Green Roofs And The Ford Rouge Project©

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INTRODUCTION

Green roofs have existed in some form for centuries. The earliest known examples were the Hanging Gardens of Babylon which can be traced back to 2100 B.C. (Osmundson, 1999). In Norway, sod roofs were installed as a way of sheltering its inhabitants from seasonal extremes of hot and cold. Similar roofing techniques were used by the settlers of the Great Plains, primarily because the scarcity of lumber and other building materials left them no choice (Osmundson, 1999). In the past 30 years, efforts have been made, primarily in Germany and Switzerland, to identify and improve green roof technologies (Peck et al., 1999).

BENEFITS

Numerous benefits can result from the adoption of green roof technologies. These benefits can be categorized into four major areas: ecological, economic, aesthetic, and psychological. Common ecological benefits include the recovery of green space, moderation of the urban heat island effect, improved storm-water management, water and air purification, and a reduction in energy consumption. The "urban heat island effect" is a major concern in large urban areas where paved surfaces and typical tar roofs are the norm. Because of the solar energy reflected from these surfaces along with other heat-generating industrial activities, ambient air temperatures tend to be higher in urban areas. Air temperatures immediately above conventional tar and gravel roofs have been recorded to be up to 77°F warmer than those roofs with vegetation (Peck et al., 1999), thus adding to the urban heat island. On a typical summer day in Atlanta, the temperature within the city can be 10°F warmer than the surrounding countryside (Rosenfeld et al., 1998). Vegetation on green roofs reduces reflection of solar radiation so air temperatures above buildings do not increase and add to the urban heat problem.

Green-roof surfaces also help mitigate storm-water runoff problems. Due to the prevalence of impervious surfaces in urban areas, storm-water runoff has become a major concern. Water that would normally percolate into the ground runs off rapidly, thus straining most municipal sewage systems. The rapid runoff may result in flooding, increased erosion, and it picks up surface contaminants that end up in our water supply. In addition, sewage systems may overflow and result in raw sewage that is discharged directly into our rivers. The larger amount of runoff also results in a greater quantity of water that must be treated before it is potable. A major benefit of green roofs is their ability to absorb storm water and release it slowly over a period of several hours. Green-roof systems have been shown to retain 60% to 100% of the storm water they receive (Thompson, 1998).

Economic benefits of green roofs include reduced energy bills. Seventeen percent of electricity produced in the United States is used to power air conditioners and it is estimated that the adoption of green roof technologies could save $500 million per year in energy costs (Rosenfeld et al., 1998). The insulating effects of the green roof substrate and plants provide an additional barrier to heat entering or leaving the

building. Also, the plants act as a wind buffer and metabolically active plants carry away heat via evapotranspiration (Eumorfopooulou and Aravantinos, 1998). Green roofs have been shown to decrease the inner air temperature of a building by 5°F compared to buildings with no roof vegetation (Liesecke et al., 1989). In addition, green roofs have a longer life-span than standard roofs because they are protected from ultraviolet radiation and the extreme fluctuations in temperature that cause roof membranes to deteriorate. Further benefits include the aesthetic and psychological advantages of plants and gardens.

THE GREEN ROOF RESEARCH PROGRAM AT MICHIGAN STATE UNIVERSITY

Our green roof research program at Michigan State University (MSU) came about as a collaborative effort with Ford Motor Company. William Clay Ford, Jr. is dedicated to revitalizing the Rouge Plant in Dearborn from a 20th century icon to a 21st century model for sustainable and environmentally sensitive manufacturing. Decades of industrialization and commercial production have led to the contamination of air, soil, and water in and around the Rouge River Watershed. Installing a vegetated rooftop covering 450,000 ft^2 on a new assembly plant is part of Ford's efforts to decrease or eliminate the negative environmental impact of their production processes. This installation will be the largest in America and will serve as a model for sustainable architectural technology.

The objectives of our research are to evaluate plant species, propagation and establishment methods, substrates, several commercially available drainage systems, water and nutrient requirements, and water quality and quantity of runoff. Criteria for evaluating species include rate of establishment, capability to exclude invasive weeds, heat and cold tolerance, drought tolerance, survival and persistence, and fire resistance. Experiments are being conducted on 27 simulated roof platforms measuring 8 ft × 8 ft that were built by Ford at the Horticulture Teaching and Research Center at MSU. The site is equipped with a weather station, thermocouples measuring temperatures at various depths in the growing substrates, and electronic tipping buckets that record the volume and rate of storm water runoff from the individual platforms. Measurements are taken every 10 min, 24 h a day, and are recorded on a datalogger that can be downloaded onto a laptop computer. Data collection has been obtained for the past two seasons. These observations served to assist with the determination of a green roof design for the Ford assembly plant.

