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Vertical Bionic City, New Futuristic Footprint

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ABSTRACT: Solutions to the urban problems of the future must assume the new reality of mega cities. The inevitable technological progress must find a balance with the 'bio-ecological' recovery of the natural environment. In the vertical bionic city, all these occur; bio intelligence and giant structures of the city are merged into a single. These structures try to survive by relying on working together as a single organism alive, as ants work in their nest. What makes them so efficient? What makes them work all together? What will be the future form of our building environment? Our future habitable environment it is more likely to be in a vertical built form, against the horizontal city form. There are many reasons to believe that the new vertical cities will be more sustainable than the conventional horizontal city. If this logic is accepted as the future scenario, then the question facing all planners and architects today is: Should we take this build form and make it more socially accepted, physically habitable and human? This paper examines some of the key implications of this scenario, and the criteria for the design and planning of our future sustainable built environment as the vertical cities in the sky.

KEYWORDS: Bio intelligence, Mega city structures, vertical city versus horizontal city.

I. INTRODUCTION

Vertical cities are the new trend in creating new buildings for 21st century with ecological aspects inside. For the first time in history more than half the world's population is living in towns and cities. We passed this milestone in 2008 and by 2040 two thirds of us are expected to live in urban environments. Urbanization presents us with a wealth of new opportunities and huge challenges.

Further economic development and innovation, potentially expected, but also threatens to exacerbate key global problems, including resource depletion, climate change, and inequality. Solutions to the urban problems of the future must assume the new reality of mega cities. The inevitable technological progress must find a balance with the 'bio-ecological' recovery of the natural environment. Bionic science is an alternative to the philosophical thinking and scientific development of mankind's urban models. Based on the bio-technological axiom that 'nature did it first and better [1].

"Bionics" first emerged in Russia in the mid 21-th century as a combination of natural, engineering and technical sciences. Bionics aims to be a field of study that bridges biology and industrial technology. It studies the structures and processes in biological phenomena in order to apply this knowledge to the development, improvement and humanization of mankind's technological environment [2].

II. THE PHILOSOPHY AND THE CONCEPT OF CITIES IN XIX- XX CENTURY

Industrial city, Tony Garnier

Tony Garnier proposed an industrial city approx. 35 000 inhabitants. The city was situated in the southern France on a site with high land and a lake to the north, meanwhile in the south it was located a river and a valley. Garnier took into consideration all aspects of a city, the governmental, residential, manufacturing and agriculture practices. The functions of the city were separated from each other by locations and patterns. The heart of the city (public area) was grouped into: assembly halls, administrative services, museum collections and sport facilities [3].

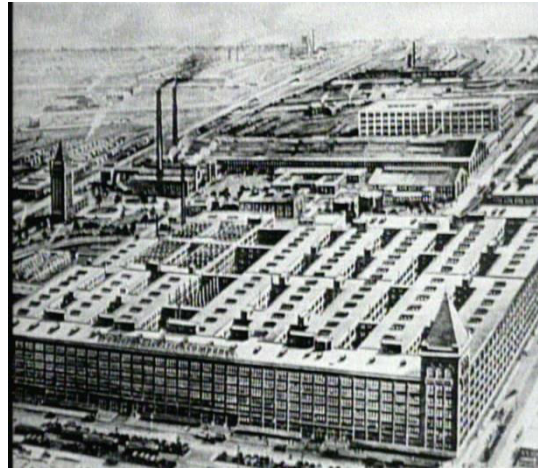


Fig. 1. Industrial city, Tony Garnier

Garden city, Ebenezer Howard

Howard analysed in his book, the reason of the inhabitation movement for countryside to cities and vice versa. According to him these movements functions as magnets. His solution was to develop a city structure including the characteristics of a city and the characteristics of the countryside. The garden city includes different zone, street and green areas. The core contains a central park and its area is about 4km². The core is surrounded by a commercial, cultural and administrative zone. The circulation is realized through a railway system in order to exchange goods [4].

