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PROTECTION
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RE-CREATING INDIGENOUS ARCHITECTURAL KNOWLEDGE IN ARCTIC CANADA AND NORAWY

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ABSTRACT: Long resident peoples including Gwich'in, Inuvialuit, Copper Inuit, and Sami, Coast Salish and others have learned over countless generations of observation and experimentation to construct place-specific, biomimetic architecture. To learn more about the heritage value of long-resident peoples' architecture, and to discover how their architecture can selectively inform adaptable architecture of the future. we engaged Inuit and First Nations knowledge-holders and young people in re-creating tradition-based shelters and housing. During the reconstructions, children and Elders alike expressed their enthusiasm and pride in the inventiveness and usefulness of their ancestral architectural wisdom. Several of the structures created during this research are still standing years later and continue to serve as emergency shelters for food harvesters. During extreme weather, the shelters contribute to a potentially widespread network of food harvester dwellings that would facilitate revitalization of traditional foodways. The re-creations indicate that building materials, forms, assembly technologies, and other considerations from the architecture of Indigenous peoples provide a valuable heritage resource for architects of the future.

KEY WORDS: Indigenous, Arctic architecture, Inuit architecture, reconstructions, heritage

1. Introduction and research questions

Tradition-based shelters have always been part of life in the high Arctic, where sudden storms and extreme cold pose serious risks to food harvesters, scientists, and other people out on the land. Safety concerns have intensified in recent times, as accelerated climate change brings increasingly unpredictable conditions. Fortunately, peoples of the far north have long traditions of shelter-building that form a key component of their architectural heritage. Because communities are often isolated and availability of purchased foods is limited, northern peoples continue to harvest foods from the land, for which they require wind-and cold-resistant shelters in most, if not all, seasons. Whether hunting seal or caribou, fishing for Arctic char, or gathering permafrost berries, families may spontaneously need a place to reside overnight or to keep less-mobile family members safe and warm. To make a shelter, harvesters would need to know: what construction materials are available? Can they be reused? How should the materials be assembled? What is the best site? Indigenous peoples of the north traditionally make such decisions depending on the time of year, materials availability, and location. Generations of architectural wisdom and practice facilitate answers to these questions[1].

To document architectural wisdom of northern long-resident and Indigenous peoples, this research undertook modeling and full-scale reconstructions of tradition-based temporary structures among Canadian Inuit (Inuit means "people" in Arctic North America), First Nations people (non-Inuit Native North Americans such as Gwich'in), and Sami (Indigenous peoples of Northern Scandinavia) in four culturally- and geographically-distinct regions of the circumpolar north (Fig. 1). The structures were compared and analyzed for their efficiency, functionality, usefulness, and adaptability to present and future situations. They were also assessed for their heritage value as architectural works of lasting importance to the communities and to the history of architecture.

2. Method: the reconstructions

The idea for this research in adaptable shelters of Indigenous tradition began in 2009 in northern Norway, when the author was invited to reconstruct a heritage structure from the northernmost region of Canada's west coast at the Riddu Riddu International Festival of Indigenous peoples in Manndalen, Norway (69°N 20°E). It was noted that the reconstructed Sami turf house (goahti, sometimes called bealljegoahti) has an iglu-like form resulting from a framework of birchwood bent over by heavy snow. Over the framework, a layer of vertically-aligned birch poles supports overlapping sheets of birchbark (waterproofing) followed by turf blocks that provided insulation. Knowledge-holders explained that the goahti would become stronger over time, since the turf blocks, which are stacked in bricklike formation, would gradually grow over and become a continuous layer that is as much as 0.9 meters (3 feet) thick at the base. As

[1] Hadlari A. Personal communication, April 7-9 2016, Inuit knowledge-holder, Cambridge Bay NU Canada; Mackin N., Moss Houses in the Circumpolar North: Architectural Traditions and Innovations That Respond to Climate Change. *International Journal of Climate Change: Impacts and Responses* Volume 8, Issue 2, pp. 1-14, 2015.

the turf settles and grows together, the finished goahti shape resembles an elliptic paraboloid[2] or possibly catenary dome, the curve of natural load transfer in an arched formation[3]. (The catenary dome is often difficult to distinguish from an elliptic paraboloid dome, especially in structures with complex forces influencing shape). Until the Second World War, goahti served as dwellings that lasted approximately 10 years[4].

Similar uses of turf for insulating and cladding temporary dwellings were noted in northern Canada, on the shores of the Beaufort Sea near the Mackenzie River Delta (Inuvik region, 68°N and 134°W). As with the Riddu Riddu festival site, stunted trees are able to grow near Inuvik because the riverway moderates extremely cold temperatures. In this region, turf-clad or moss-clad dwellings were also part of Indigenous tradition. According to Elders' testimony, the moss-clad structures were often constructed by women[5], who were able to lift the relatively light materials. Tracing the origins of these dwellings led to a 1995 reconstruction of an A-framed, sphagnum moss-block clad structure, called ne'en kan, by archeologist Jean-Luc Pilon and Gwich'in knowledge-holder Willie Simon. In November 2013, a team of high school students and Willie Simon were engaged to help rebuild an A-framed moss-clad shelter in nearby Gwich'in Territorial Park, based on Pilon's archeological research.

