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Fire and Ice
Passion Ignites Innovative Design

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BY KATIE CHALMERS-BROOKS

Disciplines Collaborate – Faculty of Architecture meets Clayton H. Riddell Faculty of Environment, Earth, and Resources with the research pairing of student Meaghan Kusyk and Feiyue Wang, professor of environmental chemistry and biogeochemistry.

FIRE AND ICE

PASSION IGNITES INNOVATIVE DESIGN

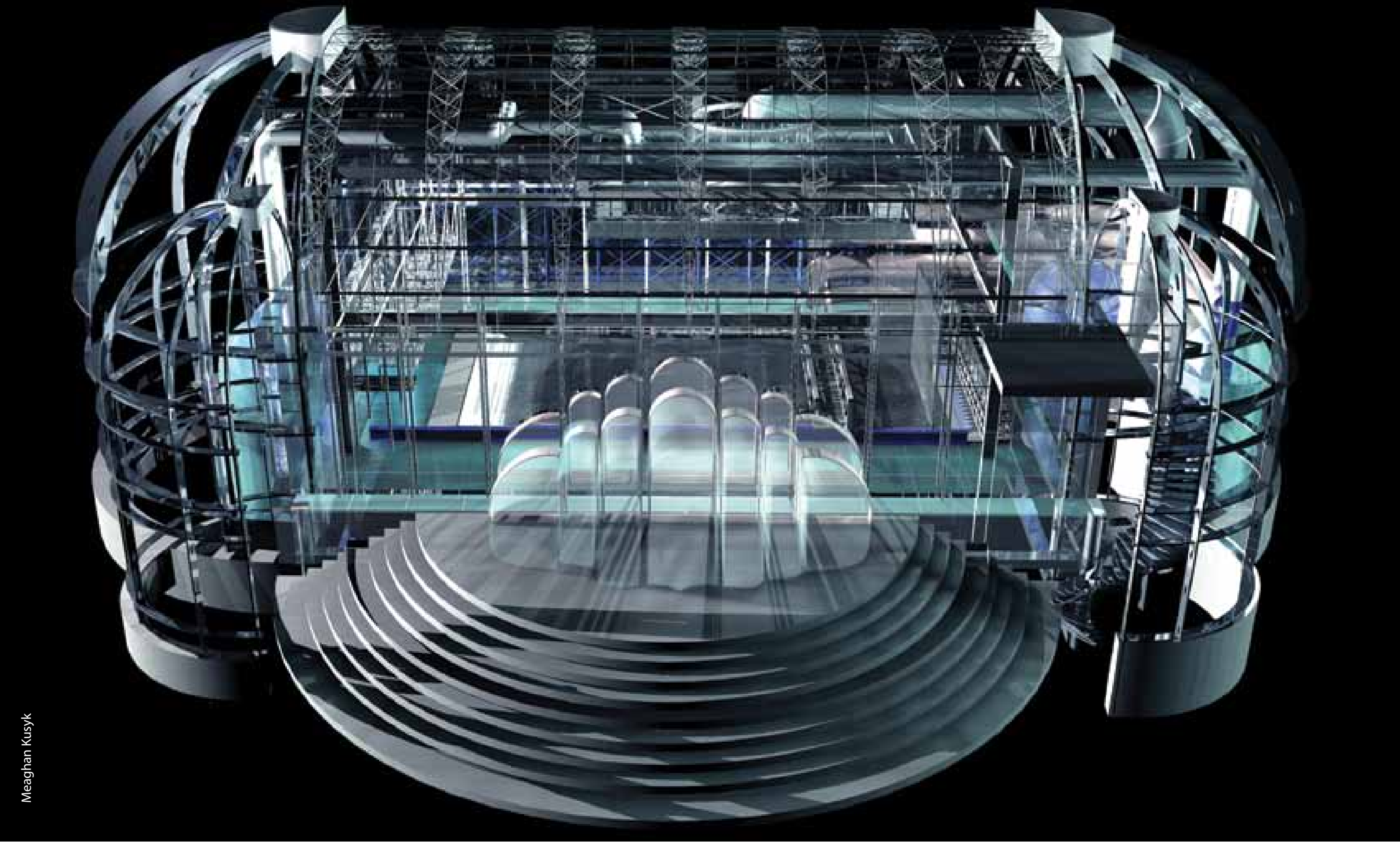
Words can barely keep up with Meaghan Kusyk. In a pace that is equal parts happy and hurried, she does her best to articulate how she, an architecture student who loves science and who has been fascinated by ice since she was a little girl, wound up being asked to design a state-of-the-art ice research facility for the University of Manitoba. The project—hypothetical for now—would allow scientists to mimic oil spills in the Arctic and then figure out how to deal with such a catastrophe.

