

Should container ports
be rushing to automate?

Prepare for climate
change and reap the
'resilience dividend'

Essential preparations
for the new generation
of mega-ships

Sweat your assets,
maximise productivity

Piloting change

Connections and opportunities
in the global container sector



Gateways to a more interesting world

Contents

4

The shipping forecast: a snapshot of the social, economic, political and environmental events influencing global shipping

20

Should ports be rushing to automate?

26

In the face of climate change, ports that build resilience will survive and thrive

34

Mega opportunity: meeting the needs of the new generation of super ships

46

Sweating the asset: how to maximise the life and productivity of infrastructure

Our kitchens, garden sheds, offices, parks, shops and favourite restaurants are filled with stuff that has travelled the oceans to get there. Indeed, whether you're reading this in hard copy or electronically, the paper and ink, or your computer, were likely shipped before reaching you. So this publication celebrates container terminals – key links in the global logistics supply chains that make our stuff more affordable.

As practioners, we know the essential role a container terminal plays in driving efficiencies across these chains – from deep sea to the quay, from ship to shore, through the yard to the gate and out into the hinterland. We know that efficiencies translate into savings for businesses, individuals, families and communities, as much as our clients. And we know that terminals are facing ever growing pressures.

Whether the challenge involves responding to bigger ships, greater throughput, increased port security, automating operations, environmental legislation, building resilience or strengthening transport links, we're here to help – it's what we do.

Sean Barker

Global leader for ports, Mott MacDonald



The shipping forecast

The container sector is shifting from a growth period into one of value, writes David Hunter, director of maritime advisory services.

We've seen the proliferation of alliances and acquisitions, both across shipping lines and with port operators building up their portfolio of terminals. Shipping companies are also increasingly investing in their own operating arms.

Inevitably, these organisations are going to serve their own interests, bringing both opportunities and threats for others in the industry. Those that can make it into the premier league of destinations, especially for the mega-ships, stand to gain advantage. Those relegated to the lower leagues face tougher prospects. Whole regions could find themselves isolated and their cost of trade going up if they are off the main trade corridors.

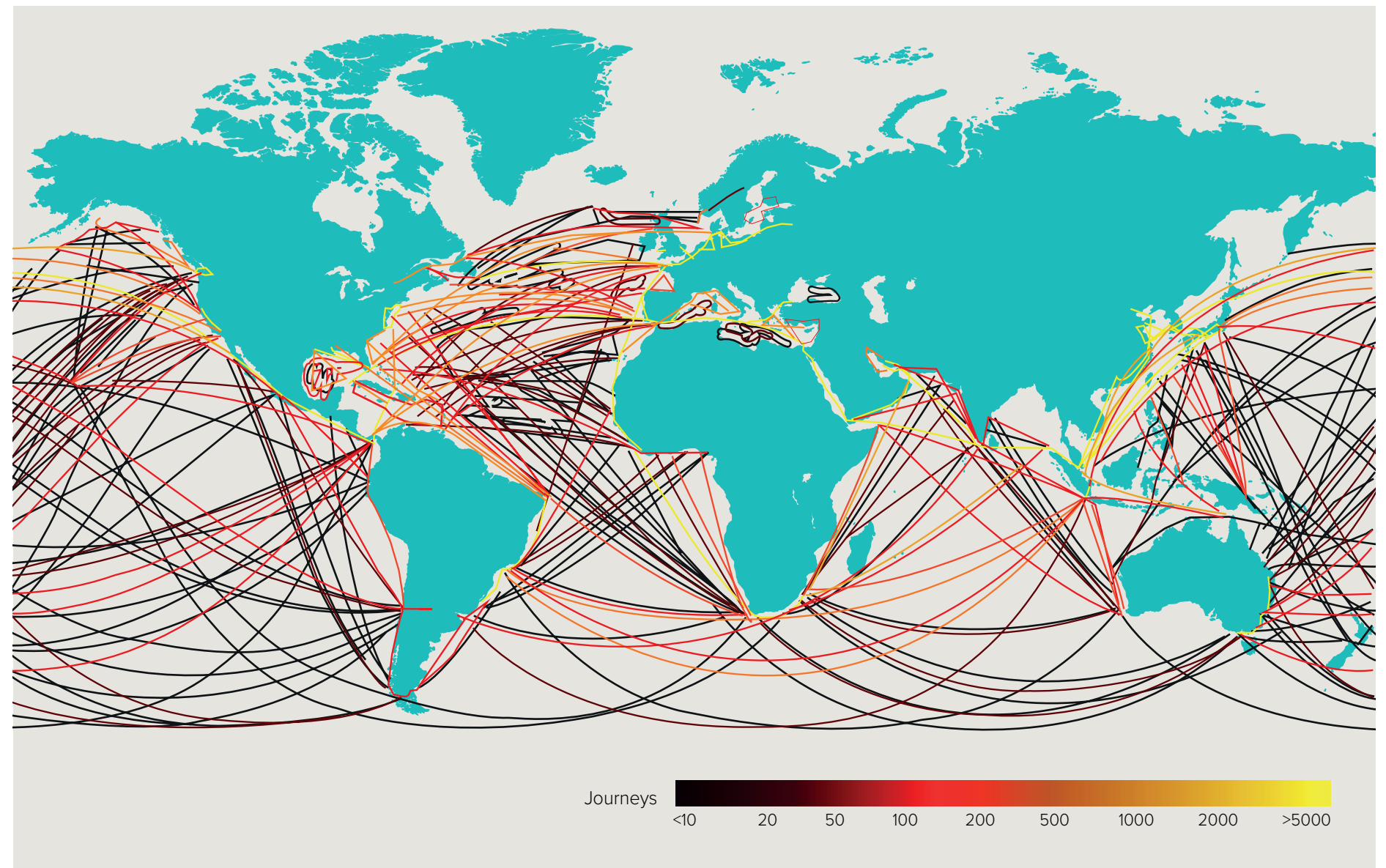
The ability to read the direction of traffic has seen the role of lenders' technical advisors and due diligence become more important: Investors want to steer clear of potential white elephants such as the over-concentration of ports in geographic hot spots that will suffer from excessive competition, or backwater destinations likely to be bypassed.

Sovereign states often regard deep ports as prestige assets, and get carried along by optimism bias. It is the responsibility of consultants to offer neutral advice that reveals where investment in port development is in the best interest of the country, or would be better spent elsewhere – health or education, for example.

Even if a port might work well in times of plenty, what happens in a global downturn, or if the container fleet changes? It is important also to recognise vulnerabilities such as terrorism, climate change and piracy.

And what of changing technologies and supply chains? Hard questions are worth asking. Owners and operators that can find answers have much to gain.

“Even if a port might work well in times of plenty, what happens in a global downturn, or if the container fleet changes? Hard questions are worth asking.”





Americas Adapting to Panama

For ports globally, but especially on the east coast and Gulf of Mexico, the current challenges and opportunities are largely rolled up in the expansion of the Panama Canal, says Andrew Cairns, ports practice leader for the Americas.



The Panama Canal expansion has helped trigger an upscaling of the container fleet globally. The new 'Neopanamax' vessels are almost three times the size of the old Panamax class, allowing owners to achieve unprecedented economies of scale. Bigger ships can pass rapidly from China to the US east coast – there's no longer a lengthy navigation around Cape Horn, or the need to transfer freight from ship to road or rail for cross-country delivery. As much as 25% of container trade is expected to shift from west to east.

Adapt or be marginalised

Ports have been preparing with a variety of harbour dredging, infrastructure development, wharf restructuring and investment in new cranes.

The Port of New York and New Jersey is spending US\$6bn, including a 10-year channel-deepening project completed at the end of 2016. The Bayonne Bridge will be raised from 50m to 70m to permit access to ships up to 14,000 TEU.

Baltimore, Norfolk and Miami have made adjustments in depth, berth capacity and handling equipment. In Savannah, the Georgia Ports Authority is deepening access to 14.3m by 2020, while neighbouring Charleston will provide 15.5m in 2019.

Speed has always been of the essence in winning business from ship owners, and the Neopanamax ships have made it even more so. The Port of Miami is tackling congestion with hinterland improvements, including a tunnel for trucks to bypass downtown Miami, and a new rail link, the Virginia Avenue Tunnel, which will allow transit of double-stack freight containers.

Large infrastructure projects are expensive. With the aid of advocacy by the American Association of Port Authorities, legislation has been passed to ensure tax revenue generated from port users is spent only on port maintenance and improvement. And shipping companies are increasingly willing to commit to ports they use, giving greater confidence that capital investment can be recouped.

Investment is enabling premier ports to adapt and compete. Subsidy via the Harbor Maintenance Trust Fund also enables second-tier ports to upgrade, to some extent. However, difficult labour relations have resulted in lost trade for principal west coast ports. And new entrants such as Canada's greenfield Prince Rupert facility in the west, a potential Canadian Atlantic port, and port-rail-port projects in Mexico, mean there are plenty of volatile factors that owners and operators must stay aware of.





UK Counting the cost of Brexit

‘Uncertainty’ is a word heard a lot since the referendum that set in motion the UK’s exit from the European Union, writes global leader for ports, Sean Barker.

Brexit negotiations have been slow to start and it could be at least two years before the split is complete. Thrashing out trade details will take much longer.

In the first of months after the Brexit vote in June 2016, uncertainty was manifested in caution from consumers and manufacturers, and a devalued pound making overseas goods more expensive. What lies ahead?

Many expect a negative impact from changing arrangements with the EU, the UK’s biggest trading partner. Without a favourable tariff structure, goods sold to and bought from the EU will cost more. Stricter customs checks will hike costs further and carry the risk of increased congestion, which may put UK hub ports at a competitive disadvantage.