Interviews with Inuvialuit Elders from the isolated village of Aklavik (68°N and 135°W) described another moss-clad structure called a qaluurvik, which was shaped as a catenary or elliptic paraboloid dome created by a circle of bent-and-tied willow. In November 2014, after a journey by ice road, videotaping was undertaken of then-92 year old Elder Persis Gruben, who explained how qaluurvik were constructed and used when she was a child. Persis noted, "They were built to be temporary, but we ended up living there for a long time"[6]. With Persis' description, and one faded archival photograph, students and Elders helped reconstruct a qaluurvik not far from the first moss-clad house.

The final two reconstructions of this research, the catenary-domed snow iglu and the qarmaq (spring iglu), a truncated catenary dome with driftwood-and-skin-roof, required the most skill to construct. In in Cambridge Bay, NU, far above the tree line (69°N and 105°W), a large iglu (12' diameter) was attempted in November 2015 with assistance of numerous Inuit Elders and townspeople. Because the form was not perfect and the blocks were cut and stacked incorrectly,

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[2] Emmons R., *An Investigation of Sami Building Structures. Sami Culture*, University of Texas , Online https://www.laits.utexas.edu/sami/dieda/anthro/architecture.htm#Thermal, 2004; Sjølie R., *The Sami Goahti, an Earthen House in the Arctic. Vernacular Architecture and Earthen Architecture: contribution for sustainable architecture*. The Sami Goahti, an Earthen House in the Arctic, Taylor and Francis Group: London, 71-76, 2014.

[3] Auroville Earth Institute UNESCO Chair Earthen Architecture, Stability Notions, On-line http://www.earth-auroville.com/stability_notions_en.php.

[4] Emmons R., *An Investigation of Sami Building Structures. Sami Culture*, University of Texas , Online https://www.laits.utexas.edu/sami/dieda/anthro/architecture.htm#Thermal, 2004.

[5] Fehr A. &Andre A., *Gwich'in Ethnobotany*, Gwich'in Social and Cultural Institute and Aurora Research Institute: Inuvik NWT Canada, 2002.

[6] Gruben P., Personal communication, Inuvialuit knowledge-holder, Dec. 18 2014, Aklavik NWT Canada.

construction failed and the iglu could not be completed. In April 2016, Inuit iglu-building expert and recognized knowledge-holder Attima Hadlari was engaged to construct a winter iglu and a spring iglu in Cambridge Bay.

