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INDUSTRY INNOVATIONS

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Multi-function drones take flight on construction sites

IAN HARVEY
CORRESPONDENT

According to a World Economic Forum report on innovation in construction, digital integration in the ICI sector will drive annual global savings of more than \$1 trillion and drones will be front and centre in the evolution.

"During the actual construction phase, drones survey and inspect the construction site. 3D printers prefabricate many of the building components. GPS and radio-frequency identification (RFID) are used for tracking the materials, equipment, and workers, in order to then optimize flows and inventory levels. Robots and autonomous vehicles do much of the actu-

al building work. 3D laser scanning or aerial mapping is used for comparing work-in-progress against a virtual model, thereby enabling prompt course corrections and minimizing corrective work," write authors of the 2016 report, *Shaping the Future of Construction*. "Take the case of a Japanese equipment manufacturer that has developed fully autonomous bulldozers, led by drones that map the area in real-time to provide data on the workload."

And that's just what Canadian entrepreneurs The Sky Guys, a professional drone service based in Oakville, Ont. serving clients around the world, is seeing happen already.

COO Tom Hanson says not only is the construction sector one of many sectors the company services but it is also one of the fastest growth areas for drone use.

Sky Guys started out as a marketing service for real estate in 2016, he says, and then saw other opportunities as other digital-driven technologies became smaller, lighter and more able to be integrated into a drone's payload.

The service has gone far beyond just providing eye-in-the-sky video and photographs for clients and is now being used to map, scan soil conditions with LIDAR, look for water leaks, capture topography and integrate with BIM to chart progress and synchronize project management timelines.

"Now we're focused on construction, real estate, power utilities, engineering, mining, agriculture and military applications," says Hanson. "We're number one in Canada and among the top 20 companies in the world."

The business opportunities grew with the technology and the expanding capabilities of digital hardware and the attendant software, he says, to the point where Sky Guys also provides data services for clients, analyzing and extrapolating key data point from the raw data.

Hanson says the business now includes designing and building the UAVs, the related hardware, as well as work on the software and data collection and analytics side.

"We provide actionable insight to improve existing project management," he says. "We're providing a turn key solution as opposed to just going out and collecting the data."

"We provide actionable insight to improve existing project management and work flows, to help them stay on time, on budget" he says. "We're providing a turn key solution as opposed

to just going out and collecting the data."

UAVs can quickly survey building sites and generate maps or plans. Once the GPS locator points are laid in at a site and programmed into the flight path, it's a simple task for a crew to fly the same pattern at intervals to track progress, says Hanson.

That's a plus for developers who don't have to rely on cumbersome machinery and expensive surveying tools or shut down sites for safety reasons.

Other technologies like VR and augmented reality engage stakeholders and clarifying design ideas. Finally, they can reduce the time operators and surveyors spend in high-hazard areas, which in turn is a health and safety bonus, say experts.

Sky Guys has about 75 ongoing and active projects at any given time both in Canada, the U.S. and around the world, ranging from residential and condo developments to civil projects such as dam, roads, bridges and railways.

"It's really endless," he says. "With BIM for example we can track progress and render 3D models, we can check earthworks by depth to ensure it's on schedule and we can look for environmental encroachment, such as a leak in a mining tailing pond."

The flight regulations vary by jurisdiction with Canada having one of the strictest regimes. Flying in Saudi Arabia, for example, is much different than piloting a UAV at construction site in Toronto.

For tight downtown sites UAV work may not be possible because of those restrictions. Hanson says they won't fly unless they can comply with regulations and always does a site check to look for overhead wires and other structures which may cause issues.

They have a network of 100 pilots qualified to fly the UAVs, some working as contractors and some on staff. Depending on the nature of the job, they will either contract out or send a staffer for the more complex, delicate assignments. A crew consists of a pilot and a spotter who is required to maintain a line-of-sight on the UAV at all times even though the pilot may have a POV (point of view) from a video screen in front of him.

"A lot of companies start out doing it in-house and quickly realize it's more complex than they thought it was," says Hanson. "Then they call us."



COURTESY OF THE SKY GUYS

Members of the The Sky Guys team release a multi-functional drone for a site shell inspection. Sky Guys drones can also scan soil conditions with LIDAR and integrate with BIM.

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COURTESY OF THE SKY GUYS

An aerial view of a project in a tight work footprint provided by a Sky Guys drone.



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Living walls breathe life into construction projects

DAN O'REILLY
CORRESPONDENT

Once a rare feature only found in a select number of buildings, living walls are now becoming more common.

