

Rethinking *Roofing* | the fifth facade



In the world of Industrial, Commercial and Institutional [ICI] construction, the vast majority of buildings have flat roofs that are often not in view. Yet they exist in the harshest of environments - baked under blazing sun, exposed to wind, rain and snow, walked upon by various trades with little concern for the integrity of the membrane. All of this while performing arguably the most important building envelope function - protecting the interior space below by keeping the exterior elements out.

DON DELANEY





TRANSFORMING NATHAN PHILLIPS SQUARE WITH A NEW VEGETATED ROOF, TORONTO [1]. AWARD WINNING GREEN ROOF RETROFIT AT CONCORD PLACE: ESRI, TORONTO [2]. ALL PHOTOS COURTESY OF FLYNN CANADA LTD., EXCEPT AS NOTED.

Roofs are also the fifth facade of the building envelope and should be an important focus when it comes to improved energy efficiency. One of the primary methods of improving a building's long-term cost efficiencies is through energy conservation. Roofing has recently become one of the key components in enabling a building to become more self-sustaining over time through energy conservation, efficiency and power generation.

Roof rating system

The Center for Environmental Innovations in Roofing [CEIR, www.roofingcenter.org] is a Washington, DC-based non-profit organization whose mission is to promote the development and use of environmentally-responsible, high-performance roofing systems and technologies. One of the early initiatives of CEIR is to develop RoofPoint™, a new comprehensive rating system for roof assemblies due out later this year.

The Center's Director of Research, Dr. Jim Hoff, explains that RoofPoint serves four functions, "It's a guideline for the selection of roofing systems that maximizes energy efficiency and minimizes environmental impact. It's a checklist to evaluate the many ways roofing systems provide economic and environmental benefits. It's an assessment system to compare alternative sustainable roofing strategies. And finally, it's a recognition program to reward environmental innovation in roofing."

RoofPoint emphasizes long-term performance and durability of the roof system, which is of particular interest here in Canada. Note that, although this is a US-based initiative, the goal is truly global innovation, and Canadian comments are encouraged and welcomed.

Reflective roofs

Roofing manufacturers themselves continue to fund R&D into new and improved products that respond to today's demand for energy efficiency, recycled content and recyclability. This is particularly true for reflective roofs. Once the domain of only metal roofs and single-ply membranes such as TPO and PVC, now virtually every type of roof system comes with a reflective option. Two-ply modified bitumen cap sheets and traditional built-up roofing can be specified with white granulated or gravel Energy Star-compliant surfaces. There are also many alternatives with low-VOC content and some recycled content that may contribute towards LEED credits.

The potential environmental benefits of reflective roofs were first identified several decades ago. Towards the end of the 90s the Cool Roof Rating Council [www.coolroofs.org] was created to develop accurate methods of evaluating and reporting the solar reflectance and thermal emittance of roofing products. This has been important work, resulting in standardized Solar Reflectance Index [SRI]

ratings being of great value to the design community.

In its current form, LEED rewards us for utilizing reflective roof systems, but there is growing concern that this may not make sense in cold climates where net energy consumption for heating outweighs that of cooling on an annual basis. In these cases, it may be more prudent to have a roof surface that absorbs solar radiation rather than reflecting it.

Intuitively, the better design approach is to consider the whole building envelop as a system, and evaluate the choice of reflective versus absorptive roof covering, taking into consideration the real insulation U-value, occupancy, site-specific issues such as shading, wind exposure and obviously local climate. Although a point may be lost under Sustainable Sites 7.2, one could argue a point can be gained for innovation in design with this more holistic approach.

Recyclability

As for recyclability, the U.S. Environmental Protection Agency [EPA] claims that 40% of total landfill waste comes from construction and demolition debris - one quarter of which is generated by roofing materials. Roofing contractors already divert the low-hanging fruit: separating and reusing ballast stone and pea gravel from inverted and built-up roof assemblies are common practice. Spent insulation boards are also redirected from landfill and



THE ACCELERATOR BUILDING IN WATERLOO WHERE A VARIETY OF PLANTS CREATE A MEADOW-LIKE EFFECT. THE ROUND WOOD STRUCTURES ARE SCREENS TO HIDE THE ROOF-TOP MECHANICAL EQUIPMENT [3].

are recycled into new insulation products.

On the other hand, while there have been advancements in reprocessing membrane materials like PVC, TPO and EPDM, the reality is the majority of these materials go straight to landfill at present. More needs to be done to encourage recycling of these products through education, infrastructure, higher disposal fees and/or legislation.