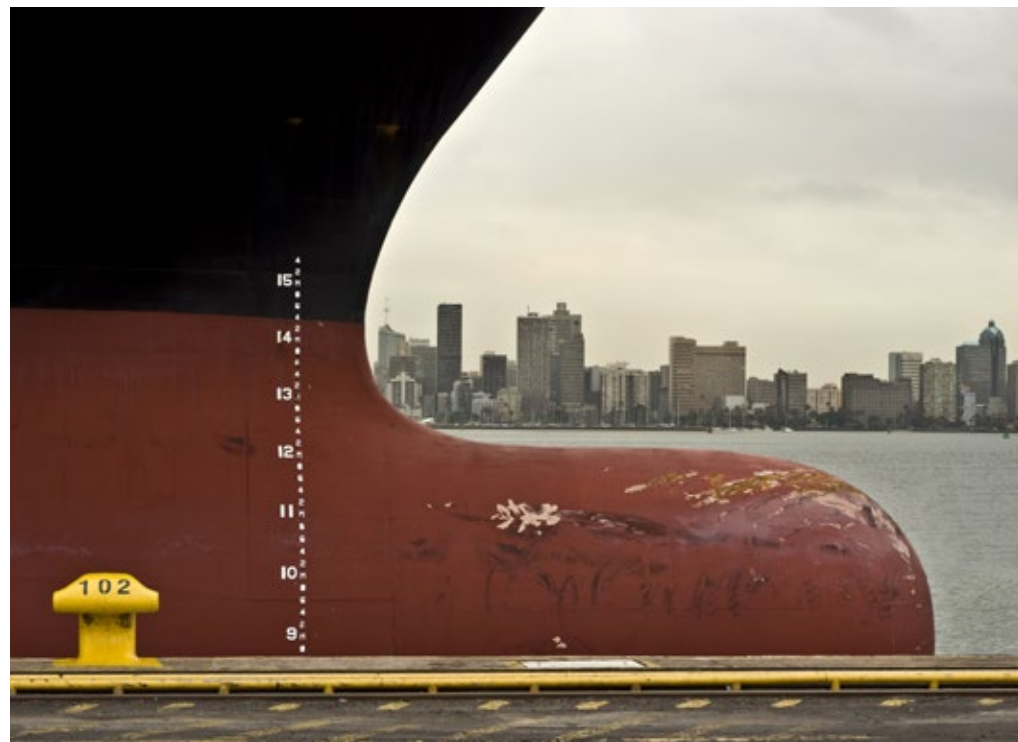
Taken together, a drop in container traffic seems possible and, with several UK ports owned by international companies, investor confidence is a concern. They may think: why pump money into the UK when we have more predictable assets elsewhere to finance?

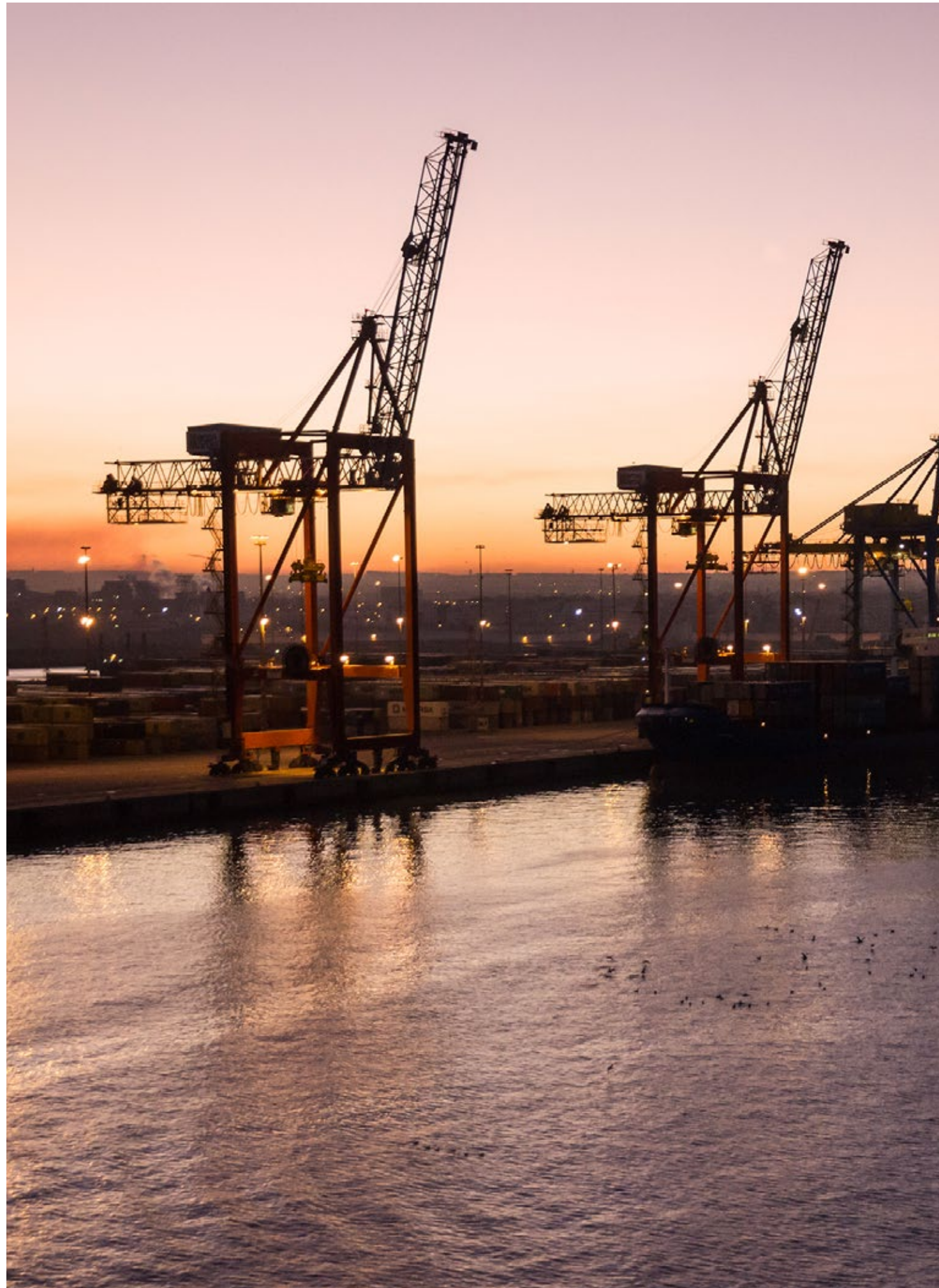
But it’s not all doom and gloom. Several operators have bucked expectations by bullishly saying that Brexit offers opportunities: The UK will be pursuing new trading relationships with partners including India, China and the US, while the weakened pound favours British exporters.

Africa

Staking a claim

As nation states and their international partners jockey for a share of passing trade, African ports are changing, says Rudie Basson, ports practice leader for Africa.





South Africa's state-owned rail and ports operator Transnet has overseen vital upgrades over the last decade (see page 50), including container facility expansions in Durban, Cape Town, Ngqura and Port Elizabeth. Against a climate of 8% GDP growth, these public works were readily funded. The sky was the limit.

The current slowdown has, however, created greater opportunity for public private partnership in terminal development to create new capacity, and safeguard transshipment traffic against competition from rival countries. The country needs to signal to investors that it will provide the stability they're looking for.

On the Horn of Africa, DP World's terminal at Djibouti is taking advantage of its position at the mouth of the Red Sea, the gateway to the Suez Canal, and its connection into Ethiopia via a 756km electrified railway. It is modelling itself as the 'Singapore of Africa'. DP World's concession at the Port of Berbera in Somaliland will add terminal capacity in the region. Further south, Mombasa in Kenya and Dar es Salaam in Tanzania are also expanding to attract