But there are a lot of variables in their design and construction and members of the still-young living wall industry need to fully understand the needs of their designer/contractor/ developer clients, says living wall specialist Ashley DeMarte, founder of Livescape, a company which builds and maintains them.

"After all, these systems are designed to be a living component of the building and buildings last for a long time."

A former tropical greenhouse worker who subsequently became a subcontractor for another living wall company, DeMarte drew on her knowledge and experience of both industries to establish Livescape three years ago.

Based in Waterloo Region, it has taken on projects in other parts of the country and is pursuing contracts throughout North America.

DeMarte entry into the trade can be traced back to her high school and university years working part time at a tropical greenhouse. During that almost 10-year period she learned both the horticultural and business components of the greenhouse industry. While attending the University of Windsor she learned about a firm that designed living walls and living roofs and decided she wanted to work for that company.

"I saw it as perfect way to blend my love for tropical plants with my university education in Environmental Studies and Visual Arts."

Initially hired as a subcontractor to service the company's systems in southern Ontario, she was later hired as a full-time employee, eventually overseeing all its projects in Canada and the United States. A few years later she was downsized in a restructuring. Even though laid off, she received a call asking for a quote.

"That's when the entrepreneurial light bulb lit up for me and I decided to start Livescape."

Right from the start, however, its business model and direction has been one DeMarte believes sets it apart from other contractors.

"After working in the living wall and living roof industry I

saw an opportunity to create a more multifaceted living wall company — one with a focus on providing a system that is best suited for the clients and goes beyond a single system approach."

Livescape meets the requirements of its clients by working with several suppliers, not being the sole representative of one, she explains.

"Designers, contractors, and building owners rely on our industry to educate them on what will work best for their buildings and their building culture. In sourcing different wall systems, we began to realize that clients need and deserve a



LIVESCAPE

Livescape created this three-storey living wall which can be found at evol1 in Waterloo, Ont.

wider range of options."

Livescape is also developing its own wall system with the help of product development mentors at the Waterloo Accelerator Centre, a University of Waterloo startup facility.

At a very basic level a living wall is a wall with the infrastructure to support plant life. They're also complex structures comprised of modules/panels, planted blankets, and bags. Some of these systems can be pre-vegetated and attached to a structural wall, or can be created as a free-standing frame or column, says DeMarte.

Several factors have to be considered in their creation including the location, the weight, and the availability of lighting, plumbing, electrical and other services. Certain plants also perform better in certain types of systems.

Tropical plants on interior walls are typically used because they don't go dormant, while winter hardy plants are required for exterior settings and the specific climate zone.

Asked what is involved in the design of a living wall, DeMarte says it begins with a dialogue with the owner/client to assess their desires and addressing issues such as maintenance.

"It is important to consider who will care for it in the long run."

As for the selection of plants, that is a process of working with the client and the plant supplier to come up with a beautiful and feasible design.

"If there is enough lead time we can work with growers to grow plants for us. Otherwise we have to see what is available."

Depending on the scale of the wall, it usually takes two to four people to install one. But there is some planning and design time required and they're usually the last or close-to-last feature to be erected in a building.

DeMarte estimates she has worked on at least 30 living walls over the course of her career. But the one she is currently most excited about is a three-storey one Livescape recently erected in the atrium of evol1, a new ultra-modern office building in Waterloo.

Developed by the Cora Group, it has the distinction of being the first-ever project to receive a Zero Carbon Building — Design certification under the Canada Green Building Council's Zero Carbon Building Standard.

