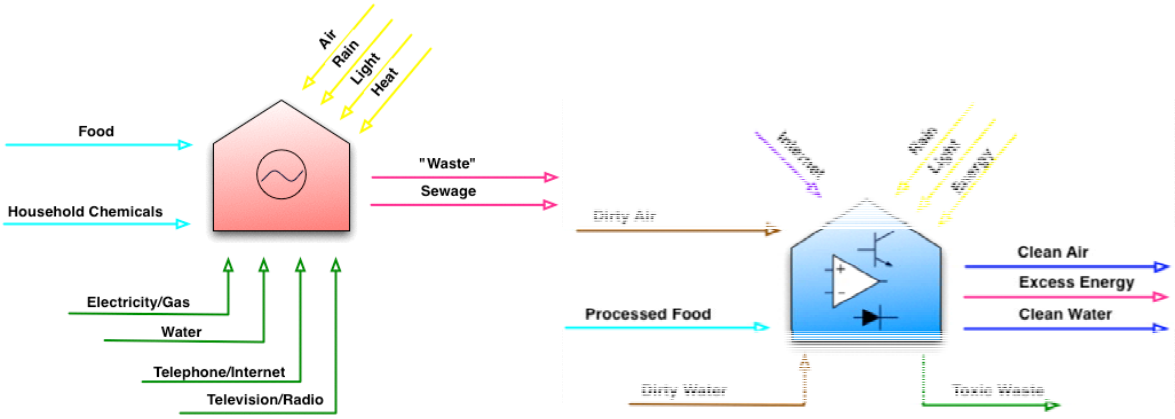
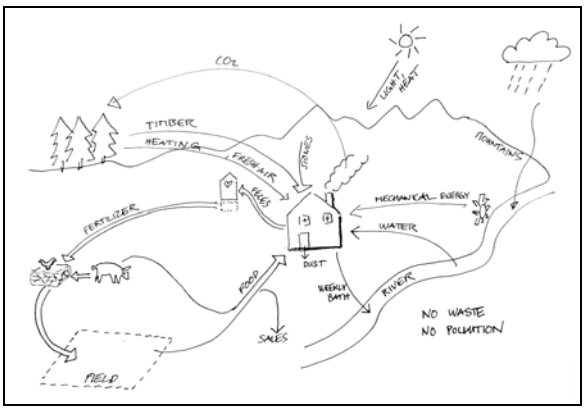


Figure 8. A „consuming" model of the house.

Figure 9. A „producing" model of the house as machine, processing energies and matters to achieve a desireable output.

We also have to consider, that the way we perceive technology, the environment and its interactions has considerably changed in the last decades. On the one hand the technological development considerably harms the environment, on the other hand we realized, that only a further development of innovative, low-energy consuming environmental technologies can lead us forward. Before the industrial revolution the human settlements were mostly integrated into nature. The natural environment was big enough to keep the system stable. With the fast growth of the industrialized society this balance went out of order. The balancing systems have now to be integrated into the house by means of technology (Figure 10 & Figure 11). Current climate reports (European Environment Agency 2004) are showing the need to act. By their decentralized location, especially houses are most adequate to be the source of this environmental balancing for the future generations.



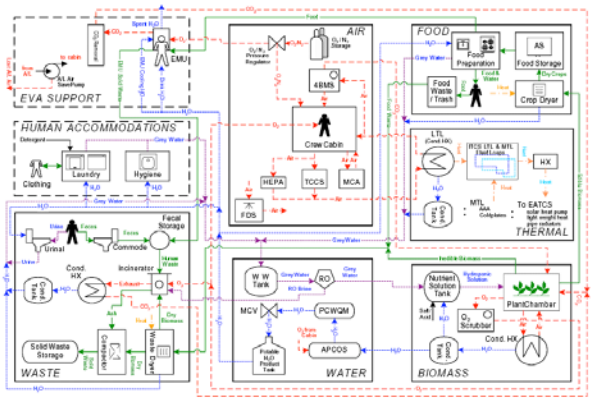


Figure 10. The system ‚House' before the industrial revolution: Integrated into the ecosystem provided by nature.