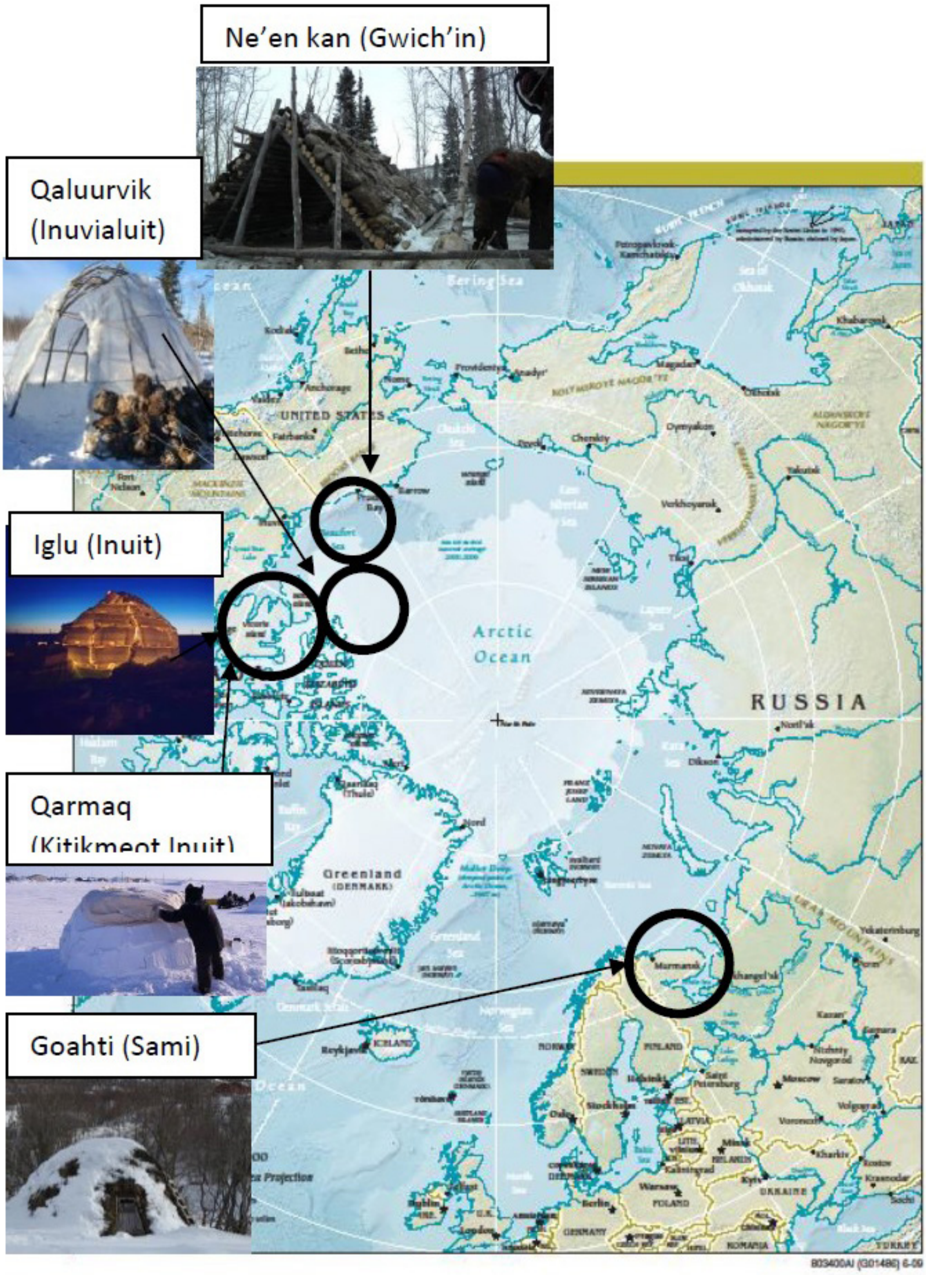


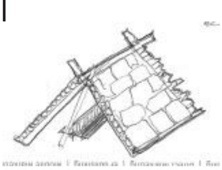
Fig. 1 Map showing reconstructions and associated regions. Photographs by the author

Photographs of the five reconstructions, and their relative locations, are shown in fig. 1. During and after each reconstruction, students, Elders and knowledge-holders from each community contributed ideas about the usefulness of the architectural ideas, and how modern methods or materials might make them more interesting and valuable for on-going use while out on the land. Then, architectural drawings were completed and measurements taken to facilitate quantitative analysis.

3. Evaluating the structures for use as Arctic winter shelters

Tables 1 and 2 illustrate characteristics of the four Canadian Arctic reconstructions and, for comparison, the Sami goahti. Analysis and discussions with knowledge-holders confirmed that the A-framed ne'en kan required a considerable investment in sizeable birchwood, which would not be available in areas of the Arctic where lumber of those dimensions was available only as driftwood or by trade/ purchase. Further, the ne'en kan was difficult to keep warm in winter, as it was generally open on one end and often had a large, open vent in the roof. The ridge proved difficult to waterproof and melting snow leaked inside. Elders explained that ne'en kan was most useful in fall[7].

The qarmaq was traditionally constructed in spring after rising outdoor temperatures and the reappearance of the sun caused the roof of the snow iglu began to melt and drip. Like the ne'en kan, the qarmaq could only be used for a short time relative to the number of hours required for construction. However, its adaptability to Arctic spring weather make it an important addition to emergency shelter knowledge.

Dwelling for family of 4 or 5	Man hours to build	Number of months used	Hours to build/ duration of use	Approx. mass of materials
Ne'en kan 	128	4 per year, 2 years=8	16	7500 lb.
Qaluur-vik 	48	110	0.44	2800 lb.

7 English M. Personal communication, Inuivialuit knowledge-holder, Dec. 2015, Inuvik NWT Canada; Jerome J. Personal communication, Inuivialuit knowledge-holder, Dec. 2015, Inuvik NWT Canada.

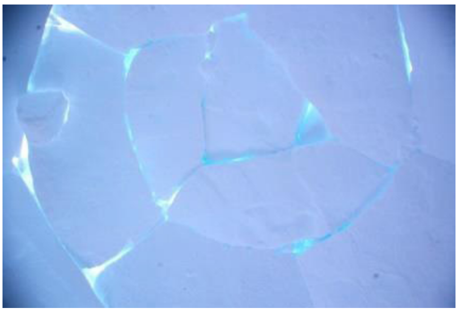
Iglu 	5	7	0.7	2500lb.
Qarmaq 	5	2	2.5	2100lb.
Goahti 	120	120	1	8400lb.

