Vegetation in Architecture

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The global population is increasing rapidly, and by next year over 50 percent, some 3.3 billion people, will live in urban areas. While cities offer opportunities for living a life with a low ecological footprint, they suffer from pollution, noise and remoteness from nature. Integrating vegetation into the urban fabric allows us to improve these quality of life issues, while offering many innovative opportunities for green architecture. Whether part of a highly engineered wetland, or simply a low-tech way of providing dappled shade, plants can be part of a sustainable design solution. At the same time, they offer biophilic benefits (an affiliation between humans and other living organisms) to inhabitants, increase the ecological productivity of the site, and connect buildings with their unique local environment. While the possible benefits are great, design considerations and responsibilities are atypical. A multidisciplinary design team will need to think holistically, commit to strategies and collaborate in order to successfully incorporate vegetation into green buildings.

Sustainable advantages come through integration of vegetation into the building envelope and into its mechanical and plumbing systems. Basic architectural strategies can include using evergreen vegetation as a buffer against prevailing cold winter winds. Evergreen vines on a wall trap an insulating cushion of air and reduce wind chill. Deciduous vegetation can be used for seasonal shading, and also, through evapotranspiration, can cool the surrounding air. Depending on climate, well irrigated vines (preferably with grey or rainwater) can result in temperatures up to 10°F cooler than the surrounding air.[1] It has been calculated that a 10°F (5.5°C) reduction in the temperature immediately outside of a building can reduce the amount of energy needed for air-conditioning by 50 to70 percent.[2]

Many sustainable architects have the benefits of xerioscaping (landscape that does not require supplemental irrigation) foremost in their minds. Although it is important to eliminate the use of potable water for plant irrigation, the design team should consider sources of wastewater that can be used. Irrigation can greatly increase the rate of growth of plants, their rate of evapotranspiration and their possible contribution to summertime cooling strategies. It can also be part of the stormwater management and waste water treatment systems. Vegetated roofs and facades and designed landscapes can allow downsizing or elimination of conventional plumbed stormwater systems. Especially important in areas with combined storm and sanitary sewers, this helps reduce overloading of the system with resultant overflows of raw sewage into nearby waters. Extensive green roofs (with 4 inch substrate) have been shown to retain 70 to 100 percent of summer rainfall and 40 to 50 percent of winter rainfall. [3] Designed landscapes such as bioswales, rain gardens and constructed wetlands purify stormwater and allow it to infiltrate into the ground to recharge the acquifers instead of entering a piped sewer system.

More extensive purification of grey and black water can be done by biological wastewater treatment systems that use aquatic and wetland plants in conjunction with bacteria, algae, and other organisms. (Grey water is wastewater from bathing, hand-washing, dishwashing and laundry; black water contains sewage.) A constructed wetland is an exterior system, and serves as an intermediate step between a septic tank and a drainfield, making pollution of groundwater less likely. An interior system treats grey and blackwater waste within planted tanks in a greenhouse space and may reuse the water for nonpotable uses.

Indoor plants purify, humidify and oxygenate air, improving indoor air quality greatly. Research at the University of Guelph in Ontario led to a design for an indoor green 'biowall' which circulates air through it, oxygenating the air and removing pollutants, especially volatile organic compounds and carbon

monoxide.[4] Purifying air in this way can lead to lower requirements for exterior air, and associated conditioning, lessening energy demand for the building's HVAC system.

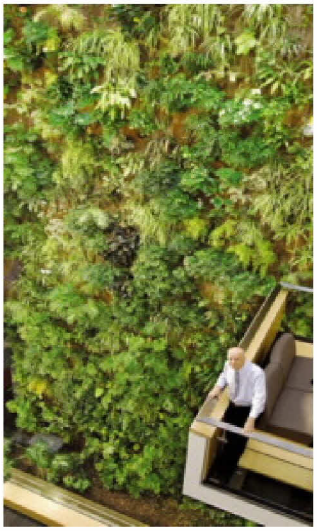

Figure 1. University of Guelph 4 story biofiltration plant wall. (Photo: Ken Kerr)

When cities increase the amount of vegetation within them, reduction of particulates, pollution and carbon dioxide, and lessening of the urban heat island effect can be observed. A 2002 study in Toronto found that urban summertime temperatures in the city could be reduced by up 2 to 4°F if just 6 percent of the cities rooftops were greened.[5] Plants, especially locally native ones, also provide food and habitat for birds and insects, enhance biodiversity and the site can be made ecologically productive, sequestering carbon dioxide for the life of the plants.

Human food production within buildings or on rooftop greenhouses is also a possibility. The ecological cost of transporting food thousands of miles from farm to table is huge, and indoor urban agriculture allows food production year round for local consumption. Studies have been done to incorporate hydroponic production of crops with a double skin curtain wall - integrating the benefits of cooling, shading and fresh air into the building's HVAC systems (Figure 1).

Perhaps the most cost effective and rewarding benefit of integrating vegetation into buildings is the biophilic connection it gives to building occupants. Biophilia has been defined as "the connections that human beings subconsciously seek with the rest of life". Studies have been done similar to those showing the benefits of daylighting to student learning in schools, retail sales or employee productivity. Views of plants have been shown to increase worker productivity, decrease absenteeism and reduce recovery times for patients in healthcare settings. [6] Plants are part of the high quality environment that sustainable architecture should provide. As building technology improved throughout the 20th century the possibility of providing a uniform environment led to many buildings losing their vital connection with their environment. People are now beginning to question the desirability of that uniformity. Many opportunities for richness and meaning come from connecting a building to its environment, animating architecture through the play of daylight on a wall, the passing of a breeze, or the variety of light, shade and color that plants can give.