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Future-ready underwater asset management

How to combine Strategic Asset Management (SAM) with underwater technology and Geographic Information Systems (GIS) to better understand submerged port infrastructure

In partnership with:

esri Australia

ROVING INTELLIGENCE

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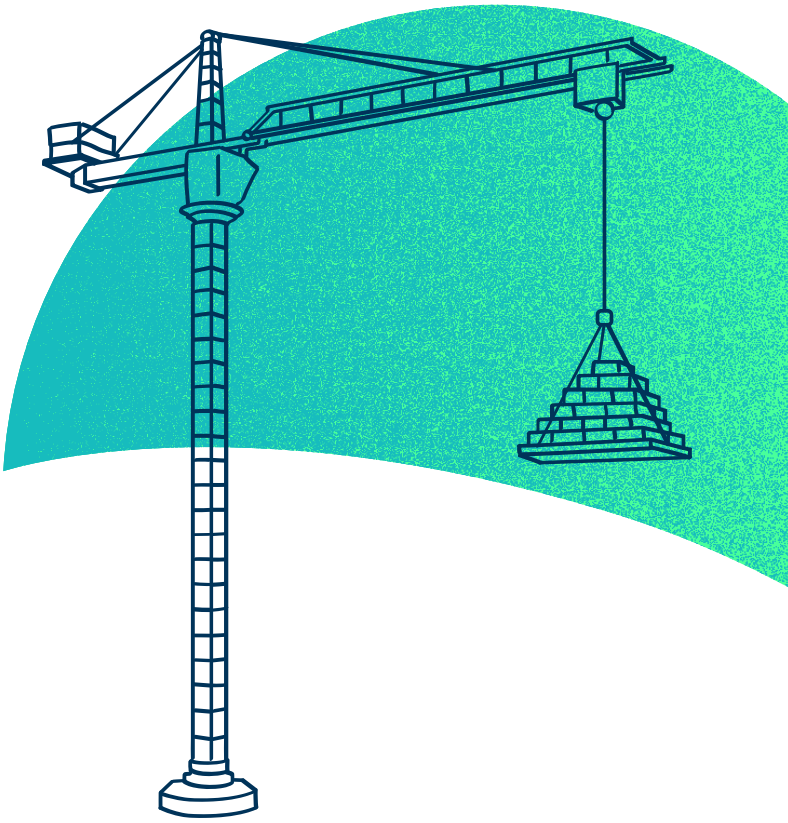
The Australian Port Landscape

A lot of activity is happening right now around asset management in the Australian ports sector. Many ports are either implementing new asset management systems, upgrading existing systems or wanting to get better value out of them to optimise the performance and uptime of critical infrastructure.

It's no wonder why. With the ever-increasing flow of global trade, maritime trade volumes are expected to triple by 2050, according to the OECD. As an island nation, Australia relies on sea transport for 99 per cent of its exports, with much of our domestic freight also depending on coastal shipping, making the smooth running of ports crucial to the economy.



While port custodians understand the importance of maintaining and preserving their asset portfolio, they also recognise that many of their assets are ageing and reaching the end of their lifecycle – another driver to avoid the potential risk of breakdowns, downtime and supply chain delays.

It's why at any given port, you're likely to see engineers walking around, ticking checklists and capturing information about the attributes, condition and performance of infrastructure to support long-term financial and asset management planning. While this is widely the case for above-ground port assets such as cranes, vehicles, facilities and terminal equipment, for those below the water's surface – like piles and sheet pile walls that support berths, jetties and wharves – it's a different story.

Underwater assets have historically been much more challenging for ports to assess. While divers carry out periodic inspections when it is safe to do so, visibility is not always clear, and there can be cold water temperatures, currents, and bad weather to contend with. Without reliable data, and the ability to see condition trends, it can be difficult to present decision-makers with a clear picture of required maintenance funding.

For these reasons, the level of asset management maturity within ports and marine structures tends to lag behind that of other sectors. To help raise maturity levels, this paper explains some of the methods, tools and innovations available to support asset management at ports and the understanding in particular of below-water assets.

