

Engineering in Canada's Northern Oceans: Research and Strategies for Development

A Study for the Canadian Academy of Engineering

Summary

The study is being conducted by a team comprising Ken Croasdale, Robert Frederking, Ian Jordaan (Chair) and Peter Noble. Presentations on ongoing work were given at the recent Annual Meeting of the Academy in St John's on June 26, 2014. The power point presentations have been made available to the Academy for interested persons. A report is being prepared on the study together with its conclusions and recommendations.

The areas of study are Canada's northern oceans, the Arctic and Atlantic, and waters and seas that are part of or adjacent to these oceans, including the waters within and around the Canadian archipelago. The various islands are separated from each other and the continental mainland by a series of waterways, the Northwestern Passages. The technical emphasis of the report is the study of engineering needs for future development in northern oceanic waters. The focus is primarily on natural resource development and infrastructure needs for other activities such as Arctic community re-supply and Arctic shipping and maritime safety and security.

The study commences with a review of recent reports, including two of the Centre for the North (CFN 2011, 2013). These reports emphasize the importance of climate change, infrastructure, emergency response & SAR as well as commodity prices in northern development. Climate change will improve the accessibility of northern marine waters; an increase in shipping is possible but there are complicating factors. It is concluded that "the way that the risks and benefits of economic development are weighted and managed must make sense to Northerners, keep their interests front and centre, and effectively capture the Northern context." Leveraging public-private cooperation and partnerships is advocated. "Boom-bust" issues, for instance when mining activities create substantial activity, and then decline, can be an important issue in planning. Transportation infrastructure in Northern communities is significantly more expensive to develop than in the South and at present is sparse. Warming, permafrost degradation, declining viability of winter roads must be taken into account in new designs. The importance of marine transportation is emphasized. CARD (2013) in their Arctic Development Roadmap, focussed on the oil and gas industry and consulted extensively with industry. The principal issues raised were environmental protection, ice management, ice mechanics and loading, station-keeping in ice and environmental characterization.

For the subject report an inventory of Canadian centres oriented towards northern research has been carried out, together with a detailed review of present-day

Canadian expertise. Canadian contribution to codes and standards, many of them international, has been summarised. The report includes a set of case studies of Canadian involvement in northern engineering in the following areas: Beaufort Sea, East Coast of Canada, Caspian Sea, Barents Sea, Voisey's Bay, Arctic islands and pilot production, Arctic Pilot Project. An inventory of mineral resources and port infrastructure has also been undertaken. Barriers to development are seen as transportation, infrastructure, energy and people.

Past use of the Northwest Passages has been reviewed, including the voyage of the S.S. Manhattan, and Canada's icebreaker design and construction of the 1970's. The Canmar fleet and in particular the Kigoriak, as well as the Beaudril fleet, have been reviewed. Canada's EER capability is viewed as being a world leader. Recent shipping activities have been centred on the MV Arctic, MV Umiak, MV Nunavik. In Canada's waters, destination shipping, for example associated with mining activities, is seen as the important activity. Canadian infrastructure to support northern marine activities is sparse, in contrast to Russia, which has year round activities and considerable infrastructure. Russian continues to expand its capability for Arctic marine operations.

The study group conducted a brief review of climate change and in particular its influence upon shipping. The conditions in the Northwest Passage are known to be highly variable from year to year. The IPCC finding of a warming trend and thinner ice is accepted, but any use of this trend in planning of transportation and engineering activities must be considered in the light of year-to-year variability, and the possibility of old ice in the passageways of the Passage. In brief, IPCC is accepted but interpretation in Arctic is far from straightforward. Engineers must account for all relevant uncertainties in their planning. Concerns regarding permafrost degradation and road construction have been noted.

With regard to Arctic sovereignty, it is important to emphasize the need to have a strong presence. A sovereign state is represented by one centralized government that has supreme independent authority over a geographic area. There are responsibilities associated with this authority. For an Arctic State, in the 21st century, these responsibilities and obligations can only be satisfied by the extensive use of technology, including ships, aircraft, and remote monitoring systems. The Polar icebreaker CCGS Diefenbaker will be available when completed in some years' time. In the meantime Canada has very limited capability; the Arctic Offshore Patrol Vessels, now being designed and built, have limited ice transiting capability. While there is little evidence at present of a challenge to Canada's sovereignty in the north, Canada is ill-prepared to address any future challenge.

Innovative activities are advocated. Engineering research is needed in the areas of ice structure interaction, ice loads on ship hulls in heavy ice, and efficient ice-worthy propulsion systems. The team proposes for consideration several "visionary" projects and programs within the list below.

Recommendations

1. Education

Improved access to educational facilities in engineering and technology by northerners is seen as a priority, and we advocate the commencement of instruction in engineering and technology at CHARS linked to expertise in other Universities in Canada, for example Memorial University. The concept could be similar to the Ny-Ålesund research facility in Svalbard which is managed by the Norwegian government.

2. Arctic LNG—Clean Green Fuel for the north

The Arctic has an abundant supply of natural gas both in the Beaufort Sea region and in the Arctic Archipelago. Arctic communities and activities need fuel. It is proposed to develop an Arctic LNG Public-Private partnership to supply LNG both for fuelling government Arctic operations and supplying local community needs would provide clean green fuel Arctic fuel which would, for example, allow year round icebreaker operations

3. Mobile Arctic Engineering Research Platform

In this concept an iceworthy ship would be developed to be the engineering experiment itself, rather than a platform for science laboratories. Ice transit experiments, hull and propeller loads, study of towing of arrays in ice, ice management strategy development, experiments to develop support of sub-sea developments in ice are possible functions, with Nanisivik as a possible northern base.

4. Canadian Arctic Railway along the McKenzie Valley from Hay River to Inuvik

A Canadian Arctic Railway would provide a two-way system which could be used to deliver materiel for northern construction as well as fuel and other essentials for local communities presently serviced by summer barge traffic on the McKenzie River. The system could bring Arctic oil to southern markets, and the rail road would provide a strong logistics link to the western arctic which would improve infrastructure; reinforce Canadian Arctic Sovereignty. Further, the system would allow for development of other natural resources such as mining and forest product, along its route. Possibly fuelled by LNG.

5. International Arctic Ocean-Space Engineering Experimental Station (IAOSEES)

A permanent base is proposed on Hans Island, which is currently disputed territory in the Kennedy Channel between Canada and Denmark. The IAOSEES (pronounced *Eye-Oh-Seas*) would be jointly managed by Canada and Denmark as a shared facility available to members of the Arctic Council. There is a need for large scale experimentation to further advance Arctic marine & offshore engineering.

6. Northern Involvement

It is recognized that traditional knowledge plays a role in engineering for Northern Oceans and that there is benefit from close relationships between engineers and Northern residents through organizations such as the Centre for the North, CFN, which provides a forum for research and dialogue on Northern and Aboriginal issues.

References

CFN 2011. Bristow, Marta and Gill, Vijay. 2011. *Northern Assets: Transportation Infrastructure in Remote Communities*. Ottawa: The Conference Board of Canada.

CFN 2013. Fournier, Stefan, and Margaret Caron-Vuotari. 2013. *Changing Tides: Economic Development in Canada's Northern Marine Waters*. Ottawa: The Conference Board of Canada.

CARD 2012. *Arctic Development Roadmap*. Center for Arctic Resource Development, C-CORE, St John's