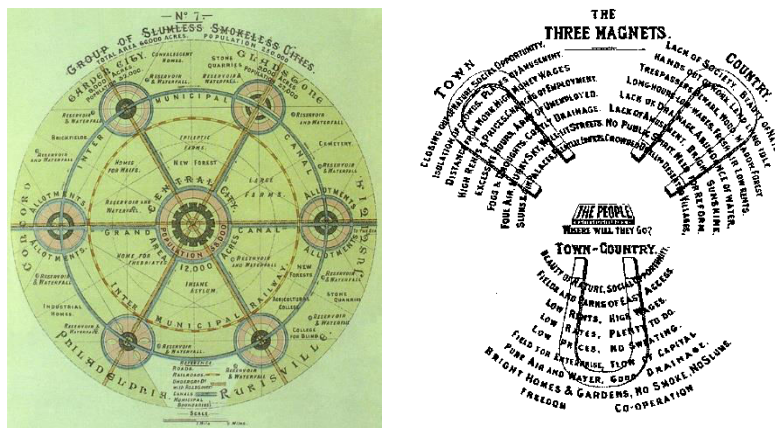


Fig. 2. Ebenezer Howard's 3 magnets diagram

Broadacre city, Frank Lloyd Wright

Frank Lloyd Wright believed that the freedom of movement made possible with the improvements in technology was the main reason of a man's success. The automobile, the electrification the improvement in communication were the technology assessments of the century. According to him true democracy is achieved by reclaiming one's individuality and engaging in "nature architecture" rather than communal living of the cities. His aim was to develop a different way of life which was not an imitation of European counterparts to Foster creation. Later it was renamed Usonian [5].

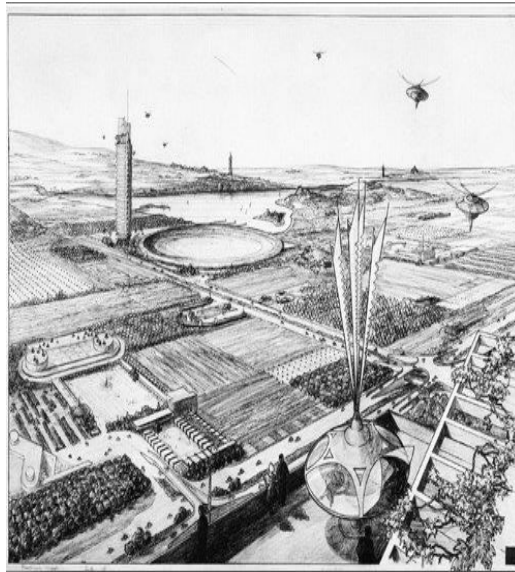


Fig. 3. Sketches for Broadacre City project by Frank L. Wright

“Plan Voisin” Le Corbusier

The “Voisin Plan” was predicted in a strategical area of Paris, France. The plan paves the way for a dense communication network. The cross-shaped skyscrapers create the image of a high-rise city. The area occupied by them was only 5%. The remaining of 95% was intended for large communication arteries, parking’s and green spaces. The parks which are develop at the feet of these skyscrapers give the impression of a large garden city. The plan envisions a quadrupling of its inhabitants, from a density of 800 inhabitants per hectare to a density of 3600 inhabitants per hectare (eco districts). Urban planning is intertwined with architecture and architecture with urban planning. Each skyscraper can welcome from 20 000 to 40 000 employers. All the 18 skyscrapers together can welcome 500 000 – 700 000 employers. Metropolitan lines in quadrilateral networks run at the feet of the building in order to facilitate the movement of the crowds. The architectural history (world heritage) carried over the years is respected. Plan does not claim to provide the ideal solution for Paris, but can serve to take the level of discussion to a higher one [6].

