Slide 1

Hello and welcome, my name is Rob Taylor.

The presentation today is about Drydocking Technology. Topics include history, current industry trends, current projects, and innovative ideas to improve facility design and operational outcomes

I want to take this opportunity to thank the Royal United Services Institute for inviting me to speak here today.

Time and attention are two of the greatest gifts we can give. I appreciate all you taking time from your day to attend this presentation.

We will move through the presentation quickly to leave time for questions and discussion.

If there is interest in receiving a copy of the presentation and notes, please contact me via email.

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Bardex is a marine engineering company that manufactures all our systems in house.

Our product lines include deep water mooring systems, vertical shiplift systems and ship transfer systems

Bardex is active on 6 of 7 continents, participating in offshore and onshore marine infrastructure projects.

We work in every maritime sector; Defense, Commercial, Offshore Energy Production including Oil, Gas, Wind Energy, yachts, and small cruise ships.

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I am a licensed Civil Engineer. My background is in Heavy Industrial, Commercial, and Maritime Infrastructure projects with a focus on design and fabrication of heavy steel structures and heavy lift design and execution.

I serve as the principal engineer at Bardex, working with clients, participating in project design, product development, staff development, and outreach including committee roles with PIANC, ASCE.

I develop and patent new systems and equipment solutions aimed at improving outcomes for our clients annually.

I participate in design code updates as an industry expert with certifying authorities such as Lloyds.

My work takes me around the world, engaging with industry, presenting at professional conferences, and working with clients. I travel about 100 days annually.

When I am at home in Santa Barbara, I enjoy cycling, hiking and body surfing.

As I remarked to Colin, I am a design engineer not a professional speaker. I am located down in the engine room of the good ship “Get It Done.” I’m honored to be here with all of you.

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Maritime support infrastructure is both a strategic and economic asset for Canada and many other countries This capability is essential for construction, maintenance and repair of both government and civilian ships.

We are seeing increasing global investment to support ship construction and maintenance. This demand is driven by many factors.

increased focus on national security

reshoring of vessel construction and sustainment capability

renewable energy transition

efforts to reduce carbon emissions

offshore energy production moving to new and less developed regions including Namibia, Africa and Guyana, South America

global expansion of aquaculture

shift towards fewer and larger commercial fishing vessels operating further from home ports to serve global markets

and demand for more and larger leisure and cruise vessels

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Infrastructure or Tool? Ship handling systems are sometimes referred to as tools. I first encountered this terminology at La Ciotat Shipyards where we installed the Atlas Shiplift System. Ship handling systems are a class of infrastructure that is designed and built for a specific purpose.

Central to the success of any nation to achieve maritime economic goals is modern shipyard infrastructure.

Ship launching and retrieval technology includes Slipways, Drydocks, Floating Drydocks, and Vertical Shiplift systems.

Understanding the available technologies, capabilities, time scales and budget for these infrastructure projects is necessary for success.

The maritime industry faces many challenges

A shortage of experienced engineers, due to the cyclical nature of investment in this class of infrastructure

Siloing of information due to the compartmentalized nature of vessel design, infrastructure development, and shipyard operations

Workforce development to staff and run maritime sustainment facilities

Bardex has adopted an open engagement policy to address these industry challenges. The goal is to build communication between all industry stakeholders including vessel designers, ship builders, refit facility operators, and operations experts known as Dockmasters or Shipwrights.

Many facilities operate two or more of these technologies. Our area of specialization is vertical lift and transfer systems. To better serve our clients, we make work outside our area of specialization. Our engineers attend dockmaster training which helps them to understand the operational challenges our clients face and introduces them to other drydock technologies.

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Slipways are the oldest type of marine infrastructure. In the modern era, these systems are used primarily for refit.

Slipways can be oriented parallel or transverse to the vessel center line.

This technology is scalable, the Titanic and Goliath were built on a marine railway.

Modern slipways retrieve vessels using either a chain or wire rope driven by mechanical means

Construction of new systems is rare.