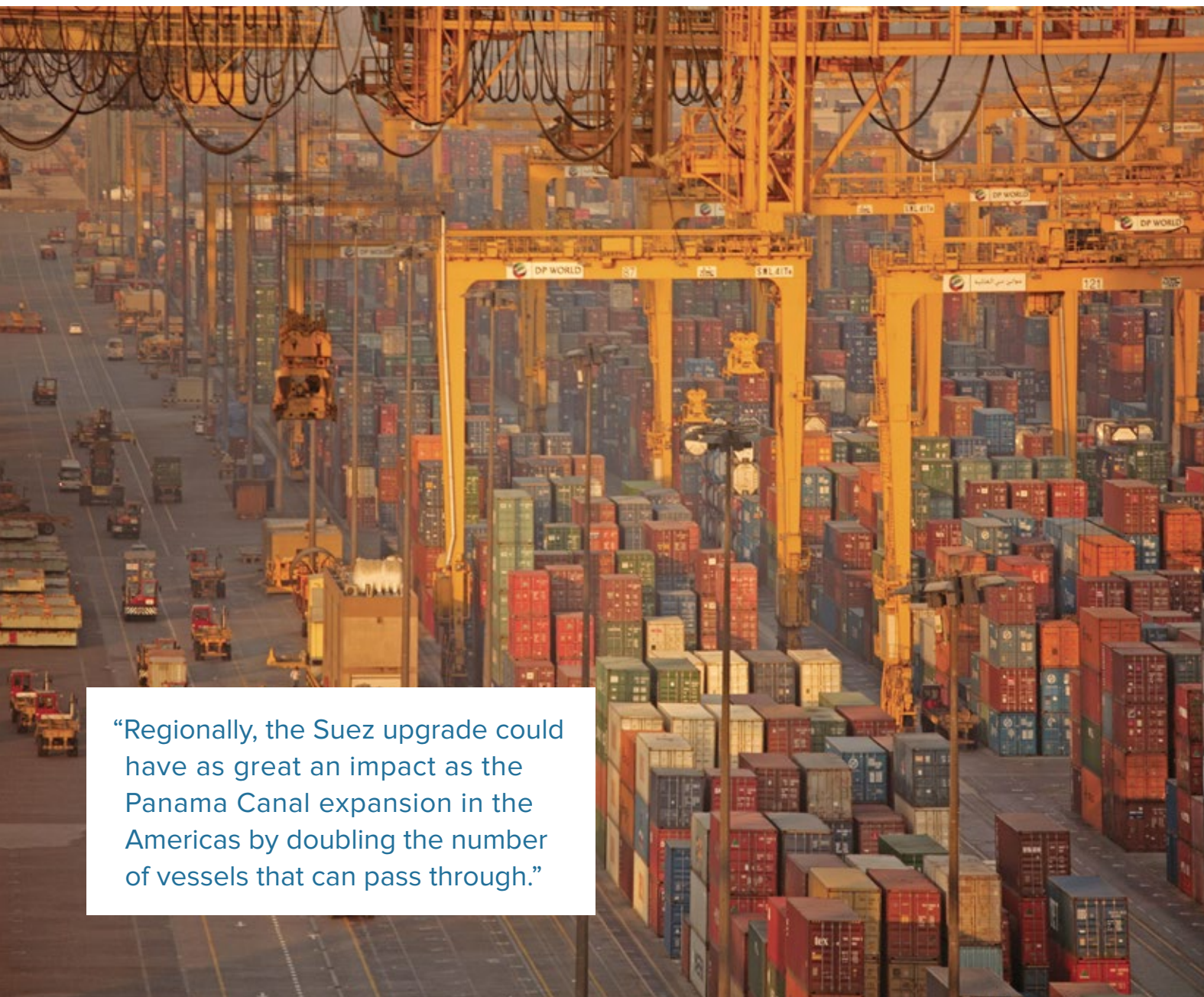
bigger vessels, while Maputo in Mozambique is dredging the harbour from -11m to -14m with a view to boosting cargo to over 40Mt a year by 2043.

The Gulf of Guinea, on the west coast, is a hotbed of activity, as the major players open their ports to passing trade from the Far East. The city of Lome in Togo has led the way, now welcoming ships of up to 8500 TEU. But it will soon face competition from larger facilities in Ivory Coast, Ghana and Nigeria – although the spread of piracy in the Gulf will need to be curbed. The west coast's rise has been matched by developments in the Mediterranean, especially Morocco, Algeria and Egypt, which are all investing heavily in new infrastructure.

Long discussed and now gaining momentum on the back of the terminal capacity being developed on all four African coasts are the transport corridors criss-crossing the continent. These will serve to increase trade with landlocked countries. Indeed, development of the corridors is accompanied by an increasing number of inland container depots being developed as local freight handling stations.

Middle East Expansion and evolution

Vast new ports in Kuwait, Abu Dhabi, Saudi Arabia, Qatar and Oman are jostling to upset the longterm dominance of Jebel Ali in Dubai, writes Sean Barker.



“Regionally, the Suez upgrade could have as great an impact as the Panama Canal expansion in the Americas by doubling the number of vessels that can pass through.”



With limited local consumer populations, many ports have relied largely on transshipment, with their success linked to global economics. With increasing regional capacity, the slowing of the global container market will bring these neighbouring giants into keener competition. The Gulf states have created impressive industrial free zones close to their ports to lock in import and export trade. Recent announcements will see this trend continuing.

Iran has announced a number of port developments, including the proposed Chabahar development. It is being developed with assistance from Indian investors and aims to rival the Chinese-backed Gwadar port development in Pakistan. Iran's emergence as a regional powerhouse servicing landlocked countries of central Asia, in addition to its own consumers, will have interesting impacts on regional trade flows in the Gulf.

Strategic developments in Oman and Saudi Arabia and the proposed GCC rail freight network will also play roles in the future of shipping and port activity in the region.

The region's ancient position as the meeting of East and West is set to continue, aided by widening of the Suez Canal which almost doubles capacity and halves transit times. The Canal is 20m deep and has no locks, so can already take the world's biggest container ships. Its greater capacity will have an impact on regional and, potentially, global trade.

Dubai's World Expo in 2020 and the 2022 FIFA World Cup in Qatar will focus the world's attention on the Gulf, with an expected economic dividend that will unquestionably be felt in the region's ports.



Asia Pacific Emerging rapidly

North Asia, in particular China, continues to grow its container port market albeit no longer at the rocket-propelled pace of a few years ago, says port sector leader for Australasia, Sam Harris.

Chinese ports are attracting more foreign investment, but planning, design and development remain the preserve of domestic design institutes and contractors.

Hong Kong and Taiwan have lost market share to mainland ports, but elsewhere in South East Asia there is incredible growth. Singapore is investing heavily in efficiency, including cutting-edge automation.

Indonesia, with a population the size of the US spread across an archipelago of 17,000 islands, spends 25% of GDP on transporting goods, compared to 6-7% in Singapore. There is a huge drive to improve efficiency, increase scale and develop hub ports, with the aim of undercutting regional rivals on price.

The facility of Kuala Tanjung in northern Sumatra is slated to be the next big gateway hub. It won't be the last. There is a large programme of works around ports in Java and Jakarta with 25 new developments starting over the next five years. They will draw in investment of hundreds of billions of dollars.

Vietnam and Thailand have also recently undergone development and continue to offer opportunities, although they are more mature markets.

Myanmar is another fascinating proposition, with the potential to become a regional powerhouse. This young nation has a lot going for it geographically. But there are clear challenges around foreign investment.

In shipping and trade terms, Australasia is closely linked to Asia, offering major hub port services on the north-south route. The country remains a happy hunting ground for Asian investors.

Australian ports have undergone a cycle of expansion in the last 20 years and expertise in automation, port planning and simulation modelling is recognised globally. Recently, the government has been looking to capitalise on its investment in the sector by privatising ports. The new private port owners will be aligning future investment to returns, rather than moving well in advance of trade demands as the government has done in the past.

We can expect to see increased levels of automation to reduce manpower and address potential security threats. Another concern is increasing urban encroachment on ports, which are under pressure to be good neighbours.

New Zealand is making significant investments in deeper draft vessels to service its export of agricultural produce.



Australasia Adapting to privatisation



Should ports rush to automate?

Automation: Miracle cure or red herring? Senior ports and maritime engineer Alex To appraises the opportunities and benefits.

Mention automation in container ports and most people think 'heavy machinery', and the use of robotics and software to replace humans operating cranes and vehicles. The new fully automated Euromax Port at Rotterdam offers a state-of-the-art example of how the substitution of manual operation can bring impressive efficiencies and competitive advantages. Containers move from ship-to-shore, quay-to-stack and yard-to-gate without humans physically touching them.

Ports that can afford horizontal transfer systems and electric automatic guided vehicles (AGVs) can expect to see a return in terms of safety and scheduling. Removing the human element may also allow an increased number of shifts, 24-hour operation and less downtime due to adverse weather. And of course, machines can reduce health and safety risks for humans. Software doesn't get distracted by a football match or have a bad night's sleep.

But the upfront costs are huge and may not prove worthwhile where labour is affordable. Manual ports are also more flexible to changing economic climates in what is traditionally a volatile marketplace. Terminals that are wary of the risks may choose to pursue semi-automation instead.

Harnessing the internet of things

Heavy machinery is just one chapter of the automation story. In today's economic climate, where efficiencies are sought across every facet of the supply chain, port operators are wise to implement an integrated port community management system that will control and harmonise all aspects of daily business from a central data hub.

A customised system will connect, co-ordinate and optimise everything: wet side activities such as vessel arrival, berthing, anchorage, bunkering and exit; dry side activities such as control, authorisation, customs, stacking and registering; and hinterland activity such as trucks and rail traffic entering the port gate. By smoothing the logistics chain – so that every party knows what's happening and when, and automating access through intelligent scanning of bar codes and licence plates – port operators can turn ships round quicker and lessen the threat of costly delays.

Hamburg Port offers an example of how smart infrastructure and advanced use of data can increase trade flows and protect resources. Speeding up connections in the port is integral to its ambitious target to achieve a 70% reduction in operational costs over the next seven years. In particular, the port is succeeding in increasing container capacity without increasing landmass, by creating a port-wide 'nervous system' – its own Internet of Things. "By gathering data from around the port, the system creates intelligence, and puts it to use in real-time," according to the port's smart technology partner Cisco. "Port traffic is faster. Port logistics are simpler. Delays that were once inevitable are eliminated."

The case for automation may be compelling, but it is worth stressing that it should not be treated as a trophy worth chasing at any cost. Automation is not a panacea, if the processes are not right. Before you swap your workforce for algorithms, a far more cost-effective and efficient approach may well be to improve what you have already.



Power struggle

Automation poses some tough power supply-related questions for ports, says senior project manager Peter Mallin.



For all the advantages over diesel, electrical automation puts much more demand on a port's power supply. Traditional quay cranes often have peak demands of around 2000kVA. While a typical automated stacking crane (ASC) may only peak at 50% to 60% of that, an automated terminal could easily be looking at two or three dozen of them – so drawing several tens of thousands of kVA when operating a full stretch.

Automated rail-mounted gantries (ARMGs) and stacking cranes (ASCs) don't need to 'see' to work and can be operated at night without floodlights, so there's some saving on illumination. And power can be regenerated from the lowering of containers. But these don't cancel out the large step up in power demand between non-automated and fully automated terminals. An estimated rise of around 25% is likely when switching from electric rubber tyred gantries to ASC operation on a like-for-like basis.

