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THE GREEN FIELDS OF FORD Will a pioneering, ultra-thin application work for the largest green roof in North America?

By **Lorraine Johnson**

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In the autumn of 2002, workers installed vegetation mats on the green roof. Ford used the Xero Flor system, which is designed to retain water on the roof, to support plants.

When Henry Ford acquired a 2,000-acre stretch of marshy bottomland around 1915 in Dearborn, Michigan, at the confluence of the Rouge and Detroit Rivers, he created a manufacturing complex on a scale never before seen in American industry—an “ore to assembly” complex that included a foundry, a railroad with 100 miles of track and 16 locomotives, and a production facility in which a new car rolled off the line every 49 seconds.

Now the Rouge Center—Ford’s largest industrial complex, with 600 acres and five manufacturing plants—is undergoing a \$2 billion upgrade to remediate the effects of nearly 100 years of automobile production. One of the more high-profile aspects of this project is the green roof that has been installed on the new Dearborn Truck Plant’s final assembly building. At 10.4 acres (454,000 square feet, half of the factory’s total area), it is the largest green roof in North America.

The vegetation up there—eight football fields carpeted in green—seems to stretch forever. This is a roof that has seasons—the dozen sedum species changing color from lavender to yellow, accented by deep reds and purples. This is also a roof that hums—not just with the exhaust fans but also with insects. When I was up there in late summer, monarch butterflies were busy collecting nectar, fueling up for their migration to Mexico. While green roofs are common in Germany (with some places mandating them through building codes), the adoption of the technology in North America is still in its infancy. As more research into the benefits of green roofs demonstrates their ability to cool a building in summer, insulate it in winter, absorb and slowly release rainwater, and extend the life of the roof membrane, more companies will look to incorporate green roofs on their

buildings. For Ford, the most compelling reason to include a green roof was that the vegetated roof collects and filters rainfall and helps to manage stormwater discharge.

If the Ford green roof succeeds as an exercise in innovation, it will also—and in some ways primarily—succeed as an exercise in solving the challenges of scale. “Yes, people thought we were nuts,” Don Russell, the manufacturing sustainability manager at Ford’s Environmental Quality Office, confesses. “But when you have your CEO behind you, you’re going to be all right.” Add to that the persuasive power of William McDonough, the architect who led the design team for the environmental innovations at the Ford Rouge Center and who proposed the idea of a green roof to Ford. According to Roger Schickendantz, associate partner at William McDonough + Partners in Charlottesville, Virginia, “We worked with Ford for several months to establish an environmental framework for the redevelopment of the Rouge complex, and we looked at goals for habitat restoration, water use, stormwater management, soil improvement, and so on. For McDonough, the re-creation of habitat is extremely important. The idea that birds could fly over and nothing has been changed in the basic landscape, that the green roof replaces what has been taken away, that is very important to Bill. His goal is to create living, breathing buildings that operate in harmony with nature.”

It remains to be seen whether the habitat created on the roof will be a meaningful replacement—in terms of biodiversity and ecosystem functioning—for the forest and wetland originally on the site of the Ford complex. But what the green roof does accomplish, whatever the long-term habitat results might be, is to add 10.4 acres of vegetation where there would otherwise be bitumen and gravel. For the nesting killdeers that have already shown up, the Ford roof is home.

The environmental goals were clearly persuasive, but Ford also needed to consider practicalities, in particular the green roof’s performance as part of an overall strategy for stormwater management. William McDonough + Partners proposed a natural stormwater management system, of which the green roof was one component, to include a network of underground storage basins, porous pavement installations, wetlands, retention ponds, and swales.

According to Russell, the practical concerns related to such a massive green roof installation were cost, structural and performance issues such as leaks (“there can’t be any leaks; if the assembly line shuts down for five minutes, you’re out a few million dollars”), and aesthetics (“it has to look good year-round”).

