How the Australian Port Sector is ushering ports across the world into a new digital age

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Summary
The need to accommodate ever larger vessel fleets under increasingly severe weather patterns is a reality that ports across the world are scrambling to deal with. In the face of extreme challenges, the Australian Port Industry is pioneering a new approach to managing safety and efficiency of waterside operations that is quickly being adopted across the globe. Through a maritime digital twin approach, ports are able to quantitatively screen risks associated with each stage of a port call ahead of the vessel's arrival and critically evaluate potential mitigation options. Based on predictive analytics and machine learning, with assimilation to real time data and integration with third party services, the digital twin approach is providing operators with the ability to enhance critical decision making with physics based decision support.

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Introduction

Ports are under increasing pressure to safely accommodate increasingly larger vessels. Between 2011 and 2021 the global proportion of mega-container vessels (> 10,000 TEU) increased from 6 to almost 40% [1]. Port infrastructure (channel depths and widths, quayline & mooring infrastructure and towage resources) are not growing at the same pace. This is resulting in uncertainty around precisely where the safe operational limits are and when they will be exceeded. The grounding of the EVER GIVEN in the Suez Canal in March 2021, held up almost $10bn of trade a day [2] and caused global scale delays, showing just how serious the consequences can be.

Australia's Port Sector

In Australia, extreme weather events are increasing both in frequency and intensity. In March 2022, the Port of Brisbane suspended shipping for 3 days during one of the nation's worst flooding disasters on record. High rainfall, strong winds and recurring persistent swell conditions from regional pressure systems are causing increasing levels of shipping delays, resulting in supply chains across the country being disrupted.

In an unprecedented move, the Australian Port Sector took a collaborative approach to these challenges. Leaders in the sector aligned on a vision to use predictive analytics, machine learning and real time data to drive improved decision making around critical maritime operations.

Quantitatively assessing safety risks allows each port to dynamically manage critical operations, on a ship by ship basis. Greater understanding and oversight of risks then allows the regulators to critically evaluate options that may be outside the standard, static operating policies. This provides a level of flexibility that is becoming increasingly essential as uncertainties in the external environment are growing.

Partnering with leading technology institutes DHI and FORCE Technology, the Ports invested their knowledge & resources into developing specialised pieces of technology that could evaluate the risks associated with individual stages of a port call e.g., safely transiting through navigation channel, safe mooring, safe swinging. Housed in a single framework, each port's developments couple with the next, to build a fully integrated, digital replica of a port's waterside assets – the world's first physics based, maritime digital maritime twin.

Through its ability to provide quantitative risk assessments of highly complex, in-situ, dynamic vessel behaviour, the digital twin approach pioneered by the Australian Port Sector is fast becoming an alternative to static port rules worldwide

Port of Brisbane

Led by the Port of Brisbane, the dynamic under-keel clearance (UKC) forecast module was the first module conceived and developed in 2017. Driven by a navigation engine designed for full bridge simulators; assimilated with highly complex, 2D & 3D numerical metocean models, the system can mathematically recreate a transit of any vessel, at its given load state and handling characteristics, transiting through any channel in the world and screen for risks to safe UKC.

The benefits to PBPL have been substantial with three times the number of bulk carriers departing

with a draft greater than 14m and a 33% increase in container vessels with a draft greater than 13m within the first year of it being developed.

With three large container terminals operating in the Fisherman Island Precinct, the port also initiated the development of the safe berth management module. Accommodating larger ships at berth often results in sharing of mooring infrastructure, more lines attached to individual bollards than usual, and limited space between ships at berth. The berth planning system identifies an optimal mooring arrangement for each individual ship at berth and forecasts expected loads on mooring infrastructure ahead of the ship's arrival. In this way, operators are able to evaluate multiple arrangements, identify low-risk tie-ups and continue to operate safely with confidence.

Flinders Port Authority

Situated in the Great Australian Bight, Port Adelaide is subject to strong tidal residuals from storms deep in the Southern Ocean. Strong, sudden squalls can impact port operations at short notice. In order to improve reliability and continuity of operations around larger vessels (LOA>300m) Flinders Port Authority (FPA) co-developed a module that allows the operations teams to screen the risks associated with safely swinging large containerships under the upcoming wind and current conditions and predict the towage resources required for each operation. Integrating directly with the port's vessel scheduling database, the system provides clear, automated alerts to traffic operators and pilots around swing operations of concern, in a highly efficient and streamlined manner.

Port of Melbourne

Vessels transiting to the Port of Melbourne, the largest container port in Australia, can navigate through challenging currents at Port Philip Heads. Constraints on channel widths and berthing space have compelled the port to invest in innovative methods to increase operability of existing assets.

Drawing on the efficiency of integrating risk assessments at each stage of a port call, the Port of Melbourne drove upgrades to the berth planning system and furthered the development of a significant piece of engineering that is transforming the world of pilotage – the safe handling and manoeuvring module. The system uses a state-of-the art, full mission simulator engine combined with an innovative approach towards the mathematical modelling of the ship hydrodynamics where the various hydrodynamic forces acting on the manoeuvring ship hull are presented through a mathematical series of velocities and accelerations experienced onboard and are reduced to a mathematical form through a regression formula.

Pilots are able to perform daily, ship by ship risk assessments to evaluate to describe the complexity of ship handling required due to the underlying metocean conditions and vessel's manoeuvre performance characteristics. Each Pilotage is assigned a risk rating based on quantitative transit handling performance metrics of channel occupancy, minimum distance to toeline, reserve rudder capacity and rate of turn error.

Southern Port Authority

Esperance Port experiences significant infragravity wave action (long period waves). Through the phenomenon of resonance, these long period waves can drive generate extremely large surge motions (upto 12m peak to peak) at berth. This highly progressive port has invested in a leading development that builds again on the safe berth planning tool. Integrating the existing mooring analysis tool with a high resolution, 3-dimensional wave model it is the first piece of technology of its kind in the world. The ability to dynamically forecast long period wave induced moored vessel response – 7 days out, enables the port to see safety risks ahead of time and evaluate options for mitigation. Apart from significantly improving the safety metrics, it also provides the port with a way to extending berth utilisation when mooring risks are demonstrably low.

Conclusion

In the face of rising external threats, the Australian sector is investing in technology as a means to quantitatively manage risks to safe waterside operations. Aligned in a vision to integrate science based information into critical decision making, the ports have co-developed pieces of technology that, together, forms a holistic picture of where risks to safe shipping lie and provides the ability to evaluate mitigation measures. Shedding its competitive stance, backed by a genuine desire to improve conditions across the board, the Australian Port Sector is ushering the maritime industry away from traditional, static rules and beliefs, into a new digital age.

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