Installing back-up power will require several megawatts per berth, which doesn't come cheap. A 10MW back-up system will cost in excess of US\$4M. It can also be a challenge to find enough space in the heart of a port. The 10MW system would typically occupy 420m² and the loss of operating area has to be balanced with the amount of revenue per hectare that might be lost.

Keeping the lights on

Most big ports are situated in areas with well-developed infrastructure, but some high-volume facilities may lack a guaranteed electrical supply all year round. Power outages can lead to severe financial penalties and the reputational damage is difficult to calculate. There is also the safety question of leaving loads swinging in the breeze. Taking these factors into account makes it far easier to justify the cost of providing back-up power.

Automation tends to be tackled in phases, moving from one set of equipment to another but each stage can build up issues for the next. Layouts of equipment, logistics and associated ducting and cabling have to be carefully considered. Laying down the right power infrastructure is a challenge. But failing to act will make stepping toward full automation a problem later on.

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No substitute for experience

Project
Caribbean Container Port
Location
Bahamas
Client
Confidential
Expertise
Application of BIM in design of an automated yard

The competitive advantage to be gained by being fully automated – when your rivals are not – results in understandable secrecy when an operator takes that step.

We designed a fully automated terminal expansion in the Caribbean – a state-of-the-art facility that pushed boundaries and forged new relationships with suppliers and third parties.

Our team of designers, led by senior project manager Ann Woulfe, extended the quay length from 800m to 1500m, boosting throughput from 1.5M TEU to more than 3M. One of the successes of the project was the use of building information management (BIM) to create

3D virtual models across the three core engineering disciplines: civil, electrical and structural. Delicate and interdependent tasks such as siting the load-bearing crane rails for automated stacking, connecting the electric supply into the ring main and laying fibre optics for port communications were made much easier and more accurate.

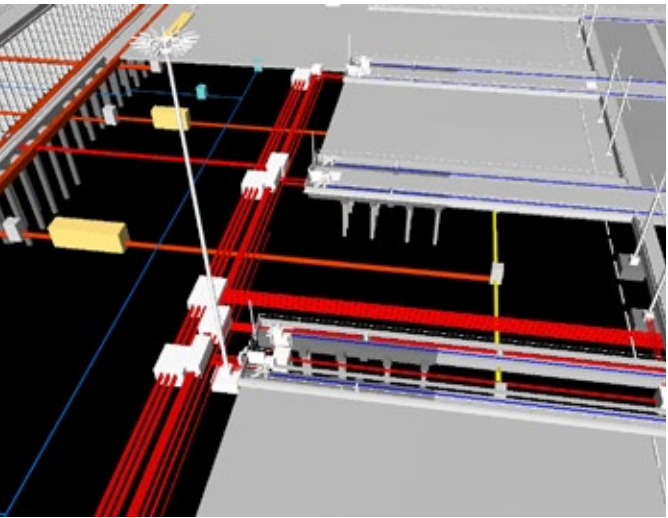
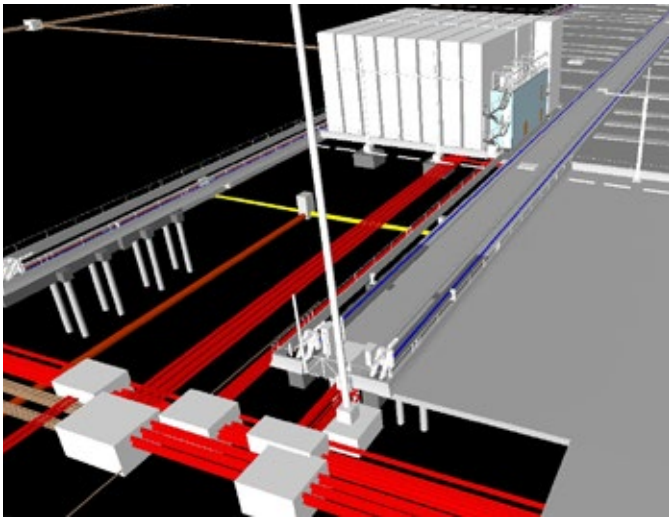
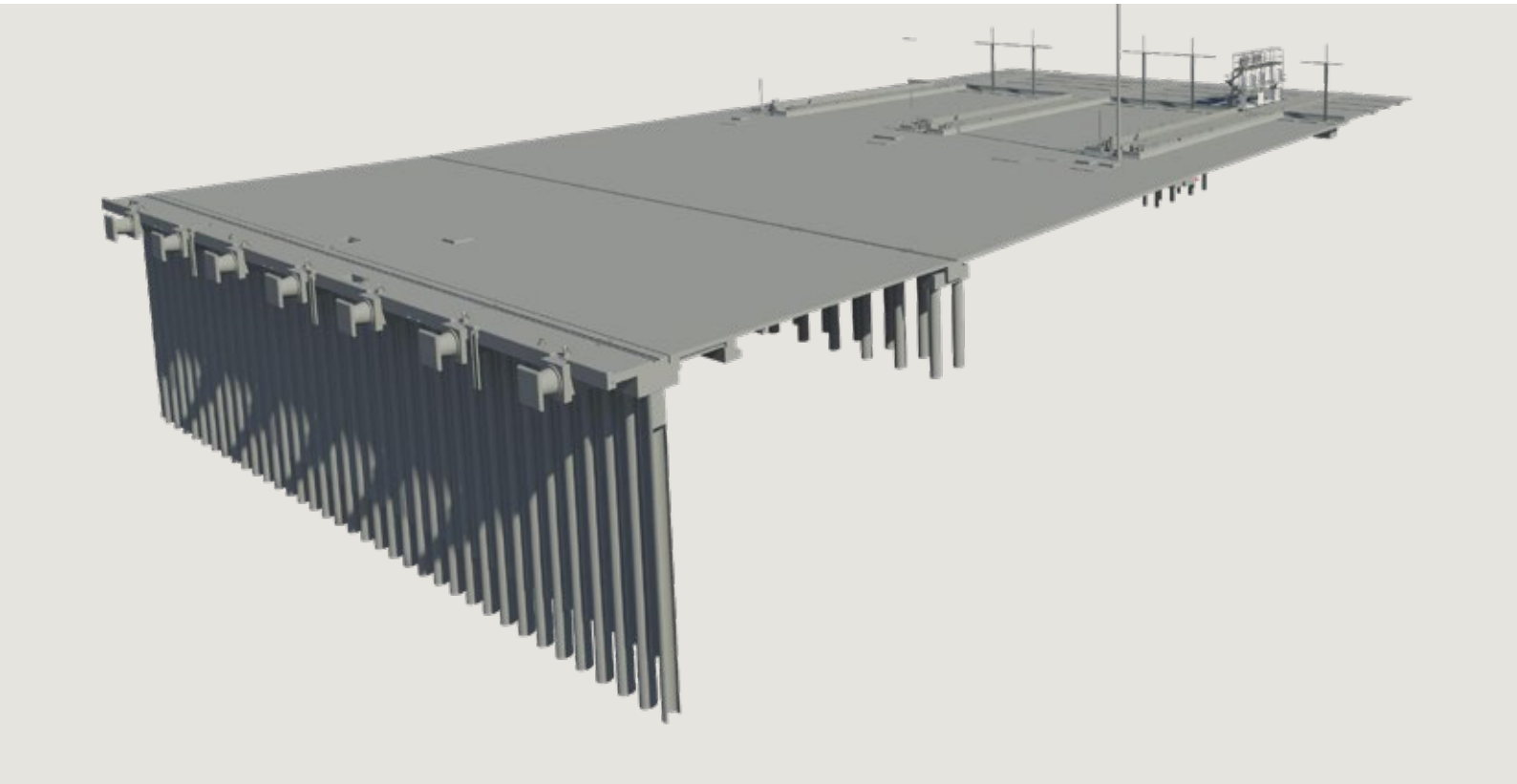
“That was a game changer within the realm of port design,” says Ann. “The stacking area was extremely congested, so getting the drainage right first time would have been almost impossible with 2D modelling. We were able to find the right fit quicker and with fewer compromises, which delivered further efficiencies for our client.”

Ann also highlights the open, collaborative environment within the multi-disciplinary team as a key reason for the project’s smooth running. “BIM demands a one-team culture and we made sure that nobody worked in isolation. Each of the core disciplines, plus the principal suppliers, could see each other’s plans at all times.” Design, construction and logistics were all included.

“I’ve never seen another consultancy approach a job like this, in this way. It was a unique achievement and I’m extremely proud of our efforts. This was a hugely challenging assignment, with a lot at stake, and we came through well. We worked under intense pressure to deliver a very

high quality product. Our client was initially sceptical of our use of BIM but, as the design developed, the value began to emerge and the client’s views changed.

“Clearly there is a significant cost and programme advantage for the project if design clashes between structures and ducts in the highly congested yard area can be spotted and corrected in the design office, and not when you have a fully mobilised construction site standing and waiting for an answer.”




Duty of care

Ian Allison, Mott MacDonald's global head of climate resilience, discusses the economic threat to ports from climate change and how owners need to think about risk right through their supply chain to protect their business.

It's hard to over-emphasise the importance of ports for domestic and global trade. More than 80% of the things we eat, drive, use and play with are shipped by sea. So, when we talk about climate change, we're talking trade and the everyday lives of people.

The financial case for climate resilience is strong. Shipping companies are intolerant of business disruption risk. In worst-case scenarios, ports that do nothing may be bypassed by shipping companies if they cannot guarantee a safe and efficient berth as sea levels rise, and as wind speeds and storm surges intensify.

