SPECIAL REPORT

Research Manitoba

STRATEGIC INVESTMENTS

THREE WINNIPEG RESEARCHERS ARE WORKING TO ENHANCE THE PROVINCE'S ECONOMY AND PROTECT ITS ENVIRONMENT

Research has long played a critical role in Manitoba's economic and social development.

As a result, the provincial government has taken steps to support research in several areas deemed to be of strategic importance to the province's continued growth.

The researchers carrying out this important work are funded through Research Manitoba.

Reporting to the minister responsible for Jobs and the Economy, Research Manitoba was established last June through the consolidation of several provincial programs.

With an annual budget of $17 million, Research Manitoba supports researchers working in the fields of health, natural sciences, social sciences, engineering and the humanities through a variety of programs and grants.

This special report, sponsored by Research Manitoba, highlights some of the outstanding work being carried out by researchers in the fields of communications, construction technology and watershed management. In each case, the work being done by these researchers is helping to ensure Manitoba continues to build a strong, environmentally sensitive economy, one that will continue to thrive in the years ahead.

A WATERSHED IDEA

U OF M RESEARCHERS ARE WORKING TO HELP BRING LAKE WINNIPEG BACK FROM THE BRINK OF ECOLOGICAL DISASTER

By Joel Schlesinger

David Lobb strolls out onto the dock, feeling slightly disappointed as he gazes out at the water in the experimental retention pond, located on a farm about 45 minutes south of Winnipeg.

It is early spring, and levels are lower than expected because the snowmelt hasn't been as significant as in past years. Yet the water quality is still of interest to the professor of landscape ecology and watershed systems, so he takes a sample from the pond to take back to the lab at the University of Manitoba.

Although the water will be examined for a number of chemical indicators, Lobb is primarily interested in one: phosphorus.

A common fertilizer used in agriculture, phosphorus is a major water contaminant that has attracted a lot of attention in recent years. Too much of it is ending up in Lake Winnipeg, pushing one of the largest freshwater bodies of water in North America toward the brink of ecological collapse.

In a bid to help prevent such a disaster, the Manitoba government named Lobb Senior Chair of the Watershed Systems Research Program in 2010 and Genevieve Ali as Junior Chair in 2011. The $1.5 million initiative, funded through the Manitoba Research and Innovation Fund, now under Research Manitoba, is charged with finding solutions to the lake's woes.

And this little experimental pond, as it turns out, could not only hold the key to reducing phosphorus run-off, it could also help alleviate problems associated with drought due to climate change.

To understand how, one first needs to appreciate the nature of the problem.

Lake Winnipeg's water quality issues started to emerge in the early 2000s. At the time, scientists pointed out that the lake was headed towards severe eutrophication – essentially an over-abundance of plant nutrients like phosphorus in the lake which leads to a loss of oxygen available for aquatic life.

Phosphorus is a naturally occurring element, so some will always be present in the watershed. And life everywhere, including in the lake, depends on these natural sources. The problem, says Lobb, is that too much phosphorus is being generated by human activity and ending up in the lake via wastewater and agricultural run-off.

"Phosphorus is not creating massive ecological problems yet, but it could get so bad that it will," says Lobb, who is also a professor in the Department of Soil Science in the Faculty of Agriculture and Food Sciences at the University of Manitoba.

Basically, eutrophication is a case of too much of a good thing. At first, increased phosphorus in the lake actually benefits aquatic life because algae feed on it, and algae feed fish. Both have thrived as a result. In the long term, however, this situation threatens the very existence of the lake.

"What happens is when algae die, the decomposition consumes a tremendous amount of oxygen in the water and that's when you can get fish kills," says Lobb. "In a nutshell, that's the problem."

The implications are vast. Lake Winnipeg – one of the world's largest fresh water bodies – would become a lifeless cesspool. The fishing industry – worth $25 million annually – would cease to exist, and the recreational

David Lobb prepares to place a suspended sediment trap in the Red River to demonstrate how it is used to test for phosphorus run-off in water.

value of the lake – one of Manitoba's most notable attractions – would decline.

As they embarked on their research, Lobb and Ali decided the first thing to do was figure out how phosphorus enters the watershed from crop production. The research revealed some surprises.

While the conventional wisdom of the day held that fertilizer was the main source of phosphorus run-off, Lobb and Ali noted that, in fact, farmers were not overusing it in crop production.

