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LIVING ARCHITECTURE MONITOR®

A GREEN ROOFS FOR HEALTHY CITIES PUBLICATION

VOLUME 21 / ISSUE 3 / FALL 2019

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THE AWARDS OF EXCELLENCE ISSUE

- WILL AI ROBOTS REPLACE DESIGNERS?
- ON THE ROOF WITH... AWARD WINNING GREEN ROOF PIONEER CHARLIE MILLER
- WHO'S THE GREENEST CITY OF THEM ALL?
- PLANT SELECTION FOR BIODIVERSITY
- 2019 AWARDS OF EXCELLENCE WINNING PROJECTS
- WHY DOESN'T BOSTON USE GREEN ROOFS TO COMBAT FLOODING?

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VOLUME 21
ISSUE 3
FALL 2019

INSIDE

On the cover: Awards of Excellence Winning Health Education Building Green Roof in Kansas City, Missouri by Jeffrey L. Bruce & Company. (See pages 9-10)

LIVING ARCHITECTURE MONITOR®

VOLUME 21 / ISSUE 3 / FALL 2019 - THE AWARDS OF EXCELLENCE ISSUE

LIVING ARCHITECTURE MONITOR IS PUBLISHED FOUR TIMES PER YEAR IN PRINT AND DIGITAL FORMATS BY GREEN ROOFS FOR HEALTHY CITIES (GREENROOFS.ORG) 2019 IS OUR 20TH ANNIVERSARY OF PUBLISHING!

MISSION

Green Roofs for Healthy Cities' mission is to develop and protect the market by increasing the awareness of the economic, social and environmental benefits of green roofs, green walls, and other forms of living architecture through education, advocacy, professional development and celebrations of excellence.

SUBSCRIBE

Subscriptions to the magazine in either a print or digital format are included in a membership to Green Roofs for Healthy Cities. Four levels of membership are available (in U.S. dollars):

1. Supporter Membership - $55
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CELEBRATING ROOFTOPS AND THEIR AMAZING POTENTIAL!

ZIP LINING BETWEEN ROOFTOPS AT ROTTERDAM'S ROTTERDAMSE DAKENDAGEN - CELEBRATING THE CITY'S ROOFS

Photo courtesy Leon van Geest

'Out of site – out of mind', so the saying goes. Unless one is peering down from a high tower, typical city dwellers rarely think about the miles and miles of roof space above them. Yet all too often we tend to overlook the amazing potential of these largely wasted spaces in our cities.

But this is changing, and no where faster perhaps than in Rotterdam, a city that was literally flattened during WWII. They have a unique festival every year that celebrates their rooftops called "Rotterdamse Dakendagen". The festival is designed to show how the 14.5 million square meters of mostly flat rooftops have the potential to contribute to a vibrant and future-proof (climate resilient) city.

The festival is kind of like "Doors Open" for historic buildings, but it is entirely focused on rooftops. "The festival has to do with the exploring the vast potential of our rooftops", explains Leon van Geest, one of the founders of Rotterdamse Dakendagen. People purchases passes for admission to more than 70 rooftops over a two-day period.

These rooftops feature a wide range of activities and events – from classical music concerts to bars, coffee shops, art exhibits, green roofs, children's play areas, and even pop-up restaurants. Last year, the organizers were able to arrange zip lining between building rooftops, with thrill seekers buzzing over the streets below (see image).

In this Awards of Excellence Issue of the LAM, we are celebrating exceptional green roof and wall projects from across North America. Congratulations award winners! These award winners demonstrate that our industry continues to provide many innovative uses for our roofs and walls.

They provide us with inspiring examples of the fact that the roofs and walls of our buildings have much to offer us, if we are willing to think differently about these spaces, and invest in turning them into living architectural assets.

The opportunity is there and the design and installation capability are there. We just need more designers and decision makers to wake up to the amazing potential of these spaces – something they do with creativity and daring in Rotterdam each year.

Sincerely yours,

Steven W. Peck,
GRP, Honorary ASLA
Founder and President

NEW ASTM STANDARD FOR LEAK DETECTION

BY CHAD HERRICK, TECHNICAL DIRECTOR, DETEC ELECTRONIC LEAK DETECTION

ASTM-D8231 Standard Practice for the Use of Low Voltage Electronic Scanning System for Detecting and Locating Breaches in Roofing and Waterproofing Membranes was published July 1, 2019 and provides a detailed a procedure for performing Electronic Leak Detection (ELD) on roofing and waterproofing. D8231 expands on the scanning platform method described in ASTM D7877 Standard Guide. D8231 creates a more detail-oriented solution for ELD, dedicated to the scanning platform with two important additions. One pertains to the electrical properties of the membrane and the substrate under the membrane. Technical advancements reflected in the new ASTM practice allow conductive and semi-conductive membranes such as black EPDM and cold fluid applied membranes to be tested. D8231 mandates that the membrane have a surface resistance greater than 10^7 ohms-per-square. The substrate under the membrane must have a surface resistance less than 10^4 ohms-per-square. See www.global.ihs.com to purchase the standard.

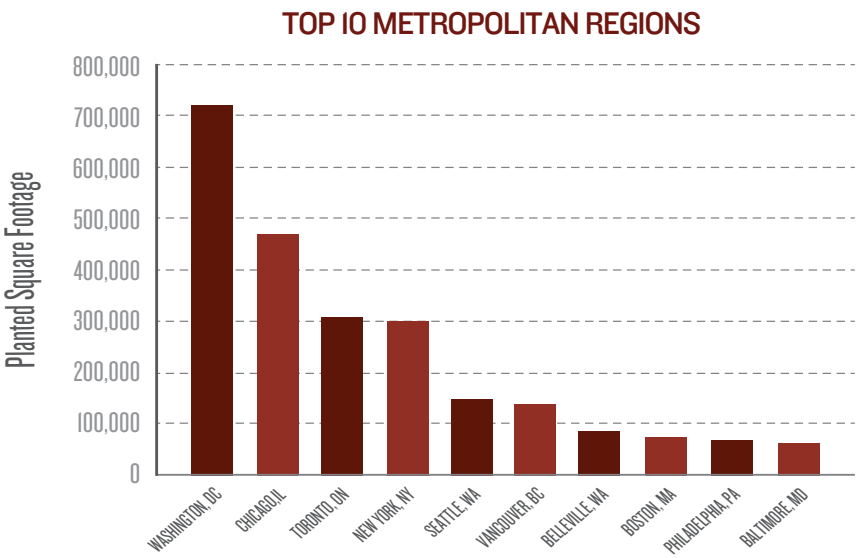
GRHC PUBLISHES NEW POLICY REPORT

This report provides an overview of best practices in policy making for green roofs and walls and provides links to dozens of jurisdictions which have implemented regulations and incentives. www.greenroofs.org/policy Click here to download a copy.

GRHC ANNUAL MARKET SURVEY RELEASED

BY BLAINE STAND, MEMBERSHIP MANAGER, GRHC

GRHC has released preliminary findings from its 15th Annual Market Survey report on the growth and composition of the green roof industry in North America. The survey was completed by 13 corporate members and provides data on the type, location and square footage of green roof activity. The data provides a snapshot of industry activities.



URBAN LAND INSTITUTE REPORT

The Urban Land Institute issued a report called Scorched: Extreme Heat and Real Estate which describes the science of the overheating of our communities and provides examples of developments and policies that help us adapt. https://americas.uli.org/wp-content/uploads/sites/2/ULI-Documents/Scorched_Final-PDF.pdf

ON THE ROOF WITH...

GREEN ROOF GURU CHARLIE MILLER, P.ENG.

INTERVIEW BY STEVEN W. PECK, GRP, HONORARY ASLA

Charlie has been working to develop the green roof industry for more than 20 years. He started on this path after visiting Germany in 1997. He founded "Roofscapes", now "Roofmeadow" and has won numerous awards of excellence over the years. Charlie is not a man to mince his words, and he has tirelessly championed the ability of green roofs to manage stormwater – particularly detention. Now semi-retired, I caught up with Charlie to solicit his most recent thoughts on the industry in this Twenty-Year Anniversary On The Roof With…

LAM: *Hi Charlie. Thanks for taking this interview, I know you are 'semi-retired' but your perspective is very valuable. You've won quite a few awards of excellence for your work over the years; what project stands out as your greatest accomplishment and why?*

CM (Charlie Miller): I would cite three projects. Cira Green in Philadelphia showcases the flexible use of roof-top Best Management Practices (BMPs). These are concealed in a park-like setting in which steep slope stabilization and high wind counter-measures were required. For a demonstration of biophilic design, the Jackson National Headquarters in Lansing, combines a meadow with a classic Sedum flower carpet. The entire assembly rests on a dramatically warped roof surface. Finally, the LeFrak Center at Lakeside in Prospect Park completely conceals the main building under a forested and landscaped surface that blends imperceptivity with the surrounding terrain. The project includes 100 per cent rainfall capture and reuse.

LAM: *Green roofs provide a multitude of benefits, but you have argued that stormwater detention, is the most important benefit for cities, at least within the sphere of civil engineering. Why is*

detention 'king', over say retention, which is a well established benefit with ASTM standards.

CM: By virtue of their huge surface area and their large lateral extent, green roofs are natural flow rate control BMPs. They change the hydrologic response of the roof surfaces that they cover. Their most reliable benefit is to reduce the frequency of high runoff events. This is why they are a powerful tool in reducing combined sewer overflows (CSOs). Used by itself, the ASTM method E2399 should not be used to predict retention. It provides useful information about media properties that can influence both retention and detention rates when media is included as part of a green roof system. This effect is not predictable and different green roof systems must be evaluated to determine actual performance, given that they have the ability to retain and detain water beyond growing media properties using moisture retention and drainage layers for example.

LAM: *What are the biggest challenges to designing green roofs for better stormwater detention, a subject you have been working on for more than a decade?*

CM: Two decades, actually. We have enough data to know that green roof performance is influenced by many variables. However, a sufficient investment has never been made in collecting appropriate field and laboratory data that could lead to developing better design. If the market demanded better green roof performance, then manufacturers would be incented to fund more research.

LAM: *What is your perspective on how stormwater is currently regulated in the U.S.? What needs to change?*

CM: Green roofs are not incented in most regulations. This is largely because green roof flow rate control benefits are not recognized, or accounted for. In the 1980s a shift was made away from regulating release rates toward regulating runoff volume. This was done mostly for practical reasons, in order to simplify enforcement. Reduction in runoff volume became a proxy for reducing flow rates. However, rate control is still the final goal when it comes to reducing CSOs and minimizing flooding and stream bank erosion. To allow the most flexible use of the best methods, including green roofs, a tilt back toward rate control metrics would be beneficial.

