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GREEN ROOF AND LIVING WALL IN THE ROLE OF ECOSYSTEM IN SUSTAINABLE URBAN DWELLING

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Abstract

It has been said that something as small as the flutter of a butterfly´s wing can ultimately cause a typhoon halfway around the world. Chaos Theory effect can be applied in an actual climate change issue. Forests, fields, gardens, and natural areas are being replaced with concrete, bituminous and unnatural surfaces. Necessity of recovering green spaces and natural areas is becoming more critical. Questions of sustainability, improving quality of life, solving current ecological issues are goals urban and architecture community can solve. Key factor of not forgetting about nature we have been given is designing healthy green cities, covering building in plants, integrating wildness in cities, designing and constructing vegetative roofs, living walls, implementing green policies. Integrating nature to city may seem fashionable, expensive and not necessary. Microclimate and building´s ecological footprint is very high. Balance of artificial and natural environment is way how to maintain sustainability. Co-operation of landscape and dwelling is bringing nature to city. Green is one of the key elements in environmental strategy. Balance means minimizing of breaking close ecosystems. Designing one big artificial ecosystem that wouldn´t be destroying real natural ecosystem is the goal of this paper. Urban ecology and environmental issues need to become an integral of development, construction, policy and way people think. Green roofs and living walls offer solutions how to find a place for nature in designed world. Positive approach on local scale may cause positive worldwide impact. Like the flutter of a butterfly´s wing.

Key words*: balance of artificial and natural environment, ecology, four infrastructures, nature in cities, sustainability.*

INTRODUCTION

Here it is. You said you love gardens."
"What is this place?"
"I made this place. This is my work. I was a landscape architect. I had my own company for a while."
"I´ ve been here before."
"What do you mean?"
"Here it is. You said you love gardens."
"What is this place?"
"I made this place. This is my work. I was a landscape architect. I had my own company for a while."
"I´ ve been here before."
"What do you mean?"
"I know this is gonna sound really strange, but I dreamed of this place. These flowers, everything. It´s beautiful. I had no idea. What a joy it must be to create a place like this."
Very simple dialogue from really simple romantic movie, Just like heaven, describes a little bit main theme of this article. Gardens, green roofs, living walls have captured people´s imagination all over the world. They keep surging the popularity because of very simple reason. They just seem right. Right because of the way they look good, because of all the benefits they are bringing to a building´s user, because of all the aesthetic pleasure to the people who see the building and also to all the wider surroundings. The sense of giving nature back what we have inherited, putting plants and nature back into the hard and stark environment full of concrete, bituminous and unnatural surfaces touches something deep within us. It doesn´t matter if the roof or wall is big or small, it is an act. Act full of symbolism and deep meaning.
Bringing nature into cities and urban dwellings has always been a very desirable amenity of urban planners and architects.
Many masterplans with lots of green areas and free spaces were representing symbolic meaning of people owning land. Being close to nature, able to touch the tree, walk barefoot on

the grass has so deep meaning and idea for every human that it sets to zero all the negatives.

The act of greening a building, act of greening a bus stop, kiosk, placing garden on existing building makes deep statement about the way we see, or the way we should see the world. Buildings with green tops should become fascinating objects. Grass and vegetation has on earth its natural horizontal space. So why should it be a problem putting soil on top of the building and have things growing. There is something strange about it, more than ecological. This reconciles humans with nature (Dunnett, 2011).

The truth is that for most of us, all this may seem very idealistic. To put a garden on our garage. Why not. But this is where it should start. Lots of joy, beautiful gardens, small domestic green roofs or sheds, garden offices, studios, bicycle sheds and other small structures. This article is about installing, constructing and planting a green roof whether it is on little houses, work places, anywhere, where is an opportunity to bring nature back to a place where it had been previously banished and its relationship and impact on all the other environments surrounding us.

MATERIALS AND METHODS

"We love to make new things, to experiment with materials and create a very unusual encounter between the rough and the natural, the smooth and the artificial, to incorporate nature so there can be the smell of a garden where you would not expect it.", said Jacques Herzog (Blanc, 2012).

Michael Van Valkenburgh has created little 130 m^2 green roof (Figure 1) for the building of the American Society of Landscape Architects in the heart of Washington D.C that was installed in April 2006. The project was undertaken with the goals of demonstrating the environmental and aesthetic benefits of green roofs (Jodidio, 2009).

The building´s original roof was a rubberized membrane, which had already begun to develop pinhole leaks. Two HVAC units were located toward the center of the roof. The roof held also another three HVAC units. Access to the roof was limited to a wall-mounted ladder and hatches. That is why part of the project was to design a stairway to provide an access for viewing and maintenance.