"They (farmers) often remove more phosphorus from the land through harvesting than they put on," says Lobb. "That doesn't mean that the system isn't a little bit leaky."

But the larger problem, they discovered, is that certain agricultural practices designed to prevent soil erosion and water contamination actually end up increasing the flow of phosphorus into the watershed.

One of the most problematic practices is conservation tillage. This involves farmers leaving their fields untilled through the winter so the remaining parts of the crop – the stalks and roots – provide soil stability, preventing erosion from wind and run-off.

"That is still the most widely promoted practice in the world; however, it turns out that in our environment, the Canadian Prairies and northern Great Plains in the U.S., most of the phosphorus comes off agricultural land during snow melt," he says.

And it's not the soil that is releasing the phosphorus; it's the plant life.

"It is coming from plant residue that's on the surface, so we found that while conservation tillage may reduce soil erosion, it actually increases phosphorus in the surface waters."

Their findings, published in the *Journal of Environmental Quality,* gained a lot of attention internationally, in no small part because they were so controversial.

"We were basically saying that a practice that has been done for decades to protect the environment is doing the opposite in this part of the world."

Their research also called into question another long-held practice. Farmers have long been advised to preserve riparian areas, leaving large buffers of plant life around marshes, streams and other water features. That, too, actually increases phosphorus contamination, Lobb says.

"People are extending those areas, trying to increase the width of riparian buffers, hoping to improve water quality, but that actually increases the amount of unmanaged vegetation that in turn increases phosphorus in the run-off."

While their work has upended the thinking on certain agricultural practices, Lobb says these concepts do not have to be entirely abandoned. They just have to be modified.

For example, conserving riparian areas is incredibly important for a variety of reasons, including promoting ecological diversity. Management of riparian areas can be modified by designing them to better disperse and detain run-off, particularly during spring snowmelt, and by harvesting and removing vegetation, thereby reducing the phosphorus that would otherwise end up in the run-off.

Soil erosion prevention is also important, but research now indicates improving rotational tillage practices can reduce erosion while improving water quality compared with the practice of conservation tilling.

Ultimately, though, the research done by Lobb and Ali does confirm that farm run-off will always be a problem during the snow melt or after heavy rains because the water has no place to go. It either sits in the field – a problem for crop farmers – or drains through the watershed – a problem for lakes.

As a result, Lobb and Ali, who is an assistant professor in the Department of Geological Sciences in the Clayton H. Riddell Faculty of Environment, Earth and Resources at the University of Manitoba, focused on coming up with a system for farms to capture the run-off coming from the land so the water does not go downstream. And this is where the experimental retention pond comes into the picture.

"This may be by far the best solution for the Red River Valley," he says. "If you can trap that spring run-off (in a pond), and reuse it back on the farm, you've increased the utility of that water and decreased the damage it causes downstream through eutrophication or flooding," says Lobb.

Not only could ponds on farms help avert an ecological disaster in Lake Winnipeg, they may also help mitigate the effects of climate change. "It's an elegant solution because it addresses so many problems with no downside," he says. "If farmers can control the water, and carry it from one season to the next or from one year to the next, they have the ability to minimize environmental risk while getting a huge economic benefit," he says. "This would make farming much more sustainable during droughts, even allowing it to expand and become more profitable – so it's really a no-brainer."

Still, Lobb says more work needs to be done to test his and Ali's theory and determine just how effective ponds can be in reducing phosphorus run-off.

Nancy Wheatley and Shokry Rashwan with a bag of recycled tires.

TURNING WASTE INTO TREASURE

RED RIVER RESEARCH GROUP EXPLORES ECO-FRIENDLY CONSTRUCTION SOLUTIONS TO HELP INDUSTRY BUILD A GREENER TOMORROW

By Joel Schlesinger

What's garbage to some is opportunity to others.

Take the pile of shredded old tires sitting on a concrete floor at Red River College's Centre for Applied Research in Sustainable Infrastructure (CARSI).

To most people, the shards of rubber are nothing more than a pile of debris in need of disposal.

But to Shokry Rashwan, the Paul Charette–Manitoba Applied Research Chair in Sustainable Construction at Red River's School of Construction and Engineering Technologies, the rubber fragments represent a potentially valuable resource. That's because he believes recycled tires can be used to build greener homes in Manitoba.

