



- Panama Canal Expansion
- The autonomous ship
- Ukraine port crisis
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Panama Canal Edition 63



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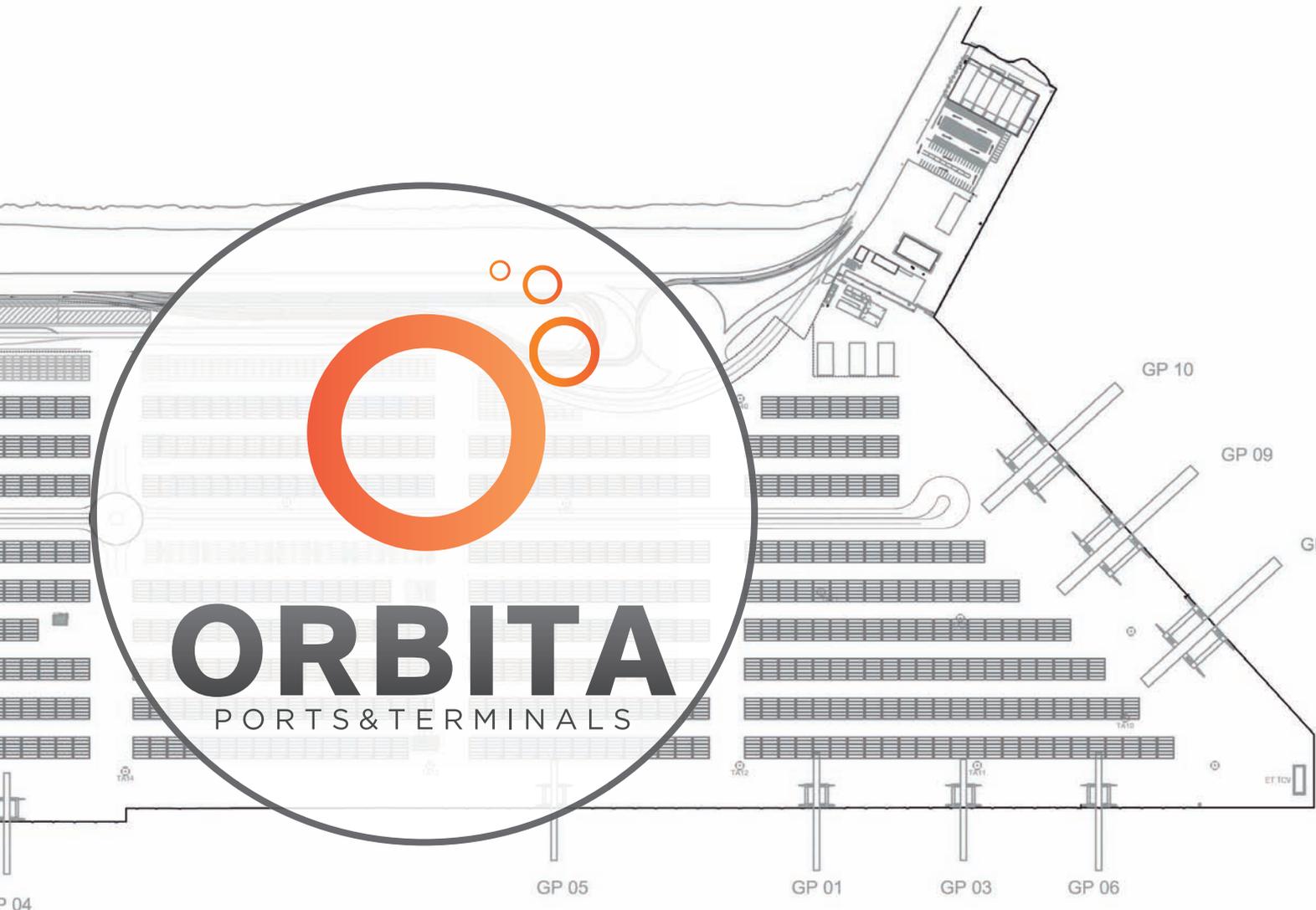


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I was completely bowled over by the feedback we had from our readers concerning Issue 62 – the gold-fronted PTI Collector’s Edition. Nothing compares with getting positive feedback from our readers and partners and their enthusiasm was understandable: that issue included nearly 200 pages on all aspects of port technology, not to mention 20 exclusive PTI interviews featuring the big names in equipment supply in the global ports and terminals industry. What’s not to like?