Ports' ability to provide reliable, high quality service to customers depends on a network of physical assets and third party suppliers, each with its own life support network. Social, economic, financial, policy and regulatory shocks have the potential to affect all parts of this network.



“Fully resilient businesses not only deal with climate events; they rebound faster to gain a better position than their poorly adapted, less resilient competitors.”

“The economic and social consequences of climate events, as organisations falter and fail, can be profound. There is a business dividend from investing in resilience – whether that is in the form of improved protection or better emergency planning.”



House of cards

When climate events hit an insufficiently resilient asset system they can exert a shock load that triggers a collapse of functionality. Events can damage physical infrastructure, wipe out stock, disable supply chains and trigger cascade failures through interconnected asset systems. Potential vulnerabilities require continual analysis and management.

When things go wrong, the effect is cumulative. As asset systems become overstressed they start to fail more frequently. Degradation or loss of service provision can result in breach of contractual and regulatory obligations, leading to more onerous terms, tighter scrutiny and potentially shifts in policy. Loss of revenue and profitability can result in low investor confidence and harder borrowing terms exactly when additional finance is required. All this is in addition to the service disruption itself.

Realising the resilience dividend

The stark truth is that most asset owners are underprepared for the impacts of climate change. This is partly because the premise of resilience is a new one. We are only just moving from a state of mitigation into adaptation. But the cost of inaction is potentially devastating.

While the tests for vulnerability are straightforward to analyse, many ports haven't yet made the investment to understand their risk exposure, let alone the physical measures needed to combat the risks.

The first and most important step is recognising the need to adapt. Just as there are time cycles for business planning, which embrace financial reporting, investment, contracts and asset operation, climate systems also operate to regular patterns. Port owners need to recognise this link and plan for extreme climate events just as they need to plan for the impacts of currency rate fluctuations, political elections, regulatory periods or economic cycles.

Fully resilient businesses not only deal with climate events; they rebound faster to gain a better position than their poorly adapted, less resilient competitors. Achieving continuity of operation and service provision gives organisations the opportunity to grow both market share and profitability, providing a clear 'resilience dividend'.

Changing before the climate

In the next 10 to 20 years extreme weather events will become normal. Beyond 20 years we will see the emergence of long-term climate impacts. Recognising the threats and putting adaptive measures in place is vital for long-term resilience.

1.

Rising sea levels

Sea levels have risen by 0.2m in the last century and are set to rise by 1m or more by the end of this one. Often, ports will undergo a review of existing structures whenever there is a change of use, or when they refurbish berths or repair fenders. But a more proactive approach may prove prudent. Quays, jetties, mooring dolphins and bridges may all be impacted, resulting in significant damage to infrastructure and business disruption if not addressed. Incorporating long-term adaptation management is key. Raising the levels of quay wall copes and breakwater crests, and the soffit levels of suspended jetties and dolphin structures will give greater clearance from mean sea levels.

2.

Stronger wind and more powerful storm surges, more often

The concept of increased storminess is well understood. The frequency and magnitude of significant storms are increasing. As witnessed during recent hurricanes, ship-to-shore and yard stacking cranes are vulnerable to higher wind speeds, and the heavier downpours that accompany such events cause flooding and flood damage to equipment, structures and utility supplies including water and electricity.

3.

Rising temperatures

Ports need to recognise the effects of global warming on day-to-day operations as increased heat and changing humidity can impact equipment and result in higher levels of disease and dust, affecting workers. The resulting need for additional refrigeration and ventilation will inevitably raise energy usage and the environmental footprint of the port.

4.

Shifting trade patterns

As part of the global supply chain, ports are indexed to fluctuations in trade which may become increasingly volatile due to fluctuations in the climate. Failed harvests, changing land use, population movement and protectionism could all impact the amounts of goods arriving at the port gate. Ports are therefore wise to monitor their business strategies, consider diversification and identify opportunities.

5.

Changes to shipping routes

The current focus of trans-global shipping lines is the upgrading of the Panama and Suez Canals. However, with rapid ice melt in the northern hemisphere especially, there is the long-term potential of rival routes in the Arctic region, bringing both risks and opportunities.

6.

Reliance on hinterland

Port owners may find themselves more impacted by climatic changes inland, including flooding to rail and road systems, or damage caused by higher temperatures. Identifying ways to mitigate impacts – either by working closer with government departments or having alternative supply routes to avoid regular choke points – are worth investigating in advance.

7.

Reluctant or expensive insurance firms

Insurance firms will inevitably stay one step ahead of the changing weather. Ports that fail to adapt may find themselves faced with higher or prohibitive premium costs. Embarking on a climate resilient approach will prove the best way to keep the underwriters on side and prevent ports becoming uninsurable.

8.

Accounting for human impacts

Ports will need to stay aware of the local social cost of climate change, which may manifest itself in a number of unexpected ways. Worker safety concerns may increase, while climate change may also lead to local tensions with communities.



Award-winning diplomacy

Until recently the inland seas of central Europe were treated as a dumping ground for all sorts of waste, and pollution arising from ship collisions was commonplace. A Mott MacDonald-led consortium delivered a two-year project to support the development of a common security management, maritime safety and ship pollution prevention project for the Black and Caspian Seas.

The award-winning €3.4M project has improved the adoption of international legislative frameworks and conventions for maritime transport, security and environmental protection in the Black Sea and Caspian Sea countries. Covering areas as diverse as ship construction and licensing, port and harbour navigation and disposal of substances at sea, the objectives reflected the riparian states’ commitment to converge domestic environmental legislation with that of the European Union’s Water Framework Directive.

Progress has been especially poignant for project director Wim Verheugt, who worked as an environmentalist in the Black Sea region during the 1990s, leading an action plan to protect numbers of rare pelicans and cormorants.

“Back then, the seas were poisoned by toxic pollution and untreated sewage. It had reached a tipping point, and the riparian states recognised the need for change. This contract was of strategic importance.

“It suited Mott MacDonald brilliantly, with its need for trans-boundary environmental management and cross-sector expertise, especially maritime and transport consultancy.

“The greatest challenge was balancing local and regional needs. Getting everybody to pull in the same direction required a lot of face-to-face dialogue. We trained local experts who kept momentum building after our role ended. It’s humbling to play a part in something that makes such a noticeable difference to communities and wildlife.”

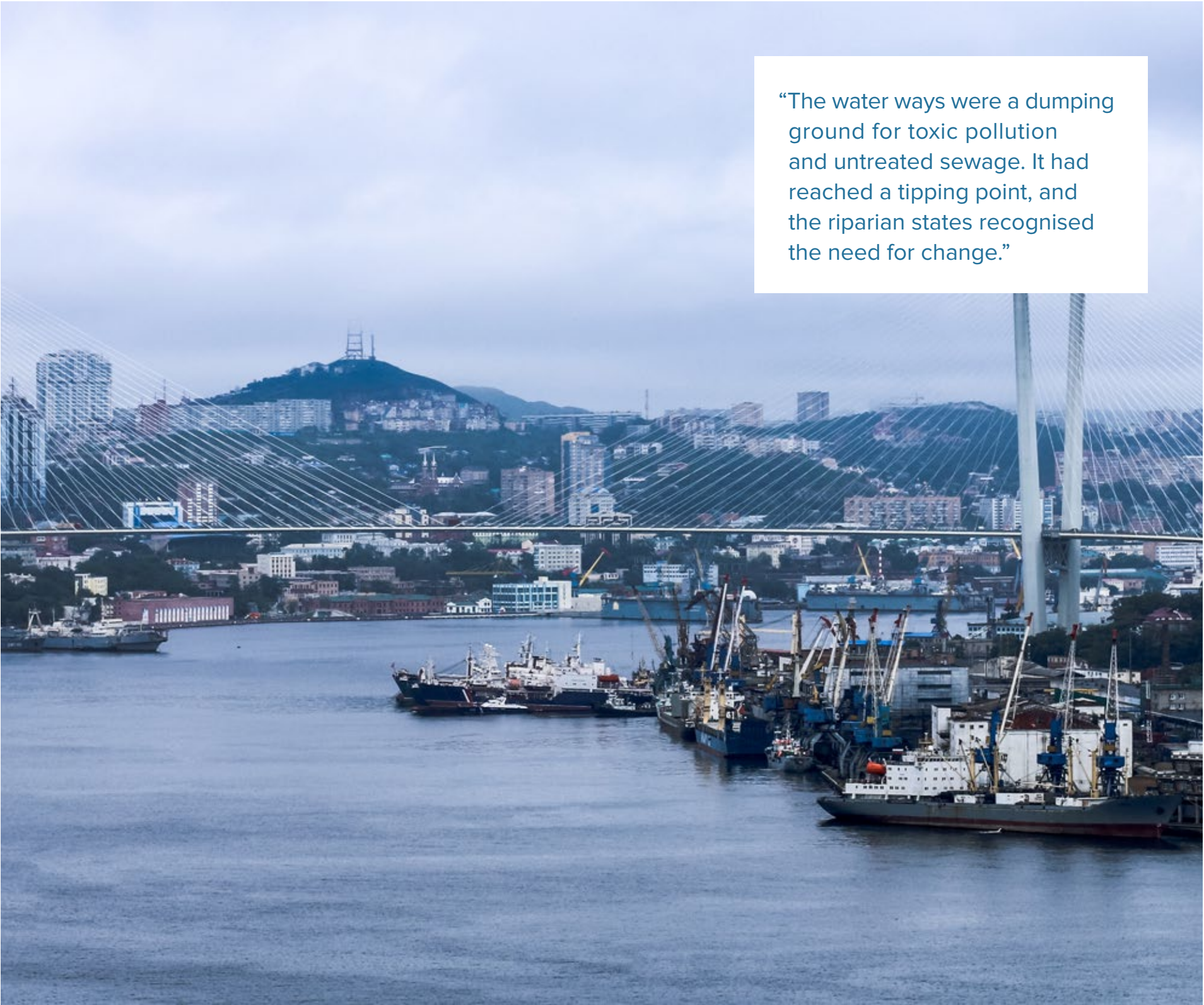
Project
Common environmental management for TRACECA countries