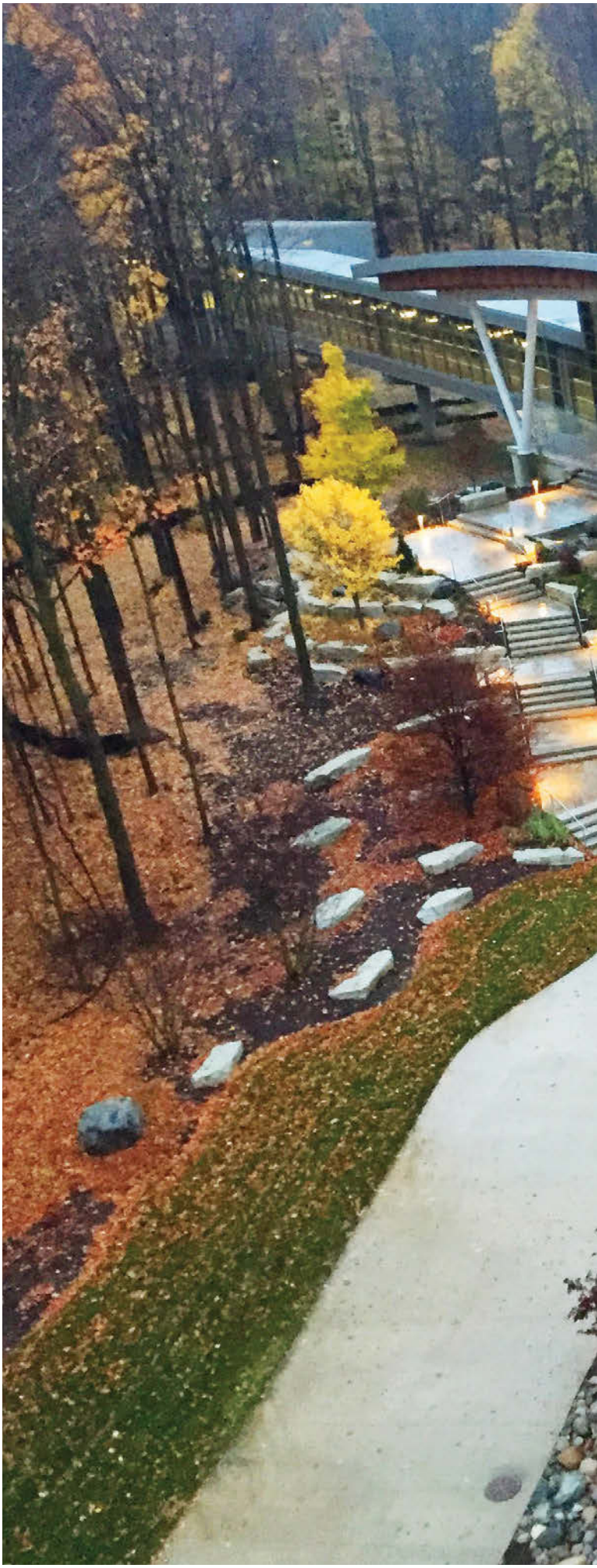
LAM: *How have things changed in this industry over the past 20 years?*

CM: I have seen little change in the past 20 years. One bright spot has been the increased emphasis on passive green surface management methods. I would say that engineering hydrology is stuck in an older paradigm and that some fresh thinking, using the power of 21st century computational algorithms, would unlock more benefits and savings.

LAM: *What advice would you give the industry regarding what it needs to do to secure greater growth over the next 20 years?*

CM: My recipe would be to: 1) fund more research, 2) design better systems, and 3) professionalize the green roof contracting industry.

For more information visit roofmeadow.com



"THE SEDUM FLOWER CARPET AND MEADOW BLEND TOGETHER SEAMLESS ON THE JACKSON NATIONAL HEADQUARTERS IN LANSING."

- CHARLIE MILLER, GRP, FOUNDER ROOFMEADOW

Image courtesy of Charlie Miller

ENHANCING BIODIVERSITY ON GREEN ROOFS THROUGH PLANT SELECTION

DR. BRADLEY ROWE, MICHIGAN STATE UNIVERSITY, EAST LANSING

Most would agree that biodiversity is important for a sustainable world. On a much smaller scale it also applies to green roof and walls. Biodiversity can be enhanced by providing environmental conditions that will support a diversity of plant species and then in turn these plant communities may provide habitat for wildlife.

Images courtesy B. Rowe

One of the main factors that influences plant diversity is substrate moisture which is directly related to substrate depth. The importance of depth was evident in a plant community study conducted on the MSU Molecular Plant Sciences Building (Vandegrift et al (2019), Ecological Engineering 138:264-273, https://dx.doi.org/10.1016/j.ecoleng.2019.07.032). Seventeen species of native perennials and grasses were planted at two depths, 10 cm and 20 cm, irrigated for two years until established, and evaluated over a period of eight years. Only seven of the original species survived the entire time and *Allium cernuum* was by far the dominant species at both depths. *Sporobolus heterolepis* and *Koeleria macrantha* were also present in the 20 cm zone, but died off in the 10 cm zone. Substrate moisture was likely the main cause as many species did not survive a moderate drought that occurred during 2016. The study emphasizes that many herbaceous perennials may require supplemental irrigation during drought periods and it points out the importance of long-term studies to accurately evaluate green roof plant communities.

Although the lack of substrate moisture contributed to plant death, a decrease in plant diversity is not uncommon. A similar decrease in diversity was observed on an irrigated roof over six years in Sheffield, UK (Dunnett et al (2008) Urban Ecosystems 11:373–384, https://doi.org/10.1007/s11252-007-0042-7). Numerous other studies have found similar decreases in diversity over time with the main cause usually attributed to drought. In contrast, a study conducted on an intensive roof in Germany found that diversity increased over time before reaching an equilibrium (Catalano et al (2016) Landscape and Urban Planning 149:11-19, https://doi.org/10.1016/j.landurbplan.2016.01.003). The main differences between this roof and the others were the deeper substrate (26 cm) and the fact that ruderal colonizers were not weeded. Colonizing species could become established, whereas on the shallower extensive roofs they were either removed or died because of the shallower depth. If species diversity is desired then removal of colonizing species should be avoided. In addition, designing a roof with various depths will increase plant diversity as different species find their niche where they can compete the best.

The plant community present will also influence a roof's ability to provide wildlife habitat for microorganisms, insects, birds, and other animals. For example, edge sensitive avian species such as *Branta canadensis* (Canada goose) and *Charadrius vociferous* (killdeer) require vast open areas with short vegetation characteristic of a sedum roof, whereas other species prefer more vertical structure often found on intensive roofs where they can perch in trees or shrubs. In a study we conducted involving 12 green roofs in Michigan and Illinois, we identified

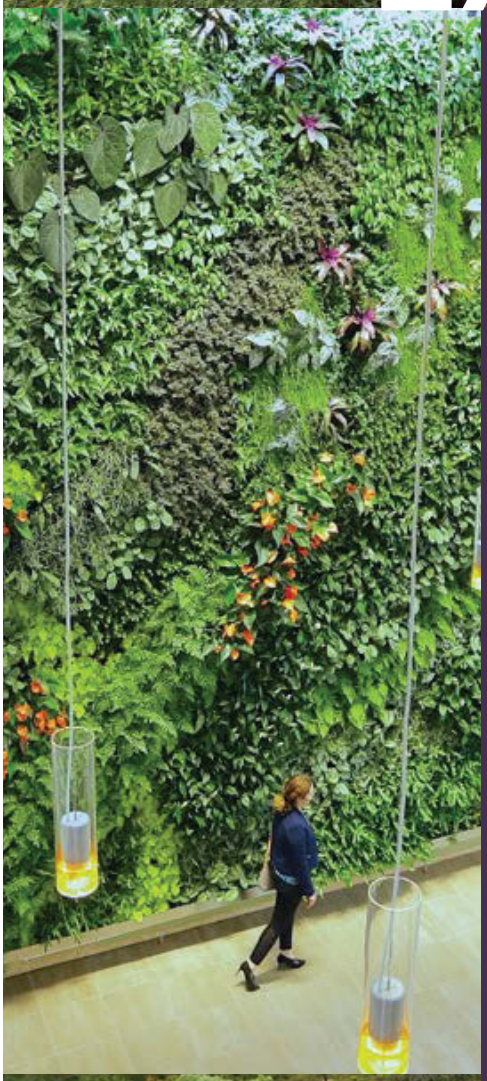
26 native bird species that visited the roofs (Eakin et al (2015) Wildlife Society Bulletin 39(3):574-582, http://dx.doi.org/10.1002/wsb.566). Intensive green roofs provided higher use probabilities for more species than extensive roofs and although many birds were recorded on the roofs, possibly as stops in a wildlife corridor connecting existing habitats, the likelihood of use at any particular time was relatively low. The green roofs seemed to complement habitats provided in the areas immediately adjacent to green roof buildings, but did not appear to provide suitable nesting sites for many bird species.

Regarding invertebrates, the same concepts of structural diversity apply. Variations in substrate depth and composition as well as plant structure will influence invertebrate abundance and diversity. Bare spots without vegetation can even add to invertebrate diversity. Invertebrates also rely on the structural diversity of various species of plants and the plant species present depends on substrate depth. Roof height, roof area, percent vegetation cover, and roof age are also factors. Other beneficial elements that can encourage invertebrates are the use of native soils, adding a variety of rock sizes, and incorporating woody debris such as logs. These additional structures should increase habitat components for invertebrates, with subsequent increases in avian, reptile, and mammal species.

In summary, green roofs provide an opportunity to add biodiversity to our communities, especially in urban areas. Varying substrate depths will provide favorable microenvironments for a greater number of plant species with variations in season of flowering, plant height, and spread. This structural diversity in plant species will then provide the microhabitats for various flora and fauna to live which increases the overall diversity.

Brad Rowe has been conducting green roof research at MSU since 2000. Research topics include plant selection, growing substrates, carbon sequestration, stormwater runoff, energy conservation, and roof vegetable production. He was the founding co-chair of the GRHC Research Committee and received the GRHC Research Award of Excellence in 2008. Brad also teaches a course on green roofs and walls at MSU (www.greenroof.hrt.msu.edu).

AWARDS OF EXCELLENCE 2019



JUDGE'S TABLE

We would like to thank the judges who generously donated their time and expertise.

Jeffrey Bruce, GRP, FASLA, ASIC, LEED
Jeffrey L. Bruce and Co. LLC

Chris Brunner
New York Green Roofs

Terry Guen, FASLA
Terry Guen Design Associates

Michael Krause
Kandiyo Consulting

Monica Kuhn, GRP, O.A.A
Monica E. Kuhn, Architect Inc.

Christopher Lyon, MBA
Tournesol Siteworks

David J. Yocca, FASLA, AICP, LEED AP
Conservation Design Forum

Ishi Buffam
University of Cincinnati

Dr. Reid Coffman
Kent State University

Virginia Russell, FASLA, RLA, LEED AP, GRP
University of Cincinnati

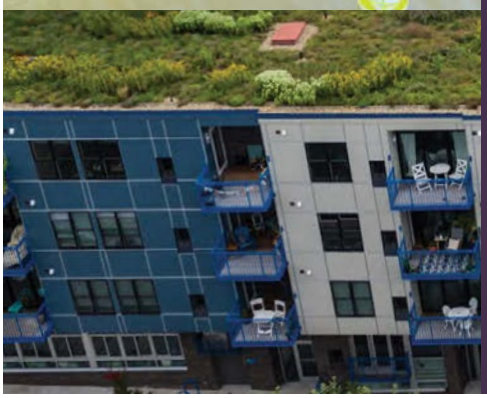
Dr. Youbin Zheng
University of Guelph

Peter Lowitt, FAICP
Devens Enterprise Commission

Hamid Karimi, PhD
DC Department of Energy & Environment

Jeff Joslin
City of San Francisco

Awards to be presented at Grey To Green Conference, DC, October 29, 2019.