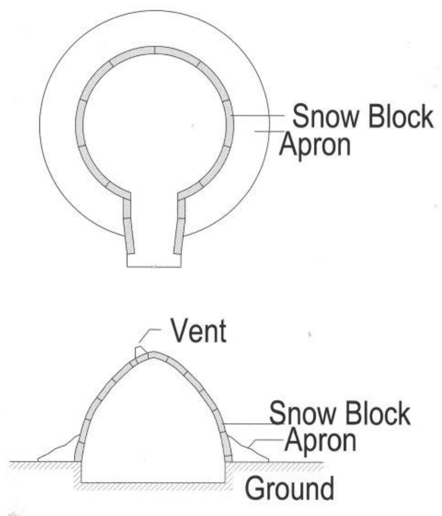
Tab. 1 Comparing efficiency of Arctic shelters

Dwelling for family of 4 or 5	**Ease of construction**	**Adaptability to modern situations/ on-going usefulness**	**Thermal performance**	**Materials availability**
Ne'en kan 	Easy to build, main wood components relatively heavy	Reasonable emergency shelter in summer, autumn	Fair	3" and 4" caliper birch only found in warmest regions of Arctic
Qaluurvik 	Easy to build	Excellent emergency shelter, modifiable with modern materials	Excellent when clad in skins, then moss, then outer layer of skins	Materials are light and abundant in Arctic where willow grows
Iglu 	Requires skill to correctly spiral the blocks, built rapidly by skilled builders	Excellent emergency shelter when snow is only material available	Very good when heated immediately after construction	Requires consistent snow packed during a single storm
Qarmaq 	Slightly easier than the iglu because the top blocks are not needed	Excellent emergency shelter in spring in areas where trees do not grow	Good, but not as good as iglu	See iglu
Goahti (Sami Turf house) 	Wood assembly requires skill. Birchbark removal and installation requires skill	Good shelter, considerable manpower and wood required	Excellent	Curved birch trees rare. needs about 20 small trees, with bark carefully removed

Tab. 2 qualitative comparison of Arctic shelters. Drawings and photographs by the author

Further analysis and discussion continued with the four domed (or partly domed) structures: goahti, qaluurvik, iglu, and qarmaq. Visual characteristics of each are indicated in Table 3. It may be noted that all these reconstructions have a nearly identical floor plan measuring 11'-2" (3.4 meters) diameter on the interior face, with a floor area of 97.63 $ft.^2$ (9.07 m^2). For Inuit from the Cambridge Bay area, 1.8 m2 per person was recorded as an average number of occupants in an iglu[8]. For the purposes of this research, each dwelling listed below is assumed to accommodate a family of two adults and 2 or 3 children. Although the heights of structures tend to vary somewhat, the average volume of each dwelling would be approximately 570 ft^3 (16.14 m^3).

<table>
<tr><th>Type and images : looking upwards to the roof, and construction photos or sketches</th><th>Plan and section, and proposed adaptations</th></tr>
<tr><td>Iglu (snow house)


</td><td>

Adaptation: present day Inuit heat their iglus with propane stove instead of traditional seal oil lamp</td></tr>
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8 Lee M. & Reinhardt G. T., *Eskimo Architecture: Dwelling and Structure in the Early Historic Period,* University of Alaska Press: Fairbanks AK, 2002.

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Qarmaq (spring snow house)

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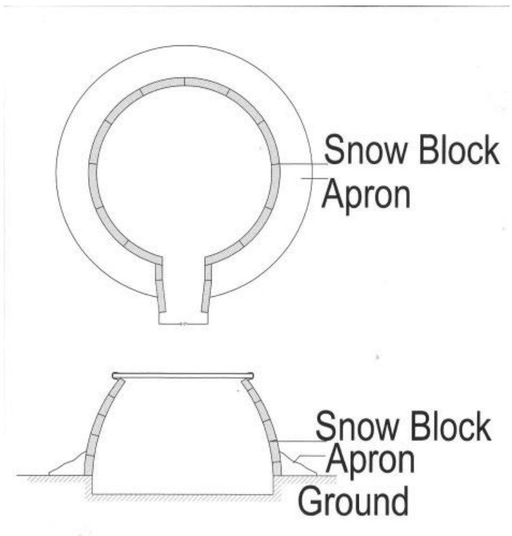

Adaptation: propane stove, use of tarps along with skins for roof, use of string to fasten roof instead of traditional snow blocks

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Qaluurvik (moss/ willow)

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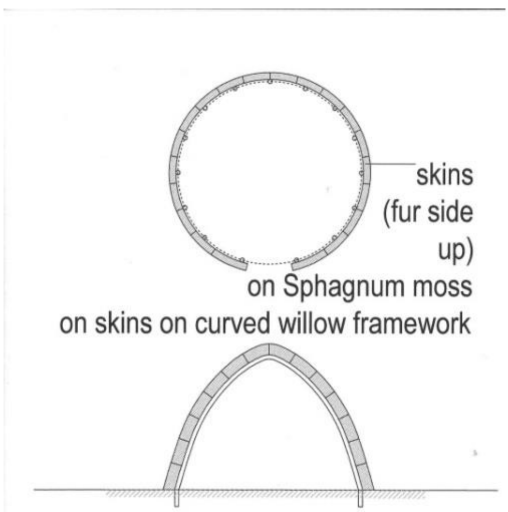