Figure 11. Diagram of a Human Habitat for Mars: Nature needs to be fully integrated as a technical system. Waste should be not existant anymore. (The diagram shown is based on current NASA Mission plans, where waste is still part of the system.) Source: NASA.

The new approach of spacemen technological thinking, can also bring the control over the environment back into the hands of the people, a ressource, which cannot be made up by even the most sophisticated infrastructure.

Christopher Alexander, the father of pattern languages defined the Leapfrog opportunity by using local resources ten years ago, perhaps knowingly. In his lecture in San Jose (1996, as cited in Gupta, 2004)) to a group of software programmers, he commented that:

"In traditional society where lay people either built or laid out their own houses, their own streets, and so on, the adaptation was natural. It occurred successfully because it was in the hands of the people that were directly using the buildings and streets. So, with the help of the shared pattern languages, which existed in traditional society, people were able to generate a complete living structure.

In our own time, the production of environment has gone out of the hands of people who use the environment. So, one of the efforts of the pattern language was not merely to try and identify structural features which would make the environment positive or nurturing, but also to do it in a fashion which could be in everybody's hands, so that the whole thing would effectively then generate itself."

Obviously, there is also a strong political element in this, since control over resources is a strong element of power.

3.3 Towards a New Generative Architecture

TANSTAAFL - "There Ain't No Such Thing As A Free Lunch"

Robert Heinlein in "The Moon Is a Harsh Mistress"

It has been shown before, that houses are merely more than diluters of matter and energy and are dependent on a fairly high in- and output. Space Habitats have to minimize the loss

of matter and create closed-loop autonomous Life Support Systems. Two examples shall show, how the study of nature and a fairly low-tech support of existing capabilities of nature can increase the desired effect.

3.3.1 NASA BioHome

The BioHome was a small, quite low-tech facility created by NASA that could support one person in a fully functional habitat. One of the influences of the project being the results from data obtained on the 1973 Skylab 3 (SL-3), where a total of 107 Volatile Organic Concentrators (VOC) were offgassed by synthetic materials that comprised the SL-3. However, the study of indoor air quality was not the only focus of the project, as it was a part of research into closed ecological life support systems.

Construction of the BioHome was concluded in 1989 and construction materials included synthetics which gave off the aforementioned VOCs. The BioHome itself resembles a mobile home in size where it contained a living area and treatment facilities for human waste and air. The BioHome had living facilities that could support one person and foliage plants were placed throughout the structure, aiding in air purification. In addition to the plants, a prototype fan-assisted plant filter was installed; the filter had the removal capacity of 15 standard potted plants. The BioHome was equipped with monitoring ports for the detection of VOCs, which were measured using mass spectrometer / gas chromatograph equipment.

The BioHome was used for a variety of experiments into, and including: Wastewater Treatment by the use of plants, Harvesting Drinking Water, Crop Growth and Air Purification. The facility is still in use and has paved inroads into creating self-supporting life support systems (BioHome, 2005).

Figure 12. The NASA BioHome project.

Figure 13. Indoor plants were used to clean the air of the BioHome. (sources: Wikipedia and http://www.wolvertonenvironmental.com/air.htm)

3.3.2 DesertSeal

Another example is the project ‚DesertSeal', a tent for hot-arid climates, which is making use of local energies for cooling itself (Figure 14). The tent has been the result of a study performed by Architecture+Vision for the European Space Agency ESA, to investigate the use of space technologies for inflatable tents in hot regions (European Space Agency, 2005)

Desert Seal is designed specifically for hot arid environments where the air becomes considerably cooler the more distant it is from the Earth's surface. During the day, the temperature can easily reach 60°C and beyond at ground level, while just 2-3 metres above it can be 40°C lower (Figure 14). In fact, also traditional persian buildings have been using this effect (Figure 15) as well as animals like the camel with its high legs and high nose (Figure 16).