Location
Black and Caspian Seas basin

Client
European Commission’s EuropeAid Cooperation Office

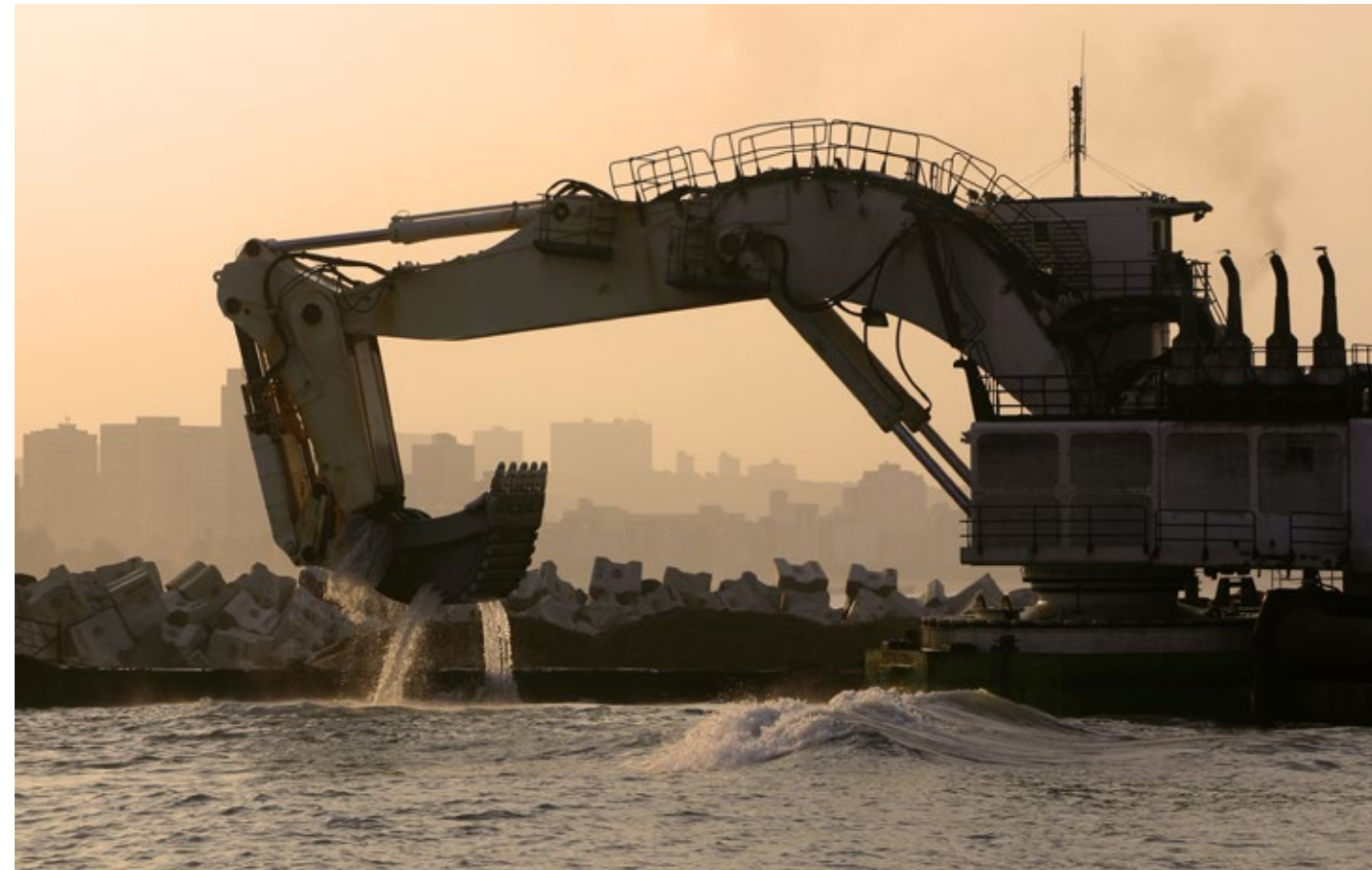
Expertise
Programme management, stakeholder engagement and institutional capacity building

“The water ways were a dumping ground for toxic pollution and untreated sewage. It had reached a tipping point, and the riparian states recognised the need for change.”



Mega opportunities

Ever since the 11,000 TEU Emma Maersk broke records in 2006, megaships have grown in size, capacity and number, says Sean Barker.



Why are we seeing ever-larger vessels?

The simple answer is 'economy of scale'. Clearly, bigger vessels reduce the transit cost of each individual shipped container. Where there is demand there will be supply – and where there is profit there will be competition for supply.

Today's megaships are the latest strategic move by the shipping sector to reduce cost of supply, an evolution that dates back to when Columbus initiated globalisation by shipping goods from the Americas to Europe.

So, ports are forced to adapt?

In effect, yes. Historically, ships have always led the way in terms of technological advances, with port infrastructure playing catch-up to these changes. Increases in ship size traditionally result in more complicated logistics chains and require increased port and hinterland infrastructure capacity, which comes at a cost. Lest we forget, the port is part of an integrated supply chain, which facilitates the bringing of goods from distant places to the doorstep of the consumer.

The shipping lines have done their part in reducing supply chain costs, and they're now looking to the ports to match their contribution. Indeed port congestion has been cited as the new barrier to international trade.

What are the implications of this changing landscape for port infrastructure?

With larger vessels arriving more consistently, ports will clearly need to improve their productivity. Factors influencing productivity can be grouped as physical, institutional and organisational, and they all play their part. From 2000 to 2010 there was an upward trend from 47% to 57% of increasing port efficiency within developing regions.

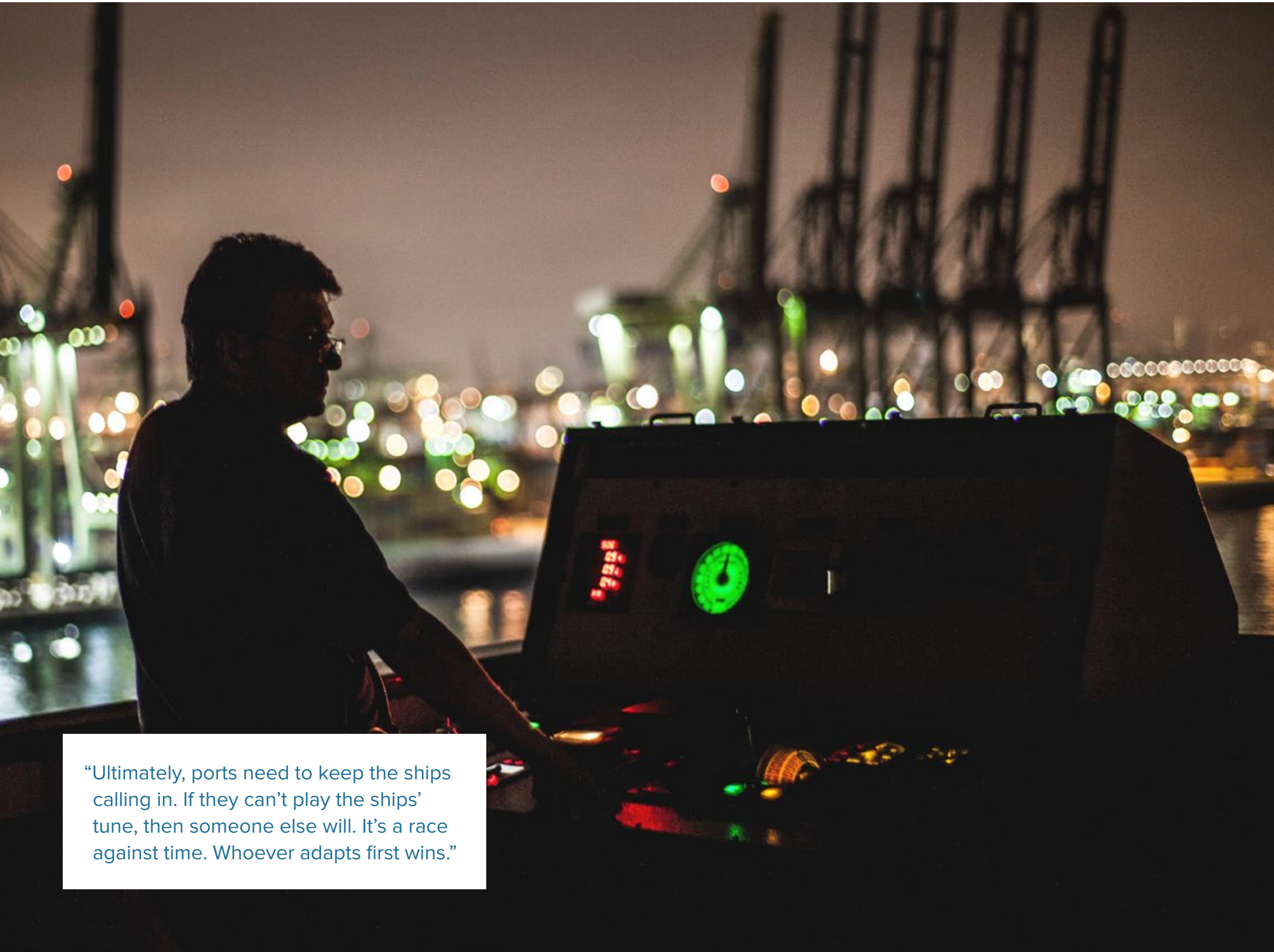
The principal factors were found to be – in no particular order – increased private sector participation, reduced corruption in the public sector, improvements in shipping line connectivity, improved landside multimodal links and improvements to physical infrastructure.