Adaptation: tarps were tried instead of skins for waterproofing. Clear tarps facilitate use during winter and provide views of northern lights. The tarp also helped retain heat from the sun

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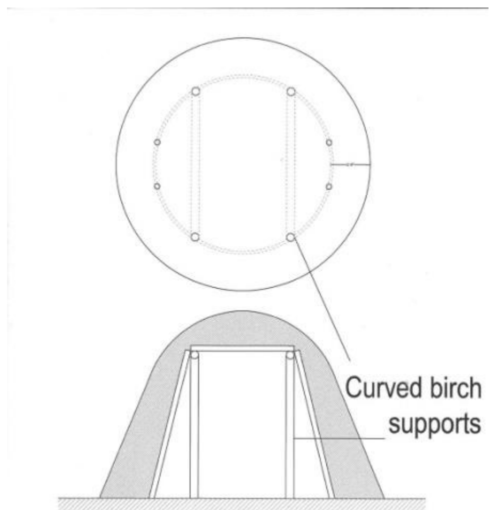
Goahti (birch framed turf house)



Adaptatation: most modern Goahti with a fireplace in the centre have a stovepipe rather than the traditional stone vent built at the base of one wall. Modern windows and doors may be used

Tab. 3 Images and drawings of adaptable winter shelters (photos E. Hadlari and N. Mackin, drawings N. Mackin)

4. Shared characteristics among selected vernacular short-term dwellings of the circumpolar north

Numerous similarities emerge when examining characteristics of high Arctic dwellings adaptable as modern shelters:

(a) FORM. The four domed dwellings represent one of the strongest and most stable forms in nature, the catenary dome, seen in its purest form in the iglu[9]. If the iglu is built any way other than as a catenary dome, and other than with the characteristic spiralling of the snow blocks, it fails[10]. By contrast, the A-framed ne'en kan is intrinsically unstable as the frame has a tendency to kick outward at the base. During the reconstruction of this research, the ne'en kan

9 Kershaw G. P., Scott P. A., Welch H. E. , *The Shelter Characteristics of Traditional-Styled Inuit Snow Houses*, Arctic Vol. 49, No. 4 (December 1996) P. 328 – 338, 1996; Handy R.L., *The Perfect Dome*, American Scientist May-June 2011, Online http://www.americanscientist.org/issues/pub/2011/3/the-perfect-dome.

10 Hadlari A. Personal communication, April 7-9 2016, Inuit knowledge-holder, Cambridge Bay NU Canada; Kershaw G. P., Scott P. A., Welch H. E. , *The Shelter Characteristics of Traditional-Styled Inuit Snow Houses*, Arctic Vol. 49, No. 4 (December 1996) P. 328 – 338, 1996; Handy R.L., *The Perfect Dome*, American Scientist May-June 2011, Online http://www.americanscientist.org/issues/pub/2011/3/the-perfect-dome.

was sited so it could be braced against several live birch trees, which prevented the base logs from splaying outwards. The qaluurvik employed less material and was much faster to build than the ne'en kan, but still resulted in a much stronger form[11] that would last many years under heavy snow and wind loading[12].

(b) LOCAL MATERIALS: Use of materials accessed from immediate vicinity of building site is a characteristic of most vernacular dwellings, and important when considering emergency shelters. All reconstructions of this research employed materials from the immediate vicinity. Cambridge Bay in winter offers few materials, as even large rocks are buried in snow. For the iglu and qarmaq, the snow was tested to make sure it was of an even consistency and the right firmness.

(c) BUILT BY ONE OR FEW PEOPLE: In the reconstructions of this research, the ne'en kan took the most people: a team of 8 students and 2 adults worked steadily for 10 hours, and 2 adults spent an additional 14 hours cutting and stacking moss blocks and birchwood poles. As shown in table 1, the qaluurvik takes the least man hours to build per month of use, with the iglu second and the goahti a close third. As temporary shelters, all three rate highly for taking few people to build a substantial, lasting, well-insulated dwelling.

(d) PASSIVE HEATING AND INSULATED ASSEMBLIES: Well-insulated structures are key to survival in the Arctic, and also useful in other places of the world, including very hot places. Moss, turf, and snow are all good insulators. Depending on surface area to volume ratios, snow iglus provide as much as 45°C. increase in temperature with only one seal oil lamp[13]. Other passive heating strategies included minimizing heat loss through ventilation openings, which, to conserve heat, are typically located away from the peak of the dwelling (Fig. 3) (with the exception of the ne'en kan, which often included a hole in the roof). Fig. 2 shows additional passive heating strategies used in vernacular Arctic dwellings.