During the day, an electric fan in the top of the tent, 2.26 m above the ground, constantly blows cooler air inside, thus reducing the temperature inside the tent. The fan is powered by batteries charged by flexible solar panels mounted outside the tent (Figure 17). During the night, the desert ground radiates heat off to space and is quickly reaching temperatures below zero degree Celsius. Since air is acting as a good insulator, on higher levels it stays considerably warmer. The fan on top is now running on batteries and blowing warmer air into the tent.

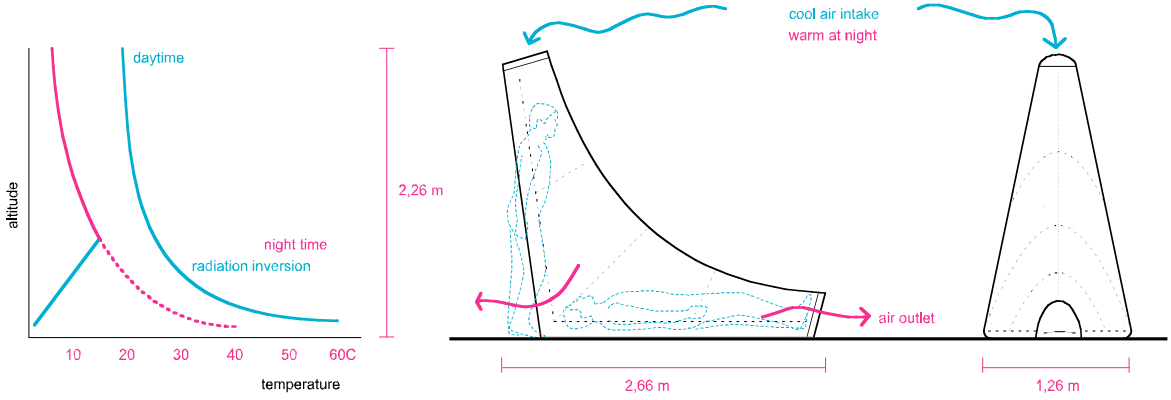


Figure 14. Desert Seal is making use of the specific temperature curve found in the desert. Cooler air is blown into the tent form the top by a solar-powered electric fan. (Source: Architecture+Vision)

The tent consists of an air beam structure made of polyethylene-coated material. It has an awning in silver-coated high-strength textile to reflect the heat and provide protection from direct sunshine. The L-shaped tent allows upright entry and also minimises the aerodynamic load.

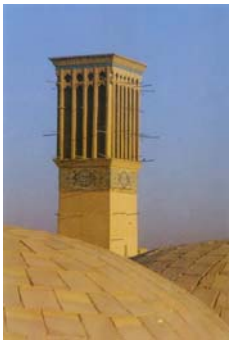


Figure 15. A wind scoop tower in the historical city of Bam, Iran

Figure 16. The Desert Seal tent is collecting cooler air at higher levels. (Source: Architecture+Vision)

Figure 17. Desert Seal has a heat reflecting silver-coated awning and uses a flexible solar cell to power the fan on top. (Source: Architecture+Vision)

The tent is making use of environmental energies. This only has become possible by recent developments in lightweight flexible solar panels and high capacity batteries. As technology evolves more design ideas suddenly become possible.

3.4 Conclusion

The building technology sector has been increasing constantly through the last decades and is already reaching 40-50 percent of the costs of a building. This trend will continue as technology and especially environmental technology is developing. A new understanding of the house as an active regenerative contributor to the local ecosystem and the intelligent use of passive and active devices will likely generate a new kind of architecture. Houses will be in active exchange with their local ecosystems. There will be eventually no need for a centralized infrastructure. The individuality of the place with special environmental conditions will be in one kind or another visible in the architecture. This is opening the potential to generate places with identity, a genius loci, if not just the technological aspect, but all phenomena of a place are taken into account.