"The rolling prairies of Kansas are featured on this undulating medical school green roof."

Jeffrey L. Bruce

STATE-OF-THE-ART LEARNING SPACE TO SUPPORT NEW MODELS OF TEACHING

University of Kansas (KU) Medical Center is a new, iconic facility 170,000 square foot facility to accommodate modern learning and facilitate the education of a greater number of physicians, nurses and allied health care professionals. The new building serves as the primary teaching facility for the KU Schools of Medicine, Nursing and Health Professions that includes a simulation center and flexible, state-of-the-art learning space to support new models of teaching. Design elements inspired by key facets of the building's purpose: connectivity, identity, a healthy and sustainable environment, and transparency. The site featured natural elements and the heritage of Kansas with a terraced courtyard and outdoor space with features representing the rolling prairies of Kansas.

The site and neighborhood was highly urbanized, so the conditions of the surrounding ecological systems were badly degraded. The Health Education Building (HEB) represents a pioneering resilient oasis within a sea of dysfunctional natural processes, designed to be restorative to the community far beyond the boundaries of the project. The improved ecological function which extends to the neighborhood includes a significant improvement to stormwater runoff, reductions in urban heat island, wildlife habitat and food sources, establishment of nutrient cycling and improved air quality.

The green roof is located on top of a series of classrooms that are conditioned space, having direct impact to the mechanical systems of the structure. The green roof also provides indirect contributions to the reduced energy costs of the adjacent campus buildings. The green roof reduces urban heat island temperatures around the existing structures, thereby reducing their cooling requirements. The Landscape Architect calculated the impact of each cycle of the 100,000 gallon of use irrigation represents 140 tons of evaporative cooling mitigating the impact of urban heat island in the city core.

HEB utilizes a limited simple palette of native plants and prairie grasses which is intended to provide the framework for further natural development in biodiversity. The majority of the green roof on site has been returned to natural ecological function with a limited intervention in the future. Much of the plant material was selected from a native prairie species which will provide increased resilience of the native ecological community as niche species establish them-

CATEGORY
Extensive Commercial/ Industrial/Institutional

PROJECT
Health Education Building

LOCATION
Kansas City, MO

AWARD WINNER
Jeffrey L. Bruce & Company

TEAM MEMBERS

Green Roof Consultant
Jeffrey L. Bruce & Company

Landscape Architect
Land3 Studio

Design Architect
CO Architects

Landscape Contractor
Hermes Landscape

Soil Blender & Supplier
Missouri Organic

Architect of Record
Helix Architects

General Contractor
McGowen Gordon

Testing Laboratory
Turf & Soil Diagnostic

Image courtesy JLB & Company

"The Landscape Architect calculated the impact of each cycle of the 100,000 gallon of use irrigation represents 140 tons of evaporative cooling mitigating the impact of urban heat island in the city core."

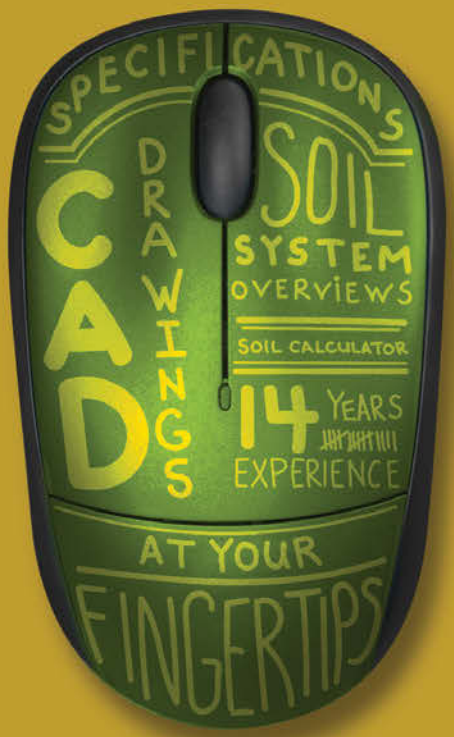
Jeffrey L. Bruce

selves in this framework. The greatest challenge of this project was balancing the narrow profile with the need for biodiversity. Landscape Architects optimized a solution that supported a food chain biodiversity which restored the critical insect ecology as the second trophic level in the food chain which supports secondary consumers of predators or parasites of herbivores, typically songbirds and bats.

As one of the most technically and architecturally advanced health education centers in the nation, this project demonstrates the creative integration of ecological function and implementation of new green technology while providing a brilliant new urban park for the community.

While the primary use of recycled materials were compost in the growing media and wood mulch the landscape was designed to minimize the use of materials with higher embodied energy. Over 95 per cent of the landscape materials and furnishings were sourced within 20 miles of the site greatly reducing transportation costs.

The regulatory environment and campus facilities were generally apprehensive about the project because it was a very different approach to stormwater management. Although supportive of the concept, it had never been proposed or permitted by the city. In order to succeed with the design solution, the design team needed to create a new set of design standards to document and present to the city engineer for approval.



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Images courtesy K. Dakin Design

"It just made sense, this green roof. The clients did not want to stare out their bedroom and bathroom windows onto a bare, roof membrane. Especially when they are nature lovers and avid gardeners: this green roof just made sense."

Karla Dakin, Principal; K. Dakin Design

THE GREEN ROOF THAT JUST MADE SENSE

This green roof just made sense. The clients did not want to stare out their bedroom and bathroom windows onto a bare, roof membrane. Especially when they are nature lovers and avid gardeners. To make their dreams come true, the clients collaborated closely with local professional green roof experts to install a lush green roof atop their detached garage. As a residential project, the design process was a collaboration between the landscape architect, the clients and the green roof installer. The clients were very involved in the process, attending to every detail and selection.

The bio-diverse, selection of host species for the roof, gleaned from years of studying the flora in nearby foothills and prairies, was repeated on the ground landscape, integrating a top to bottom, holistic, design approach.

The green roof is primarily seen out the bedroom and bathroom windows of the residents. Throughout the seasons, this prairie landscape is the first and last view of the day. There is access to maintain and hang out in the green roof across a small roof straddling the detached garage and the home.

Native plants, host plants, and biodiversity were the conceptual drivers behind the landscape design of the yard, from the ground to the roof. The biodiversity of the plant list calls in as many birds, bees, butterflies, and insects as possible as well as referencing the native prairie plants of the Front Range of Colorado. Many of the same species like Agastache, Aster, and Echinacea are repeated on the ground level gardens. This green roof is completely organic and is maintained by the owner, an avid gardener. Deadheading flowers is kept to a minimum. Plants are allowed to repeat and spread across the green roof. Some plants, like cosmos have even made it up from the ground level gardens.

CATEGORY
Small Scale Residential

PROJECT
Room For A View

LOCATION
Boulder, CO

AWARD WINNER
Green Roofs of Colorado

TEAM MEMBERS

Contractor/Installer
Green Roofs of Colorado

Landscape Architect
K. Dakin Design

HOSPITAL FARMING TAKES ROOT IN BOSTON

The Boston Medical Center rooftop farm, built in 2016 on BMC's power plant building, revitalizes the previously underutilized roof space with a farm meant to benefit the whole community. The farm was designed for agricultural productivity, accessibility, water savings, and to minimize the building's negative effects on the surrounding urban environment. For example, the green synthetic turf layer between planting beds reflects more light than the underlying black waterproofing, emitting less heat throughout the day and night, reducing its contribution to urban heat island effect. The farm has also reduced the hospital's energy consumption by increasing its local food consumption and decreasing its "food miles".

This rooftop farm supports 25 different crops and 2 bee hives. The diversity of crops supports local pollinators, which, along with the hives, pollinate nearly 75 per cent of the food on the farm. The farm has flowers in continual blossom throughout the season creating habitat for beneficial insects and pollinators.

The rooftop farm grows food for use in the hospital's cafeterias, patient plates, food pantry, teaching kitchen and in-hospital affordable farmers market. The farm location was chosen because of its visibility from the Shapiro Building; a glass backed building housing many of the hospitals main clinics caring for hundreds of patients each day. These patients have excellent visual access to the farm, directly across the street from where they are receiving care.

The irrigation system is a remote-monitored smart drip irrigation system that can be controlled by a smart phone. The system saves water by monitoring weather conditions and shutting off irrigation when rain is in the forecast. Drip emitters deliver water sub-surface directly to the roots to minimize water usage and evaporation.

The local community has many opportunities to engage with the farm through weekly tours and volunteer opportunities as well as free educational events for patients and employees. Additionally summer camps are offered in partnership with the teaching kitchen offering 2 weeks of free summer camp for patient and employee kids and 4 weeks of summer camp programming with Boston Public Schools and Boston Public Health Commission.

The farm is integrated with the Nourishing Our Community program which includes the rooftop farm, Teaching Kitchen, and Preventative Food Pantry. The Teaching Kitchen holds classes for patients and staff, topics include: 'cooking for cancer survivors', 'cooking on a budget', 'cooking with diabetes', ' cooking 101,' to name a few. The Preventative Food Pantry supports individuals with special nutritional needs that are referred to the Pantry by BMC primary care providers. The Pantry is often used by patients with cancer, HIV/AIDS, hypertension, diabetes, obesity, heart disease and other chronic conditions. Both the Food Pantry and the Kitchen receive fresh produce from the rooftop farm.