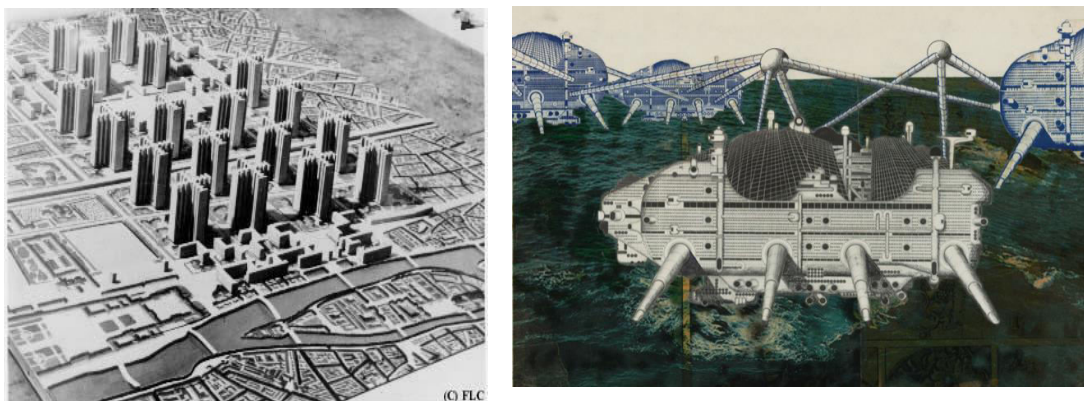


Fig. 4. (a) Sketches for City of Three Million Inhabitants Le Corbusier (b) The walking city, Archigram

The walking city, Archigram

The walking city is a city embodied in the movement of machinery, a kind of walking insect artificial intelligence. The city makes possible urban life in various parts of the world. The futuristic design of the city is modelled to sought resources too. The inhabitants of the city are urban nomads. They want to enjoy the comfort of the city always on the move. The walking city is the ancestor of smart cities [7].

III. INTERPRETATION OF NEW INTERNATIONAL COMPETITION FOR FUTURISTIC

The internal competition was titled “Ultimate Sky Tower” and ideas were called for that may solve diversified problems inherent in current urbanism by way of a vertical city with the height of 1,600 meters. The site for consideration was set in the Middle East where an additional issue of water supply should be taken into account. Technological feasibilities of the proposals were somewhat sunk to allow the applicants free and creative ideas, while they were asked to give some considerations. The competition was announced in June 2007 and closed about a month later [8].

Liquid Crystal Tower

The Liquid Crystal Tower is an ultimate oasis on an inshore island, a mile-high tower city utilizing the power of nature to the maximum as well as protecting people from its severity. The sea waters the tower and the tower returns the water to the sea. People from the coast and from the open sea are interlaced in the tower creating a city that no one has ever seen. (Figure 5)

1. Energy collection: Solar panels.
2. Steam generation: The collected power is used to boil seawater and provide necessary potential for the steam to rise up by a chimney effect in the centre core.
3. Intermediate power generation: Steam turbine.
4. Generation of distilled water: The steam is naturally cooled down and condensed to distilled water at the top of the tower.
5. Water usage and return to the sea: The distilled water is stored and supplied to each part of the tower along the light wells by the potential energy and finally returned to the sea.

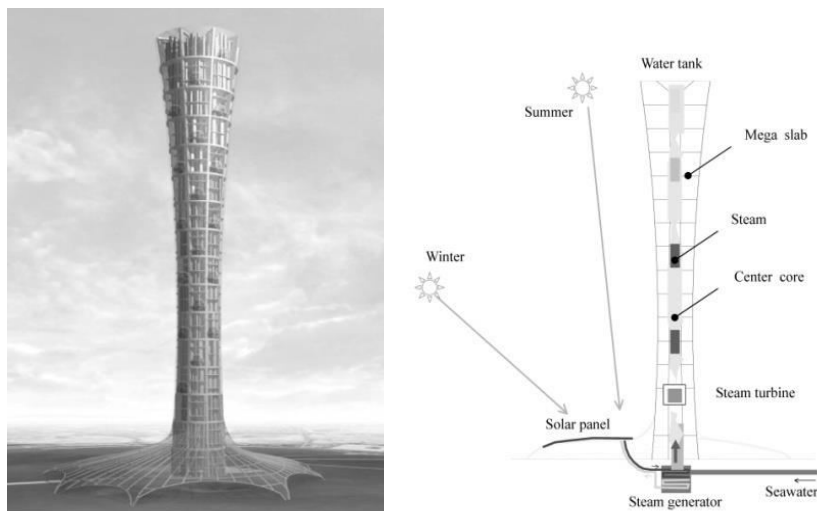


Fig. 5. (a) Liquid Crystal Tower (Nishimura et al.); (b) Water circulation system