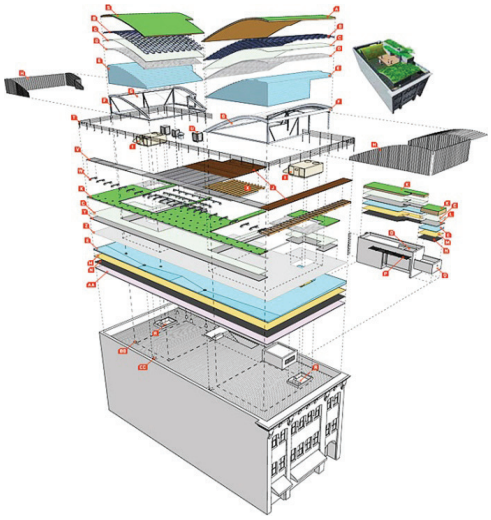

Figure 1. ASLA green roof scheme

Significant parts of this new roof design are two elevated forms in shape of wave (Figure 2), formed from rigid insulation. Both forms are covered with a green roof system. One wave is covered with semi-intensive green roof planting medium, the second one is covered with extensive green roof planting medium (Figure 3). The depth of the soil was calculated to correspond with the roof´s structural capacity in each area. The effect of the waves is to bring the plants up to eye level, create an intimate, semi-enclosed space on the roof, in the middle of a big city. All HVAC units are removed and covered with designed waves. The forms are constructed from layers of extruded polystyrene insulation with a structural steel skeleton anchored to the roof deck. Sides of polystyrene are covered with galvanized steel material that protects the insulation. Thanks to the fact that this vegetative roof is a project, it was very important that the top of the designed roof top would be visible from the street. Next signature element of this roof top is intent of greening the maximum possible area. Extensive green roof system – rest green coverage of the roof placed in the central zone and access path of the roof. This part of the green roof is covered by an aluminum grating walking surface to maximize

both usable space and environmental benefits. The area under the grating has soil depth of 70 mm. The grating floats 70 mm above the soil surface, when mature. Walking on the grating helps the sedum trim back. Of course it is anticipated that the sedum growth is going to appear in some places of the grating. Design of the top of the stairway is also green, but the roof designed here is intensive. 300 mm of soil and roses. Design of the top of the elevator shaft is covered with 500 mm of soil and sumac trees. Metal trellis on the elevator shaft and on the stairway is designed for several species that are being trained to grow on it. An irrigation system is placed on both of the sides to facilitate watering (Somerville, 2007).

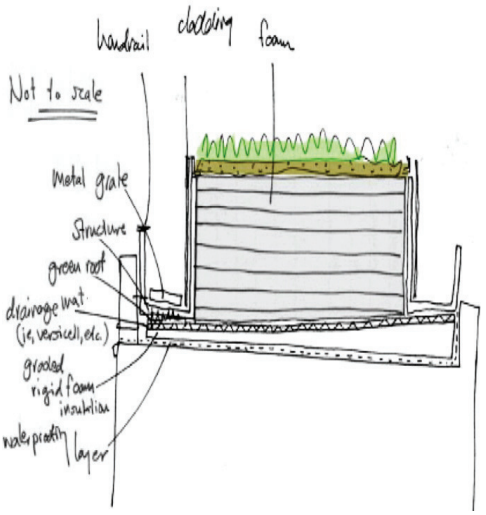

Figure 2. Sketch of green roof´s wave

Using artificial materials to make lightweight mounds, he in a sense invents a new landscape in a very small area, providing users not only with a bit of greenery, but also changing their perspective on the city. Given that roof space is generally underused and ugly in most cities. The roof is transformed into an expressive display of green roof technology. Nature brought into a city is an example of support of active social space. This project might be seen as a small example of what might be done on a much larger scale, given sufficient public space interest and financial incentive (Jodidio, 2009).
Processes that are being monitored are: process to track stormwater retention, temperature, water quality and plant performance. Here are few extensive and semi-intensive green roof performance data of full report. Energy savings: Engineering analysis showed that the green roof created a 10% reduction in building energy use during winter months and negligible difference in the summer. Further analyses showed that ASLA should show a 2-3% savings in the summer in the identified cause of this deficit - overcooling of the building. Following the engineer´s guidance, ASLA will change cooling of the building and will follow up with further monitoring. Water retention: From July, 2007 to May, 2007, the green roof retained nearly 75% of the total rainfall (736mm). This kept 105 000 liters out of the city sewer system. The roof typically retained 100% of (25 mm) rainfall. Water quality: The green roof did not add any nitrogen to the runoff. Water quality testing shows that the water runoff contains fewer pollutants than typical water runoff. Most significantly, the roof is reducing the amount of nitrogen entering the watershed (Somerville, 2007).