CATEGORY
Urban Agriculture

PROJECT
Boston Medical Center Rooftop Farm

LOCATION
Boston, MA

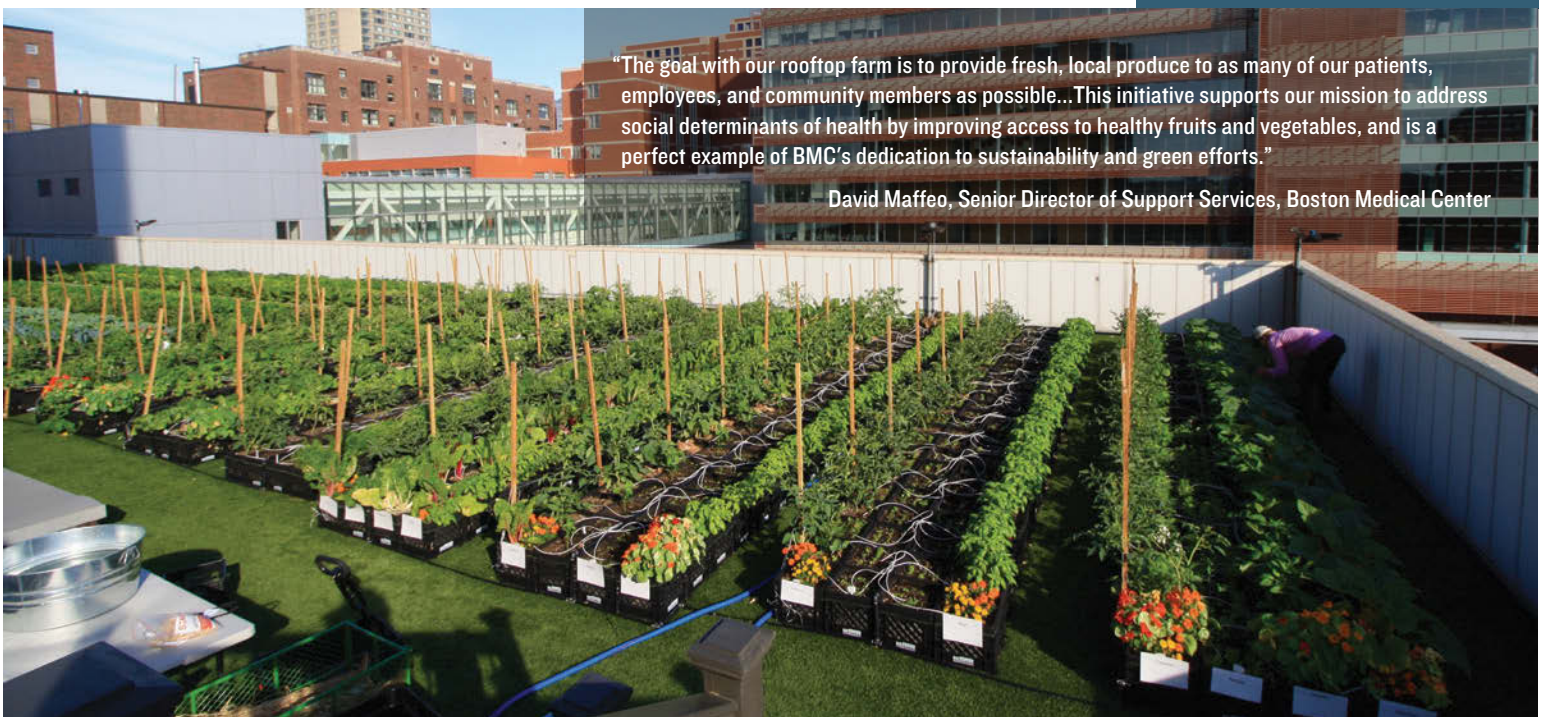
AWARD WINNER
Recover Green Roofs

TEAM MEMBERS

Designer & Installer/General Contractor
Recover Green Roofs

Client
Boston Medical Center

Farm Manager
Higher Ground Farm



"The goal with our rooftop farm is to provide fresh, local produce to as many of our patients, employees, and community members as possible...This initiative supports our mission to address social determinants of health by improving access to healthy fruits and vegetables, and is a perfect example of BMC's dedication to sustainability and green efforts."

David Maffeo, Senior Director of Support Services, Boston Medical Center

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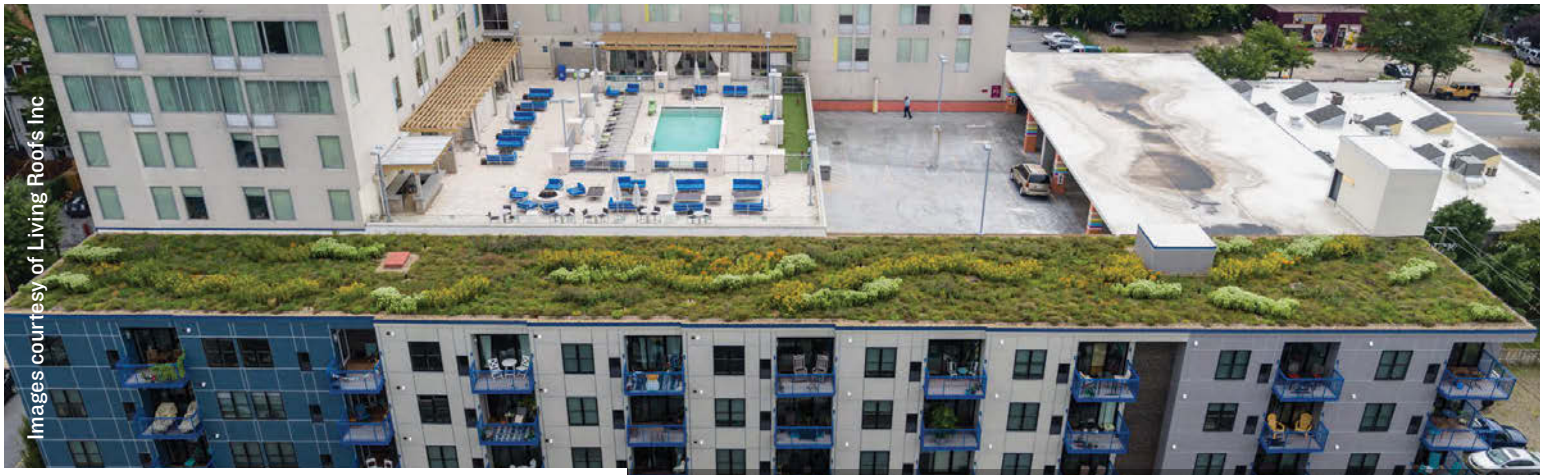


Images courtesy of Living Roofs Inc

"The green roof on the Garage Apartments demonstrates how a small roof can have a big impact on the ecological health of the city. Asheville is located in a region experiencing tremendous development as well as pollinator habitat loss and other threats to biodiversity. The roof on this urban infill project was designed to provide habitat and food sources for native pollinators. The roof is teeming with life and has become a beautiful amenity for the client and the surrounding buildings."

Kathryn Ancaya, Landscape Architect, Living Roofs Inc

INFILL REVITALIZATION FOR BEE CITY USA

Public Interest Projects (PIP), invested in the heart of Asheville when downtown was neglected and empty and spearheaded the revitalization of the now thriving downtown. True to their mission, they have not stopped influencing development over 20 years later. PIP identified a small sliver of land behind the Aloft Hotel as an infill opportunity to incorporate housing (still a scarcity in downtown) and commercial space. As with all of their projects, they aimed at environmental and social sustainability.

The green roof was a part of that desire, and PIP teamed with Living Roofs, Inc to design and install a unique green roof in the city. The roof is teeming with life and beautiful to look at and demonstrates how even a small green roof can have a big impact on the ecological health of the city.

Due to the mountainous terrain of Asheville, many streets have views of the roof, so taller species of grasses and perennials were used in the design to increase awareness of the living roof. Another consideration was the adjacent hotel pool deck. The green roof is highly visible from this area and ensures that the thousands of guests who stay at the hotel leave with a new awareness and appreciation of green roofs. With this in mind, the plant community was designed as a 'stylized meadow' with large drifts of blooming plants.

The City of Asheville was the first city in the United States certified as a Bee City USA. Bee City USA is a program of the Xerces Society that has 93 Bee Cities all of whom endorse a set of commitments, defined in a resolution, for creating sustainable habitats for pollinators. Asheville is located in a region experiencing tremendous development as well as reductions in pollinator habitat loss and other threats to biodiversity. The green roof was designed to support a diverse plant community focused on pollinator habitat and food sources through plant selection and layout. The plantings were designed to support native plants in a very intentional way, creating a pocket of beauty in an unexpected place, and all sourced from within the region. We were also able to engage with local growers to custom grow important pollinator plants such as Mountain Mint and Solidago. The plant selection was the first step in developing a dynamic urban community that supports native pollinators, reduces heat island effect, and allows rain to infiltrate and evapo-transpire more like it would in nature. The green roof provides habitat and food for butterflies and other pollinators and songbirds within downtown Asheville.

CATEGORY
Multi-Unit Residential

PROJECT
Garage Apartments

LOCATION
Asheville, NC

AWARD WINNER
Living Roofs, Inc

TEAM MEMBERS

Design, Installation, Maintenance
Living Roofs, Inc

Developer
Public Interest Projects, Inc

Architecture
Alberice Architecture + Design, PA

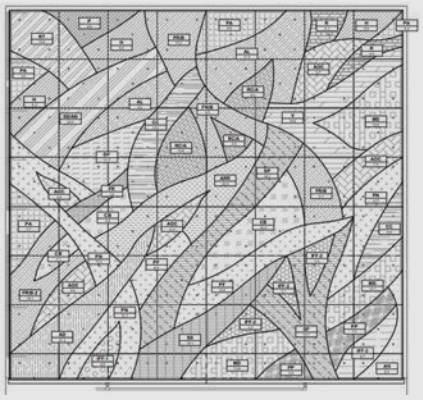
General Contractor
Garanco Construction

Planting Design
Roots First Design

Images courtesy of Urban Strong

"I was thrilled to have the opportunity to collaborate on such an incredible project. It reflects not only the nature of the company's plant research work but also its commitment to environmental stewardship. And the lush and wild nature of the plant tapestry offers all who pass under the living wall a reprieve from their hurried day."

Alan Burchell



A DIRECT REFLECTION OF USE

International Flavors and Fragrances (IFF) was interested in a living wall for the renovation of their R&D facility lobby. IFF artificially creates flavors and fragrances based on extensive studies of plant species. Known for walking the talk in the world of sustainability, and they wanted a living wall solution that complemented the rest of the Cradle to Cradle Certified™ products, building materials, and finishings they were using.

After factoring in their design goals and available infrastructure, a modular hydroponic planting panel system was chosen with an automatic non-recirculating irrigation system. This system was chosen for its high content of recyclable materials, inorganic growing media, unlimited planting surface (non-pigeon-holed), high energy and water-efficient operation, ultra-low plant turn-over rate, wide potential plant palette, and local greenhouse/assembly facility. IFF felt this highly sustainable system was reflective of their commitment to environmental stewardship.

To directly reflect the facility's nature, our team dedicated a portion of the living wall to plant species currently being studied on site, selected to appeal to a broad range of senses such as texture, color, and depth. To reflect the nature of the client's business, particular attention was given to fragrance during plant species selection. We used species such as coffee plants and vanilla orchids.

The living wall includes a remote monitoring irrigation system. The comprehensive design allows the manufacturer to work with our local maintenance technicians to monitor flow, adjust irrigation sequence/intervals, and precisely delivery water and nutrients to plants in a highly efficient manner.

A long skylight running the entire width of the living wall was designed and installed directly above the system to reduce the auxiliary lighting energy load for much of the year. The lighting system has been programmed to ramp up during the winter months when natural light becomes insufficient.

The living wall is striking in its two story size and greets all who enter the lobby. This soaring atrium is a hub of corridors passed by most staff several times a day en route to the greenhouse, cafeteria, and research labs. The green wall is great for sound attenuation as it offers echo muffling given that the lobby is frequently used as a communal area. It is central to the lobby's biophilic design and offers all who look at it a reprieve from their hurried day. An opportunity to connect with nature during the day the wall is a source of mental health benefits for all who see it.