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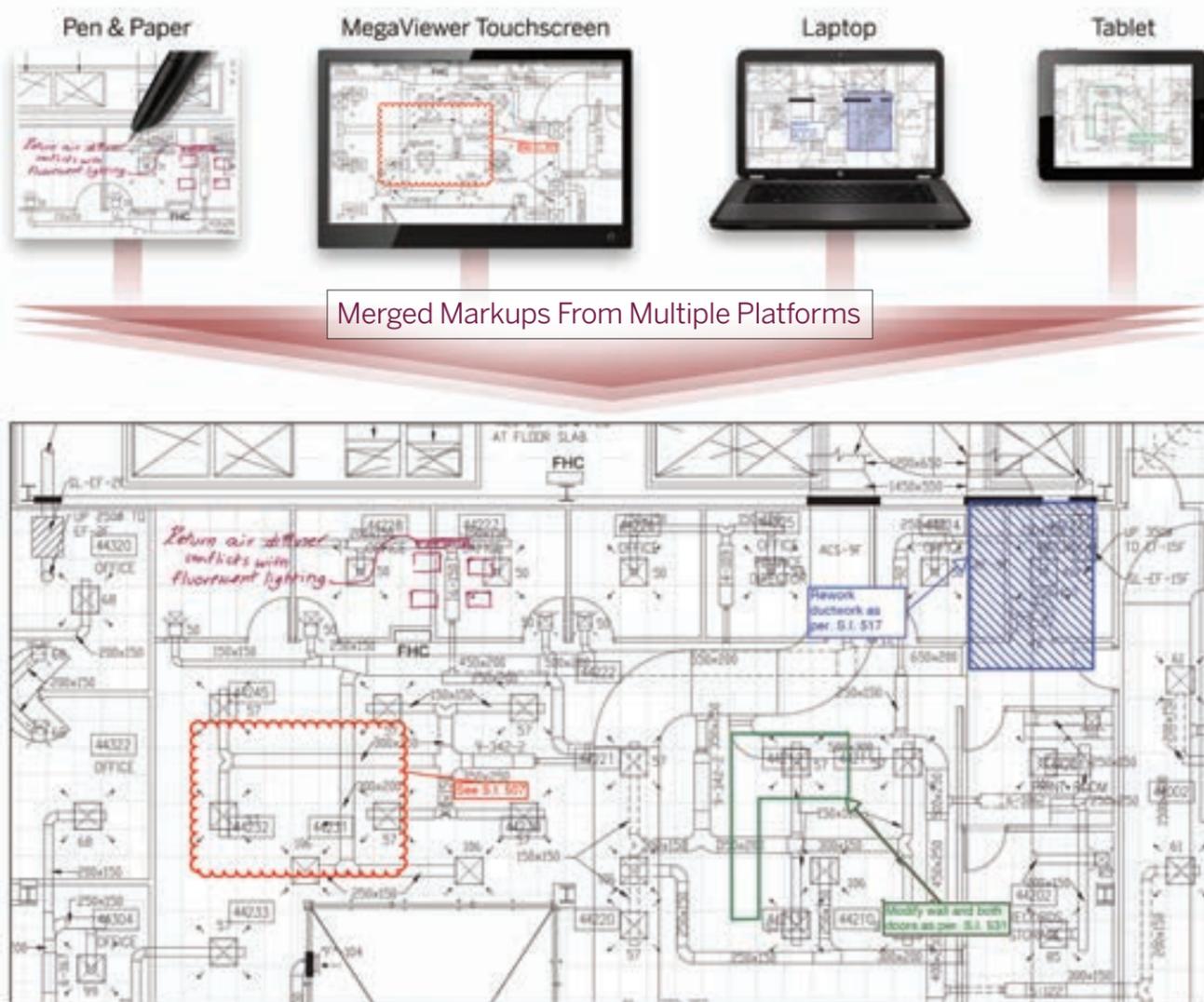
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Floor power to you: new building products harvest pedestrian energy

PETER KENTER
CORRESPONDENT

Pedestrians walking across the floors of busy concourses expend plenty of energy. Researchers and building product manufacturers continue to search for ways to harness that energy to perform useful tasks from powering lights to providing intelligence on traffic flows.

A research team led by Xudong Wang, a University of Wisconsin-Madison professor of materials science and engineering, has developed a prototype wood floor designed to convert footsteps to electricity.

“The Pavegen system can also integrate with batteries and capacitors,”

Will Brook
Pavegen Systems

The 96-square-foot prototype is made from recycled wood pulp that's been seeded with chemically-treated nanofibres. Together with embedded electrodes, the system creates static electricity, known as triboelectricity, under the pressure of footfalls. The energy is then harvested by wires running through the flooring.

Wang notes that the floor design represents a trade-off. Making the flooring material more resilient could improve energy harvests, but make walking difficult.

“We're not harvesting so much power that it would drain the energy from the people walking across that section of flooring,” he says.

The prototype was placed in a busy hallway at a campus student centre traveled by

thousands of pedestrians each day.

“In its current state of development, the technology doesn't produce enough electricity to light up a building, but we are powering small LED lights at the test site,” Wang says. “Right now we're thinking the most reasonable application is to use that electricity to run self-powered sensors in smart floors that could track foot traffic.”