Transition from keel up to block module vessel construction

the development of marine travel lifts to handle smaller vessels more efficiently

high CAPEX and OPEX cost

environmental concerns

and low throughput are contributing factors.

Large slipways require civil works extending out into deep water. Obtaining permits for construction in navigable waterways is difficult, delaying development schedules.

The submerged infrastructure is vulnerable to damage, hard to inspect, and difficult to maintain.

Multiple slipways are required to accommodate high operational volumes, increasing CAPEX and OPEX costs for facilities using this technology.

Slipway operation is generally not tide dependent.

Maintenance dredging around the submerged civil works is a challenge.

Failures have occurred with this technology.

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Drydocks are a common type of shipyard infrastructure.

These systems typically handle larger vessels.

The trend is to modify existing large drydocks with intermediate gates and lift in/out capability to increase throughput without performing a complete evolution.

Drydocks can be retrofitted with vertical shiplift systems in situations where reactivating the drydock is not commercially viable.

Economic viability is a challenge especially for larger, older drydocks. We will discuss examples later in the presentation.

Drydocks are tide independent.

Weather can be a factor for floating gate operations.

The CAPEX and OPEX costs are high, new construction in developed economies is limited by

available space

cost and schedule for permitting, design, and construction

environmental concerns affecting both construction and operations.

The transition to block module assembly has greatly reduced new vessel construction in drydocks

Safety is an issue, failures resulting in deaths, injuries and asset losses have occurred

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Floating Drydocks are the most common tool for launching newly built vessels and sustainment

This technology is less expensive to plan, construct, and deploy from a civil perspective. Where onshore space for dry berths is not available, this type of floating system is a solution.

FDD purchases are easier to finance, the asset can be repossessed in the event of a default

Floating drydocks do not require extensive civil construction to support installation and operation, bypassing some coastal development regulatory challenges.

FDD vessels are expensive to design, build, and operate. Operating this infrastructure requires training and experience.

They are classed as ships and require regular maintenance and class inspections, a method for sustaining the asset is an important consideration when evaluating this technology.

The design consists of steel ballast tanks that are vented to the atmosphere. Sea water is pumped into and out of the tanks to ballast the vessel up and down.

This design leads to corrosion issues

accumulation of sediments in the ballast tanks

and ballast water management concerns.

Performing ship repair and maintenance on a floating structure can lead to release of pollutants into the environment

Floating drydocks also have a history of failures including

capsizing due to stability issues

structural rupture resulting from improper ballasting and/or poor maintenance

Pump and valve failures resulting in sinking

Weather, tides, and water depth often limit operational windows

Ballasting during shore transfer operations is a slow and delicate process

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Vertical shiplift systems provide high volume ship handling at lower CAPEX and OPEX costs than drydocks

These systems are tide independent and can be operated in a broad range of weather conditions.

Servicing vessels on shore reduces risk of pollution

Modern shiplifts have capacities from 1500 to over 27000 tons.

Capacity is not limited by technology, lifting and launching larger vessels is possible

Locations with adequate onshore space and deep-water access for 150m and longer vessels are limited

Shiplift systems provide the most economic benefit when connected to a large hardstand area capable of hosting many vessels concurrently.

This technology is ideal for 60 to 150m vessels.

Large drydocks and FDD units struggle to serve the small to mid-size vessel market cost efficiently.

Vertical shiplifts have been in continuous use since 1827 when John Blackwood, a Scottish engineer built the first “Screw Dock” in New York. Two more systems followed in Baltimore and Philadelphia. There is only one surviving example of this technology in Bridgetown, Barbados. A 1200-ton system with a 46ft x 240 ft wood and steel truss platform. This system operated continuously from 1893 to 1984.

Some modern vertical shiplift systems utilize wire rope. These systems have a well-documented history of wire rope failure resulting in injuries and damage to both the system and assets.

Chain-based systems were introduced into the market in 1967. Chain based vertical lift systems are the only vessel docking and launching technology that have a perfect safety record over the last 58 years.