CATEGORY
Interior Green Wall

PROJECT
International Flavors and Fragrances R&D Lobby

LOCATION
Union Beach, NJ

AWARD WINNER
Urbanstrong

TEAM MEMBERS

Sales, Technology Consulting, Project Management
Urbanstrong

System Provider
EcoWalls

Installation, Commissioning, Ongoing Maintenance
Parker Plants

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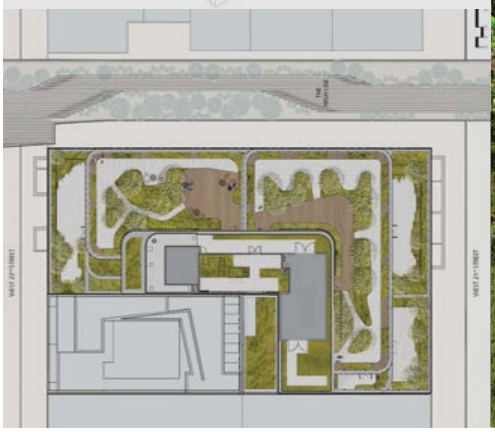


Images courtesy MKM Landscape Architecture

"MKM Landscape Architecture designed exterior terraces for a new commercial building on West 22nd Street, adjacent to the High Line. There are several terraces on each of the 14 floors, which provide tenants with green spaces and views. Curved metal planters and wild gardens are interspersed with wooden decking and paved walkways to provide flexible use venue spaces."

Mark K. Morrison

WILD GARDENS IN MANHATTAN

The concept for the project is to create wild gardens in Manhattan that echo and enhance the nearby High Line, and provide habitat for birds and pollinators for a new commercial building on West 22nd Street, adjacent to the High Line.

Numerous terraces with intensive green roofs create outdoor rooms for projected commercial tenants. Curved planters and wild gardens interspersed with wooden decking and paved spaces provide flexible use venue spaces for tenants, both for retreat from the work environment, and on the tenth and eleventh floors, for events. By providing multiple planted terraces on every floor, as well as a several large planted terraces and vegetated upper roof, this project creates a green cool zone in an otherwise densely paved area.

Green roof media is installed throughout every terrace, including under the pavers, ensuring maximum stormwater absorption and retention, as well as encouraging plant roots to spread throughout the terraces, with the added benefit of making the trees and plants more wind-resistant as well.

The plantings have been selected to provide habitat for migrating birds and pollinators. The proximity of the High Line Park enhances the opportunity for habitat, adding to a patchwork of green zones and small parks that are scattered throughout the Chelsea neighborhood just south of 34th Street. The building is on the Atlantic Flyway and therefore the plantings were selected to provide habitat for migrating birds, as well as pollinators. Each floor provides several terraces with outdoor spaces, creating vistas, and trees. The plantings are tall and lush, surrounding the people inhabiting the spaces with the opportunity to experience planted environments just by stepping through the wide access doors and edible grapes planted along the green screens.

The windows are set back under overhangs, both to provide shade for the terrace users, and to minimize bird strikes. All terraces have trees or columns in front of the windows to discourage bird strikes. Limestone / concrete pavers were locally sourced from a company in Brooklyn, NY. All wooden decking in this project is Kebony, which is very stable, and will not require any maintenance on the part of the building owners. It is a sustainable product since it is not a tropical hardwood. The plantings are all native and low-maintenance, with abundant ground covers, so once all is well-established, there should be bi-annual clean-ups, trimming, and fertilizing of trees.

CATEGORY
Intensive Commercial/ Industrial/Institutional

PROJECT
510 West 22nd Street

LOCATION
New York, NY

AWARD WINNER
MKM Landscape Architecture PC

TEAM MEMBERS

Landscape Architect
MKM Landscape Architecture PC

MEP Engineer
WSP Flack+Kutz

Building Code Consultants
Jam Consultants

Energy Modeling LEED Consultant
Viridian Energy & Environmental

Elevator Consultant
Van Deusen & Associates

Acoustic Consultant
Shen Milson Wilke

Architect
Cookfox Architects, LLP

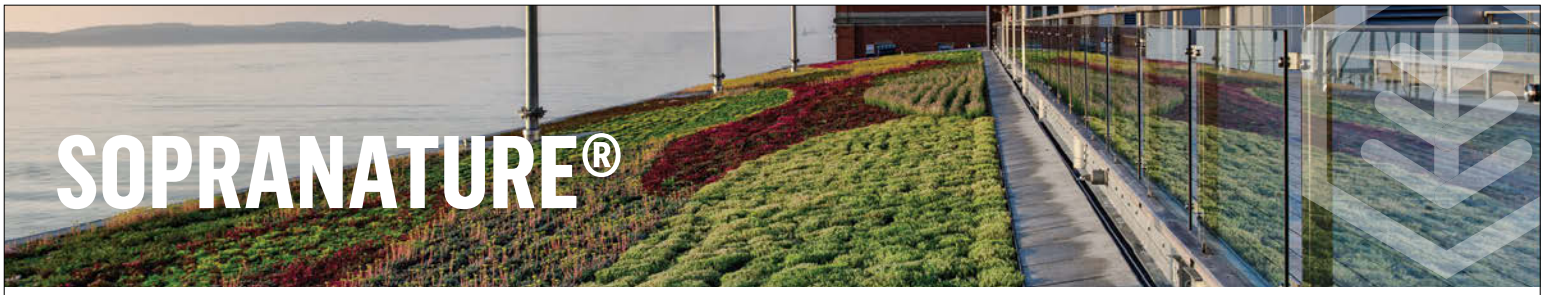
Structural Engineer
DeSimone Consulting Engineers

Exterior Wall Consultant
Buro Happold Consulting Engineers PC

Lighting Consultant
Brett Malak Lighting Design

Exterior Maintenance Consultant
Entek Engineering PLLC

D.O.T. Consultant
Delargent Design Architecture PC



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The Journal of Living Architecture (JLIV) is the official, peer-reviewed journal of the Green Infrastructure Foundation. The JLIV is written, reviewed, and edited by living architecture research professionals, sharing with their colleagues: successful educational applications, original research findings, scholarly opinions, educational resources and challenges on issues of critical importance to living architecture professionals and educators. The JLIV is published exclusively in the Living Architecture Monitor magazine and online at livingarchitecturemonitor.com. The magazine publishes the abstracts of each published JLIV manuscript, with a link to the full paper online.

Volume 6 Number 1 Pages 62-81

AN ECOMIMICRY DESIGN APPROACH FOR EXTENSIVE GREEN ROOFS

Caroline Nash[1,*], Mihaela Anca Ciupala[2], Dusty Gedge[3], Richard Lindsay[4], Stuart Connop[5]

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Extensive green roofs (EGRs) have been promoted as a multifunctional urban green infrastructure (UGI) solution that can ameliorate some of the negative environmental effects associated with urbanisation and provide habitat for wildlife. To date ecological EGR research remains limited, yet studying and understanding the ecology and ecological processes of these novel urban ecosystems could maximise their potential to conserve biodiversity and deliver multiple ecosystem services to urban areas. Here we present an overview of how a novel 'ecomimicry' approach can be used to ensure that locally important habitats are created and restored as part of urban green infrastructure strategies, and that biodiversity is embedded at the heart of EGR design. This can help urban developments meet sustainability targets and contribute to the goal of no-net-loss of biodiversity. Conserving urban biodiversity through ecomimicry will increase opportunities for urban communities to reconnect with nature and improve the quality of life for people in cities.

THE GREATER OHIO LIVING ARCHITECTURE CENTER OF EXCELLENCE

BY DR. REID COFFMAN, EXECUTIVE DIRECTOR, GOLA

The Greater Ohio Living Architecture (GOLA) center provides a gateway for interested people to connect to the fields of living architecture and green infrastructure by offering teaching and a community of discovery exploring advanced conceptualization and informed experimentation. The mission of GOLA is to promote and advance the teaching and research of living architecture.

The 11.6 million people in the State of Ohio are distributed across five major markets: Cleveland, Cincinnati, Columbus, Toledo and Akron/Canton. Ohio is home to numerous roofing and living architecture manufacturing companies, as well as to many startups. To cover the region's needs, GOLA is a consortium-based center of three institutions: Kent State University (Kent/Cleveland, OH); University of Cincinnati (Cincinnati, OH); and Heidelberg University (Tiffin, OH), partnering with Green Roofs for Healthy Cities to enable resources for pedagogy, research, and advocacy linking to the greater Ohio profession, industry, and trade.

The center consists of 19 design and science faculty, working collaboratively on over a dozen research and studio projects and initiatives. Current research initiatives include:

- Biodiversity Roofs and Living Architecture: Transference and interpretation of novel ecosystems in the Great Lakes (rock prairies, shale barrens, creek slumps, gravel bars, bluff rims, and ledges), for urban and coastal wildlife habitat.
- The status of research and pedagogy in living architecture: The inventory and analysis of current research, funding sources, course work, theses, and other academic aspects of living architecture.
- River Dredge reuse/recycle: New light weight growing media made with Cuyahoga and Maumee River dredge has been lab tested and currently under field trials. Various mix combinations are targeted for specific ecosystems services.
- Rare Plant Re-introduction study: The re-introduction of extirpated and endangered plants: Solidago ptarmicoides and Viola peditifida.
- Design Decision Tool: A prototype communications tool has been developed to aid interdisciplinary teams identify, design, and select green infrastructure and living architecture. Currently in beta testing and will be in market 2019-20.
- Substrate Ecology: Roof soil biota and community ecology characterizations (bacteria and fungi) and the relationship to ecological services. Ohio and Great Lakes Region, Published results expected 2019-21.
- Substrate Design, Biochar: Testing the effects of the incorporation of biochar into green roof substrate, on plant vitality and productivity, runoff water quality, and the retention of water and nutrients.
- Substrate Design, Organic Matter: How does the amount and type of organic matter in the substrate influence the long-term health of the plant community, and other ecosystem services provided by green roofs?
- Design and development of pneumatic green wall: Conceptualization and testing of multi-patent project on a self-inflating interior culinary wall.
- Block and Building scale Heat Stress: Data and thermal modeling of extreme heat events and green infrastructure and living architecture's role in moderation of human thermal comfort and health risks. In phase two.

SELF INFLATING PNEUMATIC CULINARY GREEN WALL CONCEPT.

Image courtesy GOLA

GOLA faculty across universities possess a broad array of research and teaching facilities. The new College of Architecture and Environmental Design (CAED) at Kent State and the Cleveland Studios (Cleveland) house studios, labs, classrooms, and space for gatherings. The College of Design, Architecture, Art and Planning (DAAP) at the University of Cincinnati holds large lecture halls, classrooms, labs, and various meeting spaces. All institutions have various field sites and labs. GOLA Associated Labs and Studios include:

- Novel Ecology Design Lab, NEDlab (Reid Coffman) new design and studio space.
- Landscape Architecture Studio, (Virginia Russell) design and conceptualizations of roofs and walls.
- Urban Ecosystem Ecology and Biogeochemistry Lab (Ishi Buffam), new chem/biological analysis lab.
- Soil Ecology Lab (Chris Blackwood), new state of the art soil ecology lab in Integrated Bioscience Bldg.
- Architectural Sciences Lab (Adil Sharag-Eldin), human health and atmospheric simulations lab.
- Materials and Structures Lab (Rui Liu), new mock up and materials physical testing laboratory.
- Watershed Hydrology Lab (Anne Jefferson), new urban water resource and analysis lab.
- University of Cincinnati Center for Field Studies UCCFS, (Lentz/Buffam).
- Applied Quantitative Ecology Lab (Christie Bahlai), new invertebrate community and data science lab.
- National Center for Water Quality Research (Laura Johnson).