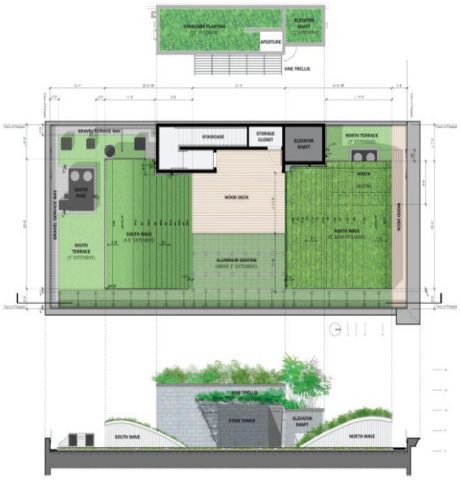

Figure 3. Overhead and cross section schematics

Temperature differences: The green roof has been as much as 15 ^{0}C cooler than conventional black roofs on neighborhood buildings. Temperature differences are greatest on the hottest days. Temperatures on the ASLA roof differ by area - areas with thicker growth and better coverage are cooler. The coolest is the stairwell roof, followed by the plantings under

the grate. The hottest area is the south terrace, which has the most exposed gravel/growing medium. Temperature differences are a result of both shading and plants evaporation. Temperature differences should increase over time in all areas on the roof as the plantings mature and fill in. Plant performance: Different plant species were planted in different areas based on soil depth and expected heat, light and water conditions. As part of the experimental nature on the roof, the planting palette was particularly broad and included both commonly used green roof plants and species not typically used on green roofs. All of the plantings under the grating are highly successful, showing excellent growth and coverage. On the extensive portion of the roof, hard species of Sedum performed well over other Sedum species. Growth was slowest on the south mound and on the south terrace, where initial planting coverage was thinnest and where the hottest temperatures were recorded. Some of the experimental plants used in these areas did not grow well (Somerville, 2007).

RESULTS AND DISCUSSIONS

"Biodiversity is what we build on national environment. We have to do it with great care on ecology of the land, use of water on the use of energy. If we don´t do this with care, there will not be a future for other generations. Sustainability is very important. It is no point to have a success today, and not have it tomorrow. Sustainable, low carbon buildings, buildings that don´t need that much energy, well planned buildings. We need to design building of 21´st century, buildings responsible to its environment." This is what Ken Yeang says about sustainability, environmental problems, earth´s issues and human´s part in this ecological loop.

Key factor of designing health cities is bringing nature and wildness into dwellings, covering roofs and buildings in plants, integrating natural life in cities, designing and constructing vegetative roofs, living walls, implementing green policies and changing people´s minds about ecological issues. Integrating nature to city sometimes seems fashionable, expensive and of course not necessary, but the potential of artificially designed ecosystem that improves sustainability, microclimate etc. in dwelling is really high. Balance of artificial and natural environment, co-operation of landscape and dwelling is needed. Artificial environment deals with importance of greenery in it and natural environment deals with new ecosystem built in it. Ken Yeang, father of bioclimatic skyscraper, claims that green design is the blending of four infrastructure strands into a seamless system. Each of the system is represented by its colour.

The grey (engineering) infrastructure is the usual urban engineering infrastructure of roads, drains, sewerage, water reticulation, telecommunications, energy and electric power distribution system. These engineering systems should integrate with the green infrastructure rather than vice-versa, and should be designed to be sustainable (Yeang 2009).

The green (eco) infrastructure parallels the grey. This is an interconnected network of natural area and open spaces that converses natural eco-system values and functions. It also enables the area to flourish as a natural habitat for a wide range of wildlife, delivering benefits to humans. This eco-infrastructure is nature´s infrastructure and it is very vital to have it in the masterplan. Linear wildlife corridors connect existing green spaces with larger green areas, and can create new habitats in their own right. These may be in the form of newly linked woodland belts of wetlands, or existing landscape features such as overgrown railway lines, hedges and waterways. Any new green infrastructure must also enhance the natural functions that already are there (Yeang and Spector, 2011).

Eco-infrastructure takes precedence over other engineering infrastructures in the masterplan. By creating, improving and rehabilitating the ecological connectivity of the immediate environment, the eco-infrastructure turns human intervention in the landscape from a negative into positive. Its environmental benefits and values are framework for natural systems that are fundamental to the viability of the area´s plant and animal species and their habitat, such as healthy soil, water and air (Hart, 2011).

The connectivity of the landscape with the built environment is a horizontal and a vertical process. An obvious demonstration of

horizontal connectivity is the provision of ecological corridors and links in regional and local planning which are crucial in making urban patterns more biologically viable. Connectivity over impervious surface can be achieved by using eco-bridges, undercrofts and ramps. Besides improved horizontal connectivity, vertical connectivity is also necessary, since most buildings are not single but multi-storey. Designers must extend eco-corridors upward, with greenery spanning a building from its foundations to the rooftops (Yeang and Spector, 2011).