To decide which green roof system to use, Ford embarked on a lengthy series of trials, beginning in 2000, in conjunction with McDonough Braungart Design Chemistry (a product and process design firm cofounded by William McDonough and based in Charlottesville, Virginia) and the horticulture department at Michigan State University (MSU). “The original plan was to develop a modular system of interlocking trays,” explains Russell. The idea for the modular tray system originated from McDonough. “Bill had envisioned a new technology for green roofs, and he wanted to develop it, using a super-absorbent polymer that absorbed water and released it slowly; roof trays would

contain it,” says Schickendantz. One of the advantages of this tray system was that it could be planted at ground level before being installed on the roof. Thus, with funding provided by Ford, the initial research project involved testing 64 prototype trays planted with a variety of native plant species in four different substrates.

After one growing season, all the natives had germinated in the four substrates, but by the autumn of 2000, the natives were showing signs of stress in all but the expanded slate medium; it appeared that the super-absorbent polymer was outcompeting plants for moisture. Given this and other problems, Ford decided to terminate the modular tray experiment and to conduct trials using green roof systems that were already commercially available from four major green roofing product manufacturers—American Hydrotech, Sarnafil, Siplast, and Xero Flor.

In the ensuing tests, 12 platforms using the four manufacturers’ systems were installed at MSU’s research facility. The platforms tested included various combinations of expanded slate, sand, compost, and peat and three different plant groups and propagation methods: sedum plugs, native plant plugs, and sedum seeds. Bradley Rowe, an associate professor of horticulture at MSU, says, “We found that sedum vastly outperformed all of the natives. Without irrigation, the natives either died or went dormant by June, resulting in a brown mass of dead 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. Native perennials and grasses can be used to provide an aesthetically pleasing green roof, but the plants must be irrigated or grown in a deeper substrate.”

Sedum’s toughness in a thin growing medium and its ability to tolerate drought make it ideal for green roof applications, according to Rowe. Describing the MSU test beds during a summer of 90-degree temperatures and 7 weeks without rain, he says, “Sedum just laughed at it.” Charlie Miller, a green roof designer and principal of Roofscapes, Inc., of Philadelphia, has done extensive work with a variety of green roof systems and plants (he was not involved with the Ford roof), and he points out that in very thin green roof systems, water availability is only half the issue: “Moisture aside, root temperature is going to vary tremendously. There are only a handful of plants that can tolerate those extremes. Sedums are an excellent choice in that case.”

Another advantage of the sedum, in comparison with the natives in the trials, was that in a very thin substrate (just 2 centimeters), sedum outcompeted weeds, whereas the native beds, requiring a deeper substrate of 6 to 10 centimeters, allowed rampant weed growth. With concerns about the combustibility of the natives (“a burnoff every three years was not an option for us,” notes Russell) and the maintenance costs of weeding, Ford decided to use the Xero Flor system, in which mats of sedum are grown at ground level in the 2-centimeter growing medium and then installed on the roof.

Although the Ford roof had been designed to hold 25 pounds per square foot in the center portion, and an additional 15 pounds per square foot in the side sections, the Xero Flor system—the lightest and thinnest green roof technology available in North America—weighs in at just 9.7 pounds per square foot when fully saturated, making it one of the

lightest and thinnest green roof technologies available. The total depth of the system, including all components from membrane through to growing medium, is a mere 2.5 to 3 inches.

While a thinner substrate depth means less weight, it also limits the choice of plants that can withstand such a thin growing medium to, basically, sedum. (Miller points out that, in general, when you increase the growing medium from 1 inch to 3 inches, “you open up 20 to 30 genera of plants you can use; with 6 inches of substrate, you’re now up to 100 genera.”) However, since the thin substrate severely limits weed growth, its much-reduced maintenance costs, in Ford’s view, more than make up for a limited plant palette.

Although most of the drainage layer and related materials were shipped from the parent Xero Flor company in Germany, materials for the substrate were purchased and blended locally in Michigan. Likewise, Ford decided to grow the sedum blanket locally, turning an old industrial landfill site the company owned into a “sedum farm” during the spring and summer of 2002. Fifteen acres of the site were contoured and divided into nine separate fields; plastic sheeting was laid down to prevent root growth into the soil, and the substrate mix was spread by a mechanical spreader. Sedum seeds and clippings were placed on top and the entire surface was covered with water-permeable shade cloth. The young plants were watered daily and fertilized during the growing season, and there was one major weeding done in midsummer.

