Green Roofs: The Ecological Solution in Design

EEOS 479

Steven vonFleck
History of Green Roofs:

The concept behind green roofs is an effective & alternative means of environmental technology. This technology has been around for over 60-70 yrs throughout Europe, being establish in Germany and within the Scandinavian countries. Nevertheless this form of roof, has been around for 1000s of years, One of the very first ones appeared in Babylon around 500BC. or what is referred to as the Hanging Gardens of Babylon. This is one of the Seven Wonders of the World. The very original design was develop in Iceland, where they built houses with sod ceilings and walls. The country lacked the natural resources for construction purposes, so they adapted to what they could find to do this. These sod houses became very popular throughout the Scandinavian countries at the time. The ceilings were constructed of turf & the walls the same but much more insulated. The first few layers of the wall were built up with stone & rocks. “The rest was constructed by alternating strips of sod and turf, any driftwood that was confiscated was also included in the design.” Besides providing homes for them, the green roofs & the walls supplied extra insulation for the people living there during extreme weather.

Germany did not invent this type of technology for the green roofs. In the 18th century these roofs were built to represent wealth and status among the population. They were constructed on manor houses and castles by Germany’s wealthy. The trend then expanded across to Europe in the 19th century. The first signs of green roofs in the US. appeared within the 20th century. To this day, Germany has the largest Green roofs in place throughout the world. The benefit of using this technology has help to promote construction of them throughout the country.

In Europe this form of technology has become well ingrained & established. This is from direct collaboration between both state, municipal along with significant governmental financial support. By creating this, a well sustain market has been establish throughout Europe for green roofs. They are
widespread in countries such as Germany, Austria, Spain, Switzerland, France among many others. The industry is growing rapidly & has been since the early 1980s. In North America this type of environmental technology has been poorly understood & underdeveloped with very little growth & progress throughout the U.S. market for green roofs which has been almost stagnant & very sluggish. Growth of the green roof industry has been changing slightly furthermore much has to be improved & more invested so that this technology can make a difference within the U.S. Only within the last 4-7 years has the US saw an marginal increase of green roof activity, with the majority of this coming from Europe.

“Green roof technologies not only provide the owners of buildings with a proven return on investment, but also represent opportunities for significant social, economic and environmental benefits, particularly in cities.” (Tokarz 2006)

Design & Function/ Materials:

The design qualities of having an green roof installed are vastly beneficial & essential. Air quality in the cities these are in, dramatically improves & destroys pollution.

Green roofs absorb the heat & carbon monoxide from our cars & industries, filtering the air moving across it. “Through the process of photosynthesis plants convert carbon dioxide, water & sunlight—energy into oxygen & glucose. This cyclical process supplies animals and humans with oxygen and food.” (Tokarz 2006) Airborne particulates are removed from the air depending on the foliage type, thus providing us with the clean air that we so need. The scenery created by the roofs has an recreational effect on people to go outside more and gaze at these green gardens, despite the fact many are living in congested cities as Chicago, N.Y. or LA & throughout the world. Stress levels will diminish and people could be more friendly & happier as they might have feelings of euphoria within them. The spaces formed by the green roofs enables birds, & other animals to migrate there helping to alleviate ecological effects in urban areas.
There are two types of green roofs: intensive and extensive. The intensive green roofs can contain & secure large trees, shrubs, and well preserved gardens. The intensive roof garden is designed with a foot of soil depth. “This adds 80-150lbs per square foot of load to the building structure.” (Tokarz 2006) This design includes elaborate irrigation and drainage systems because annual precipitation can not feed the more intensive plant life. Regular maintenance for this type of green roof is required always. The other form of green roof does not require much maintenance. The extensive roof can grow many types of vegetative ground cover and plants. “Plants from the Sedum genus are usually used because they are hardy and colorful.” Having access to an extensive roof garden by the public is usually restricted. The extensive roof is designed with 1-5 inches of soil in depth that adds 12-50lbs per square
foot of weight. This design consists of a basic irrigation and drainage systems. Maintaining this form of garden roof is not complicated.

The construction of these gardens can be very difficult because of the many layers required. The roof construction must have a waterproofing layer that is durable adequate to safeguard this type of structure over time with minimal maintenance. “An example of a commonly used waterproofing agent is a fluid applied rubberize asphalt membrane.” (Werthmann 2007) Above this layer is called the moisture retention mat, this retains a section that holds water in there for future plant use. Within the moisture retention layer is a root retardant that prevents plant roots from penetrating. The root barriers contain copper sulfate to prevent plant growth. The next layer is called the drainage layer, several types of drainage layers are used by different contractors. Some of the layers have drainage channels that allow excess water to collect and drain. The water now enters small cups that still collect water that is absorbed into a soil medium for plant use in the future. “The water contained within the cups provides a moist, beneficial subsoil environment for the plants, without allowing fungus or root rot.” (Tokarz 2006) After a filter fabric mat is set up to stop soil particles from entering the drainage layer.