To test the theory, Rashwan and some colleagues and students in the Sustainable Building and Construction Research Program at Red River's Notre Dame campus launched a multi-year study to determine whether little bits of rubber from old tires can be used as backfill – instead of sand, gravel and dirt – for basement slabs and foundations.

The research chair that enables Rashwan to carry out projects like this one is funded through an endowment that was created by a $1 million donation from Paul and Gerri Charette that was matched by the province. Paul Charette is the former president and current chairman of the board of Bird Construction.

It's not the first time Rashwan has come up with a way to turn waste into treasure. Twenty-five years ago, he developed a method to incorporate sawdust into the production of concrete blocks, making them lighter and improving their insulation value. In fact, he has spent nearly 35 years in construction research, developing new products and helping improve processes and new technologies. As a result, he has developed a reputation as one of Canada's most innovative civil engineers in the area of environmentally friendly construction techniques.

But the research into using rubber as backfill for basements, now entering its third and final phase, is among the most interesting projects he has done to date.

"The original hypothesis was this may reduce heat losses through the basement," says Rashwan. But there are other benefits. For example, rubber could also increase the longevity of basement foundation walls because it is lighter than dirt and sand, and it doesn't retain water. Both characteristics mean the basement walls will be under less pressure, which would help reduce the likelihood of cracking, says Rashwan.

The project underway at the sustainable construction program excites Rashwan for a number of reasons, not least of which is that it underscores the important role a college like Red River can play in the field of applied research. "When I was offered this position, I was very excited about the idea because historically colleges were not known to be research centres like universities." Instead, he says, "They've always focused on hands-on training."

That started to change about a decade ago when government, academics and industry realized colleges like Red River were an untapped resource for the field of applied research. "While universities certainly do this kind of work, they also focus a lot on basic, theoretical and academic research," he says. "But here, about 99 per cent of the research we do is applied, and it's largely driven by a need from industry."

The tire project is a prime example. It started when OTR Recycling, which collects and recycles old tires, along with Tire Stewardship Manitoba (TSM), the provincial tire recyclers' association, and Manitoba Hydro approached Rashwan about the idea.

The first phase, started in 2013, involved students building a miniature concrete slab at CARSI to determine whether the rubber would hold up to concrete's weight, which it did. Success meant they could move on to phase two, which involved determining other material properties like drainage and stability. That work wrapped up earlier in the spring, and now they're moving on to phase three. "For that, we will build a full-scale basement on campus, and we will use this material like it would be used for actual building in the real world," he says. "Then we will monitor for two years to see what happens in winter and summer."

The piece of concrete on the right has been embedded with recycled tires to determine whether they can enhance durability when used in construction.

Yet this research represents just part of the work underway at the sustainable construction research program. In another project, Rashwan is working with TSM to determine whether old tires can be refined into a product that can be mixed into concrete blocks to help reduce material weight associated with concrete while giving the block higher insulating value.

Not all the work taking place under Rashwan's purview involves developing new construction techniques and materials. The sustainable construction research program is also focusing on a project to monitor the energy efficiency of newly constructed LEED (Leadership in Energy and Environmental Design) homes in Manitoba.

The project, initiated by Manitoba Hydro, architectural firm ft3 and Manitoba Housing, involves 72 LEED homes in Brandon, The Pas and Thompson, and is designed to determine whether the buildings are meeting expectations in terms of energy efficiency.

As Rashwan explains, while LEED homes are expected to offer many eco-friendly benefits, including energy efficiency, water conservation and improved air quality, no one knows for certain whether they will perform as well as intended. "In commercial and institutional construction, LEED is very common," Rashwan says. "But in residential construction, it's still not very common yet."

At the moment, the research involves gathering the actual electricity readings collected by Manitoba Hydro and comparing them to the projections. "So far, there is no testing or experimental work," Rashwan says. "All the research is based on statistics, so we look at the numbers so we can say whether the real consumption numbers are better or worse than the projections and why."

As with other research projects, work is ongoing, but the sustainable construction research program has already proven to be an invaluable resource for the province's construction industry since it began in 2012.

Builders, architectural and engineering firms, and manufacturers of construction materials are watching its work closely. "As a matter of fact, with the backfill project, we're trying to put together a group that includes builders for the next step, which will be applying these techniques in the real world."

The work being done at the school today may one day set the industry standard – that is if the results prove the project's hypotheses correct. "What we're trying to do here is do all the research legwork for the industry," he says. "And the more we do that now, the greater the impact in the future for the industry and homeowners, too."