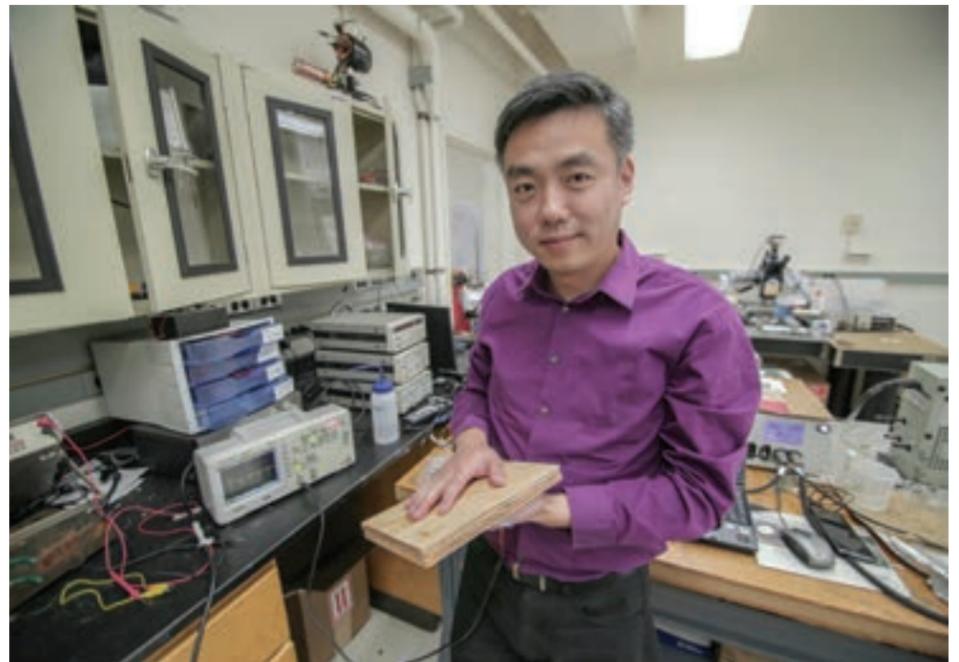
Wang's continuing research will focus on improving triboelectric materials as well as piezoelectric materials — composite materials generating electricity under pressure.

U.K.-based Pavegen Systems is taking a different approach to harvesting pedestrian energy. The company's signature product consists of interlocking triangular tiles outfitted with pressure-activated flywheels at each apex.

“As people step on the tiles, their weight causes the top surface to vertically displace by between 5mm and 10mm,” says Will Brook, communications analyst with Pavegen. “This creates a downward pressure on the generators beneath, initiating a rotation in the electro-magnetic mechanisms to produce off-grid electrical energy and data.”

The triangular tile design maximizes the energy and data-generating potential of every footstep by allowing each generator to harvest energy through the corners of six adjacent tiles.

The tiles measure 19 inches along each edge and are made of glass-reinforced plastic, polyester resin and stainless steel. The tiles generate three joules of electrical energy per footstep or around five watts of power per person. One step can generate enough electricity to power a three-watt LED lightbulb for one second, or provide six seconds of talk time on an iPhone 8. Walking 144 steps can provide enough energy to power a Nissan Leaf for one metre.



STEPHANIE PRECOURT/UNIVERSITY OF WISCONSIN-MADISON

Professor Xudong Wang of the University of Wisconsin-Madison holds a sample of the energy harvesting floor technology which uses wood pulp and harnesses nanofibers.

Real-world applications powered by the system include LED lighting, sensors, and data capture and transmission.

“The Pavegen system can also integrate with batteries and capacitors to store and control the deployment of energy,” says Brook. “In DuPont Circle in Washington, D.C. batteries store the energy of around 10,000 people a day walking across three Pavegen walkways in the new Connecticut Avenue Overlook Park. This energy is then deployed at night to power the architectural lighting of the location, as well as providing a constant data feed to our client.”

Pavegen systems have been installed in 200 projects in 30 countries, including Har-

rods department store and Canary Wharf in London, and installations in France, Nigeria, South Africa, Brazil and Kazakhstan.

Brock notes that people walking across the tile system become personally engaged with the projects via an app that connects to smart phones using low-power Bluetooth beacons.

“The app enables people to see how much electrical energy they are generating and to convert this into rewards,” he says. “That allows people to interact with energy and sustainability in a way that they can't with renewables like solar and wind. At our installations in London, Washington and elsewhere, we've observed people returning to the sites on a daily basis.”