Vegetated roofs

The current excitement about green or vegetated roofs might suggest to the uninitiated that they were a new phenomenon, but very likely the early prairie settlers who lived in grass roof "soddies" would have chuckled at the thought. What is new is that we are trying to do more with less. This means less growing medium to reduce weight [and the structure to support it], and more drought-tolerant plants to reduce water consumption.

Green Roofs for Healthy Cities [www.greenroofs.org] has extensive information on the diverse benefits of green roofs. In Canada, the City of Toronto leads the way in supporting the widespread incorporation of green roofs on new buildings, and the installation of retrofit green roofs on existing buildings. The recently completed 3,400m² green roof retrofit on the podium roof at Nathan Phillips Square is an effort by the City to demonstrate leadership in support of its new Green Roof Bylaw, which took effect earlier this year.

All the original insulation and pavers were removed and recycled and a new hot rubber waterproofing layer was added to the concrete surface prior to insulation and green roof

installation. The structure was sufficient to support up to 150mm of growing medium, but the added elements [green roof] on top of the insulation meant that a handrail had to be added to the existing parapet.

The strongest arguments for green roofs in the ICI market, however, are the tangible benefits to the building owner, particularly with respect to added life expectancy for the roof membrane. There have been many estimates made of how much additional life expectancy a green roof provides to a roofing membrane. The truth is that we can really only speculate. There isn't enough history to provide a conclusive answer for our climate.

Bear in mind, though, that a well-built roof, one that is constructed to the manufacturer's specifications, will eventually fail for one of two primary reasons: either the membrane will break down from UV exposure, or breaches will occur at transition details [parapets, curbs, etc.] from stresses created by temperature fluctuations over multiple seasons.

Green roofs address both of these issues. Research conducted at NRCan [Lui and Baskaran, 2003] has demonstrated that vegetated roofs maintain a relatively even temperature at the waterproofing level thus mitigating wide temperature fluctuations. And, as one would expect, their build-up shelters the membrane from UV exposure.

Anecdotal evidence has illustrated this. The landscaped roof of the parking garage at the iconic Lake Point Tower in Chicago built in 1969 has recently required remedial work. The small trees originally planted are now not so small, resulting in excessive loading and concrete creep. What is interesting is that an

investigation into the state of the waterproofing revealed that the original multiple felt and coal-tar pitch appeared as good as the day it was placed. The soil placed over it, averaging 300mm to 1200mm in depth, but as much as 3m in some locations, seems to have protected the waterproofing from aging. We can conclude that covering the membrane with the growing medium, which is unaffected by UV, and which has insulating properties to mitigate temperature swings, will increase the life of the roof.

Skylights

Skylights have been used for years as a means of admitting energy in the form of natural light through a roof. Skylights can either use transparent glazing through which one can view the sky, or fitted with translucent glazing to admit diffused light.

Diffused light is more desirable within an occupied space because it results in less glare, making it easier on the eyes and avoiding hotspots created when direct sunlight strikes a surface below. Glare of this kind can make working conditions intolerable.

For many low-rise, deep plan commercial buildings, introducing daylight into the depths of the floor plate can be challenging. For new buildings, north-facing clerestory glazing or skylights can generally be configured to solve this problem. However, for existing buildings, these solutions are often not simple because of cost and structural limitations. In such cases, innovative solar tubes can be retrofitted onto an existing roof. Supplied with prefabricated flashings, they can be strategically located



SOLAR TUBES CAN BE PARTICULARLY USEFUL IN BRINGING DAYLIGHT INTO EXISTING DEEP PLAN BUILDINGS [4]. CHALLENGING LOGISTICS AT TORONTO CITY HALL PODIUM [5]. SOLAR PV ON TOP OF NORTH VANCOUVER PUBLIC LIBRARY. [COURTESY OF PCL WESTCOAST CONSTRUCTORS LTD.] [6].



over common space, such as aisle ways in warehouse storage areas, to give sufficient task lighting, even in slightly overcast conditions.

Ideally this type of natural light source is fitted with a diffuser which scatters the light thereby avoiding the hot spots associated with more traditional skylights. Also, to enhance efficiency, they can be combined with an automated lighting system that monitors light levels and adjusts illumination accordingly. These combinations can have a return on investment of less than five years in most situations. Other accessories can be included, such as reflective tubes that conduct light from the roof through, say, a drop ceiling to the enclosed space below making the addition of natural daylight possible where it wasn't before.