The initiatives being undertaken through the sustainable construction research program underscore the importance of applied research at Red River, says Nancy Wheatley, Dean of the School of Construction and Engineering Technologies.

As she explains, enrolment in the School of Construction and Engineering Technologies has jumped by 50 per cent over the last eight years, an indication of the growth in the Manitoba construction industry. Investments in applied research at the school have enhanced the level of education and training at Red River. And that, in turn, helps strengthen the economy by helping to create a knowledgeable, innovative workforce capable of leading in their respective fields.

"Really, the role of the college is to prepare individuals for careers through exceptional applied education, partnerships and research," she says. "This, in turn, should result in improving the economy of the province."

MAKING CONNECTIONS

WINNIPEG'S CISCO INNOVATION CENTRE FOR COLLABORATIVE TECHNOLOGIES EXPLORES NEW FRONTIERS IN HOW WE LIVE, WORK AND PLAY

By Joel Schlesinger

From a distance, the glass and steel structure standing in front of Winnipeg's Millennium Library looks a bit like a street light in the shape of a martini glass.

But as you watch the colours and patterns swirl around the 360-degree LED screen at the top of the 10-metre high structure, you begin to realize that this is more than just a fancy lamp post.

In fact, the structure in question is called a FNLTR. And, according to Herbert Enns, it is a prime example of how art, design and technology can be combined to create new forms of expression in urban environments.

Enns should know. In addition to being an artist, architect, and a professor of architecture at the University of Manitoba, Enns is also the Director of the Cisco Innovation Centre for Collaborative Technologies at the University of Winnipeg.

Funded by the federal government, Research Manitoba and Cisco, the innovation centre has provided Enns with a broad mandate to study digital communications technology and its impact on how people live, work and play in the digital age. As a result, Enns has immersed himself in a wide range of projects that seek to understand and harness the powerful new communications technologies coming on stream.

It's a role that has important implications for Manitoba, economically and socially, as the province seeks to get ahead of the high-tech communications curve. But that doesn't mean the job can't be fun.

Enns' work with the FNLTR, particularly in April during the Winnipeg Jets' first-round NHL playoff appearance in 20 years, illustrates the point.

CentreVenture, which owns the FNLTR, asked Enns and Winnipeg filmmaker Mike Maryniuk to come up with something special to celebrate the occasion. Maryniuk responded by creating a loop of animations featuring Jets' jerseys dancing around the FNLTR LEDs doing the wave, much to the delight of those passing by the structure on Graham Avenue across from the MTS Centre. He uploaded the short clip to the FNLTR computer through an advanced fibre optic network.

For Enns, the display was an example of what can be achieved through the innovative use of technology. "This sweet, simple animation of hockey sweaters represents the raw and creative capacity of people in Winnipeg who work in digital media. Projects like the FNLTR potentially give them a platform to express their work throughout the city," he says.

But there was a more serious side to this venture, says Enns.

"It's a lot of fun, but the more fundamental piece of the puzzle is the technology – the beauty here is we can access a server and download content from anywhere to the FNLTR."

Someday soon, public urban media platforms like the FNLTR will be commonplace in Winnipeg – featuring works of artists 24/7.

But these intriguing murals for the 21st century represent just a small piece of a bigger picture for Enns, who does most of his work at the innovation centre's physical location on the third floor of the University of Winnipeg's new Richardson College for the Environment and Science Complex at 599 Portage Avenue.

Although often referred to as a "lab," the centre isn't a laboratory in the traditional sense. A windowless boardroom with an oval table and auditorium-style seating for 18 people, the venue may not seem much different from other seminar rooms at the university. What makes it unique, however, are the three, large, high-definition screens placed at the edge of the oval table and facing the rest of the room. The room also features an abundance of other high-tech communications equipment, including high-resolution cameras, supplementary high-definition screens, directional speakers and microphones, and a touchscreen controller. The result is a "lab" that is among a handful of advanced teleconferencing facilities in the world.

And on those three large screens resting along the board table, individuals from anywhere in the world equipped with similar technology can connect "virtually" to the University of Winnipeg. "The technology is so good that within seven or eight minutes of being online, you completely forget about the screens," Enns says.

Each time a meeting is held at the centre – and there have been hundreds so far – Enns conducts his research. "I call it a lab because it's a place where we study how people interact with this technology," he says. "But I really feel as though I play the role of host for the meetings by helping people use the technology to their advantage."