Over 350 students per year take coursework in living architecture. This occurs through a range of academic levels. Currently, one Post-Doctorate, three doctors; eight masters of science; one Masters of planning; three Masters of landscape architecture, 18 undergraduate research theses and over 100 undergraduate and graduate green roof design studio projects and case studies. Students in field ranging from biology to architecture can partake in some 30 courses related to living architecture and green infrastructure.

GOLA is seeking new partnerships with international to local companies to develop new knowledge and train university students. With colleagues at Canadian universities and at the Swedish University of Agricultural Sciences, GOLA faculty are working on several collabortive research initiaves:

- Long-term development of green roof ecosystems: Plant communities and nutrient and carbon sequestration capacity are being monitored on green roofs varying in age up to 20 years since establishment, using a chrono-sequence in Malmö, Sweden.
- Microbiome of green roofs: Assessment of bacteria and archaea on a variety of green roofs in Ohio and successional changes in these communities over 20 years in Sweden.
- Green roof nitrogen-fixation: Does nitrogen fixation occur at appreciable rates on green roofs and how do we bolster this function to improve the long term sustainability of green roof ecosystems.
- Roof and wall habitats and templates: Exploring Great Lakes ecosystems for transference to buildings.

FOR MORE INFORMATION

Visit GOLA https://www.golacenter.org/

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WHO IS THE GREENEST CITY OF THEM ALL? HOW SHOULD THE GREEN ROOF WORLD MEASURE SUCCESS?

BY DUSTY GEDGE, PRESIDENT, EUROPEAN GREEN ROOF ASSOCIATION

Measuring the success of green roof policies and strategies should be a key element of what a city does. Success for cities is different from measuring market size and value. From the green roof industry perspective market value of course is an imperative - individual company's sales and installations increasing year on year will be key. Yet from a city perspective sales mean little. It is area that counts!

Over the years of my work in London campaigning and providing policy and design advice on green roofs the key question has been - what impacts have the London Policy had since it came into effect in 2008. The only way to answer that question was to map every single green roof! And for a city the size of London that is not a casual endeavor. So, over the last few years, I personally set out to undertake the exercise. The results of this mammoth mapping exercise form a very important element of the new London green roof report published in April this year. The data provided includes infographics for the whole of the Greater London area, each London borough and for the Central Activity Zone, a key planning zone in London.

Whilst the exercise was aimed at charting the success of London's policy, we also published an estimate of the area of green roofs in various cities in the world to provide some idea of the success of London when compared to other leading cities. This table is based on some research undertaken by the Humbolt University in Berlin, as yet unpublished, that I was party to because I was providing data on London for 2015. Of course, part of this exercise intended to show that London is on par with many other cities cited as being at the forefront of the green roof revolution. As a Londoner with a degree of ownership of the policy, the intention was to show the doubters that London was on a par with other cities beyond Germany, Switzerland and Austria.

There is not space to review the table, (opposite), in detail, but it does bring into focus how data is collected in a city and what that data actually means. At present, the data collection methods used vary from city to city. I do know that certain cities in the world have mapped in detail their green roof areas – namely Dusseldorf and Vienna. Others have used permit tracking, some have done so manually. Currently, there is no accepted method for tracking green roof installations.

The other question is how best to compare cities of different sizes and populations. One key element I took from the original research in Berlin was to present data not as total areas – big numbers always grab attention – but as the area of green roofs per citizen. This relates to the idea of the amount of green space per urban citizen as an indicator of health in cities proposed by the World Health Organisation.

Considering the two most successful green roof cities in the world, Basel and Stuttgart, provides a perspective on the use of this metric when it comes to green roofs. Whilst Stuttgart's total area was twice as much as Basel's in 2015, Basel has over 5.71m^2/per person (PP) compared to Stuttgart's 3.38m^2/pp. Does that tell a better and more interesting story than total area? I think so.

More work needs to be done to refine methods of calculating green roof area and how best to use the data to compare cities and work to improve policy development and implementation.

TABLE: GLOBAL GREEN ROOF AREA AND DENSITY, 2015

The table below ranks cities in terms of square metres of green roof per inhabitant, which is in line with the World Health Organization's urban health indicator of green space per urban inhabitant. This is a more appropriate metric when demonstrating how well cities are performing in terms of green roof provision. The figures reveal that while certain cities have an impressive total green roof area, the density - or sq m^2 per inhabitant - is actually relatively low. London's CAZ, on the other hand, has a total green roof area that is slightly below average when compared with most other cities, but has a much greater square metergae per citizen.

	POPULATION	TOTAL AREA OF GREEN ROOFS (M^2)	GREEN ROOFS PER CAPITA (M^2 / INHABITANT)
BASEL	175,131	1,000,000	5.71
STUTTGART	590,000	2,000,000	3.38
LINZ	193,814	500,000	2.57
MUNICH	1,450,381	3,148,043	2.17
VIENNA	1,714,000	2,560,000	1.49
MALMO	303,000	400,000	1.32
HANOVER	522,686	638,500	1.22
LONDON'S CAZ	230,000	205,000	1.21
DUSSELDORF	588,169	698,000	1.19
BERLIN	3,600,000	4,000,000	1.11
WASHINGTON D.C.	681,170	254,470	0.37
ROTTERDAM	634,661	235,000	0.37
AMSTERDAM	813,562	300,000	0.36
MELBOURNE CITY	148,000	54,000	0.36
PORTLAND	570,000	157,989	0.27
CHICAGO	2,700,000	508,130	0.19
TOKYO	13,184,161	1,345,250	0.10
TORONTO	2,615,060	250,000	0.09
SINGAPORE	5,100,000	468,000	0.09
COPENHAGEN	510,000	40,000	0.07

The figures have been collated from various cities and organisations and from work as yet unpublished by Humboldt University. Data collection methods vary. It should be noted that figures for London realte only to the Central Activity Zone as data for the Greater London area for 2015 are not available.

FOR MORE INFORMATION

Dusty Gedge has been a green roof designer and activist for more than twenty years and currently serves as the President of the European Green Roof Association. dusty@dustygedge@co.uk

ECO-INCENTIVE PROGRAM FUNDED GREEN ROOF AT EVERGREEN BRICKWORKS IN TORONTO.

Image courtesy Annemarie Baynton

LESSONS FROM TORONTO'S MANDATORY GREEN ROOF BY-LAW:

A DECADE IN THE MAKING AND A DECADE MAKING POSITIVE CHANGE

BY STEVEN W. PECK, GRP, HONORARY ASLA, GREEN ROOFS FOR HEALTHY CITIES

What is the recipe for positive policy change? Political and bureaucratic leadership with pressure from outside groups are undoubtedly essential ingredients required to implement new policies that future-proof our cities against the climate crisis.

In 2009, in the City of Toronto, these ingredients were present under the political leadership of Mayor David Miller and Deputy Mayor Joe Pantalone with the adoption of Toronto's Green Roof Bylaw, the first in North America. Earlier in the process, Jim Kamstra, a Director with the City's Facilities and Real Estate Division, played an important role in building the 2001 pilot green roof at City Hall and Eastwood Community centre in partnership with Green Roofs for Healthy Cities (GRHC). Ongoing bureaucratic leadership leading up to the By-law was provided by Joe D'Abramo, a Director in Toronto's Planning Division and Ann Borooah, then Chief Building Official.

Both were instrumental in working with the development industry and achieving a green roof bylaw requiring and governing the construction of green roofs in Toronto. Deputy Mayor Joe Pantalone ensured the By-law was not watered down. City Council approved (one vote short of unanimously among councillors left and right), the Toronto Green Roof By-law in May 2009.

Externally, the by-law had very wide spread support from community and housing advocates and environmental groups, due to its ability to reduce the urban heat island, better manage increasingly aggressive stormwater challenges, support biodiversity and provide more much needed greenspace in the rapidly developing city. At Green Roofs for Healthy Cities (GRHC), we had been laying the ground work for this policy, with pilot projects, training, advocacy and research leadership. Professor Hitesh Doshi of Ryerson University was hired by City Planning and Toronto Water to conduct one of the first comprehensive cost-benefit assessments of widespread green roof installation. This assessment built on the work of researcher Dr. Karen Liu of the National Research Council, Institute for Research in Construction, and the private sector members of GRHC who combined forces to build a research and demonstration project on the roof of the Toronto City Hall in 2001.

These were the ingredients that allowed Toronto to become the first major North American city to require green roofs on almost all new residential, commercial and institutional buildings. The Green Roof By-law also included detailed construction standards for all green roofs built in Toronto in order to maintain quality, health and safety. The by-law supported the already established Eco-Roof Incentive Program which receives funds from developers that wish to pay cash-in lieu of a required green roof. The Eco-Roof incentive provides financial incentives for existing building owners to implement green and/or reflective roofing.

IMPLEMENTING MULTIPLE POLICY OBJECTIVES

The Green Roof By-law implements policies of the Official Plan and supports the goals and objectives of the Wet Weather Flow Management Master Plan, Transform TO, and the Resilience Strategy. Policy objectives include:

- Urban heat reduction – heat map showed hot spots throughout the city
- Stormwater management – combined sewers, aging infrastructure
- Climate change goals – GHG emission reductions of 80 per cent by 2050
- Reduced energy demand for cooling
- Creation of urban green space
- Habitat creation & increased biodiversity
- Air quality improvements
- Creation of green jobs

WORKING UP TO A MANDATORY REQUIREMENT

Prior to the passage of the by-law, the City's earlier Green Roof Strategy directed that green roofs be achieved on new development through the planning approval process. In 2007 alone, 14 green roofs were achieved through this process. The City's own buildings, as well as the buildings of its agencies, boards and commissions were also required to implement green roofs on 50 per cent of all available roof space. These procurement requirements on public buildings coupled with the new development approvals created the basis for industry development and greater familiarity with green roof technology, which at the time was not well known. When the Green Roof By-law came into effect on January 31, 2010 for all new residential, commercial and institutional buildings or additions greater than 2,000 m^2 of gross floor area, it was no surprise to the building industry. In fact, many developers had already been implementing green roofs as amenity space in their residential development projects.