The bottom layer & final one is the soil medium. A lighter form of soil is required, because of the weight. This soil contains a mixture of shale, pumice sand and some organic matter. There is a concern about the soil mixture because of pollutants. “Mixes with large quantities of compost have been shown to export nitrogen and phosphorus.” “According to the USDA Agricultural Research Service suggests the mix with a high quality compost, manufactured using industrial byproducts high in iron and manganese to reduce the phosphorous solubility.” This type of mix, should promote hydrated plant life without oversaturation. This depth of soil medium depends on the type of green roof that is being constructed.

The final process for completion of the green roof is the installation of the vegetation.
The vegetation that is chosen must survive harsh weather patterns, also for it to flourish in any form of climates. It should blend into the surroundings and landscapes of the area that its located in. It also must withstand direct radiation, drought, frost, and strong winds. The intensive green roof could have trees, bushes, and other large plants for the landscape as the extensive one smaller plants and grasses are more likely. The type of plants used are from the sedum genus variety.

Environmental Benefits -- Implementation:

The benefits of installing & building a green roof are immense and very beneficial. There are the economical benefits, aesthetics, food production, and long term environmental conservation impacts, within the surrounding areas that they reside in. These economic benefits range from cost savings for the building owners & companies residing in them. The materials to make the roof, maintenance expenses are reduced with a savings on heating & cooling costs. Sound insulation is achieved through the soil, plants & a trapped layer of air within the roof. Sound waves from machinery, traffic, & airplanes are all reflected, deflected & absorbed. “The substrate tends to block lower sound frequencies and the plants block higher frequencies.” (Werthmann 2007) “They can reduce heat from the sun’s heat island effect & absorb airbourne particulates and storing carbon” (Wood 2005) The vegetation from green roofs helps by cooling the air, slowing air movement and acting as a substrate to settle out and detoxify. (Werthmann 2007) They protect the underlying roof material by eliminating exposure to the sun’s (UV) radiation & extreme daily temperature variations. They also serve as living environments for small animals & birds. They offer an attractive alternative to regular roofs, addressing increasing concerns about the urban quality of life. Noise reduction seems to be diminished from the outdoors while the buildings are insulated from weather harsh temperatures. In door sound is reduced by 40 decibels. In addition to this, green roof
Green roofs also reduce sewage system loads by managing the amounts of water for better drainage. The soil within these types systems acts similar to a sponge & absorbs the excess water from rains. “Research has shown that extensive green roof systems can reduce runoff by up to 90% annually (varies with climate, soil, and pitch of roof)” (Werthmann 2007) New buildings on the municipal storm drainage system with green roof s installed have much improved drainage. This mitigates flooding overloads on watersheds and erosion of surrounding lands. Fisheries and other marine life are preserved and more protected.

Storm water management systems dont have to be installed when green roofs are in place. Water that falls on traditional roof systems runs right into the sewer system. “Flat roofs only provide up to 0.2 inches of storage in rooftop depressions, but the majority exits the area.” (Tokarz 2006) The amount of runoff coming from these roofs significantly increases the amount and flow storm water runoff from urban areas which is a major component of flash flooding. Green roofs filter the water runoff on its way to an aquifer. “They buffer acid rain and remove nitrates and other contamants as water slowly percolates through the soil.” (Tokarz 2006) What remains will occur hours after water flows into sewer systems from the runoff loads on to the impervious surfaces.

Costs and Maintenance:

Roofing construction costs for green roofs are usually more expensive in contrast to the conventional type found on the majority of roofs. They are higher because they cost more for the labor and materials that is necessary for installation. In the US the cost for an extensive green roof is $10-18 per square foot or higher as oppose to a traditional roof which cost $1.25 per square foot for 2006 rates. These costs seem to be very expensive the reason is that there is only a limited number of contractors in the US that are skilled in constructed Green Roofs. Green
roofs are costly in the beginning, nevertheless for the long run they become cheaper than the traditional roofing structure because of the long term savings on energy new roofing materials “The addition of a green roof will increase the property value, which allows building owners to charge higher rent fees.” (Green Roofs H.C. 2005) The insulation that the green roofs have, reduces heating and cooling costs for any building that they are installed on. Green Roofs protect the original roof from ultraviolet degradation which extends the life of the original roof for 40-50 years. This saves the building & home owner 1000s of in dollars replacement and building expenses.

The extensive green roof systems require very low maintenance, which sometimes consists of one or more weeding and watering. Sporadic clearing of the leafs and plant roots from the drains are required. Extensive green roofs must only be seeded with some form of controlled release fertilizing in order to manage storm water systems. Regular fertilizers should not be used on extensive green roofs. “German studies have approximated the nutrient requirement of vegetated roofs to 5gN/m2. It is also important to use a substrate that contains not much available nutrients.” (Werthmann 2007) The intensive green roofs require more maintenance do to the size and area of them. This includes mowing, weeding, and some fertilizing. They also need more sunlight and take much longer to preserve for these type of green roofs. If appearance is not an issue, fertilization and maintenance is generally not needed at all, on extensive green roofs.