What are the most commonplace improvements?

To accommodate these vessels requires investment across the suite of port infrastructure: dredged channels and pockets, quay structures, yard configurations, gate facilities, handling equipment and power provision. In the port hinterland we need joined-up strategies promoted by regional governmental entities to identify and drive initiatives to facilitate efficient movement of goods to and from our ports.

Globally, port operators are seizing this window of opportunity to create integrated systems that complement the megaship supply chain. As history shows: if ships are laden, then ports must make themselves ready.

Wet side story



“Ultimately, ports need to keep the ships calling in. If they can’t play the ships’ tune, then someone else will. It’s a race against time. Whoever adapts first wins.”

Senior project manager Peter Mallin explains the wet side challenges faced by ports in welcoming the latest generation of megaships.

The oceans’ biggest beasts are multiplying in number, with effects stretching from open sea to hinterland connections. Wider, taller and larger ships are more susceptible to currents and wind loads, and are by nature more difficult to navigate to port within existing spatial and towage constraints. Bigger or more tugs will be needed, and tug operators need to be specially trained for the task.

Megaships need wider, deeper approach channels and harbour basins. When fully laden, megaships can draw -16m. Many European ports provide -17m low tide draft, while Euromax in Rotterdam has been dredged to -19.5m. Maintaining an approach channel to that depth is a potentially crippling cost and some ports, for now, have settled for deepening berthing pockets only. Ships are able to manoeuvre in and out only at high tide – a solution put into practice at Hamburg Port. Real-time simulation can help to ascertain optimum navigation strategies and optimise harbour upgrade requirements and towage provisions if necessary.

Offering efficient connections

New Panamax megaships apply proportionately larger forces against the quay than their forbears, with greater wind surface, displacements and prop wash. Deepening of berth pockets can critically reduce the cantilever strength of quay walls. Allied with greater lateral loading on mooring bollards and fenders, and increased loading from the larger reach cranes serving megaships, wall reinforcement may be required. Ground engineering solutions such as tie-back anchors can provide a cost-effective way to extend the life of existing walls, avoiding the need for longer, stiffer new piles. In many situations, additional riprap protection is needed to protect against scour.

As with all engineering decisions, careful study of structural capacity and wind records is essential to determine if upgrades are really necessary.

Avoiding the choke

Getting megaships to berth is just half of the equation. Upgrading crane facilities dryside and then into the hinterland is another pressing challenge. Senior ports and maritime engineer Alex To outlines the key obstacles and opportunities.

With a greater volume of containers per call to handle and with megaships expected to remain at the port on average 20% longer, it is crucial that ports plan for improvements in the handling of containers to reduce turnaround times.

An obvious solution is to deploy more ship-to-shore cranes, but this is not as simple as it sounds. Most quayside cranes are designed to be wider than container bay blocks, which means that when a crane is working, bays either side are blocked off and cannot be worked on by the adjacent crane. This issue of bay blocking requires a complete rethink of how quay cranes are built and supported at the quayside.

An example of innovative crane design, which eliminates the issue of adjacent bay blocking, is the Fastnet crane concept developed by APM Terminals, where the cranes are individually mounted on a single elevated girder supported by automated moveable pillars. This enables cranes to work on all bays of the ship.

However, the deployment of more cranes usually leads to a greater power demand for the port, which may sometimes be the key constraint (see page 22).

“The throughput may only be marginally more with megaships, but the little-and-often pace of before is replaced by massive-but-less. How do operators cope with the need to perform faster in peak times of activity, and make the most of downtime?”





Fresh perspectives

Finally, even if more cranes are adequately accommodated at the quayside, the full benefits may not be realised as the stowage pattern of the containers on the ship determines the actual number of cranes that can work on the vessel. An even spread of containers across the bays of the ship is required for full utilisation of quayside cranes.

The number of boxes handled per lift could be increased to improve the handling rate. Traditional crane arrangements consist either of two TEUs or a single FEU (40ft equivalent unit) utilising a single spreader and head-block.

Modern-day innovations have seen productivity of cranes improved by utilising two trolleys, increased hoist speeds and deploying tandem FEU lifting configurations using two spreaders and head-blocks. A tandem FEU configuration can essentially allow for the lifting of four TEUs, two FEUs or a combination in a single lift.

Although the handling of more containers per lift will improve quayside productivity, there are a number of associated operational factors, which need to be considered for this option to be fully beneficial. With the utilisation of tandem FEU cranes, congestion at the yard and wharf areas is

likely to be exacerbated since a greater number of tractor trailers are required for each lift. To reduce congestion a tandem chassis can be employed under the crane where four TEUs or two FEUs can be transported per tractor-trailer. The main disadvantage of a tandem chassis is that the terminal layout might have to be reconfigured to accommodate the larger and wider tracker trailer system.

Scaling the peaks

Quayside handling efficiency doesn't finish the jigsaw. Once the quayside matches the demands of the megaship, the efficiency of the terminal yard must also accommodate

quayside operations. The biggest impact on yard side operations will be the increase in operational peaks and the duration of these peaks. The throughput may only be marginally more with megaships, but the little-and-often pace of before is replaced by massive-but-less.

How do operators cope with the need to perform faster in peak times of activity, and make the most of downtime? Megaships will be quayside for 20% longer, but the incentive to get them out quicker – closer to 60 TEU an hour than 40 – not least to avoid demurrage – is increasingly important.

The right models and solutions can help clients make better use of downtime to organise stacking so that containers are more quickly stored, registered and moved on, so that the megaships are turned around quicker. Ports will also welcome more than megaships, so it's important not to over-focus on these giants, which may not visit every day. Port optimisation is therefore a valuable exercise.

Storage capacity is one of the key choke points of the container terminal, and should be increased where possible. Long container dwell times can also have a telling impact on yard storage capacity. However, to reduce dwell times, significant

alterations in port administration and cross-organisational procedures are required, which may not be easily achievable.

Well-established ports are sometimes unable to increase appreciably in size as they are limited by adjacent infrastructure, urban development or areas of environmental/ecological importance. Where onsite storage can't be increased, inland depots or dry ports can provide relief to congested terminals, especially if multimodal transportation is also utilised.

Beyond the fence line

Ports operators should ask themselves: are local transport links sufficient to allow for the greater volume of containers

passing through the port? In the UK, where ports are privatised, operators are asked to contribute to the cost of upgrading local transport links as a result of port upgrades. Working with local authorities and national transport agencies is crucial to ensuring local infrastructure can accommodate more frequent peaks in port movements such as those that occur when megaships call to port.

By getting the masterplan right from the start, ports can avoid bottlenecks down the line. But often, the more practical and affordable solution is to assess the limitations, adapt existing infrastructure and then integrate them to create a system that works.



Retaining the competitive edge

Moored bow to stern, it takes almost a quarter of an hour to walk the length of two super post-Panamax ships. In the summer of 2013, we were appointed by contractor Volker Stevin as designer for the extension of Berth 9 at Felixstowe Container Terminal. The port needed 920m of quay so that it could serve a pair of 18,000 TEU vessels, each measuring 400m long and 15.5m deep. The Berth 9 extension involved construction of 190m of new quay wall and deepening of the entire berth to -18m chart datum, giving a retained berth height of 24.6m, or 25.5m allowing for overdredge.

In addition to the 190m berth extension was a 95m return wall and a 190m rear wall, foundations for the ship-to-shore gantry cranes, pavements, utilities and services associated with dredging and reclamation and a remote mooring

dolphin. Full award was made to Volker Stevin in early summer 2014 and works were completed on site in autumn 2015.

The new front wall was formed of 2.56m diameter contiguous tubular piles to match the design on the existing quay. These piles were some 35m long. The seaward crane rail was again set centrally above the front wall tubular pile in a precast/in situ cope beam arrangement while the landward rail was set within a beam spanning between single tubular piles spaced at 5.4m centres longitudinally. The crane gauge between seaward and landward rails was set at 35m. The rear wall was formed of a combination of combi-wall and sheet piled wall to suit loading conditions. A central anchor wall, formed of continuous AZ24 sheet piles, was used to tie back both the front and rear walls.

“The principal technical challenge on this project was to design the new front wall – challenging in its own right – to match the performance requirements of the existing structure that was being extended,” explains senior project manager Peter Mallin.

“Loads put on to these structures are substantial and they create structural deflections under different load combinations – vertical and lateral. Berthing line and in particular crane rail alignment tolerances are tiny in comparison with the scale of the supporting infrastructure – here the specified installation tolerance on gauge between the front and rear rails was some +/-3mm – as it was on the existing quay. Designing new infrastructure to match the performance, measured in millimetres, of existing infrastructure, can be particularly challenging.”

Project

Felixstowe Container Terminal

Location

UK

Client

VolkerStevin

Expertise

Tender and detailed civil engineering design

The urgency to extend capacity at Felixstowe was particularly acute given the facility’s standing as the UK’s biggest and busiest container port, and one of the largest in Europe. The port handles more than 4M TEU and welcomes approximately 3000 ships each year, with a vast network of connections through road and rail.

“It’s a hugely competitive sector, with different ports vying for their share of traffic,” adds Peter. “Those that have existing commitments with shipping lines don’t want to lose them to a rival port in the same region or even within the same company. They have to balance the need to keep pace with the growth of ships, while using existing space as much as possible. It’s important to make sure nothing goes to waste, which is where we can really help as a consultancy.”