4 The Mercury House Programme

The reduction of the energy use of buildings and their eventual self-sufficiency is an important objective, but regarding the expected development of the world's climate, this may not be enough. Buildings of the future should not only visually improve the environment, but also physically. They should clean the air, collect and purify water, produce energy and fresh vegetable and food for our daily needs. The NASA BioHome project employed inhouse plants for wastewater treatment, harvesting drinking water, crop growth and air purification. A

more compact vertical arrangement of plants, supported by robots and LED lights can become the ‘green lung’ of a house. The house would become the technological equivalent of the tree, actively cleaning the air and water around it. The house would become an active part of the ecosystem.

This concept is followed by the ‘Mercury House Programme’ of Architecture+Vision. The inhouse research programme is taking the house as a platform for technology development. Informed by the requirements for Human long-duration spaceflight, the Mercury House Programme is researching for an architecture, which integrates modern technology developments to make a place better not worse. The programme is understood as prototype development. Core objectives are prefabrication as well as in-situ resource utilisation, advanced life-support systems to become independent from public infrastructure, exploration of modern materials and shapes, energy provision for in-house use and mobility, modern lifestyle in active exchange with the environment and creation of a genius loci by a modern approach.

The MercuryHouseTwo (Figure 18) presented here, is one of a series of prototype houses.

20 years from now first human beings may be one Mars. To get there, fully autonomous energy and life support systems will be developed. Systems will run on low energy needs and will be small and lightweight. On Earth, houses, which are energy independant, collect their own water and recycle most of the waste of their inhabitants, need to be developed urgently. The dependency on centralized infrastructure makes a community very vulnerable like recent power blackouts showed. The rich western world can develop these houses and thus keep its technology lead. The mass market of the homebuilding industry will benefit not only the domestic economy, but also the developing world, by making economic water and energy recovering systems available. This scheme looks into the future. The revolution of materials fostered with nanotechnology will result in an evolution of the architecture and a change of the paradigm of the house. The MercuryHouse concept is a reaction on the vast landuse of the single-family home. The organisation is vertical - like a tree - with a muscle-powered lift. Furniture is all integrated as in a yacht or aircraft. The house comes prefabricated out of the factory. The big wheels allow the transport and fast removal in case of emergencies situations like floods or hurricans. Most of the housekeeping tasks will be made or supported by small robots. A robot-maintained greenhouse is growing fresh food. Small children monitoring systems are built-in and, when children are older their natural drive for climbing and experiencing the 3rd dimension is given.

Figure 18. MercuryHouseTwo is a concept house by Architecture+Vision introducing mobility, pro-active environmental systems and interactive, robot-supported environments. Credit: Architecture+Vision.

The house is transported on its own wheels, pulled by a truck (Figure 19). It is pulled up in vertical position by ropes. When it is standing, water tanks integrated into the hull are filled with water to add weight and heat storage. The water is provided by a local service or can be collected on-site, thus minimizing the transportation weight of the house. Two side legs further ensure high stability of the house, which does not need concrete foundations.

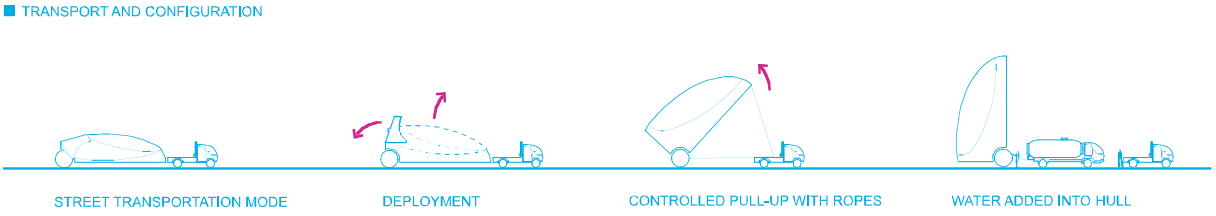


Figure 19: Diagram showing transportation and deployment of the MercuryHouseTwo.