Spiral Sky City

Since ancient times, man has sought to construct cities on green belt along mighty rivers. In the Middle East, an abundance of parched land has made people aware of the preciousness even more and cultivated diversified means of living with the nature. On this occasion, a high-rise city abundant in water and greenery is proposed, extending skywards for 1,600m around the integration of a 30km spirally coiled river and foliage promenade. This is named “Spiral Sky City” (Figure 6). A city is created through insertion of both artificial base sections (skeleton) housing commercial facilities and functional units (infill) into the spiral (Figure 6). Unit alteration and addition can occur as is required. Both their density and the direction from which they are viewed will greatly affect the image of the city. To preserve a rank as the world’s tallest building, the height of the spiral and artificial base sections can be extended to compete with other high-rise projects. Artificial base sections are laid every 100m and supported by additional units as necessary. High-speed vertical elevator transportation and spiral sky tram transportation run throughout the city. Energy gain via solar and wind power generation units as well as effective water usage through subterranean desalinization and recycling units, orients the spiral toward an entirely self-sufficient city. Creation of a Spiral Sky City

would effectively promote the expansion of surrounding greenery. Through manifold Spiral Sky City installation, parched earth could be converted into fertile land.

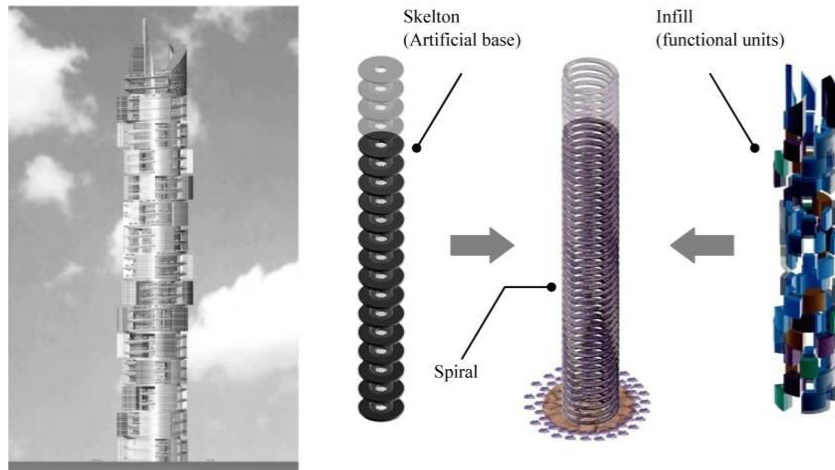


Fig. 6. (a) Spiral Sky City (Ueda et al.);(b) Skelton and infill

Tower of Life

With worldwide explosion of population and improvement in the standards of life, securing water resources has become more and more crucial for many cities. This is especially true to the Middle East, where water purification plants play even more important role to the people’s living due to the desert environment. Proposed here is a permanent source of clean water, “Tower of Life”, a water tank for a city. It is not any ordinary water tank, but a 1,600 meters tall “city within a city”, where people live and work. The tower will constantly supply pure water not only for the inhabitants within, but also for the nearby areas. In order for this tower to continue operating far into the future, it is intended to consume minimum amount of energy, and to produce energy by itself. Gravity, wind power, solar power, and evaporating energy are all utilized by means of a high-efficiency energy conversion technology, for maximum self-efficiency. The features of the tower include:

1. A huge water tank always with its full capacity at the top. The water is carried from underground in a vapour state and condensed here.
2. A mega-structure system consisting of metal-tube mesh. A double-layered exterior skin with built-in solar cells for power generation.
3. Interior spaces naturally ventilated through the “punctures” opened through the outer skin.
4. Shuttle elevators with 5 stories and capacity of 180 people.
5. An open-air “garden-in-the-sky” with a “station” for shuttle elevators at every 100 meters in height
6. An underground vapour plant where seawater is taken in, evaporated and desalinated so that pure water is carried to the top of the tower in a vapour state.



Fig. 7. (a) Tower of life (Yoshimoto et); (b) Puncture in outer skin

Mile High

The aim of this design is to secure a large floor area in the high-rise section of the tower with a high real-estate value by shaping the high-rise section into a horn, departing from the traditional towers with pointed top. The horn-shaped top of the tower is not only highly rational in terms of structural mechanics but is also expected to have an effect of bringing the wind environment in the habitable area inside the horn to the same level as on the ground. In addition, a cooling system that utilizes a day/night temperature variation is made possible by using the large surface area of outer side of the horn.