PV Roofs

Energy generation is yet another way roofs are being utilized for purposes other than just keeping the weather out. Photovoltaic [PV] systems on rooftops are a preferred way of creating distributed power, especially under incentives such as the Ontario Feed-in-Tariff [FIT]. The program, based on a German model, pays small energy producers a premium for the power they produce as a way to encourage growth in this emerging market.

The premium helps to offset the high initial

cost of construction. However, there is growing optimism in the green energy sector that we may be approaching grid parity without the need for government incentives in the not too distant future.

Maintenance for long life, less waste

With all these initiatives, maintenance is the key to sustainability. The common belief is that commercial flat roofs have a life expectancy of 25 to 30 years. However, a study by Drucker Worldwide found the real-life average to actually be 17 years. The primary reason for this discrepancy is a general lack of ongoing preventative maintenance.

Roofs, be they green, white, black, inverted or even metal all require ongoing preventative maintenance programs where regular annual [or more frequent] visits are made to clear

drains, remove debris and unwanted plants, re-caulk or seal where needed, inspect flashings and transition details for fatigue, etc. This is strongly recommended by manufacturers and the Canadian Roofing Contractors Association [CRCA] alike.

In fact, preventive maintenance is a requirement for extended roofing material warranties. Too often maintenance is thought of as an unnecessary luxury - if the roof isn't leaking it must be fine. Unfortunately, many infiltration problems take time to reveal themselves. In the meantime, water is saturating insulation making it redundant, separating adhered layers through freeze/thaw, compromising much larger areas of the roof than just the immediate leak location, not to mention putting at risk valuable equipment and product housed within the building.

A regular maintenance program will ensure the roof system will fulfill its anticipated service life, thereby mitigating the risk of a leak as



SEALANTS SHRINK AND CRACK OVER TIME. REAPPLICATION ENSURES INTEGRITY [7]. CLEARING ROOF DRAINS IS PART OF ONGOING ROOF MAINTENANCE. [8].



as well as avoiding premature replacement and the associated waste that would generate.

We live in interesting times. The need for a more sustainable built environment is creating challenges and opportunities for all. The roof of a building is, in some ways, the new frontier for many of these innovations. ◀

DON DELANEY, P.ENG, LEED AP, IS ENVIRONMENTAL SOLUTIONS MANAGER WITH FLYNN CANADA LTD.

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Read this article and Self-Report to the AIBC to receive 1 Core Learning Unit

SELF-REPORT FORM: www.aibc.ca/member_resources/professional_dev/flyers/AIBC_Self-report_a1.pdf
SELF-REPORT ONLINE: www.aibc.ca/member_access/ces/index.html

See answers on p. 8

Print and retain completed questionnaire

Non AIBC members should copy the questionnaire, fill it in and submit to their respective architectural association to receive a CLU

1. Roofs have a role to play in sustainable design in what areas?

- a. Improved thermal efficiency of buildings
- b. Power generation
- c. Operating energy reductions
- d. All of the above

- b. 20%
- c. 40%

2. Roof assemblies on Canadian Buildings can now be evaluated using the RoofPoint™ Rating System.

True or False?

3. The RoofPoint rating system can be used as a design tool for comparing the life cycle performance of alternate roof assemblies.

True or False?

4. Reflective or low albedo roofs can only be achieved with metal or membrane roofs such as PVC and EPDM.

True or False?

5. New research has shown that reflective roofs may not be the best choice on:

- a. heating-dominated buildings
- b. cooling-dominated buildings

6. According to the US Environmental Protection Agency, roofing materials represent what percentage of the construction materials currently sent to landfill?

- a. 10%

7. What are the two most common causes of failure in exposed roofing membranes?

- a. Thermal stress
- b. UV degradation
- c. Impact by hard objects
- d. Failure of chemical-based adhesives

8. Green roofs can extend the life of waterproof membranes by eliminating UV exposure and stabilizing temperature fluctuations.

True or false?

9. Research by Drucker Worldwide has concluded that lack of maintenance can reduce the life expectancy of a roof from as much as 30 years to as little as:

- a. 25 years
- b. 21 years
- c. 17 years
- d. 13 years

10 In what applications is solar tube technology particularly useful?

- a. New narrow plan buildings
- b. As a retrofit in existing narrow plan buildings
- c. New deep plan buildings
- d. As a retrofit in existing deep plan buildings