Public Impact-- Aesthetics:

The impact and influence of green roofs has a dramatic effect on people living & working around them. Not only do they have a very good look & natural view to them they create improved mental, physical health for everyone that views them. The natural views seem to generate more productive, happy, & relaxed people. These roofs beautify and restore our cities back to a clean environmentally sound world. “Psychological studies have shown that the restorative effect of a natural view
holds the viewers attention, diverts their awareness away from themselves and from worrisome thoughts thereby improving health.” (Tokarz 2006) People living in a high-density regions are known to be less likely to develop diseases if they have access to garden on a terrace or balcony. “This is partly due to the additional oxygen, air filtration and humidity control supplied by plants but also from the therapeutic benefits that result from caring for plants.” (Tokarz 2006) Plants seem to provide a series of sounds, smells, colours and movement not yet understood entirely, which have a major effect on human health and fitness of individuals. A research experiment was done on patients in the same hospital, from the similar types of operation, all studied all views on to a landscaped courtyard versus a brick wall. “The patients with the green view had shorter post-operative stays, took fewer moderate and stronger painkillers and had fewer negative evaluation comments from the nurses.” (Green Roofs H.C. 2005)

Some other values of having these roofs installed are used for recreation space, relaxation, improvement of production at work and property values with the green roofs installed, increases usually by 6-15 %, also known as a form of tree cover. They form an natural outdoor experience that is livable and delightful for all. Green roofs contribute to the lack of green space in many urban areas. Studies have shown that outdoor activities in natural settings such as gardens & parks are very important for helping people manage with stress and in non-stress related needs. The creation of shared roof gardens allows people to feel ownership of their building and meet others in a relaxed setting. “Green roofs can be specifically designed to mimic endangered ecosystem habitats, including the prairie grasslands of the midwest US, the rocky alvars of Manitoulin Island and the Great Lakes region in Canada.” (Green Roofs H.C. 2005)

Boston & decline of Green Roofs:

Within the city of Boston, Green Roofs are practically non-existent. The majority of the roofs are inhabited by technical equipment. Technology from the inside of the building has taken over the
outside. “Today the roof is in the firm hands of the HVAC guys.” “Air Handlers, ventilation pipes, window washing equipment and heating vents are all rampant as the floor plan below commands.” (Werthmann 2007) The rest of the roof, are covered with water proofing materials. In a dense and wealthy neighborhood such as commonwealth ave. have almost every roof in use & has a terrace without a garden or green roof in place. It is obvious a failure and disgrace. How did this become this way, it seems that there were many factors that led to lack of green roofs in this city, furthermore with the rest of the country. The largest factor is the expense of a roof garden in comparison with a regular roof. The addition of a roof garden for a developer to consider is the cost, a green roof eliminates that savings. Not only does the contractor must come up with the materials for the green roof, nevertheless they must reinforce the whole structure for the weight of the building to support this. “For the average developer who has a revenue expectation of seven years, the increase of the value of the property through a roof garden does not occur fast enough to be profitable, moving the roof garden into the realm of a luxury item.” (Werthmann 2007)

Some other aspects & factors were considered also for the decline of green roofs in Boston. Another was the exodus of the middle class into the suburbs, who could of maybe afforded one of these roofs. This drained the city of people, who maybe would have had a terrace or green garden built. There were maintenance problems, because earlier roof gardens leaked, & weren’t designed right from the beginning. This created an fear and avoidance of the roofs, some type of prejudices that still persist to this very day. As with anything these days in Boston, it is ironic the corrupt bureaucrats on Beacon Hill, scrounged up $25bil. or more of taxpayer money for the new highway & tunnels that just placed more cars on the road and nothing for the MBTA, which is in the red, our decrepit, mismanaged transit system. The Environment left for the people to preserve and raise awareness of. Furthermore this was not the case in the industrialized nations of Europe and much of the credit is do to the Scandinavian, German speaking countries that established the Green Roof movement, well over 40 years ago. Canada, Iceland and Greenland could be included in this as well.
Green Roofs are the environmental solution for the US, it’s been going on in Europe for some time now. Some cities in the US have adopted the green roof effect, Chicago, Portland, OR. have them in place, while Boston is left out in the stone age. Besides the benefits of Green Roofs agriculturally, are substantial & significant. The drawbacks such as the higher maintenance costs, and a lack of regulatory bodies should not deter this. “The German green roof industry benefits from both direct financial investment and changes in regulation to encourage green roofs by over seventy local governments.” (Werthmann 2007) Without some form of state & government intervention along with private construction companies, otherwise the Green Roof Industry would flourish within the U.S. equalling that of Germany, Switzerland and Europe. This will take time as standards are adopted and implemented as we could appreciate & value these natural scenes on our roofs not as a barrier, however for the well being of the planet and world.
Bibliography


Tokarz, Erika: “CEER Green Roof Project” Villanova University
Villanova, PA. (2006)

Mountain Equipment Cop, store – Toronto, CA.

L’Historial de la Vendée, museum Western, France

Seattle City Hall --- Seattle, WA.
Millenium Park, Chicago, IL. 24 acres, one of the largest green roofs in the world.

Vancouver Public Library: below
Roof garden of the Art and Exhibition Hall: Bonn, Germany

Melbourne’s 6-star CH2 building, Australia
Earth homes by: Swiss architect Peter Vetsch