The house comes with an inflatable greenhouse as shown in Figure 20 and Figure 21, which is maintained by robots. The greenhouse can provide several important functions. The greenhouse can collect heat in winter and provide cooling in summer. The plants can clean water, air, compost waste and provide food. The development of the greenhouse technology to provide a safe biogenerator for a house or apartment building, is a very interesting challenge. There are different disperse developments in space expleoration and food industry, but none directed to the building technology market.

The sharply rising costs for energy, water and waste, as well as the wish of houseowners to become independent will open a big market for autonomous systems in the Western societies. The Fraunhofer Institute recently predicted a substantially growing market on passive houses in the next 10 to 15 years (Fraunhofer Institute for Solar Energy, 2004). There is a clear trend of houses becoming self-sufficient again. The development of a biogenerative greenhouse system into garden house size or rooftop size will generate a big market and have a highly positive effect on the environment.

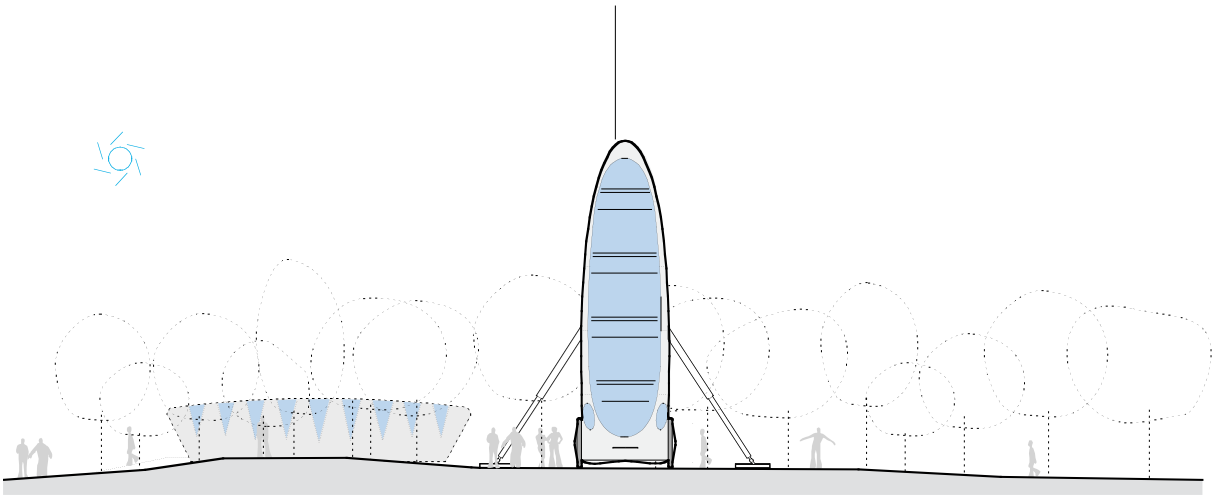


Figure 20: Elevation of the MercuryHouseTwo with the inflatable greenhouse on the left.

