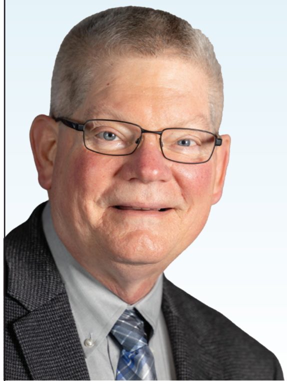

LOCKS, DOCKS AND BEYOND

Engineering that Keeps the Great Lakes and St. Lawrence Seaway Moving

BY RICHARD MUELLER, *President/CEO,* NETSCo

The Great Lakes and the St. Lawrence Seaway System are more than just impressive bodies of water. What lies within this extensive waterway system is an incredible feat of engineering – a series of locks and docks that serve as the critical infrastructure for shipping and trade in North America.

One of the most ambitious endeavors in creating this system was the joint design and engineering effort between Canada and the United States to construct the St. Lawrence Seaway – a shared vision of progress. Opened in 1959, this intricate network of locks, channels and docks connected the Atlantic to North America's heartland.

The Vital Role of Locks

The Great Lakes-St. Lawrence River system is a vast, interconnected body of freshwater, extending more than 3,700 kilometers. Starting at sea level, it raises ships some 180 meters to the surface elevation of Lake Superior. Given the varying elevations of the lakes, channels and rivers in between, locks and canals are essential for bypassing swift currents and the towering falls at Niagara and allowing ships to safely navigate through this extensive watercourse.

The locks are situated at key points like Sault Ste. Marie between Lake Superior and Lake Huron and the Welland Canal, which bypasses Niagara Falls, and at points along the St. Lawrence River. These locations were chosen for the natural features of their landscapes, accessibility to shipping lanes and potential for integration with the existing water infrastructure.

Locks are essentially water powered elevators for vessels, equipped with gates and chambers to manage water levels and facilitate the vessels' transition between different elevation points. The lock chambers are either filled from an upper level to lift vessels or drained to lower them, ensuring a smooth transition from one section of the system to another. This design is energy-efficient and durable, ensuring continuous operations under substantial loads and diverse weather conditions.

Early locks in North America date back to the 19th century. when even then, the waterways were critical lifelines for transporting goods. The pioneering Welland Canal, completed in 1829, featured a series of wooden locks that circumvented Niagara Falls. Initially, it was composed of 40 wooden locks measuring 24 feet wide with an 8-foot depth.

Early construction of the locks involved hand-dug channels and wooden frames. Local timber was a popular choice for the lock gates and doors due to its availability and ease of repair. The stone masonry used in chamber construction provided necessary durability, given the high water volume and variable temperatures experienced within the region.

The lock gates utilized a simplistic balance beam design. However, despite their efficiency, these mechanisms needed frequent maintenance due to the wear and stress from the shifting water levels and heavy usage.

Today's Welland Canal uses advanced materials such as reinforced concrete and steel instead of the timber and stone used in the past. These materials offer more durability while accommodating the much larger lock chamber required for our modern ships.

One of the more exciting technological innovations in the design and operation of modern locks is the adaptive lock gate. Designed to withstand the relentless pressure from vast bodies of water, these gates can automatically adjust to changing water levels due to integrated sensors and control systems. This optimizes operations and lessens the risks of flooding during adverse weather events.

Moreover, eco-friendly engineering solutions integrating renewable energy sources like solar panels and hydroelectric power in the operation of the locks not only reflect a commitment to sustainability but also ensure that the facilities contribute less to the carbon footprint, aligning with today's more stringent environmental regulations.

Electrical propulsion of gate mechanisms is another energy-efficient switch from the traditional diesel hydraulic systems. Electrical propulsion not only reduces the maintenance bills due to fewer moving parts but also cuts down on the emissions and potential water pollution without compromising efficiency or reliability.

More recently, technological improvements like hands-free mooring and significant lighting updates now allow for even safer operation.

Port Design and Logistics

Ports along the Great Lakes-St. Lawrence Seaway have evolved significantly since the first construction to adapt to modern cargo shipping demands and industry advancements.

Modern ports along this waterway now boast advanced docking facilities, deeper channels and enhanced connectivity with rail and road networks, which cater to larger vessels.

Growing commodities demand, environmental considerations and technological progress are setting new standards that support the shipping industry. Engineers and architects are tasked with revitalizing aging port infrastructures to meet these contemporary needs.

From grain to iron ore, and dozens

Soo Locks

of other liquid and dry bulk products, Seaway and Great Lakes ports handle a diverse range of cargoes, now including windmill blades and turbines. They require tailored engineering solutions like innovative vessel berth designs and climate-resilient storage facilities. Engineering firms now use 3D modeling and simulation to predict the performance of revamped port structures, a huge leap forward from the traditional trial-and-error approach.

The digital age is ushering in smart technologies at ports, increasing operational efficiency and safety. Sensors, drones and predictive analytical tools offer real-time data on water levels, weather patterns and structural integrity for more informed, real-time decision-making.

Automation and artificial intelligence hold substantial promise in docking operations, loading procedures, inventory management and security. GPS tracking analysis, automated crane utilization and data analytics for logistical planning will soon be essential for efficient port operations. The extent that these technologies will be able to change the landscape of port design and operation has yet to be determined, as stakeholders have only begun to assess the power of their potential impact and implementation feasibility.

Future Plans

There are countless engineers who make each journey of a cargo ship through the Great Lakes-St. Lawrence Seaway System possible. These waterways witness some of the largest vessels in action, transporting goods critical to both nations' economies.

As global trade evolves and shipping demands grow, the Great Lakes-St. Lawrence Seaway System will undoubtedly evolve, demonstrating resilience and forward-thinking engineering in the face of change. ■