“The principal technical challenge on this project was to design the new front wall to match the performance requirements of the existing structure that was being extended.”





“We were able to draw in particular expertise to supplement the core team’s capability, including those who had experience across different sectors. It’s a clear example of how Mott MacDonald’s expertise is evolving to offer both the traditional and softer advisory skills for infrastructure engineering.”

Providing a critical friend

Project

London Gateway Port

Location

UK

Client

DP World, the European Investment Bank and commercial banks

Expertise

Lenders’ technical advisor

It’s well over half a century since London could boast of being truly at the forefront of international trade, but that’s changing. We acted as lenders’ technical advisor for the two-phase development of London Gateway Port. Our experts brought technical due diligence of the development and operation of this multidiscipline project, which, in time, will comprise 2700m of quay, six deep-water berths with depth alongside of 17m, 24 new-vessel class quay cranes and a capacity of 3.5M TEU.

Our team was tasked with developing borrower and lender agreements, including advising on commercial risk, outturn cost and contingency, project controls, and definition of output based performance requirements. Phase 1 funding was agreed at the end of 2011. We also provide monthly to quarterly monitoring and reporting, seeing the mega project through

construction and now overseeing operation. Berths 1, 2 and 3 were completed by the end of 2016, our services will continue until 2024 when investment payback is complete.

The port is being developed by DP World, which has put much of its own money into the project, with additional funding from nine commercial banks and the European Investment Bank.

Such a project would conventionally be undertaken by a principal delivery partner, working under an engineering, procurement and construction contract and taking all development risk. But the special purpose company created to act as client for the project, London Gateway Port Limited, wanted to develop the project with its own project management team and have the freedom to procure contracts and manage the interfaces itself.

“It was an unusual challenge,” explains project director Robert Wilson. “The lenders were potentially exposed to numerous large commercial contacts. Reassurance and trust were therefore of the utmost importance for the lenders. We worked closely with the sponsor, acting as critical friend to find the best route during construction.

“We drew in particular expertise from across our business to supplement the core financial advisory team, providing the technical insight and know-how required to assure that the best design and delivery solutions were being put forward, and translating that into easy-to-understand language.

“It’s a good example of how we can marry up hard and soft skills. We were retained for the next phases, which is always a sign of confidence.”

Sweating the asset

The ability to maximise the life and productivity of existing assets can make all the difference in achieving commercial success. Analysis and simulation of operations, from berth to gate, helps owners to spot bottlenecks or ‘fat in the system’, and test productivity improvements.



“Our client could spot and avoid problems, and see how best to keep trading during construction and handling equipment upgrades.”

We have invested heavily in Australia to create a global centre of expertise in advanced terminal simulation. We use specialist real-time software to isolate operational bottlenecks and terminal inefficiencies, and find ways to eliminate them. We have grown a reputation for changing the face of projects through innovative operational planning, often saving clients millions of dollars in development costs and even more operationally over the life of their facilities.

In 2015, we undertook a capacity analysis of the Los Angeles terminal, looking at multiple hypothetical redevelopment scenarios, with varying berth and yard layouts, and different operating equipment. Our work identified an upgrade scenario which could be delivered with least impact on operations and throughput capacity.

Project lead Rodney Hancock used simulation modelling to advise on the implications associated with implementing infrastructure and operations enhancements in the terminal, while existing operations continued. Through scenario assessment he was able to identify the optimum solution for implementing the changes with least impact. In this instance the capacity of the entire terminal would be governed by available capacity at the berth.

“Our client gained valuable insights into how best to keep trading during construction or upgrades to handling equipment,” explains Rodney. “We could help them foresee and so avoid problems. What is the best stacking strategy when operational hours are limited? How best to keep stacking mechanisms and yard equipment fully charged? We were against the clock and working remotely, so keeping open communication was vital to the project’s success.”

Leader in its field

Dynamic simulation can be used in a variety of applications for the analysis of maritime terminals, whether it’s the whole terminal or just one element such as the berth, gate, rail or yard.

The team has utilised simulation modelling on a number of terminals to examine factors such as:

- Quay crane numbers, modes and productivity rates and how these might affect ultimate capacity
- Transfer pick-up rates and numbers and how these might affect ultimate capacity
- Berth utilisations and associated vessel queuing and wait times
- Yard stacking arrangements and tractor/truck pick-up scenarios
- Yard stacking orientations and volumes and how these might affect ultimate capacity
- Yard handling equipment numbers and productivity rates and how these might affect ultimate capacity
- Gate numbers and gate processing regimes

No stone unturned

Project
Dar es Salaam Container Port
Location
Tanzania
Client
Confidential
Expertise
Terminal simulation modelling



We carried out two separate studies to look at options for a phased increase of terminal throughput. The overall driver for the client was to increase terminal capacity to match increased demand and to reduce congestion problems in the yard and at the gate.

The implications of these requirements included heavier cranes needing greater power supply, a doubling of the yard size and reconfigured entry and exit gate facilities.

“Our first study looked at options for increasing quay capacity via the introduction of new twin lift quay cranes on the existing quay and conversion of an existing and adjacent bulk quay to a container crane operation,” explains project lead Peter Mallin. “The existing quay was limited by the use of single lift cranes and throughput capacity didn’t match yard capacity.

“We reviewed extensive as-built information on the existing quay, which enabled us to analyse its structural performance under loading from the higher capacity cranes. We were able to demonstrate that the existing quay structure could deal with the larger cranes and so enable twin lift operation.”

The team also considered power. “We developed options to supply the new cranes in dedicated connection pits on the quay, without increasing the terminal’s power generation capacity.”

A second study involved review of a draft masterplan, developed in-house by the client, to increase capacity of the terminal two to three fold. Our first step was to interview port staff to understand operations at the entrance gate, within the yard and at the exit gate. We supplemented this with time and motion studies of the terminal in operation to verify processing time across the various steps.

“Initially, a spreadsheet analysis was sufficient to identify bottlenecks and whether the number of gates and size of truck buffer zones proposed by our client were adequate. Having established an understanding we then modelled the process using Arena software.”

Try before you buy

Arena is considered the world’s leading simulation software. Port operations are highly complex systems with interconnecting random and stochastic events such as truck arrival times and crane handling rates. Through the use of discrete event simulation, the random nature of operations can be modelled to mimic real-life, allowing you to appreciate, in real or fast time, the effects of proposed operational or terminal layout decisions in a risk-free environment. Bottlenecks, inefficiencies and utilisation issues can be identified with ease.

“For clients, you get to see whether your investment is well-directed. Before, it was a case of my word against yours. Now, you can set the KPIs and parameters with real accuracy, in front of your eyes.”

“We use it alongside in-house port master planning and operations advisory capabilities to help clients who are looking to develop new port terminals or simply aspiring to maximise the productivity of their current operations,” explains senior ports and maritime engineer Alex To. “It’s a one-stop shop for testing port plans from dredging requirements and infrastructure retrofits to redesigning quays and strengthening sea walls.”

Whatever you need to see

Virtually all types of ports can be simulated. Starting from the access channel, leading to the berthing of the vessel at quayside through to loading/unloading and storage of the cargo and finishing on transportation of consignments to the hinterland, each logistical step can be modelled. We may choose to simulate the entire logistics network or alternatively concentrate on one particular operation such as the port gates and truck processing system for their terminal.

We can also test existing facilities for efficiencies. It could be that tweaking the current set-up is more cost-effective than changing it wholesale. In today’s economic climate, that’s a small price worth paying.

Key applications

- Evaluate loading and unloading methods
- Identify bottlenecks in operations
- Determine facility size requirements
- Evaluate alternate capacities and schedules
- Determine the best location for landside facilities
- Determine real life storage capacity requirements
- Determine labour requirements
- Investigate reliability of plant and equipment
- Provide real-time visual representation of the port operations
- Investigate multiple scenarios in quick time
- Develop vessel traffic models

Connecting the Rainbow

Project
Transnet port major upgrade
Location
South Africa
Client
Transnet
Expertise
Engineering, procurement and construction management

Manufacturing and export, rising living standards and growing consumption, plus status as a gateway to trade across sub-Saharan Africa have made South Africa’s container ports the target for massive investment in the last decade. We provided engineering, procurement and construction management across the upgrade and expansion of 2000km of freight rail line and nine ports, including the ZAR6.2bn container terminal in the Port of Ngqura, and the ZAR4.7bn upgrade and extension of container terminals in Durban and Cape Town.

Working closely with national owner/operator Transnet, we were involved from initial planning and consultation, through

design development and construction supervision, to handover. Among the various achievements, the team recorded 5M hours with no lost time injuries in the construction of various facilities at the Port of Ngqura.

Rudie Basson was directly responsible for Transnet’s ZAR340bn rail and port infrastructure expansion at this time, and has since joined Mott MacDonald as rail and port practice lead in Africa to promote best practice and support professional excellence networks.

“These are vital projects to safeguard South Africa’s position as a major transshipment destination,” he says.

“Durban – the continent’s second largest container port behind Port Said in Egypt – is especially important, and Mott MacDonald is providing design work on feasibility for further incremental expansion around the old airport, where we aim to swap planes for ships.

“There are stiff environmental and social challenges, as the coast is a major breeding ground for fish, rare populations of chameleons, as well as a home to communities of subsistence farmers. Our breadth of disciplines allows us to come at the project from many different perspectives.”



Opening opportunities with connected thinking.

If you'd like to discuss any of the themes in this publication, or talk to us about any other ports topic, please get in touch with global leader for ports Sean Barker.
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