WSCAM: The standard for port asset inspections

Another catalyst for improving asset management in the ports sector is the creation of the Wharf Structures Condition Assessment Manual (WSCAM) by Ports Australia.

Updated in late 2022, WSCAM is considered a best-practice tool in Australia and frequently garners interest from abroad. It offers a consistent and repeatable inspection process for gathering accurate and reliable condition data on a wide range of port assets, including wharves, piers, jetties, walkways, breakwaters, revetments, embankments and other fixed assets.

It was developed to address some of the biggest challenges ports and maritime operators face in capturing condition data during inspections, with a lack of consistency being at the top of the list.

Port assets are usually inspected by different people at different times – with sometimes around 10 inspectors assessing the same structure, each producing slightly different assessment reports. WSCAM provides consistency in inspection outcomes across different asset types, regardless of who does them. It not only ensures greater accuracy in the data but also prevents operators from being locked into using any one inspector for the data to be reliable.

Besides standardising data collection, another important feature of WSCAM is that it guides inspectors on what a specific condition rating looks like. A common problem ports face is the lack of consistency in rating scales in asset reports. WSCAM helps ports stick with a classification scale from 'poor' to 'great' so that everyone knows what the lowest and highest numbers mean and that the data in the system truly reflects what's out in the field.

WSCAM also recommends listing each component and construction material for each asset type to track their condition over time. This ensures everyone follows the exact breakdown each time an inspection occurs.

With WSCAM, we now have a robust method to capture both above- and below-water asset information in a standardised format.

This is good news, but how can ports capture more of the underwater asset information they need, and do it more regularly, to make better asset investment decisions? And once they've captured that data, how do they use it to identify potential risks of service levels dropping or, worse, asset failures?

WSCAM best practice

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Collecting data on underwater assets

First, let's look at how ports can better harness technology to improve underwater asset data collection.

Traditionally, data capture on port asset infrastructure has been a very reactive process. With many ageing assets such as piers, jetties and wharves, ports have been reluctant to invest in regular data capture on assets that have stood strong for decades, and some, for a century or more. With little or no condition data, many ports and coastal councils have limited insight into the true condition of those assets and their remaining life, nor do they have a good understanding of future maintenance needs or spend.

A recent innovation that's radically changing the way operators inspect underwater assets is Remotely Operated Vehicles (ROVs). Melbourne-based ROVing Intelligence has created Australia's first industrial submersible, exclusively designed for underwater asset inspections, reducing the safety risks associated with diver-based inspections and improving the quality and completeness of asset condition data collection.

Using robotics and AI, ROVs can provide still imagery, video and multiple 3D modelling with incredibly accurate data, including measurements and geospatial positioning.

According to Matt Curtain, CEO and CTO of ROVing Intelligence, the world of asset inspection using submerged robot technology is moving quickly, with the latest in sensor and camera technology capturing underwater data to a level of detail never before possible.

"In the past three years, support for asset inspections for ports, marinas and other industries has moved beyond traditional divers collecting basic image sets and notes on asset conditions to gaining much more complete and more valuable data sets.

"ROVs can capture substantially more data to provide detailed defect quantification, enabling ports to carry out reactive maintenance activities to address critical defects and use the same information to drive strategic decision-making by converting that data into condition information."

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Matt Curtain
CEO and CTO of ROVing Intelligence

Advantages of using ROVs:

- Geospatially referenced HD and UHD video and still imagery
- Reduced WH&S risk
- Longer periods underwater than divers
- Can operate during high-traffic periods or under adverse conditions
- Continuous video footage of assets
- Use of AI technology for data analytics
- Ultra high-definition imagery and 3D models / Photogrammetry
- Imaging Sonar and Scanning Sonar for inspections in low or zero visibility
- Real-time access to data
- Accurate trend analysis through comparison of imagery across multiple inspection periods

Capturing component-level data of underwater assets

Reporting on underwater assets can now be done with such accuracy and granularity that all underwater sub-components can be assessed, presenting a more complete picture of the assets than has ever been possible.