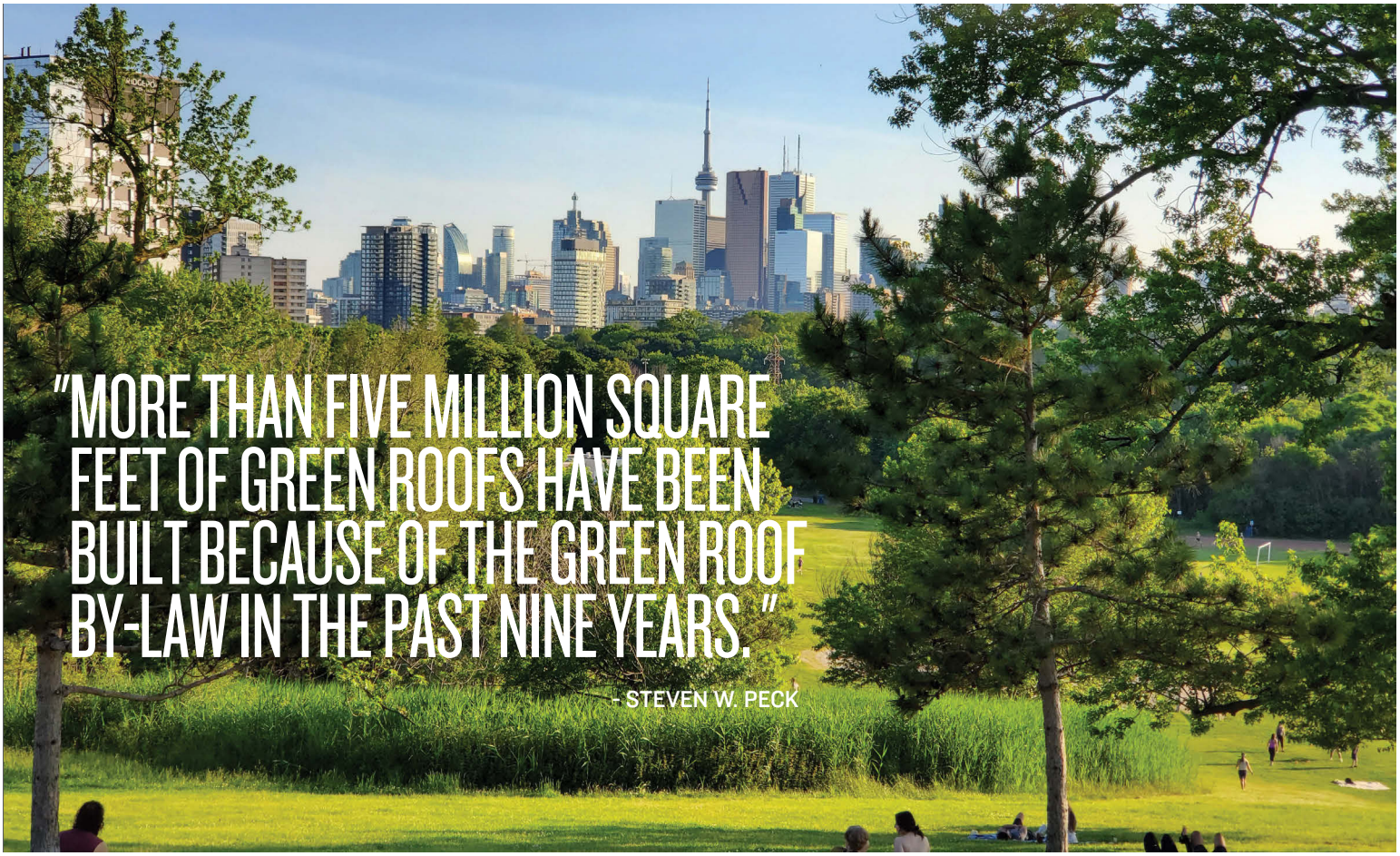
FLEXIBLE MANDATORY REQUIREMENT

The green roof requirements are graduated, ranging from 20 per cent of the available roof space for buildings with a gross floor area of 2,000-4,999 m^2, to 60 per cent of the available roof space for buildings with more than 20,000 m^2 of gross floor area. The thinking at the time was that larger projects are more able to afford the additional upfront costs of a green roof. Given our growing understanding of the private benefits of green roofs, other jurisdictions, such as Portland and San Francisco have since applied higher coverage requirements that are not graduated. Toronto built additional flexibility into the requirement by allowing cash-in-lieu payments of $200/$m^2$ for a reduced green roof area. Although not widely used by developers, the cash-in-lieu funds are collected and used in the Eco-Roof Incentive Program.

GREEN ROOF CONSTRUCTION STANDARDS

The Green Roof Bylaw includes construction standards which were developed with the assistance of a Green Roof Technical Advisory Group consisting of industry experts and associated professions, including the Ontario Association of Landscape Architects. The construction standards are designed to support best practices associated with the design, installation and maintenance of all green roofs built in the city. The standards contain detailed information on the minimum requirements for green roof design, construction and maintenance in the following areas:

- Green Roof Assembly
- Gravity Loads
- Slope Stability
- Parapet Height and/or Overflow Scupper Locations
- Wind Uplift
- Fire Safety
- Occupancy and Safety
- Waterproofing
- Vegetation Performance
- Plant Selection
- Irrigation
- Maintenance



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The City has also developed Guidelines for Biodiverse Green Roofs, which illustrate best practices for creating habitat and promoting biodiversity. The Standards and Biodiversity Guidelines are designed primarily for use by engineers, architects, landscape architects, landscape and roofing contractors and green roof professionals.

THE ECO-ROOF INCENTIVE PROGRAM

The Eco-Roof Incentive Program has undergone a number of changes since its initial creation in 2008. Originally, it provided a grant of $50/m^2$ for green roofs, which was increased to $75/m^2$ by City Council in 2013. At the same time, existing residential buildings and new construction by Toronto school boards were permitted to apply. In 2016, after stakeholder consultations, the grant was further increased to $100/m^2$. Another barrier to program participation was the initial cost of doing a structural assessment to determine if sufficient loading capacity is present to have a green roof on an existing building. Council approved adding a Structural Assessment Grant of up to $1,000 to help offset the cost of conducting a structural assessment for existing buildings. More than 14 projects have received this type of support to date. The Eco-Roof Incentive Program also provides a small incentive for reflective roofing of $2 to $5/$m^2$.

IMPACTS OF THE GREEN ROOF BY-LAW – NUMBER OF PROJECTS AND AREA

Green Roof By-law Mandatory Requirement

620 Green Roof Projects permitted by the end of 2018, resulting in 500,000 m^2 of green roof area completed or planned. More than half of the projects are multi-residential buildings, reflecting the development boom in that sector over the past decade.

Eco-Roof Incentive Program

Over the past ten years, the Eco-Roof Incentive Program completed 426 projects (353 reflective and 73 green) representing 797,507 m^2 of reflective roofing and contributing 124,000 m^2 of the 500,000 m^2 total green roof area.

Total Green Roof Area Implemented 2009 -2018: 500,000 m^2, or 5,381,955 square feet)

Using the average industry values in the Green Infrastructure Foundation's Green Infrastructure Cost-Benefit Matrix, and assuming that 20 per cent of the roofs are intensive and 80 per cent are extensive provides the following benefit values:

ANNUAL BENEFITS

- 222 million litres of stormwater retained
- 225 tons of carbon sequestered
- 3.2 million kWh of annual electricity savings for the buildings with green roofs
- 1.6 million kWh of annual electricity savings for surrounding buildings due to a reduction in the urban heat island effect

JOBS

- 1,618 FTE jobs in construction
- 25 FTE jobs annually in maintenance

> "ANNUAL BENEFITS OF THE BY-LAW INCLUDE 222 MILLION LITERS OF STORMWATER RETAINED, 225 TONS OF CARBON SEQUESTERED, 3.2 MILLION KWH OF DIRECT ELECTRICITY SAVINGS AND MORE THAN 1,600 JOBS."
>
> - STEVEN W. PECK

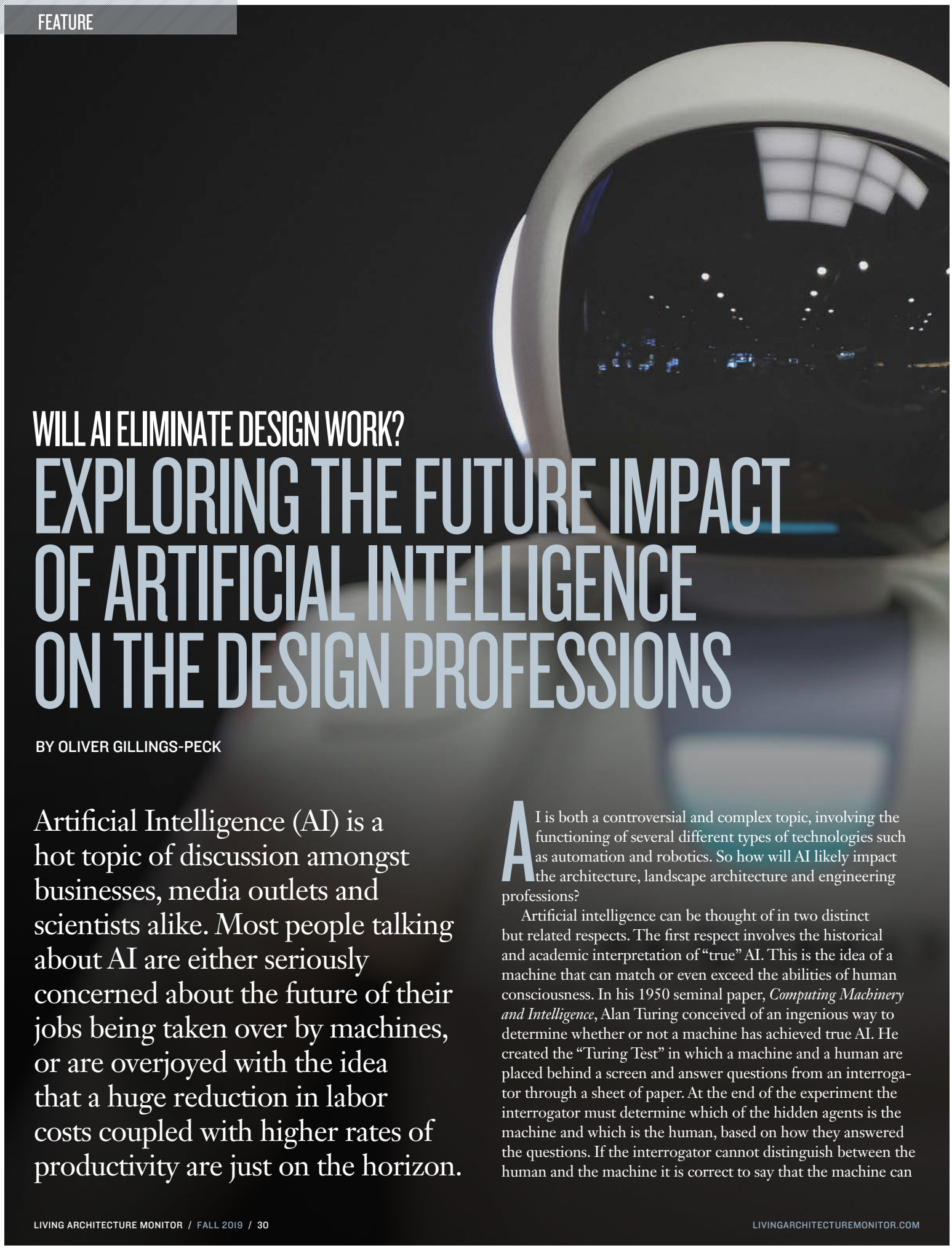
CONCLUSION

The Toronto Green Roof By-law continues to generate a significant number of measurable benefits for the residents and building owners in the city, at a low overall cost for program administration. The mandatory requirement leverages a very small proportion of the billions of dollars of private development investment in the city, and takes advantage of roof spaces that would otherwise contribute to the urban heat island, stormwater management and other challenges. The public-private partnership nature of the green roofs (benefits for owners and the public), combined with the flexibility of the by-law, has led to full market acceptance.