"It's been a dream," says the 24-year-old. "It's relevant and exciting and something that is helping researchers move forward."

Kusyk was awarded an Undergraduate Research Award to determine—if money were no object—how best to build a research centre on the Fort Garry campus where scientists could develop and test techniques to contain and clean up oil spills should they occur in the North. Her supervising professor, Feiyue Wang, the principal investigator at the university's $1.5 million Sea-ice Environmental Research Facility (SERF), says while this second ice testing facility may be theoretical for now, Kusyk's research results and renderings have prompted him to begin work on a proposal for the real thing.

That's icing on the cake for Kusyk, who is still reeling from her good fortune that such a project presented itself in the first place. It's an opportunity—which Wang said wouldn't have been possible without the Award—that Kusyk had unknowingly spent years preparing for. "It's been unreal. It's been the craziest coincidence," says the fourth-year student.

Even before the U of M became the global authority on sea ice with the opening of SERF, Kusyk was dreaming up ways to meld her passion for architecture with her passion for ice. Flipping through her portfolio from her first years in architecture, she talks about her "obsession" with the intricacies and possibilities of using frozen water in design. For her major annual projects she dreamt up plans for a unique pumping system adjacent to a home that would use melted snow and ice for energy; and an experimental testing lab—in the Arctic—where scientists could research how to build under water using ice. Experimenting with how objects transform once frozen came next. Kusyk would create temporary structures by taking all the bed sheets from her East St. Paul home, dunking them in water and—with the mercury dipped to -30ºC—draping them outside over objects like chairs or propped pieces of wood. She loved how the fabric hardened immediately and when lit from inside glowed with habitability. She also dragged outside all of her



Meaghan Kusyk

(above) Rendering of the envisioned Oil Spill Sea-Ice Research Laboratory. The pool in the heart of the building interior will allow *insitu* burning tests. (below) The envisioned design and its relationship to the existing U of M Sea-ice Environmental Research Facility.

mom's pans (which she had filled with water) in order to create unconventional building blocks, and incorporated lit sparklers within the unusual, frozen-solid creations.

"It looked like a lightning storm," she says. "I was up night after night. It was the most amazing mad-scientist thing. It was the most fun I ever had."

Kusyk unleashed the same enthusiasm for her project for Wang. An environmental scientist, he explains how more interest in industrial development in the Arctic has meant more queries from oil companies about research into how to clean up spills in ice-covered waters. SERF (which is funded by the Canada Foundation for Innovation, the Province of Manitoba Research and Innovation Fund, and the U of M) is equipped to grow ice to study its physical and chemical processes and to better understand its role in climate change, but adding oil to the mix would require a more specialized facility. Wang wondered what it would take to build another saltwater pool adjacent to SERF, "a fire and ice pond" specific to analyzing oil spills. It would have to be enclosed given that typically the quickest way to contain oil is to burn it. The year-round refrigerated building, if even doable on a suburban campus, would require sophisticated air purification systems to capture and clean the smoke before releasing it. Careful consideration would be given to figure out how to manipulate fire indoors safely, and to choosing fireproof materials.

Meaghan Kusyk

Several weeks and two binders chock-full of research notes later, Kusyk came up with a design that takes into account the unusual, practical requirements as well as an interesting aesthetic. The main components? An eight foot deep, 60 foot long and 30 foot wide concrete wave pool that simulates the movement of the ocean; electric arms to release the oil and to ignite the fire; a giant fume hood leading to an intense air purification system; and non-flammable liners for the pool that researchers can remove to analyze residue. Kusyk paid extra attention to distances between the flames and structural elements like ceilings and walls.

There are very few facilities in the world devoted to this type of research and none in Canada. The biggest challenge, Kusyk says, was sifting through the technical details of complex mechanical systems. They present a challenge design-wise as well, but she grew intrigued by how function predicts form and decided that everyone—including passersby outside—should be able to see the facility's inner workings. She could use only so much glass (since it's an energy loser) so she opted instead for translucent concrete. "I've been doing a lot of reading about innovative materials," Kusyk says.