ROVing Intelligence's approach is to start by conducting a complete survey of every surface area of submerged materials, using all its sensors and cameras to scan the environment simultaneously.

"We don't just do a swim-through—we go up and down every sub-asset that makes up a structure. By utilising AI and repeatedly doing these inspections over the asset's lifecycle, we can assess changes in the asset and therefore build a more accurate rate of deterioration very quickly," explains Matt.

One of its unique attributes is the ability to accurately pinpoint with geospatial referencing a specific area on an asset, such as a defect or corrosion, and be able to go back and observe the exact same spot year after year.

Matt says using ROVs also vastly reduces OH&S risk. "We can typically spend more time on the inspection than divers can. We can put the ROV in the water while there are ships moving about or during adverse weather conditions when harbour masters won't let divers go down."

With robotics, ports also have a greater ability to navigate poor visibility conditions and high current environments. "ROVs can hold station in strong currents which is quite difficult for a diver."

Another advantage, says Matt, is that all data is immediately available for cataloguing into asset registers and Geographic Information Systems (GIS) for comparison and trend analysis. "By being able to stream images in real time back to engineers, they can oversee and even direct the inspection."

Adding AI to the mix not only improves the accuracy and removes the subjectiveness of material condition assessments, but it can also be used for its analytical capabilities, such as assessing environmental conditions, biosecurity hazard identification, or invasive species.

"With the combination of our navigational information and our AI analytics, we can go back to the exact same spot within 14-20 millimetres and check it again in a year or two's time to develop trend analysis data."

Fig 1. Component level data capture and defect identification

Capital Investment planning using Strategic Asset Management (SAM)

Once you've captured data and begun building your asset register, the next step is understanding how to harness it to support capital investment planning.

We hear of many organisations putting off their decision to conduct capital investment planning because they're too busy implementing their maintenance management system or they want to first migrate all the data for each of their asset classes to the platform.

So, when should people start their capital investment planning process? Do you have to wait until their asset maintenance system is perfect? The answer is no, says Renuka Ranaweera, Principal Consultant, Strategic Asset Management, Brightly.

"It's easy to start building a capital investment plan by starting with what basic information you know," said Renuka. "Developing a capital investment plan requires taking a whole-of-life approach to your asset base. By using what information you have on an asset's age, condition, useful life and replacement value, you can start building lifecycle models to create 'what if' funding and service-level scenarios to predict the future behaviour of the underwater assets – providing a robust foundation for decision-making."

Renuka says using SAM for your asset lifecycle prediction modelling and capital planning helps you identify whether any assets are going to drop below a certain service level at a certain time without investment. Or, whether any infrastructure decay is accelerating faster than anticipated and therefore requires earlier intervention.

"Another advantage of using lifecycle modelling, such as Brightly Predictor, is that it's not tied to any enterprise system. You can get a snapshot of current data from any system and merge it with disparate data sources.

"Once you understand how to build lifecycle models, you begin to understand data gaps and identify other valuable information that would be useful to track. This helps you build more robust and sophisticated models. It can also help with structuring asset register data, such as grouping functional locations and componentising assets," explains Renuka.

> "By using what information you have on an asset's age, condition, useful life and replacement value, you can start building lifecycle models to create 'what if' funding and service-level scenarios to predict the future behaviour of the underwater assets.
>
> **Renuka Ranaweera**
> Principal Consultant, Strategic Asset Management, Brightly

Why ask questions of your data?

1. Understand the behaviour of your assets up to 100 years into the future
2. See the impact of different funding scenarios to optimise service level outcomes and capital and maintenance expenditure
3. Understand your risk exposure at a portfolio level so you can prioritise which issues to focus on and the consequences of delaying asset renewals against other cost considerations
4. Extend asset life and improve productivity performance.