Installation of plant material at Ford is scheduled to take place this fall and possibly continue next spring. Numerous species, varieties, and cultivars of *Sedum* are currently being grown at ground level on a nearby 15-acre previous landfill site in Allen Park. A German green roof company, Behrens Systementwicklung, is growing the *Sedum* mats or blankets and will oversee the roof installation of their Xeroflor product. The *Sedum* blankets will be harvested by rolling them up, transporting them to the assembly plant in Dearborn, and then rolling them out like sod. This process will provide an instant green roof, well in time for Ford to showcase the installation next year for their centennial celebration.

Sedum was chosen because of its tolerance to heat and drought. In our tests at MSU involving eight species of *Sedum* and 18 species of Michigan native forbs and grasses, we found that *Sedum* vastly outperformed all of the natives. Without irrigation, all of the natives either died or went dormant by June, resulting in a brown mass of dead-looking plants that could be a major fire hazard. The natives looked

fantastic early in the year, but could not withstand the heat and drought conditions when growing in only 4 inches of roof substrate. In order to grow natives, either irrigation must be present or the substrate must be deeper, an impractical solution considering the weight limitations of a green roof installation. However, all of the *Sedum* species survived and thrived under all environmental conditions.

THE FUTURE OF GREEN ROOFS IN THE UNITED STATES

Will green roofs ever catch on in the United States like they have in Europe? Several barriers to widespread acceptance exist; however, the same barriers have been overcome in Germany. First, a lack of awareness regarding green roofs prompts such remarks as "you want to do what?" and "are you crazy?" to "why would anyone want to do that?" People are afraid of what they do not know or understand. Education can help alleviate this lack of acceptance. In fact, public awareness of green roofs has increased dramatically, even in the past year. During Ford's centennial celebration in 2003, reporters will be swarming all over the Rouge facility, an event that will undoubtedly result in much media coverage for green roofs in general.

Second, green roofs may cost up to twice as much to install. However, the lifetime of a conventional roof is about 20 years, whereas a green roof should last 40 years or longer. Plus, there are all the added benefits such as energy savings to the building owner, as well as the other ecological, economic, aesthetic, and psychological benefits to society as a whole. Our corporate world needs to start thinking long-term instead of what my stock did in the last 3 months.

Third, there is a lack of quantifiable data pertaining to the benefits that green roofs can provide to the building owner, its occupants, and the community. Selling the idea to local politicians or granting agencies can be difficult if you don't have quantifiable data to back up your position. We all believe that green roofs can reduce storm-water runoff and reduce energy costs of operating air conditioners, but how much can be saved? Show me the data. That is where our research projects at MSU come in. All of the data that we obtain will be published and available to the scientific community, roofing contractors, nursery operators, or anyone else that wants to see it. Knowledge on what plant species to use, what substrate to grow them in, and water retention data are just a few of the objectives that we are working on.

Fourth, there is a lack of technical information on how to build them. The Germans have had written green roof standards for construction for over a decade. On the other hand, standards and building codes pertaining to green roof design and construction do not exist in the U.S.A. How does a roofing contractor know if they are doing the job correctly when there are no directions or experience to rely on? How do they prepare an accurate bid? Those that do become involved are taking a gamble. An American Society for Testing of Materials (ASTM) committee of professionals from industry and academia (myself included) are presently writing green roof standards for the United States. In time, the lack of technical information and experienced contractors will be a thing of the past.

Finally, Germany has experienced a 10% to 15% growth per year in the green roof industry over the past 10 years. In 1999, there were 50 million m^2 (535 million ft^2) of green roof installed, a figure that represents 10% of all flat-roofed buildings in the country. This growth is fueled largely by government incentives, a situation that is only beginning to become a reality in the U.S.A. For example, Chicago now has an energy conservation ordinance that requires that all new and replaced

roofs must contribute to the Urban Heat Island Reduction Initiative. A green roof is an ideal way to meet this requirement. In addition, direct financial benefits are increasingly being realized through tax incentives given to builders who choose to utilize construction practices that minimize or eliminate negative environmental impacts. The states of New York, Massachusetts, Oregon, and Maryland have all implemented similar tax incentives.

WHAT IT ALL MEANS TO NURSERIES AND LANDSCAPE CONTRACTORS

Nurseries that are growing groundcovers, perennials, or grasses will have the most to gain. Although woody plants can be used as green roof plants, they require a much deeper substrate, additional maintenance, and the need for a more structurally sound building. For landscape contractors, the potential exists for installations and maintenance contracts. In Germany, many landscape contractors may have construction, maintenance, and green roof divisions, and others may specialize in green roofs alone.

In Michigan and the rest of North America the concept is just now being introduced. A few installations exist in North America, but the largest will soon become a reality at Ford. This one project has already resulted in over $200,000 in orders for plant material grown at Michigan nurseries. Green roofs will likely become more common in the future. They represent an entirely new market for nursery stock and landscape contractors, and the potential market consists of all existing and future roofs in Michigan and the rest of the country. A market that it too large to ignore.

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