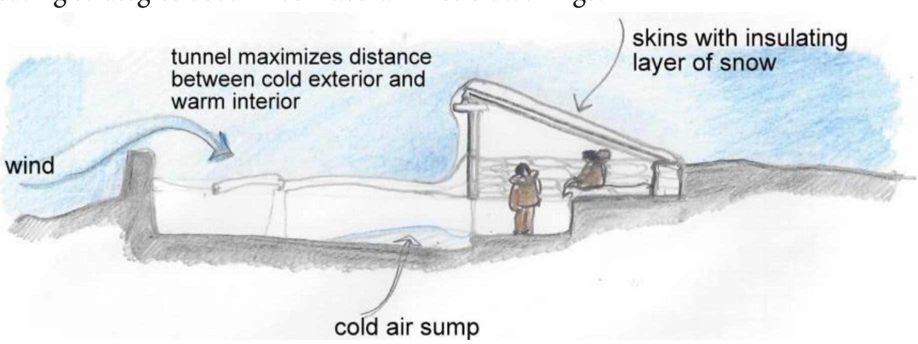


Fig. 2 Sketch of passive heating technologies in Inuit traditional dwelling

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[11] Monreal A., *Catenary or Parabola, who will tell?* DIMACS entre for Discrete mathematics and theoretical computer science, online http://www.cs.rutgers.edu/~mcgrew/dimacs/slides/Amadeo_Huylebrouck.pdf.

[12] Gruben P. Personal communication, Inuvialuit knowledge-holder, Dec. 18 2014, Aklavik NWT Canada; Inuvialuit Elders with Robert Bandringa, *Inuvialuit Nautchiangit: Relationships between people and plants*, Inuvik: Inuvialuit Cultural Resource Centre, 2010.

[13] Kershaw G. P., Scott P. A., Welch H. E. , *The Shelter Characteristics of Traditional-Styled Inuit Snow Houses*, Arctic Vol. 49, No. 4 (December 1996) P. 328 – 338, 1996.

Fig. 3 Ventilation in goahti (left) and iglu (right)

(e) WINDBREAKS AS PART OF SITING AND DESIGN: entrances would be protected by some form of windbreak, either constructed (see fig. 2) or by selecting a site in the lee of a hill or other natural protection[14].

(f) STRONG STRUCTURE RESISTANT TO HIGH WINDS: As described in (a) above, the dome-shaped buildings possess strength, particularly when reinforced horizontally. The qaluurvik was reinforced at about mid-way up the structure with horizontal willow withes; this resulted in a rigid and sturdy yet light structure[15]. The iglu and qarmaq have snow aprons that strengthen the block structure where it is weakest, namely at the point where it meets the ground[16].

(g) STRONG STRUCTURE RESISTANT TO HIGH WINDS: As described in (a) SITING ALONG ROUTES WHERE FOOD IS HARVESTED: choosing a site for a structure is crucial: unless stranded, Indigenous peoples of the Arctic would never build where there is no food[17].

5. Applications and heritage implications

When identifying which qualities of each of the Arctic winter-suited traditional shelters contribute towards an ideal, adaptable shelter for the future, it is recognized that dwellings from the past have characteristics that do not necessarily suit modern lifeways. Nonetheless, adapting

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14 Hadlari A. Personal communication, April 7-9 2016, Inuit knowledge-holder, Cambridge Bay NU Canada; English M. Personal communication, Inuivialuit knowledge-holder, Dec. 2015, Inuvik NWT Canada; Inuvialuit Elders with Robert Bandringa, *Inuvialuit Nautchiangit: Relationships between people and plants*, Inuvik: Inuvialuit Cultural Resource Centre, 2010.

15 Gruben P. Personal communication, Inuvialuit knowledge-holder, Dec. 18 2014, Aklavik NWT Canada; Inuvialuit Elders with Robert Bandringa, *Inuvialuit Nautchiangit: Relationships between people and plants*, Inuvik: Inuvialuit Cultural Resource Centre, 2010.

16 Lee,M. & Reinhardt G. T., *Eskimo Architecture: Dwelling and Structure in the Early Historic Period*, University of Alaska Press: Fairbanks AK, 2002.

17 Hadlari A. Personal communication, April 7-9 2016, Inuit knowledge-holder, Cambridge Bay NU Canada; English M. Personal communication, Inuivialuit knowledge-holder, Dec. 2015, Inuvik NWT Canada.

tradition-based or vernacular architectural ideas for modern needs is a time-honored design process[18]. Further, vernacular architectural concepts and forms as emergency shelters have on-going usefulness, particularly in areas of extreme weather such as the high Arctic. Importantly, these time-tested dwellings contribute valuable ideas to future structures through a deeper understanding of natural materials (such as moss and sea grass) and forms (such as Elliptic paraboloids), adding to their contributions as architectural heritage.