Building lifecycle models: Getting started

So, what process do you need to go through to end up with a robust capital investment plan using scenario modelling? Here is a basic workflow that we've adapted from many years of building lifecycle models with ports, local governments and other asset-intensive organisations:

1. Aggregate your data

The first step is to gather all asset-related information – not just condition data in the asset register, but also any asset management plans, long-term financial plans, service level frameworks, and risk frameworks. Armed with this information, Brightly will then perform a basic gap analysis. If sufficient data is available, we build the first cut of scenario modelling. If not, we gather more data.

2. Establish service level frameworks

The next step is to sit down with the subject matter experts to discuss service-level frameworks, treatments on assets and intervention levels. We also look at treatments performed by other organisations that we can use as a guide. If any data is missing, we can fill it with industrial benchmarks or utilise degradation profiles from the WSCAM manual.

3. Ask 'what if?' questions of your data

We then help you build 'what if?' modelling scenarios, starting with two basic questions:

- 'What is the funding requirement to maintain the asset base as per service level standards?'
- 'What is the service level we can achieve with the current budget allocation in your long-term financial plan?'

This tells us what the future will look like if you keep spending as per the current strategy. Once this is understood, you can then ask other questions to help close the gap between the theoretical and tangible, such as:

- 'How much funding do I really need?'
- 'What would our assets look like with different funding levels?
- 'Which assets need to be replaced, rehabilitated or renewed over the next 20-year period?'

4. Fine-tune the scenario models

The last step is the model calibration. We ask organisations to do a verification of modelling outputs. Then, it's a matter of fine-tuning the model by building different scenarios until we uncover the insights that are most important to support your capital investment planning decisions.

Fig 2. Out of the box Capital Works Programs

Creating a dynamic risk rating

In today's asset management landscape, it's no longer good enough to use condition data as your single driver for your capital investment plans and renewal or replacement decision-making.

How do you add depth, integrity and greater confidence to these models? What other data should you be looking for?

Capacity, utilisation and functionality also drive the type of treatments carried out and reflect more real-world decision-making. We therefore also look to incorporate asset information such as material type or location of an asset – onshore, offshore, underwater, buried – because they have a significant impact on asset lifecycles or the cost of renewals. Another aspect that's important is the organisation's risk profile.

With many ports struggling to find available funding, we need to minimise risk profiles for capital investment plans. For this, we integrate with the organisation's risk framework so we can look at the consequences of failure or criticality by modelling asset condition and performance factors to create a dynamic risk rating. This allows us to see which scenario provides the most acceptable balance of cost performance and risk.

Top 4 capital investment planning mistakes

1. **Waiting until you have the perfect data set to start**

   Don't wait because you'll never get the perfect data set. Start simple with what you have.

2. **Having data stuck in siloes**

   Besides not having a holistic view of your data, another issue is you end up with different labels and rating systems. Act now to create a single source of truth.

3. **A lack of executive buy-in**

   This usually stems from not effectively communicating the issue. When scenario modelling is presented visually and in a way that executives can understand, there is greater appetite for capital investment plans.

4. **Not understanding planning timeframes and resource/ expertise requirements**

   The typical timeframe to create a capital investment plan is usually between 3-8 weeks per asset class, requiring 2-3 days a week from staff to provide guidance on service & risk frameworks, treatment practices and testing. If that's a challenge, we can partner with you to support you through the process.

Using spatial tools to support your capital investment planning

Why is data from Geographic Information Systems (GIS) so important for ports? Because ports are inherently location focused due to being complex operations with many moving parts. Understanding an asset's condition and risk profile based on its location within a port helps executives gain a better understanding of proposed capital investment plans.

Tom Gardner, an expert at Esri Australia with specialist knowledge of ports and maritime infrastructure says, "While people say a picture is worth a thousand words, I'd argue that GIS is worth a thousand spreadsheets.

"Many location-based functions are tied in with vessel management and tracking, berthing, transportation and logistics, asset management maintenance, workforce management, and security. Added to that, GIS is used extensively in planning, land use management, lease management, environmental management, and strategic planning and development.

