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The Next Big Boom? Arctic Architecture and Cold-Climate Resources

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With winter temperatures averaging a frosty -30 degrees Fahrenheit, the Arctic is one of the coldest places on Earth. A coming blizzard of economic activity, however, suggests that one day soon it also will be one of the hottest—that is, in terms of demand for architectural expansion.

"It is the frontier, but it is becoming more known and getting more attention," says Arctic native Josh Armstrong, lead architect in the Iqaluit, Nunavut, Canada office of Stantec.

It's plain to see why: The US Geological Survey estimates that the Arctic is home to approximately 13 percent of the world's undiscovered oil and 30 percent of its undiscovered natural gas. The region is equally rich in mineral deposits and biological resources. According to the Russian Geographical Society, one-fifth of the world's fresh water and several of its largest rivers are found in the Arctic, supporting hundreds of endemic plant and animal species, millions of migratory birds, and a bounty of fish that sustain commercial fisheries.

Companies anxious to find and tap into the region's offerings will invest more than $100 billion in the Arctic by 2022, predicts Lloyd's of London. There's just one problem: Countering an abundance of assets is a shortage of roads, ports, power, and housing—the underpinnings needed to extract the region's rich resources.

It's a huge challenge, but it's also a huge opportunity—especially for architects. "The future of the Arctic is one where there will be continued expansion of cities and towns. The question is: What do those look like?" says Matthew Jull, PhD, assistant professor of architecture at the University of Virginia (UVA) and co-director of the Arctic Design Group (ADG), a multidisciplinary platform for conducting Arctic-focused design research. "We as designers can make a big difference in how we approach the future of this region."

Complementary Climate Tactics

In the Arctic, architecture isn't about aesthetics; it's about problem solving. And the biggest problems architects can solve for those living and working there are climate related. "Climate induces distortions and necessity on architecture in the Arctic," Jull says. "There's a kind of inevitability that as a designer you have to really concentrate on the specific ways buildings interact with the environment in order to make them functional."

Iqaluit's new Airport Terminal Building (ATB) perfectly illustrates how architects can activate the region's opportunities by forging relationships between natural and built environments. Conceived by Stantec and completed in June, the 10,000-square-meter facility was designed to complement the harsh winter climate in Nunavut, which spans the eastern half of Canada's Arctic. Two common problems are strong winds and drifting snow. To mitigate them, Stantec devised a curved roof that deflects wind and prevents snow accumulation.

Because snowdrifts can tower from the ground to the roof, those near the building also are problematic. To avoid them, Stantec relied on an Arctic strategy called "snow scooping."

"Along the lee side of the building, we installed a vertical wall that's set off from the face of the building by about a meter. It stands up about two meters above the roof surface and is open below," says Noel Best, the project's lead architect. "When the wind comes blasting along the curved roof and hits this vertical plane, it's forced downward to the ground and then eventually 'scoops' up again. The snowdrift is still there, but because the wind scours the face of the building, it's set off by about four or five meters from the base of the building. It's quite a wonderful system."

Daylighting and energy efficiency are also important goals—the former because Arctic winters are notoriously dark, the latter because energy costs there are notoriously high. Unfortunately, windows allow heat loss. Stantec therefore used daylight modeling software to optimize window placement for harvesting maximum daylight from minimum glazing.

Finally, there's the issue of permafrost: Because bedrock is too deep, the foundations of most Arctic buildings rest on piles, or stilts, atop a layer of permanently frozen soil.

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"Raising the building ensures the wind can blow underneath it, creating a buffer of cool air that prevents the heat of the building from melting the permafrost below, which would cause the building to settle," Best says.

Because it's the size of a football field, the ATB is too large for stilting. Stantec designed it to rest directly on the ground, mitigated by a system of passively circulating thermosiphons installed beneath the floor slab to keep the soil under the building cold.

Long-Distance Logistics

Climate isn't the only Arctic challenge architects are equipped to solve: They also can help developers contend with the region's isolation. "It's expensive to haul anything to remote small towns," says Jull's colleague, ADG Co-director and UVA Assistant Professor of Landscape Architecture Leena Cho, who cites the Arctic's harsh weather and lack of infrastructure as limiting factors making it difficult to acquire even basic building supplies. Delivery is restricted to a few months a year when shipments can arrive by plane or barge. "So designers must incorporate complex logistics into their designs and try to use locally available materials when possible."

One of the most expensive things to import is oil. "Because of the high cost of fuel oil, there's a push to create more clean-energy systems in the Arctic," explains Anchorage, Alaska-based engineer Daniel Nichols, director of facilities at WHPacific, the United States' largest Native-owned engineering firm. He says Arctic designs increasingly incorporate biomass heating systems—high-efficiency wood stoves and wood boilers—as well as micropower stations that harness solar and wind energy.

Arctic architects also must be mindful of building maintenance and operations. "You have to look for ways to make building systems more durable and easier to operate because there aren't a lot of skilled operators and technicians available who can work on things," Nichols says.

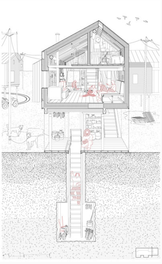
One strategy for coping with these challenges is prefabrication. Iqaluit's ATB, for example, features a combined heat and power plant that burns oil to create electricity, then uses the byproduct for heat; that system was built and tested at a factory in the south, then shipped north for installation.

"You can't go to the hardware store [in the Arctic]," says Armstrong, who adds that prefabrication reduces costs by leveraging temperate latitudes where labor and materials are more available and affordable. "It ensures you have everything you need."

Conserving and Connecting Culture

As the pace of development increases, Arctic architects face important cultural opportunities. "Architecture straddles the functional aspects and the social aspects [of building]," Jull says. "Looking at what built space can mean for communities—how it can help people live—is something I think architecture can bring to the Arctic that has been neglected in the past."

Again, Iqaluit's ATB is a prime illustration. "Buildings in the Arctic are multi-use buildings," says Best, whose team designed the airport to be not only a transportation center, but also a public gathering place. To that end, the arrivals area is a large rotunda that alludes to the Inuit igloo. Featuring ample seating, restaurants, and Inuit art installations, it's "a real crossroads for the community, with a strong architectural presence and a distinctive cultural character," he says.



Another local project—the Stantec-designed Iqaluit Aquatic Centre—is similarly dual-purpose, combining recreational facilities with open community spaces, giving locals a shared context in which to gather.

"These are not massive cities, so every building has to do a number of jobs," Armstrong says. "There are not many places in an Arctic environment where you have an open place to sit and have a coffee, like you would at a mall in the south. The airport and the pool add that component to our urban setting."

In geographies as isolated as the Arctic, community is critical. "Let's be frank," Best says. "There are big drug and alcohol issues in many of these communities. Providing public spaces where people can be actively engaged in positive community events is really important for healing those issues."

Clearly, the Arctic has much to gain from architecture. But architecture also has much to gain from the Arctic.

"With the increasing awareness of the effect of climate change, you can imagine architects coming to the Arctic and taking advantage of its extreme weather to test out whatever systems they're trying to invent," says Cho, who calls the Arctic a living "climate lab" for testing new design approaches, philosophies, and technologies. "Learning from the Arctic and how people live there can be a great addition to how we practice design everywhere."

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