The continuous review and stakeholder engagement by the City has resulted in a number of measures implemented to fine-tune the original policies with an aim of improving engagement and market penetration. Toronto demonstrates that green roofs are an excellent tool for governments seeking to implement multiple policy objectives and to strengthen the resilience of its communities in the face of the climate crisis.

FOR MORE INFORMATION

Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto. Hitesh Doshi, et. al.
To obtain copies of Biodiverse Guidelines please email: sustainablecity@toronto.ca
Details on the Toronto Green Roof By-Law. https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/green-roofs/
More information about the Eco-Roof Incentive Program: https://www.toronto.ca/services-payments/water-environment/environmental-grants-incentives/green-your-roof/



WILL AI ELIMINATE DESIGN WORK?

EXPLORING THE FUTURE IMPACT OF ARTIFICIAL INTELLIGENCE ON THE DESIGN PROFESSIONS

BY OLIVER GILLINGS-PECK

Artificial Intelligence (AI) is a hot topic of discussion amongst businesses, media outlets and scientists alike. Most people talking about AI are either seriously concerned about the future of their jobs being taken over by machines, or are overjoyed with the idea that a huge reduction in labor costs coupled with higher rates of productivity are just on the horizon.

AI is both a controversial and complex topic, involving the functioning of several different types of technologies such as automation and robotics. So how will AI likely impact the architecture, landscape architecture and engineering professions?

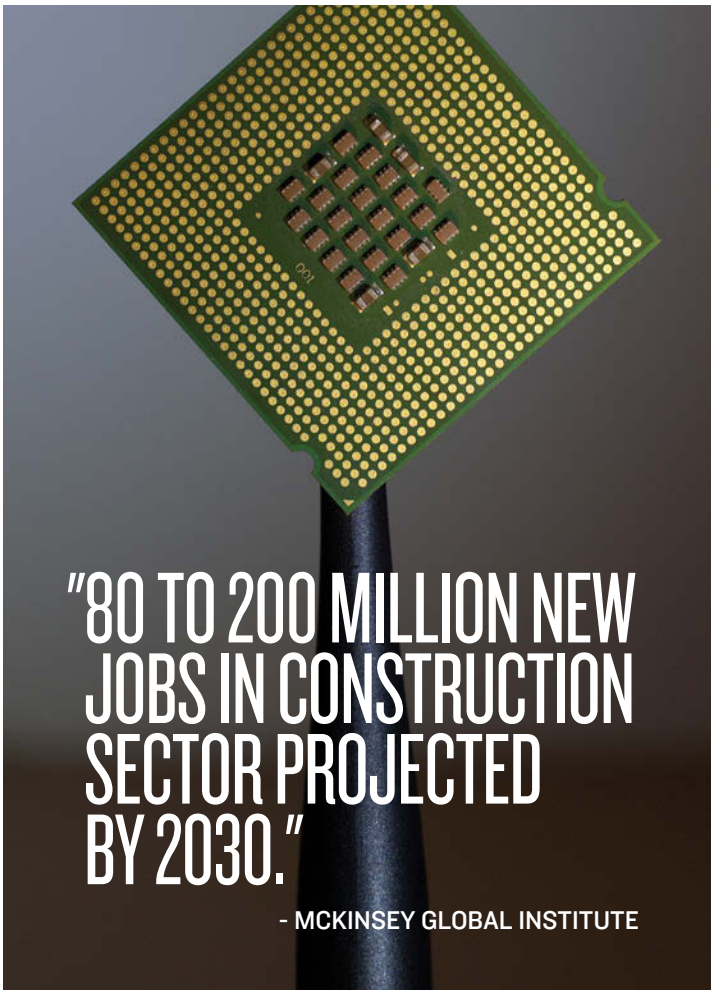
Artificial intelligence can be thought of in two distinct but related respects. The first respect involves the historical and academic interpretation of "true" AI. This is the idea of a machine that can match or even exceed the abilities of human consciousness. In his 1950 seminal paper, *Computing Machinery and Intelligence*, Alan Turing conceived of an ingenious way to determine whether or not a machine has achieved true AI. He created the "Turing Test" in which a machine and a human are placed behind a screen and answer questions from an interrogator through a sheet of paper. At the end of the experiment the interrogator must determine which of the hidden agents is the machine and which is the human, based on how they answered the questions. If the interrogator cannot distinguish between the human and the machine it is correct to say that the machine can

"think" just like a human and has achieved true AI (Alan Turing, 1950). As of today, no such computer has been able to replicate the same level of emotional and cognitive intelligence as a human, however it is undeniable that AI is developing towards that goal at a incredibly fast pace.

The second respect in which AI can be considered is in its real world application in industry. This involves the development of artificially controlled automated systems that are implemented to complete routine physical work and even some cognitive abilities like decision-making, sensing emotion, and complex mechanical actions such as self-driving cars. It is estimated that about half of all work activities globally have the potential to be completed by AI technologies and automated systems. However, the rate at which industries transition to automated systems will be impacted by factors such as development and deployment costs, regulations, social acceptance, and labor market dynamics (McKinsey Global Institute, (MGI) 2017). The MGI estimates that as much as one third of current workplace activities could be displaced by the year 2030, with a midpoint of around 15 per cent of workplace activates being automated. That translates into 400-800 million jobs being taken over by automated systems, leaving a lot of people out of a job.

Certain occupational sectors are more at risk of becoming automated while others are expected to actually see a boom in new job creation. In general, occupations that involve a more predictable set of activities and range of physical movement are more likely to become automated. MGI suggests that occupations such as IT workers, office support staff, financial workers, fine equipment installation, and food preparation workers are amongst the highest at-risk jobs to be potentially replaced by AI. In contrast, certain sectors are expected to see widespread job creation including a 90 percent increase in skilled technology occupations like computer programing and robotics. As far as engineering and architecture occupations go, the future also looks bright. It is estimated that the world will need to invest approximately $3.3 trillion annually in infrastructure by 2030, in order to keep up with population growth rates (MGI, 2016). New buildings will have to be constructed as developing countries expand, whilst developed countries will have to maintain and reinvest in existing infrastructure. Rising incomes and investment into renewable energy and energy efficiency also generate a demand for higher quality buildings. These factors are projected to create 80-200 million new jobs in the construction sector by 2030! (MGI, 2017).

Engineering, architect, and landscape architect professions are relatively safe from becoming automated, due largely to the unpredictable nature and high variability of these occupations. Being a professional architect, landscape architect or engineer involves creative thinking, negotiation, strong communication skills, and an ability to adapt to unforeseen conditions; all skills that are incredibly hard to program a computer to do. Coupled together with the increasing demand for climate adaption and mitigation, careers that specialize in green infrastructure development will be in high demand due to the challenges we face adapting to climate change. In their trend-line scenario based on present day clean energy policy intentions, MGI estimates that 10 million new jobs will be created if adequate investments are made in clean energy.



That number is doubled to the 20 million new jobs predicted in their step-up scenario, which is based on countries meeting their Paris climate accord commitments.

It is safe to say that at present, occupations within the construction sector are positively situated to benefit from adoption of AI technologies. However, if the quest to achieve "true" AI is finally achieved and therefore a computer can replicate the same cognitive abilities as a professional then all occupations will ultimately be at risk of machine replacement.

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FOR MORE INFORMATION

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McKinsey Global Institute. Jobs Lost, Jobs Gained: Workforce transitions in a Time of Automation. 2017. Executive Summary.
McKinsey Global Institute. Bridging Global Infrastructure Gaps. 2016. https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/bridging-global-infrastructure-gaps.

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Jeremy Brummitt, Natasha Lyasheva, Amol Tatiya, Jay Gearing, Jennifer Giunta, Aaron Hoffman, Phoebe Loyd, Logan Richard, John Scureman, Grant Tinney, Carlos Valencia

WHY DOESN'T BOSTON USE GREEN ROOFS TO COMBAT FLOODING?

BY OSCAR WARMERDAM, PRESIDENT, SEMPERGREEN

Boston is in trouble, and they know it. Massive tidal shifts of 10-14 feet in the Boston Harbor mean that every time a North Eastern storm coincides with high tide, the excess stormwater cannot readily flow into the harbor. The result is flooding. Boston expects this to happen every year as tidewater is expected to rise to street level in the next 15 years.

The resulting economic damages climb into billions of dollars lost. AI simulator software technology maps these impacts, as cities struggle to understand flooding complexity to see what happens how, to whom, when, and at what cost. This software deploys a diverse collection of stormwater solutions… but not green roofs!

What the flood? Why not? If roofs cover 50 per cent of downtown Boston, why are green roofs not considered part of the solution?

Green Roof Diagnostics (GRD), is a $400.000 green roof laboratory built by a consortium of Sempergreen, Knauf, Hydrotech, and GRSP. We confirmed that stormwater retention based solutions are indeed awesome and even civil engineers can agree that green roofs are great as volume reduction tools, but at the peak of the storm… does the civil engineer see a green roof a primary peak flow reduction tool? Aaaahhhh... not so much.

As an industry, we proudly state annual retention rates of 40-50 per cent. As a result, the size of 'retention cups or sponges' are our collective bragging rights. My cup (or sponge) is bigger than yours! Yet, civil engineers don't care. Let me re-phrase because this statement causes industry riots. Retention is great… unless the cup/sponge was filled with yesterday's rain.

RETENTION COMBINED WITH TRUE DETENTION CAPACITY IS THE ULTIMATE VALUE POTENTIAL OF A GREEN ROOF

Few green roofs can deliver this. Charlie Miller's unique award winning green roof designs provided both. He has been saying this out loud for 20+ years. If it were not for Charlie, Joshua Robinson and Brad Garner , software engineer, from Green Roof Diagnostics we would never have solved that problem for our clients. Brad rebuilt the GRD laboratory in 2017 to emphasize True Detention based testing. He also built the Evapotranspiration calculator in 2018 that clearly show that most storms come in clumps of 2-3 days in a row (see https://purple-roof.com/model) Simply put, on the first and or second day, the rain fills up the retention capacity of the green roof, and then it releases water as fast as it rains on the 3rd day. The re-charge rate of a retention based green roof is simply too slow (7-21 days), and because of this, software engineers prefer alternatives that re-charge quickly. …any solution with a cup or sponge that does not re-charge within 24 hours …does not qualify as True Detention.

TRUE DETENTION IN GREEN ROOFS SHOULD BE THE FOCUS

Detention is focused on peak flow reduction, and peak flow delay. If we want cities like Boston to use green roofs as primary stormwater management tools, and True Detention is what software engineers are looking for, this is what we as an industry need to provide.

Yours truly,

Oscar Warmerdam
CEO Sempergreen USA
CEO Purple-Roof


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