The blue (water) infrastructure. The water cycle should be managed to close the loop, although this is not always possible. Rainwater needs to be harvested and recycled. Surface water needs to be retained within the site and returned to the land for the recharging of groundwater by means of filtration beds, pervious roadways and built surfaces, retention ponds and bio-swales. Water used in the built environment needs to be recovered and reused wherever possible (Hart, 2011).

Site planning must consider site´s natural drainage patterns and provide surface-water management so that rainfall is not allowed to drain away. Combined with green eco-infrastructure, storm water management enables the natural processes to infiltrate, evapo-transpire or capture and use storm water on or near site, potentially generating other environmental benefits. Waterways should be replaced by wetlands and buffer strips of ecologically functional meadow and woodland habitat. Sealed surfaces can reduce soil moisture and leave low-lying areas susceptible to flooding from excessive run-off. Wetland greenways need to be designed as sustainable drainage systems to provide ecological surfaces. Buffers can be combined with linear green spaces to maximize their habitat improvement potential. Eco-design must create sustainable urban drainage systems which can function as wetland habitats, not only to alleviate flooding but also to create buffer strips for habitats. Surface-water management maximizes habitat potential (Hart, 2011).

The red (human) infrastructure is the human community. It´s built environment. Buildings, houses, hardscapes and regulatory systems like laws, ethics etc. This is the social and human dimension that is often missing in the work of green designers. It is clear that our lifestyles, economies, and industries, mobility diet and food production all need to become sustainable (Yeang and Spector, 2011).

Balance of these four infrastructures, strands, means minimizing of breaking near ecosystems. Using four infrastructures for creating one big artificial ecosystem that wouldn´t be destroying real natural ecosystem, is the goal of this paper.

CONCLUSIONS

Can we imagine that cities were like forests? Plenty of shade, diverse and rich in variety. Offering lots of fresh air and daylight. Access to clean water, animals, ants and bees living in it. Real integrated natural system and designed system in true balance. More compact mixed-used neighbourhoods full of streets crossed with parks providing livable and healthy habitat for all living things in it.

Ecological design is still very much in its infancy. The totally green building or totally green city does not exist yet. There is so much theoretical work, technical research, environmental studies etc. that have to be done and tested before we can say that we have a green building, or dwelling. On the other hand, ecological design as we know it today, offers enormous potential to transform our buildings into products, systems. For every problem that humans currently face, closed loop made of four strands using own resources is an answer.

In this article, two very strong ideas have been presented. First, extraordinary example of very sophisticated way of bringing nature into city. The building was not touched or even changed. Author of the green roof literally made a construction that was put on the roof top so the building wasn´t touched just because of the reason of bringing nature to the city. The green roof is a demonstration project how to teach the benefits of green roof technology and so it is designed. With research and education in mind. The success of each part of the constructed roof, success of soil, each plant species is being monitored in order to identify characteristics of the rooftop, but also the characteristics of the areas under it. According to monitored processes- energy savings, water retention,

water quality, temperature differences, and plant performance, it is obvious that situated green roof on the top of the building has positive effects on its reduction in building energy use, rainfall retention, reducing pollutants in water runoff, reducing heating, cooling the building. On green roof, soil and vegetation act like an insulation. When it is raining, water floods down to city´s artificial canyons. A living roof absorbs water, filters it and slows it down. This system helps to reduce overflows, extends drain system´s life and returns water to surrounding watershed.

Urban roof like this is a very challenging place. Lofty ideas of potential acres of green spaces that lie above our cities. Roofs as lifeless place of bituminous surface, violent temperatures contrasts, bitter wind and antipathy to water. As it has been proved, they can be changed into non asphalt wasteland. When we go to the rooftops in cities, we usually look out for a view. Positive change happens in case like this, when you don´t have to look for a view, because it is in front of you. Unexpected green and blue grasses, pink and yellow flowers, roses and little trees in the middle of concrete, glass and steel.

Another important idea of this article is how ecosystem in modern city should work like. The answer to ecological questions is co-operation of grey and green, green and blue and red. These relationships must be understood in smaller detail – building, but also in bigger detail – urbanism.

Both of these theories work in explained example of green roof – new ecosystem integrated in the middle of the city. The relationship between engineering infrastructure that perfectly works with green areas, living part, plants and flowers. The green part of the project is naturally followed by water line of a loop that is trying to be closed. At last, we cannot forget about the human community that is the motive force of all this.

The theory of four infrastructures works on this example and it is working on many others. Living walls, green roofs, little sheds. Urban ecology and environmental issues like these needs to become an integral of development, construction, but mainly the way people think. Green roofs and living walls offer solutions how to find a place for nature and wildness in designed world. They behave like brought natural ecosystems into one big artificial ecosystem, where they must co-operate. Positive approach like this on local scale may cause positive worldwide impact. Just like the flutter of a butterfly´s wing.

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