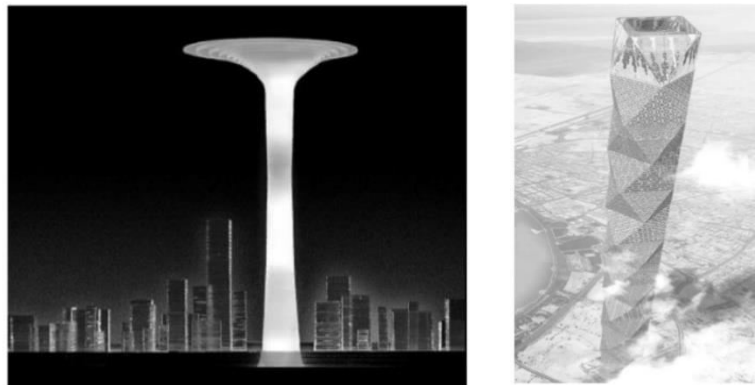


Fig. 8. (a) Paradise @ Mile High (Suga et) (b) Air Tube City (Bouda et al.)

Air Tube City

Huge triangular trusses stacked in layers on top of each other to form a spiral comprise this tower that rises high into the sky. Wind is used for power generation – the rising air from natural ventilation and stack air effect by taking outside air (fresh air) into the void in each layer. A pool laid out every 50 floors is used not only for daily life water but also functions as a passive vibration control unit.

Standing Creek

Three triangular poles are erected in a spiral design and laterally connected one another to form a stable structure. The residential spaces in the three triangular poles are open inward to protect against direct sunlight and wind pressure. The seawater pumped up from the foot of the poles flows in the outer skin of the poles and the residential spaces in the poles to adjust the air temperature in the residential spaces.



Fig. 9. (a) Standing Creek (Inoue); (b) Sky-Envelope (Ohno et al.)

Sky-Enveloper

Sky-Enveloper branches one arch into two towers that comprises the arch to form a stable structural body and envelop a town at the foot of the arch. The arch evokes the symbolism of a gate that receives the visitors from the sea and creates a new value instead of height.

One Mile Camel Hump

One Mile Camel Hump is a photosynthetic oasis dome. The panel units comprising the dome are provided with many functions, including solar power generation, power generation by the difference between inside temperature and outside the dome, wind power generation, heat ray and ultraviolet protection, and absorption of carbon dioxide and generation of oxygen by growing algae. The units work in response to climates (changes in the world outside the dome) to ensure the comfortable environment inside the dome and produce energy with efficiency.

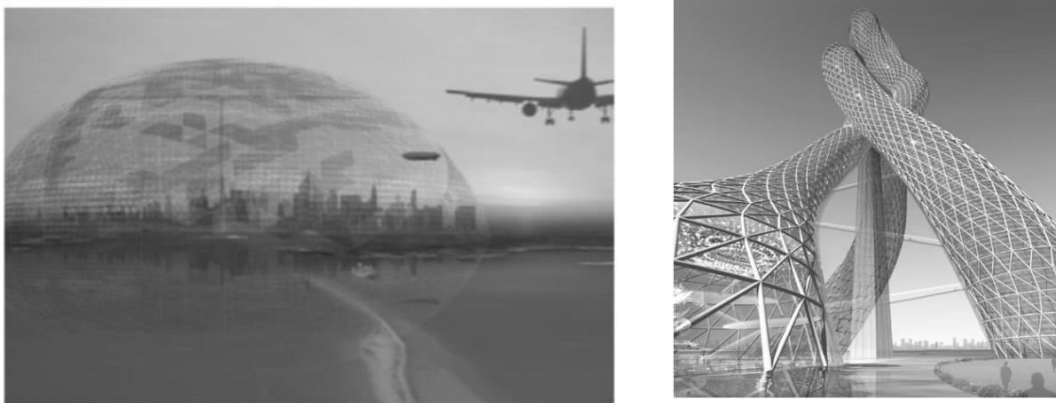


Fig. 10. (a) One Mile Camel Hump (Takamaku et al.); (b) Yggdrasill Tower (Hori et al.)

Yggdrasill Tower

Yggdrasill is formed by consolidating core functions of a city into convoluting tubes, i.e. roots of the mythical tree. This design incorporates various ingenious plans, including the wind power generation that utilizes the rising air created in the tubes, the water purification and heat exchange by the use of core strata, and the cloud seeding for rain by spraying seawater into the sky.