Since completing this fieldwork, direct applications for tradition-based Arctic structures have emerged. The Canadian Center for High Arctic Research, centered in Cambridge Bay, is interested in the life-saving potential of iglus and other tradition-based shelters, as their scientists head out into places where extreme weather can foil rescues. Food harvesters, including families, find themselves stranded and sometimes the Canadian Coast Guard cannot reach them by ship or helicopter. Impromptu-built iglus or qaluurviks (in areas where willow grows) would help people stay safe until help arrived. Temporary shelters would increase comfort, too. Fishers and hunters in the Inuvik region noted that learning to build a qaluurvik could be just the solution they need for winter nights of ice fishing (Fig. 4).

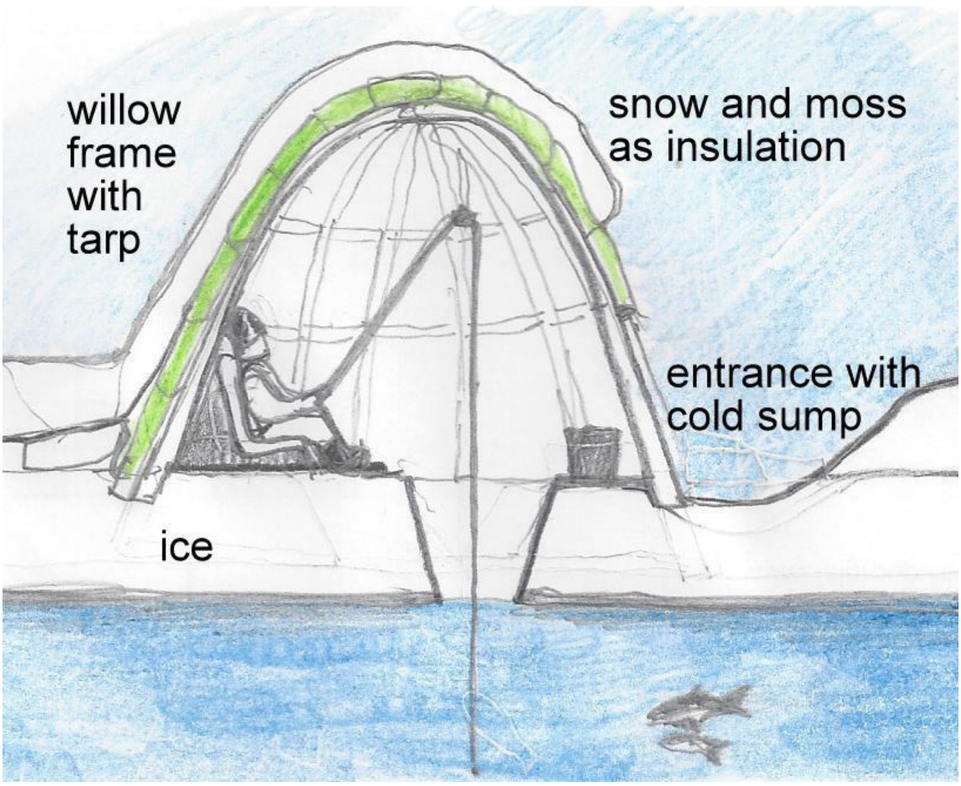

Fig. 4 Proposed ice fishing hut based on qaluurvik

[18] Sjølie R., *The Sami Goahti, an Earthen House in the Arctic. Vernacular Architecture and Earthen Architecture: contribution for sustainable architecture.* The Sami Goahti, an Earthen House in the Arctic, Taylor and Francis Group: London, 71-76, 2014; Senosiain J., *Bio-architecture*, Architectural Press: Oxford, 2003.

By contrast, curved birch goahti (bealljegoahti) are semi-permanent dwellings that might take too long to build to be useful for emergency survival. However, a simpler stacked turf house could be built in a day[19] and would facilitate unexpected overnight stays on the land. Goahti are useful in other ways, too: they become places for ceremony and story-telling, as with the reconstructions at Riddu Riddu and the University of Tromsø.

Close relationships between peoples of the far north and the natural world encourages the design of buildings that resist cold and wind, using materials found in the immediate vicinity[20]. Architectural ideas stemming from a place-based, nature-aware approach typically conserve materials by utilizing them with optimal shapes and function. Such vernacular architectural ideas employ elements of biomimicry (i.e. materials, designs, and systems that are modeled on biological processes and entities) but with an added component of long-resident peoples' cultural knowledge (sometimes referred to as Traditional Ecological Knowledge, or TEK). Using principles of culturally-informed biomimicry, Western science might look into fabricating a material that mimics the properties of sphagnum moss: a good insulator that also becomes a waterproofing layer when it grows together as a thick mat, and even acts as a carbon sink to help mitigate climate change. Similarly, birchbark might inspire a biodegradable, non-plastic, breathable waterproofing layer for the future. In addition, the catenary arch form is recognized by vernacular and academic architecture/ engineering alike as an ideal form found in nature[21].