"This all needs to be brought back together and communicated to different people within the port, as well as broader stakeholders and community. Using location is a visual tool that provides greater understanding for most people."

> "While people say a picture is worth a thousand words, I'd argue that GIS is worth a thousand spreadsheets... Using location is a visual tool that provides greater understanding for most people.

Tom Gardner
Esri Australia Industry Specialist - Infrastructure

How GIS can help with asset management

GIS (Geographic Information Systems) plays a key role in supporting asset management by integrating the location and asset identifiers, asset condition and other information to provide a higher level of operational awareness. It enables ports to maximise their investment in asset management programs by scheduling maintenance in a particular area, such as a berth, at the same time to improve efficiency. Quite often, we see GIS (e.g. Esri Australia solutions, including StoryMaps) used as a front window of asset management systems for non-expert users so they can understand what's happening.

And yet, GIS is more than just a visualisation tool – it also has analytical power which a surprising number of ports are not using. For example, GIS allows you to analyse patterns of activity in a location. By analysing workers' locations and the use of vehicles or equipment in that area, GIS can reduce health and safety risks.

GIS can also be used to analyse traffic patterns, such as understanding where bottlenecks with truck movements in particular areas of the port may exist and what's causing them.

Forward-thinking ports are starting to manage utilities, such as communication, fibre, and water networks with GIS to better understand what's happening across the terminal. They can also harness GIS to support security-related decisions, such as the best place to locate a security camera, as well as who is in each area and whether they have the right approvals to be there.

GIS is also being combined with drone technology to build a 3D representation, or digital twin, of ports. This allows operators to test what might happen in the real world, through the lens of a digital twin. For example, GIS is being used to support the what-if scenario modelling of potential spills and plumes to improve emergency response decision-making.

Fig 3. GIS scenario comparisons using StoryMaps

Conclusion

Through the combination of Strategic Asset Management with innovative underwater and GIS solutions, ports can collect far more detailed and accurate data of their submerged port infrastructure levels and use it to compare different evidence-based scenarios to support long-term financial plans and capital works programs.

The insights we can extract from the detailed data captured by ROVs gives ports the ability to make much better decisions around when and where to invest money and resources to support smooth operations and the flow of trade. And yet, this can only happen if we, as asset managers, become better storytellers.

To do this, we must be able to serve up these data insights in a way that senior management and stakeholders can understand. This is where we see the value of tools such as Esri's ArcGIS technology, featuring dashboard visualisations. Together, these tools can take complex information and present it in a clear, compelling way at the click of a button – so that understanding underwater assets is no longer like peering through murky water.

About ROVing Intelligence

ROVing Intelligence is a solution that provides underwater asset inspections and corresponding data using robotics and artificial intelligence. It is powered by optical recognition and sonar technology and removes risks related to traditional methods. ROVing Intelligence ensures organisations have the highest quality and latest data for optimising management decisions in underwater assets or ecological environments. For more details, visit www.rovingintelligence.com

About Esri Australia

Esri Australia is the nation's leading Geographic Information System (GIS) technology provider, delivering progressive solutions through the deployment of Esri's world-leading ArcGIS platform, enabling corporations and governments alike to leverage location-based analytics to drive operational efficiencies and facilitate evidence-based decision-making. For more details, visit esriaustralia.com.au

About Brightly Software

Brightly, a Siemens company, the global leader in intelligent asset management solutions, enables organizations to transform the performance of their assets. Brightly's sophisticated cloud-based platform leverages more than 20 years of data to deliver predictive insights that help users through the key phases of the entire asset lifecycle. More than 12,000 clients of every size worldwide depend on Brightly's complete suite of intuitive software – including CMMS, EAM, Strategic Asset Management, IoT Remote Monitoring, Sustainability and Community Engagement. Paired with award-winning training, support and consulting services, Brightly helps light the way to a bright future with smarter assets and sustainable communities. For more information, visit brightlysoftware.com

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