Wang believes one day the U of M will have in their arsenal such a facility, providing scientists with another small slice of the Arctic on the Prairies. The need is there, he says. As our world gets warmer, there is less ice and more open water in the Arctic which makes it easier for industry

The animals—and the people—living in the Far North are already dealing with considerable change that's coming at them with growing momentum.

to navigate and explore. "We know that the oil industry is taking shape in the Beaufort Sea whether we like it or not. We know it's just a matter of time before we will see drilling in the Arctic Ocean," Wang says. "When there is drilling, there is always the chance of an oil spill. We all have fresh memories of the Gulf (of Mexico) oil spill. Imagine something of that magnitude occurring in the Arctic Ocean? What will be the environmental implications?"

Because of the cold, the oil may not disperse and dissipate as easily as it would in warmer water. Researchers also don't know how the ice will affect typical burning practices. And if an oil slick wipes out even one Arctic species, it could have greater repercussions than you would find elsewhere since its ecosystem is much simpler and more sensitive to changes. "If one species does not do well, then it could be a disaster to the entire ecosystem," says Wang.

The animals—and the people—living in the Far North are already dealing with considerable change that's coming at them with growing momentum. Wang, who got his start studying contaminants in fresh water (in Chinese rivers and Canadian lakes), first arrived in the Arctic eight years ago when scientists had predicted it would be ice free during the summer by 2100. That date has since been revised several times; they now say it could be anywhere between 2015 and 2030. "Things are happening so fast, faster than any of us anticipated," says Wang, noting that annually the Arctic loses a section of ice the size of Lake Superior.

Global warming is complex as are its effects. Increased carbon dioxide in the atmosphere worldwide—from natural or manmade sources—is most to blame; this gas traps the heat emitted from the Earth and increases the planet's temperature. It doesn't help that there's less white ice to reflect the sun's rays away and more black ocean absorbing all that heat. The resulting warmer water then melts more ice, messes with how the world's oceans circulate and changes weather patterns (more tropical storms).

Some say reducing emissions would at least slow down the warming of the planet. "Some people say we are already at a point of no return. But there really is no consensus that we have passed this point," says Wang, a father of two who admits the early warning signs he sees in the Arctic alarm him. "The hope is that there might be other negative feedback in nature that could potentially help."

His specialty involves mercury, a toxin which for years has accumulated in Arctic waters and has been detected in area fish, mammals, and—of most concern—the humans who eat them. Mercury likely made its way here from as far back as the early 1900s in the form of pollution from industrial sources like coal-burning plants. It was Wang and his colleagues who realized that today's high mercury levels in Arctic marine mammals are not all from additional pollution but rather from changing geochemical and biological processes identified in the area which release the 'legacy' mercury that has accumulated from the past. For instance, scientists suspect a phenomenon known as frost flowers (shown on page 12) plays a major role in converting mercury from the atmosphere into a form that deposits in the ocean and accumulates in the food chain.

These frost flowers, which range from needle to fern-like ice crystals, grow on sea ice that is newly formed from open water, and not on multi-year ice that has been frozen for more than one year. With the planet getting hotter, the majority of the Arctic sea ice is no longer thick, multi-year ice so frost flowers are more abundant, which means more mercury could get deposited in the water. Wang and his colleagues unintentionally became the first to grow frost flowers in an outdoor pool—at SERF—and record their three-day evolution and demise. A dramatic shift in temperature one February morning in 2012 turned the newly filled outdoor pond into a "complete wonderland," Wang says. The phenomenon of frost flowers is difficult to study in the Arctic since it's hard to predict where the crystals will form and their short lifespan means that by the time a ship reaches them, they would likely be gone. Wang hopes to replicate this growth this winter and do further study.

"They blossomed in front of our eyes," he says, admitting he found himself coming back to SERF in the wee hours, not wanting to miss anything. "It was like I was a student again."

Kusyk can relate to his fervor. She says that during the planning of what may one day become SERF's sister facility there were some "sleepless nights."

"You get so excited about things," she says. "When you do research, you see all the possibilities, and then you want to do even more research."

Mike Latschislaw

Student collecting samples of the frost flowers at the Sea-ice Environmental Research Facility, winter 2012.