Passive heating technologies are another useful attribute of Arctic vernacular structures that translates directly into modern adaptable/ temporary structures as well as permanent architecture. Strategies include using levels and entry porticos so the warmest areas are those used by people for sleeping or activities requiring bare hands and dexterity. Siting buildings in the

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19 Sjølie R., The Sami Goahti, an Earthen House in the Arctic. *Vernacular Architecture and Earthen Architecture: contribution for sustainable architecture.* The Sami Goahti, an Earthen House in the Arctic, Taylor and Francis Group: London, 71-76, 2014.

20 Hadlari A. Personal communication, April 7-9 2016, Inuit knowledge-holder, Cambridge Bay NU Canada; Mackin N., *Moss Houses in the Circumpolar North: Architectural Traditions and Innovations That Respond to Climate Change. International Journal of Climate Change: Impacts and Responses* Volume 8, Issue 2, pp.1-14, 2015; Emmons R., *An Investigation of Sami Building Structures. Sami Culture*, University of Texas, Online https://www.laits.utexas.edu/sami/dieda/anthro/architecture.htm#Thermal, 2004; Sjølie R., The Sami Goahti, an Earthen House in the Arctic. *Vernacular Architecture and Earthen Architecture: contribution for sustainable architecture.* The Sami Goahti, an Earthen House in the Arctic, Taylor and Francis Group: London, 71-76, 2014; Inuvialuit Elders with Robert Bandringa, *Inuvialuit Nautchiangit: Relationships between people and plants*, Inuvik: Inuvialuit Cultural Resource Centre, 2010; Gunvar Gutorm, Árbediehtu (Sami Traditional Knowledge) as a concept and in practice, Diedut 1 2011, Sámi allaskuvla / Sami University College 2011, 59–76. On-line at https://brage.bibsys.no/xmlui//bitstream/id/165652/Diedut-1-2011_GunvorGuttorm.pdf.

21 Lee M. & Reinhardt G. T., *Eskimo Architecture: Dwelling and Structure in the Early Historic Period*, University of Alaska Press: Fairbanks AK, 2002; Kershaw G. P., Scott P. A. , Welch H. E. , *The Shelter Characteristics of Traditional-Styled Inuit Snow Houses*, Arctic Vol. 49, No. 4 (December 1996) P. 328 – 338, 1996; Handy R.L., *The Perfect Dome*, American Scientist May-June 2011, Online http://www.americanscientist.org/issues/pub/2011/3/the-perfect-dome; Monreal A., *Catenary or Parabola, who will tell?* DIMACS entre for Discrete mathematics and theoretical computer science, online http://www.cs.rutgers.edu/~mcgrew/dimacs/slides/Amadeo_Huylebrouck.pdf.

lee of a hill or constructed windbreak is another passive heating strategy. Siting buildings along traplines or near fishing places links architecture with food production, another consideration for temporary – and possibly permanent – structures of the future.

In future applications, forms and materials found in vernacular architecture may inform the design of buildings for Indigenous communities. Examples below suggest how innovations from Indigenous architectural history provide educational and ideological guidance to architects designing for Indigenous peoples. In an example from the author/ architect's own work, the mono-sloped curtain-wall designs of Coast Salish (western coast of Canada) peoples inspired the design of a community youth centre made from logs and prefabricated mass timber. The form, structural concept, artwork, and detailing of the traditional Coast Salish architecture are reinterpreted with modern materials and construction technologies.

Fig. 5 Left to right: model by Bill Holmes of Coast Salish traditional curtain wall dwelling; design by Nancy Mackin of Mackin and Associates for Coast Salish (Tsawwassen First Nation) Youth Centre; construction photo of TFN Youth Centre. Photo on right by Mitchell Creek photography

In summary, heritage implications of long-resident peoples' architecture include:

1. Materials and forms of tradition-based architecture are diverse and dependent on availability of materials and on climate and ground conditions. The ecological wisdom required to build the structures teaches useful ecological lessons for present day and future architecture.

2. Through architectural reconstructions, advanced concepts of materials usage and forms are envisioned and understood. Sharing Indigenous architectural heritage enhances Indigenous community members' interest in architecture and mathematics. Mathematical ingenuity of tradition-based structures, and innovations relating to assembly of materials, contribute new wisdom to architecture from ancient sources rarely recognized in architectural schools and literature.

3. Indigenous architectural reconstructions, and respectful use of ancient ideas in new architecture, becomes a living way to illustrate the origins of knowledge and to recognize the innovative qualities of long-resident peoples' architecture.

Acknowledgements

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