Commentary

Evolutionary Innovation in Arctic Marine Transportation

Lawson W. Brigham

Pioneering technological and operational innovations in the field of Arctic marine transportation have been the norm for the past six decades. Finnish ship designers and shipbuilders were long-time leaders providing the Soviet Union with innovative icebreaking ships such as shallow-draft river icebreakers, icebreaking commercial carriers (SA-15 or early *Norilsk* class ships), and shallow-draft nuclear icebreakers, all adapted to the unique Siberian coastal and river environments. The Soviet Union itself pioneered the use of nuclear-powered icebreakers since the 1959 launching of the icebreaker *Lenin*, the first nuclear-powered surface ship. Larger nuclear icebreakers were developed in the USSR and a polar ship design and development capacity continues in Russia with new nuclear icebreakers under construction. Past and current developments of the Northern Sea Route (NSR) have shown how marine access in ice-covered waters can be maintained and extended using a range of innovative polar ship technologies.

In 1969 the tanker M/V *Manhattan* sailed along the Northwest Passage (NWP) and in Arctic waters to test whether oil on the North Slope of Alaska (discovered in 1968) could be transported by icebreaking ship out of the Arctic. The 290-meter ship, a converted tanker with a new icebreaker bow and a reinforced hull, sailed from the U.S. East Coast west into the NWP and returned to New York. The project found it was technically feasible to use icebreaking tankers, but confirmed this was a seasonal, not year-round, operation because of the difficult ice conditions encountered in the Canadian Arctic. Large tanker voyages would likely be limited to seasonal voyages (Spring, Summer and Autumn) through the NWP with or without icebreaker support. The trans-Alaska pipeline was ultimately built and has effectively transported oil since 1977 from the North Slope to the port of Valdez, Alaska. However, the historic 1969 and 1970 voyages of the M/V *Manhattan* were perhaps ahead of their time since today we are witnessing large icebreaking ships sailing safely and effectively on Arctic marine routes.

Lawson W. Brigham is a distinguished fellow and faculty member at the University of Alaska Fairbanks and a fellow at the U.S. Coast Guard Academy's Center for Arctic Study and Policy. Dr. Brigham is Chair of the Arctic Yearbook's Editorial Board.

One of the most extraordinary innovations in Arctic marine operations in recent decades has been the development of advanced icebreaking carriers – essentially commercial cargo ships that are icebreakers in their own right. These ships have the propulsion power and hull strength of icebreakers and they are designed to operate without being tied to an icebreaker-led convoy. The central concept is to have icebreaking commercial ships sail independently in most Arctic marine regions, not just in summer, but during extended ice navigation seasons in Spring and Autumn. In select areas such as the western NSR across the Kara Sea, year-round ice navigation can be maintained using these capable polar ships. Three examples illustrate this successful strategy of operating icebreaking commercial cargo ships: the M/V *Arctic* in the Canadian Arctic; the *Norilsk* class icebreaking ships servicing the industrial mining complex at Norilsk; and the recent operation of the first liquefied natural gas (LNG) icebreaking carrier, the M/V *Christophe de Margerie,* along the length of the NSR.

In North America a modern, 221-meter (11 meter draft) polar ship, the M/V *Arctic* delivered in 1978, pioneered independent operations of large commercial ships in the Canadian Arctic. The ship serviced the Polaris and Nanisivik mines (at that time both operational in the high Canadian Arctic), and operates today within the Montreal-based fleet of *Fednav*, servicing mines in northern Quebec and Labrador. *Fednav* has in its fleet two additional icebreaking cargo carriers (each 189 meters in length), the M/V *Umiak* and the M/V *Nunavik*, both built in Japan and delivered in 2006 and 2014. These ships have extended marine access throughout the Canadian Arctic and lengthened navigation seasons due to their excellent icebreaking and ice navigation capabilities.

The metallurgical and mining complex at Norilsk in western Siberia ships its products out of the port of Dudinka on the Yenisey River. A regional railway connects Norilsk and Dudinka. The key component of this transportation system is a fleet of five icebreaking carriers of the *Norilsk* class that can carry nickel plates, palladium, copper and platinum to global markets. These German- and Finnish-built container and bulk ships can operate independent of icebreakers year-round on voyages between Dudinka and Murmansk (and beyond to Europe). The *Norilsk* class ships can sail without icebreaker escort eastward into the Pacific from Dudinka during a three-month summer season. The ships can carry 12-14,000 tons of bulk cargo and 700 standard containers, and continuously break 1.5 meter thick sea ice. They also make use of a 'double-acting feature,' developed by the Finnish firm Aker Arctic Technology Inc. The ships are designed to break ice moving forward in normal operations, but also can break more difficult ice by going astern; thus, both ends of the ship have icebreaking capability. Each ship has a single propulsion pod (gearless and electrical), developed by the Finnish company ABB Group that can rotate and provide thrust in any direction. The *Norilsk* class ships represent a highly successful merger of several leading edge polar ship technologies.

The construction of an LNG plant on the Yamal Peninsula along the Ob Bay is a major development in the Russian maritime Arctic. The new port of Sabetta will allow marine access to the plant by a future fleet of fifteen icebreaking LNG carriers. All of the new icebreaking ships, which can carry 170,000 cubic meters of liquefied gas and break 1.2 meters of ice, are being built in Korea's Daewoo Shipbuilding & Marine Engineering shipyard. The first ship of the class, the M/V *Christophe de Margerie*, conducted extensive ice trials in the Russian Arctic in March 2017. The ship completed its maiden commercial voyage in August by carrying a load of LNG from Hammerfest, Norway to Boryeong, South Korea (22 days) sailing along the length of the NSR unassisted in a record 6.5 days. In the future, these large LNG icebreaking carriers will sail westbound year-round (without icebreaker support) out of Sabetta and along the NSR to Murmansk and European ports. During the Summer the same ships will sail along the eastern NSR into the Pacific and to Asian markets. Most of these voyages will be accomplished without icebreaker support, but Russian icebreakers could extend the navigation season in the east with the ships under escort.

The message is clear that icebreaking commercial ships are very capable of operating independently and safely without icebreaker support. After several decades of development and operational experience in Canada and Russia, the economic viability of these modern polar ships has been proven when linked to Arctic natural resource development.

Acknowledgments

Funding for this research has been provided by U.S. National Science Foundation grant 1263678.