It's all about understanding Cisco Telepresence technology's potential, he says. The obvious benefit is it creates a virtual meeting place, bringing people together who are separated by great distances without actually being in the same room.

The idea is not new. MBTelehealth, an ongoing program of the Winnipeg Health Region, has long been blazing trails in the area by allowing people in remote communities to teleconference with health-care professionals via high-definition video link. But the Cisco lab takes the concept to a new level, technology-wise.

Besides the lab, the University of Winnipeg runs three other telepresence rooms – one at the Buhler Centre, another at the University of Brandon, and a third at University College of the North at The Pas. All facilities feature world-class communications technology provided by Cisco Systems, based in San Jose, California, and one of the world's top manufacturers of network communications equipment. "Cisco's strategy has been to populate a number of universities with innovation centres," Enns says.

The U of W facility was the first in Canada, opening in 2011, says Enns, adding that former U of W president Lloyd Axworthy played a role in landing the centre. Today, nine other innovation centres are investigating different application uses for Cisco's networking technology. Among them are the University of New Brunswick, developing advanced learning technologies, and the University of Waterloo, which is testing advanced networks that manage smart power grids. "Cisco is tapping into the inherent creative intelligence

of Canadians," says Enns.

In Winnipeg, it's the local expertise using communications technology – in part due to the work of the Manitoba Research Network (MRNet) – that attracted Cisco's investment.

As such, the main focus of study is virtual "face-to-face" interaction using telepresence. In particular, Enns is investigating how eliminating the need for professors, grad students, business executives and non-profits to travel to meetings can change how we communicate, for better or worse.

So far, the telepresence rooms have proven to be a boon, already used more than 500 times, with Anthony Tordiffe, Manager of Media Services, taking care of the schedules and setups. And they're being used with increasing frequency now that universities and other organizations are seeking to reduce costs, Enns says.

The savings on decreased travel is substantial. Already, conservative estimates suggest that Manitoba's universities, businesses and other organizations have saved more than $1 million, according to his research, but the real benefit is how the technology allows U of W faculty and students to access great minds as external examiners on thesis committees, develop and maintain national and international partnerships, host extended conferences from multiple sites, and add a rich layer of personal connectivity to distance education courses. The suites have also helped reduce the carbon footprints of the university and other organizations that use the facilities – another important consideration in the face of climate change, Enns says.

Yet the centre's research extends beyond telepresence. Besides working with local artists to leverage Cisco technology in public art installation experiments – like the FNLTR (Cisco built its firewall), the U of W's new, $40-million RecPlex indoor soccer complex is one of the first "smart" buildings in the city, with a fully converged building control network. Managed by Building Systems Manager Kyle Macdonald, all of its lighting, heating, scheduling, alarm and other systems are controllable from a tablet or smart phone, and represent the cutting edge of building design. "It's not as spectacular as the multimedia technology, but there is still this social dimension that can make people much more aware of their impact on the environment," he says. "You walk into a building and there's this constant output of how it is living and breathing in real time."

As you might expect, Enns spends a fair amount of time working with other individuals and groups. For example, Enns, along with U of W colleagues Jino Distasio, Associate Vice-President, Research and Innovation, and Richard Nackoneczny, Chief Technical and Online Learning Officer, are working with Economic Development Winnipeg, CentreVenture, IBM, and Cisco to advance Winnipeg's digital communication infrastructure across all major economic spheres, including health care, education and the arts.

In a separate initiative, Enns and Sylvie Albert, Dean of the Faculty of Business and Enterprise at the U of W, collaborated with a group, chaired by Greg Dandewich, Senior Vice-President of Economic Development Winnipeg, and including CentreVenture, IBM, and CISCO, to develop a plan for advancing digital communication capacity in the city. Their submission led to Winnipeg being named one of the top seven intelligent communities in the world by the Intelligent Community Forum in 2014.

While the Cisco centre's research is wide-ranging by design, Enns says all of it involves a "plug in and play" approach to exploring new technologies. "Cisco develops it and we help investigate the potential real-world applications of these advances," Enns says. "That's what we do here: figure out ways to harness this technology for better communication, cultural expression, and ultimately as a platform for urban development and renewal."

Herbert Enns in front of the FNLTR outside of the Winnipeg Millennium Library.