These examples play an important role in determination of the importance of high rise buildings and also in further concept of the Vertical Bionic City.

IV. REASONING VERTICAL BIONIC CITY CONCEPT

The futuristic combination of what a city needs in a whole mega city structure.

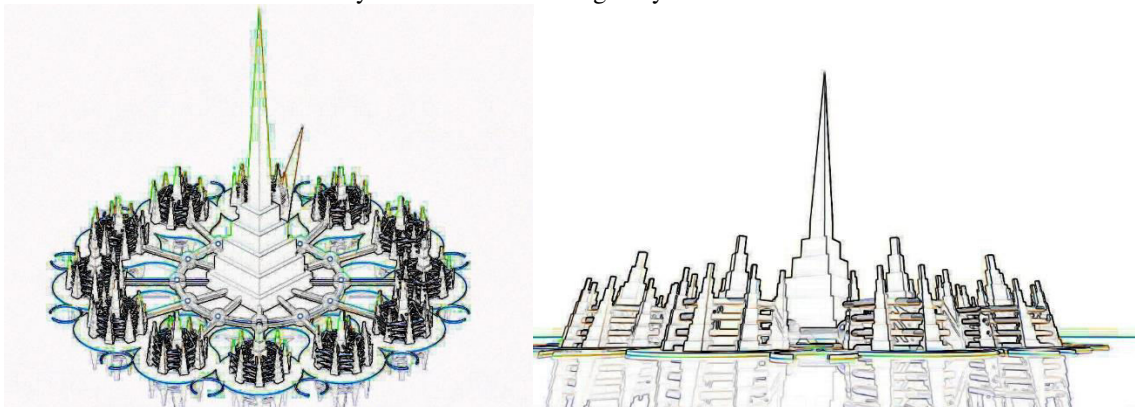


Fig. 11. Vertical Bionic City; (a) Bird eye view; (b) Perspective view (sketches by the author)

In the concept of the Vertical Bionic City, one huge structure represents a quarter (a core) and all of them together represent a city. Giant structures will meet the needs of residents from all possible directions. They will work together, exchange energy, correlate and communicate with each other vertically and horizontally. Bionic city is the city of the future where everything is programmed to be, where everything works as ants work in their nest. How do living things manipulate the five elements (space air, fire, water, earth) to their advantage? Animals, Birds, Insects, Plants, have natural defences against a wide variety of unfavourable climates. They adapt their body size, shape or temperature to adjust with the hostile climate. But some creatures like termites, birds, ants not only adapt to nature, they seek to create a comfortable living environment by building a suitable home [9].

The Compass Termites of Western Australia, maintain the temperature inside their nests to within 1 degree of 31 degrees Celsius, day & night, summer & winter, while the external temperature varies between 3°C to 42°C. This is achieved by building a wedge shaped tower mound of 3 Meters height which always points north. As the tower heats up, air inside rises drawing fresh cool air from below. Also the wind blowing across the top of the mound helps to suck in fresh air through the nest. The termites regulate the flow of air through their nests, by blocking and unblocking the channels [10].



Fig. 12. (a) Compass termites; (b) Australian termites nest

This efficient kind of model will be applied in the vertical bionic city of the future providing proper ventilation. The double skin facade will have to absorb energy from outside as ant nest do using the thermal trap concept. These largely hypothetical structures would contain a variety of residential, commercial, and agricultural facilities, minimizing individual human environmental impact, concept that contradicts the “Broadacre City” of F.L. Wright. They are often portrayed as self-contained or self-sufficient. They will be connected vertically by means of tunnels and will form a closed circuit. Internal circulation in the tunnel will be possible by high speed trains [11]. Necessary engineering network will also pass through these tunnels. Inspired by ants that find the shortest route possible to their destination, the directions of these tunnels will be well defined. Communication will occur horizontally interior of the building. Imagine 12 buildings representing 12 major neighbourhoods of a city connected between them, and these all linked together with a parent building, just as parallel, same as human body organs with the brain. They will work as a single body, as a living organism, as a computer server, which commands a series of computers.