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Current market activity and trends indicate shiplift systems are the future.

Four SIOP drydock projects are underway in US Navy Yards to refurbish or replace legacy drydocks that are no longer fit for purposes. These facilities are intended to service nuclear vessels. Costs are measured in billions and these projects take a decade to plan and complete.

We are aware of one large FDD replacement underway in the United States, a 58000-ton capacity unit at a cost of around 200 million dollars.

In the last few years, 5 North American commercial shipyards have invested in new shiplift systems. Four of these systems bypassed a competitive tender process. I believe the industry will benefit from fully investigating all technologies before making such an important decision. We recommend that clients evaluate all available options before selecting infrastructure that will support future operations for 3 to 5 decades.

Bardex is taking part in two legacy drydock reactivation projects. Both projects involve facilities that were built during WWII that have struggled to be viable as commercial enterprises. We expect this trend to continue and have developed new products and the capability to support it.

Bardex recently introduced innovative solutions such as the OmnDock floating shiplift system and the OmnLift drydock retrofit system. The aim is to reduce CAPEX costs, shorten implementation schedules, and cost effectively repurpose legacy infrastructure.

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Context drives system design. We begin with understanding the unique context of each client and project.

The picture on this slide speaks volumes about the importance of operational constraints.

To understand context, we focus on Geometry, Geology, Bathymetry, Target Vessel Market, Operational Objectives, and the EPC plan.

Of these factors, geometry, bathymetry, and geology have the greatest influence on the project cost, facility configuration, and delivery schedule

Shipyard infrastructure project design historically has proceeded in a very siloed manner. Ship designers, civil engineers, facility operators, and ship lift design specialists have limited opportunities for interaction. The number of projects globally any given year is low, 1 or 2 at most.

Engaging with all stakeholders derisks the project, controls costs, and ensures the outcome.

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We use data analytics to understand regional vessel markets.

Vessel ownership, class inspection schedule, and movements are tracked daily.

Geofencing is used to collect the vessel traffic data for ports and regions.

We use this analysis to identify the target vessel market and develop a shiplift system and facility design that best fits the data.

Our clients use this information to support the business case for financing and grant applications.

Facility operators can use this tool to identify potential client vessels well in advance of inspection due dates and book hardstand space for inspection and refit work months or years in advance.

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Civil construction is the largest cost component of a vertical lift system. Engaging with the civil design team to plan the foundation and topside civil work creates the opportunity to optimize lift station capacity and spacing to match foundation capacity. Providing early, accurate equipment loads enables the civil designer to proceed with the foundation design efficiently.

Shiplift platforms are large and heavy steel structures. Engaging with the construction team enables the shiplift system designer to leverage equipment and capability that are available in the region.

EPC planning requires extensive outreach to the local business community to identify capability that can be leveraged to install the system, building future maintenance capability in the process.

Ship handling systems are tools that enable shipyards to operate efficiently. The system design must consider the workflow of the facility. Engaging with shipyard operations and facility staff ensures the system will achieve operational objectives.

Vessel designers provide blocking plans as part of the vessel design. These plans are focused on hull pressure and make assumptions about blocking support that may not be compatible with the technology used to launch and retrieve the ship. Blocking plans can be adjusted in the during design process to ensure adequate load distribution. Life cycle loading analysis can be performed to ensure the sustainment infrastructure can support vessel maintenance through decommissioning.

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Like many facilities, the Irving Shipyard has a long history in the Halifax community. Space for expansion is limited. Access to the yard via the road network for large sub-assemblies is a challenge.

The new shiplift development expands capability by adding three “hardstand” areas for vessels that are accessed via the shiplift. Currently, the facility can only host one vessel for refit in the drydock. This drydock is too small for many of the ships the facility is currently producing.

Additionally, the shiplift system will act as a module offloading facility. Allowing the shipyard to produce large ship subcomponents that will be brought to the facility by barge and moved into the yard via the shiplift platform for integration.