The goal was to achieve 70 percent coverage in the sedum mat before installing it on the roof. By late August 2002, that target had not been met, but Ford decided to forge ahead and hope for further establishment of the plants on the roof. Using a modified concrete saw, acres of vegetation blankets were cut into squares measuring one meter by one meter, stacked onto pallets, and transported on flatbed trucks from the “farm” to the truck assembly plant.

Before being installed on the roof in the autumn of 2002, three layers—the root-impermeable membrane, the Xero Flor drainage layer, and the layer of water-absorbing fleece—were added on top of the original bitumen roof. Then the vegetated squares were moved into position on the roof using flatbed carts pulled by small all-terrain vehicles, and they were installed in overlapping grids—“a process very similar to putting shingles down,” says Russell.

After the vegetation mats were in place on the roof, an automated irrigation system was installed, laid out along the edges and above the center of the planting. Although the plants were watered regularly throughout their first growing season on the roof—the spring and summer of 2003—the question of whether or not the green roof will require ongoing irrigation, because the growing medium is thin and has a limited ability to retain moisture, is as yet unanswered. Mike Monterusso, project director of Xero Flor America, says, “We anticipate little or no watering once the plants are well established up there,” and he further notes that the sedum species used in Xero Flor’s system—including, for example, *Sedum album*, *S. acre*, *S. kamtschaticum*, and *S. telephium*—are all native to the types of environments that green roofs mimic: environments with poor soil or even no

soil and rocky surfaces with very little moisture. Schickendantz likewise says that one of the reasons for using an aboveground irrigation system, with everything suspended above the planting level, was that it's easy to dismantle. "When it was installed," he says, "the ultimate goal was that it be removed after a few years. It remains to be seen whether or not Ford will need to retain it." For now, at any rate, the company is being cautious in its predictions about whether the irrigation system can be dismantled—or will have to stay up indefinitely.

Russell is also cautious when it comes to divulging the cost of Ford's green roof. Though the company prefers to keep the details private, Russell does say, "We ended up paying about twice as much [as for a conventional roof], but it will last twice as long." In general, green roofs are considered to extend the life of a roof, and there will be cost savings associated with the cooling properties of a green roof: "Our roof won't get warmer than ambient temperature, and it may well be cooler," says Russell, something that will certainly reduce heat gain through the roof in summer and thus reduce interior air-conditioning needs.

As for the savings related to stormwater management, although Ford has not quantified this specifically in terms of financial value, the research project Ford was involved in at MSU shows significant practical benefits in terms of slowing runoff from a green roof. In the MSU trials, 66 percent of rainfall was retained by a sedum-vegetated green roof versus just 25 percent retention for a typical commercial roof with gravel ballast only. "We were able to justify the cost as part of our stormwater management plan," says Russell.

Clearly, though, for Ford, no matter how much cost considerations played a part, there is also an element of pride in pushing the boundaries, and this was key to the project. As Russell puts it, "Our green roof is a message to industry that this can be done and it can work." Steven Peck, executive director of the Toronto-based nonprofit Green Roofs for Healthy Cities, concurs about the impact that the Ford roof will have as an inspirational model: "Ford's contribution is significant in that they not only adapted a very lightweight European green roof system for a North American climate, but they have clearly demonstrated the positive economic logic behind industrial green roof infrastructure investment—on a grand scale."

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Resources

- Beginning in 2004, a new visitor center at the Ford Rouge Center in Dearborn, Michigan, will be open for tours and will offer a bird's-eye view of the green roof from an 80-foot-high observation deck. For information, call 313-982-6001 or visit www.thehenryford.org.
- Green Roof Conference, Portland, Oregon, June 2–4, 2004; www.greenroofs.ca.
- American Hydrotech, Chicago; www.hydrotechusa.com.
- Sarnafil, Canton, Massachusetts; www.sarnafilus.com.
- Siplast; www.siplast.com.

- Xero Flor America, LLC, Lansing, Michigan; www.xeroflora.com.