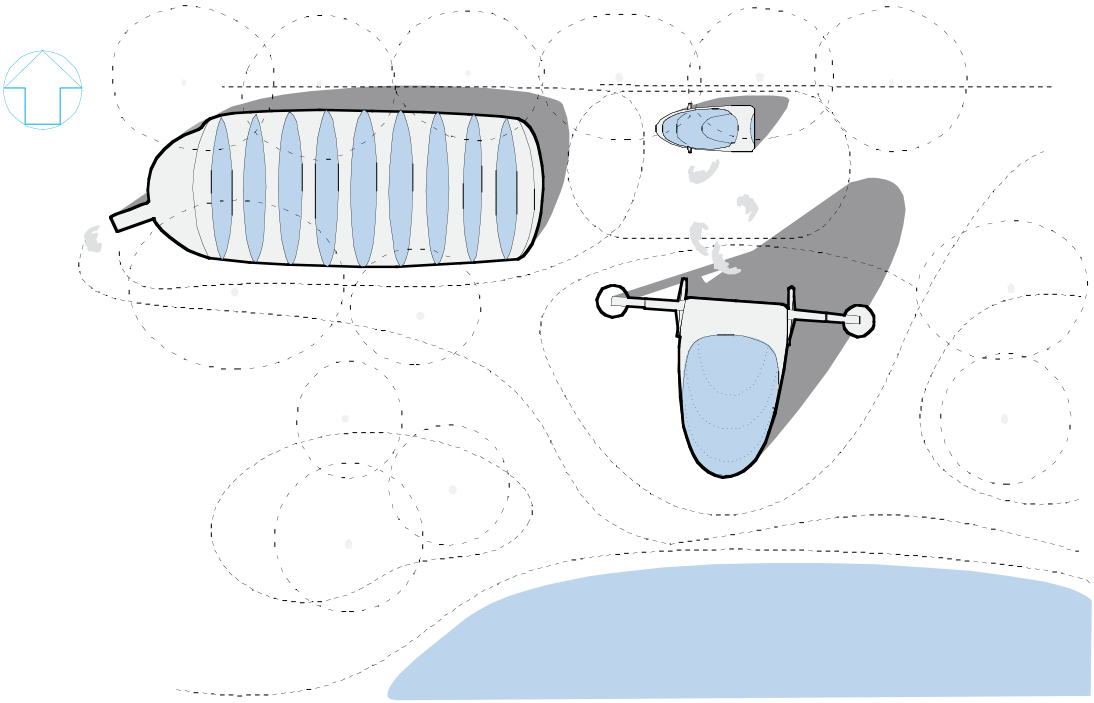


Figure 21: Plan view of MercuryHouseTwo with inflatable greenhouse and electric car. With the wheels of the house, it can be turned into the sun or away from it, depending on the energy intake, the light and/or the view desired.

The MercuryHouseTwo in its current concept has a big glazed front. It is conceived to operate with a chrome-vanadium coating, which can be set on a specific room temperature. As soon as this temperature is higher the glass becomes translucent and is blocking out further heat intake by the sun. This technology is currently in the laboratories. Alternatively, the house can be turned on it own wheels to adjust and optimize the passive solar energy intake.

The building is organized vertically with minimized spaces (Figure 22). It is more understood like living in a boat, than in a house. Vertical circulation is provided by a muscle-powered lift,

which is minimizing space requirement compared to a staircase and is offering personal fitness training. The ground floor has a storage room and a living room, which allows several people to sit together and look into the landscape. On the first floor is a small kitchen and a dining room. The upper floors contain the bedrooms with bathroom or shower and toilet.

Exhaust air is collected through the composting toilets and lead over a series of green filters into the greenhouse. Fresh air is provided through the greenhouse. The high oxygen production of the plants during the morning is used and the oxygen rich air is buffered to be lead into the house during the rest of the day. The air outlet is controllable near the beds and living room to provided fresh air near to the people.

Water is collected over the roof of the greenhouse and pre-cleaned over the plant system. The house itself has a graywater cycle feeding dishwasher and washing machine. The toilets only use minimum water for direct cleaning. Humidity of liquid and solid human waste is ventilated off into an air-cleaning recovery system in the greenhouse.

Electricity is gained by combined solar and wind power and stored in fuel cells or other technology available.