We are all aware of the man of the future. Concept of human bionics is now becoming more accessible to us, so implementation of this concept in the bionic city of the future should be mandatory. Every resident of this city must have the necessary sense of perception. When something goes wrong the residents must be notified. In order to get connected to each other special clothing should be applied to all residents. The entire city would function as a large brain. The mother core (which resembles a spaceship) is created to receive, exchange, and to collect all the necessary information from all the nodes of the city.

The city also should be very sensitive towards external atmospheric agents. It must adapt to daily climate change, temperature variations, sun movements, air movements, same as a chameleon skin do.

It should shrink when the temperatures are very low and swell when they are high, same as happens with human beings. This will be achieved through sensors. The sensors will also have direct access to the residents of the city. It is assumed that in the not too distant future, human beings must be under protection from exposure or contact with the outside world for purposes of harmful UV rays. Therefore, all this theoretical concept will protect them from the outside presupposed wild world, keeping them together in a hole mega city structure.

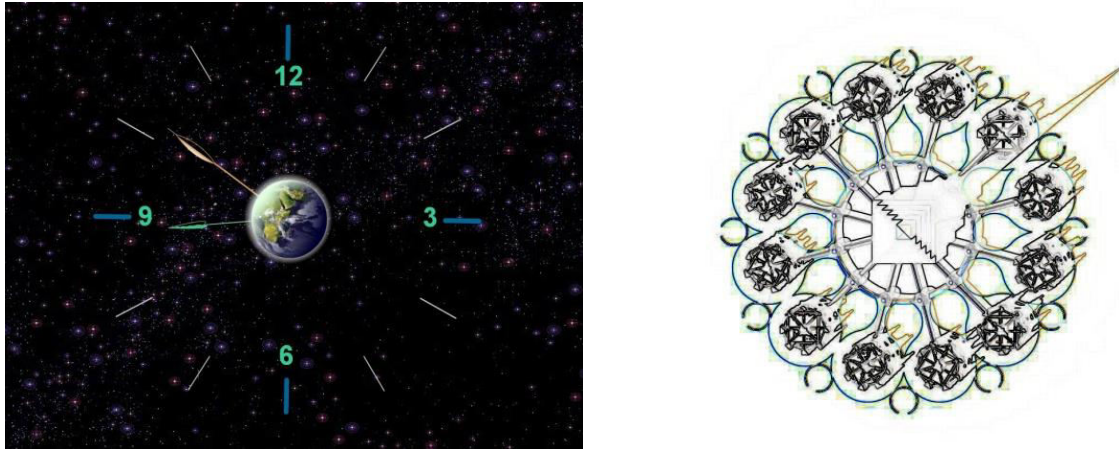


Fig. 13. (a) Clock logic; (b) Top view; (sketches by the author)

Water resources that are located in the central part of town will help to create a microclimate for refreshment during the summer season. This core will also harness energy absorbed by the underground. Wind is another key factor in the absorption of energy. It will be possible through giant turbines that will be deployed to great heights where the wind is stronger. Phase change materials, geothermal installations and photovoltaic cells should be installed too in order to benefit as much as possible from the nature.

Vertical cities can reduce farm land waste as they rise up rather than sprawl horizontally [12].

V. CONCLUSION

Tall buildings make up the urban fabric and cannot be viewed in isolation from the city. They also bring up new ethical, social, and cultural issues having a direct impact to the local communities. They generally meet the social and physical needs of the inhabitants.

A tall building has been variously called a “city within a city,” “a vertical city,” and a “city in the sky.” Thus it is apparent that a tall building is a microcosm of a large city. It is an integral part of the urban habitat having a close relationship with it. In a way it is a vertical progression of a horizontal city. The two are interactive and connected by the transportation, power grid, water supply, and waste production and disposal systems. The tall buildings can therefore play a vital role in defining liveable and sustainable cities. Both cities and skyscrapers must use fewer natural resources; create less waste; and impact less on the natural world. As the city grows the need for land grows too, therefore, it is necessary to think of alternative solutions. One of them is the vertical extension of the city. Thus, the need is a determinant factor in order to search for alternative solutions that will improve our future lives. Vertical Bionic City is a futuristic concept that respects the environment and its sustainability. The city fulfils all the needs of the inhabitants with its own energy capture systems.

Technology will continue to improve the physical systems of the city skyscrapers, however, their future will be defined by human interests and values.

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