Distributed block module construction leverages modern precision fabrication technology to efficiently engage regional capability. This approach is becoming more common globally to allow a group of smaller facilities to produce a large vessel in a decentralized manner. Expanding opportunity and leveling revenues for the participating yards provides stability for the regional economy.

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We have talked about a lot of concepts, all of which are being applied here in Halifax today. The effort that Irving is leading is preparing the facility to deliver and sustain vessels for the next 50 years of operations.

Construction of the civil works is underway. Dredging and subgrade preparation is ongoing.

The foundation system is constructed using precast concrete caisson that are constructed offsite, towed to the facility, and ballasted down onto the subgrade.

Two caissons were installed this past fall, work on additional caissons will begin again in the spring.

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Design of the ISI shiplift system began with delivery of detailed vessel metrics and a blocking plan from ship designer. This information is integrated into an FEA model for the shiplift system to test the blocking loads, ship support structure, platform and lift stations. This is an iterative design process focused on identifying and resolving any risks to the vessel or shiplift system.

Various loading conditions are considered during the analysis process to ensure the vessel can be lifted at all levels of outfitting.

The River Class Type 26 hull configuration necessitates a substantial stern overhang beyond the last keel block. This results in a load concentration at the stern block.

An area of focus for the design team is to eliminate the need for support aft of the keel blocking which will interfere with docking the vessel. The goal is to be able to dock and launch the vessel safely, and quickly.

The addition of three dry berth areas prepares the facility to host these and other vessels for future refit and maintenance work without disrupting new vessel construction.

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This analysis technique can be used for any vessel entering this facility or any other Bardex shiplift system.

The dockmasters at ISI and other facilities have responsibility for the safety of the vessel and personnel during launch and retrieval operations. Our role is to provide engineering support to these professionals.

We recommend performing this type of analysis when one or more of the following conditions are encountered:

The facility is launching or retrieving a vessel for the first time.

Vessel or blocking plan data is incomplete.

The vessel weight or density exceeds 80% of the system capacity.

The vessel has unusual hull features that affect the blocking plan.

Vessel alterations are planned during refit that will change the blocking plan.

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To recap, there are four technologies commonly used for ship handling. Of these technologies, shiplift systems connected to multiple onshore hardstands are becoming the industry standard. This is due to the ability of this tool to work at higher volumes and perform multiple functions.

Drydock construction has become prohibitively expensive, relegating this technology to defense related government funded applications. Legacy drydocks are being reactivated, and there is an opportunity to modernize legacy facilities to improve commercial viability by retrofitting them with shiplifts, intermediate gates, and lift out capability to improve commercial viability.

Use of advanced manufacturing and assembly processes for ship construction have fundamentally changed how shipyards are designed. Enabling distribution of work over regional facilities and avoiding lengthy and expensive expansion of operating facilities. Equipping these facilities with vertical lift technology further supports this trend.

Advanced FEA design and data analytics are new tools Bardex is introducing to shipyard design and operations to improve safety and increase efficiency.

The need to rapidly scale up capacity means that professionals like me must reach across boundaries and learn from other industry stakeholders to understand how to better serve the industry.

Thank you for your attention and I am happy to answer any questions the group has. If I am unable to get to your questions, please leave these in the meeting chat or email these to me and I will respond as soon I can. I have four more slides of past projects if there is interest in discussing these systems.

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The ROK Navy II system was first commissioned in 1990. The system outlasted the fleet it was designed to service. Bardex was able to rebuild the system to increase the capacity while retaining the original platform and civil works.

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Mega Yacht (60m and larger) shiplift built on the site of former commercial vessel slipway near Marseille, France on the Mediterranean. The facility has seven refit bays and hosts the world’s largest superyachts.

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The original Bardex shiplift system was rebuilt to increase capacity and extend the platform length in 2017 to launch and dock larger submarines. The upgrade was completed in 2019.

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More recent photo of the Hanwha Ocean (formerly DSME) submarine shiplift in operation from 1990 still in regular use as of November 2017.