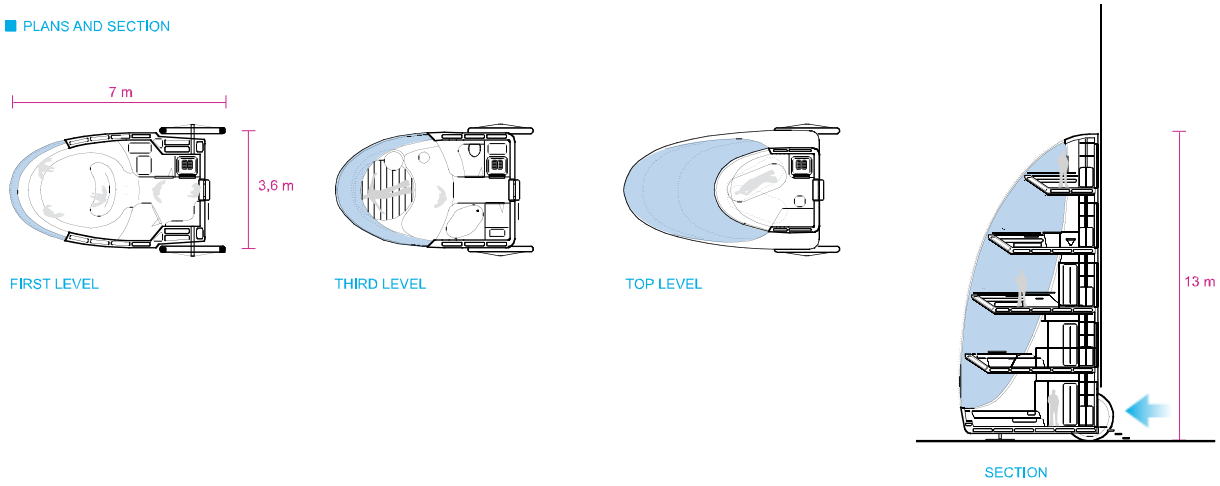


Figure 22: Selected plans and section of the MercuryHouseTwo.

5 Conclusion

The connection of people to places and their cultural interaction with their environments has created over centuries very special places and habitats, which can be expressed with the term ‘genius loci’. Examples are the city of Matera, Venice and Syrian Adobe houses along many others. The places have a special spirit of their inhabitant being in balance and harmony with the environment. The powerful growth induced by the industrial revolution has been based on the principles of concentration and the assumption of unlimited resources. This system has been creating imbalance from the beginning. The needs for power and transportation of the modern societies has been creating places, which are the opposite of a genius loci. Through spaceflight we start to see the limits of our blue planet. Large scale pollution is not only affecting our atmosphere, whose fragility becomes apparent, if seen from space.

It is argued in this paper, that a modern genius loci could be created, by a holistic understanding of the phenomena ‘place’ and its ecosystem and an intelligent interaction with it. Especially houses can take an active role in this, not just to benefit the house owners, but the whole ecosystem of the planet. If the large mass of houses can gradually turn from consuming and polluting devices into producing and cleaning ones, the change for the better would not be in the hands of committees and nations, but in the hands of responsible house owners and a large scale market, given the fact, that the housebuilding market is the surpassing the automotive, aerospace and shipbuilding market in volume all together.

Human Space Exploration is making clear the necessity and difficulty of creating fully autonomous life support systems, which are light-weight, small volume and energy-effective. The modern house can benefit from these developments, as well as spaceflight could benefit from proven systems running on Earth. The MercuryHouse Programme is a technology development platform and research programme to these systems in private houses with open-minded clients. The objective of the programme is not just to develop the technological basis for a fully autonomous house, but also to develop the architecture and the quality of the user-interaction with these systems and the natural environment. Thus, eventually creating a place with identity and character, a genius loci.

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7 Appendix

The design company ‘Architecture and Vision’ was founded by Italian architect Arturo Vittori and his Swiss colleague Andreas Vogler, both sharing a background in Aerospace Design. We set off to work for clients, who want to live and work in efficient and exciting buildings, which can compare to the technology and design strategies used in modern vehicles and electronic equipment, but also to employ our knowledge for developing countries, where housing and hygiene are a major issue. Our vision is to design buildings to clean the environment, structures to enhance the beauty of nature and spaces to inspire people generating their own visions.