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Cast Connex develops a better building block...made of steel

DAN O'REILLY
CORRESPONDENT

As buildings become taller and more complex, developers, designers, and engineers must find solutions to a litany of structural and erection challenges their peers from previous generations never had to deal with.

Toronto-based Cast Connex has developed a technology which makes those challenges a lot less daunting.

Named a finalist for the 2018 Innovation Award by the Council on Tall Buildings and Urban Habitat (CTBUH), the company's High Integrity Blocks are specially engineered and manufactured solid steel elements which simplify the design and fabrication of heavily loaded structural connections and elements.

Their first application was in the construction of the 386-metre-high (1,268-foot-high) 30 Hudson Yards mixed used development in New York City. Weighing in excess of 14 tons each, the blocks were used at the heaviest loaded outrigger nodes in the tower.

Fracture resistant, weldable, and possessing high mechanical properties, the blocks simplify the design and fabrication of heavily loaded structural steel connections and reduce the need for multiple connections in steel assembly—thus enabling safer and higher connections which are less costly to fabricate and more geometrically compact, says Cast Connex co-founder and president Carlos de Oliveira.

Those features improve the overall resilience and economy of high-rise towers and will ultimately allow designers to build taller and safer structures, he says.

And that precisely was the objective of Thornton Tomasetti, the structural designers of 30 Hudson Yards, were aiming for when they reached out to Cast Connex in 2014.

"They came to us looking for solutions," says de Oliveira, explaining the structural engineering firm was dealing with some significant steel connection challenges.

Not only is 30 Hudson Yards the largest private development in the United States, it spans over the Long Island Railway yard which severely restricts the locations for foundations and support columns—the result of which is very heavily loaded connection nodes.

Complicating the issue were architectural restraints on member sizes which led to the use of heavily utilized solid steel column sections built up from plates stacked and welded



A team makes preparations for a High Integrity Block node lift. These Cast Connex blocks are specially engineered and manufactured solid steel elements which simplify the making of heavily loaded structural connections and elements.

together—creating particular challenges at multi-axis connection points, he says.

"Engineering and fabrication of heavily loaded connection nodes in high-rise towers has always been challenging."

Conventional structural steel is manufactured by continuous casting and hot rolling, a process which results in "poor through-thickness" mechanical performance in heavy plate sections.

"Specifically, with increasing plate thickness, the achievable yield strength of the material diminishes and the potential for lamellar defects in the material increases. These material limitations must be taken into account in the design of structural connection nodes."

Addressing the challenges laid out by Thornton Tomasetti and coming up with a resolution was the catalyst for an inten-

sive two-year research and product development project for Cast Connex and its manufacturing partners.

Initially, creating geometrically complex nodes through steel casting was considered. But that was rejected because the cost for tooling each node was prohibitive.

An alternative was forging, but that option was also ruled out because conventional forging manufacturing could not guarantee that mechanical properties could be maintained through the full cross section of the solid sections, he says.

The ultimate answer was the development a new hybrid manufacturing technique which married the benefits of casting and forging, the creation of a new cast steel alloy, and the establishment of a "unique production methodology".

Every step in that long process was subject to a rigorous inspection by Cast Connex and keeping the Mexican steel fabricator Aceros Corey fully informed of the of the research project's process, says de Oliveira.

Testing by Thornton Tomasetti and a third party evaluator, which involved slicing a full scale block into sections, confirmed Cast Connex's claims about its structural strengths. By then production was already underway. Asked what would happen if the testing revealed the blocks were inferior or couldn't be used, de Oliveira replies: "We were confident about our product."

Production of the blocks commenced in June 2016. They were then trucked to Aceros Corey's facilities in Guadalajara Mexico where member stubs were welded on to build-up the outrigger nodes. Then, in turn, the nodes were shipped to a queuing yard in New Jersey and then lifted into place in early 2017 by W&W Steel Erectors.

Although the Cast High Integrity Block technology did not win the Innovation Award at the Tall + Urban Innovation Conference held in Chicago this past May, de Oliveira says just being named a finalist "was an honour in and of itself."

"We were honoured to have our High Integrity Block technology recognized by CTBUH for its potential to improve the safety and reduce the cost of high-rise construction. After dedicating our careers to simplifying and improving structural steel connections, it was extremely gratifying to have been selected as a finalist for this prestigious award."

And the creation of the blocks for 30 Hudson Yards was not a one-off project. Cast Connex's investment in the technology has generated a number of business leads which means the blocks have the potential to be used in other projects, he says.

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