This issue is also a special edition that puts the Panama Canal Expansion as our central theme. One of the largest engineering feats of the 21st century so far, the Panama Canal Expansion should have a beneficial effect on global sea trade and a knock-on effect on ports in the region. Indeed, some US east coast and southern ports are already dredging, digging and modernising in preparation for the larger ships. The passage of larger ships carrying larger loads that will be able to sail through the new Panama Canal should exert a downward pressure on haulage prices which can only increase the industry’s competitiveness. The project is expected to be completed in early 2016, and we are fortunate to have writing in this issue US-based MWH Global, the engineering firm that has been responsible for the design of the Third Set of Locks project – read about it on page 30.

This issue also offers the same lively mix of technology, interviews, analysis and comment. Thanks to our Partners in Publishing, we are able to bring you cutting-edge technical information on all aspects of the ports and terminals industry. This includes articles from Port Economics, such as that by Gordon Wilmsmeier and Ann-Kathrin Zotz who write about emerging reefer challenges in Latin America. And also from our regular contributor Professor Theo Notteboom, who writes with Kateryna Grushevska on the effect that the Ukrainian crisis is having on the region’s ports. Shanghai Maritime University is another regular contributor with two insightful articles revealing the progress of the port system in China.

Next year will be PTI’s 20th anniversary and we are going to celebrate that in style. While not wanting to give too much away, you can be sure to expect more special editions crammed with technical papers, interviews and the latest developments in this exciting sector. And it will be exciting, as the industry gradually sails out of recession and ports and terminals see more efficiencies from automation, innovation and better training. Indeed, training is a hot topic at the moment: one interesting angle is provided by TBA’s Yvo Saanen who writes about the training of operational control staff using games – an innovative and fascinating technique (p 72).

TOC Europe took place in London for the very first time in June. It was my first TOC and PTI held an unforgettable networking event at The Ritz. The sheer breadth of technology and innovation that was on display at TOC was incredibly impressive and I can only see this event growing in strength and numbers. I applaud the organisers who did such a great job in staging a very successful event. And there is more to look forward to. TOC Americas takes place in Cartagena, Colombia, on 14-16 October and, like TOC Europe, will comprise a high-level conference, exhibition and technical seminars. Get there if you can.

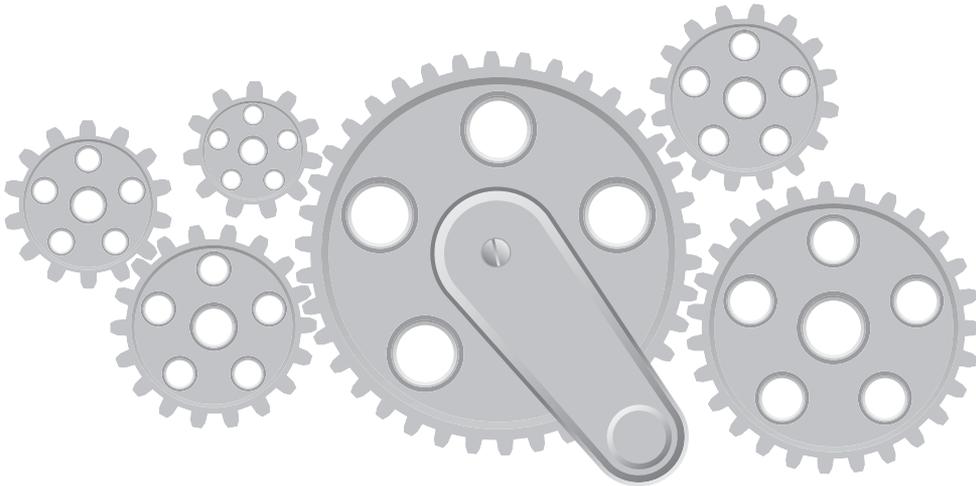
Finally, it gives me great pleasure to announce that PTI has just added two new Preferred Partners, both of whom are globally-renowned specialists in their respective fields. Navis has made huge progress in managing and optimising the movement of cargo in more than a 100 terminals worldwide. And RBS, which specialises in developing software exclusively for applications in container handling, will launch a very exciting development in 2015. It is a great privilege to welcome them both.



**James AA Khan**  
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Published by:  
Maritime Information Services Ltd  
5 Prescott Street  
London, E1 8AP  
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Tel: +44 (0)207 871 0123  
Fax: +44 (0)207 871 0101  
E-mail: [info@porttechnology.org](mailto:info@porttechnology.org)  
Website: [www.porttechnology.org](http://www.porttechnology.org)

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Design & Production:  
Tina Davidian

Printed by:  
Buxton Press Ltd

Front & Back Cover:  
Orbita Ports & Terminals  
[www.orbitaports.com](http://www.orbitaports.com)

Sixty Third Edition, September 2014  
ISSN: 1358 1759

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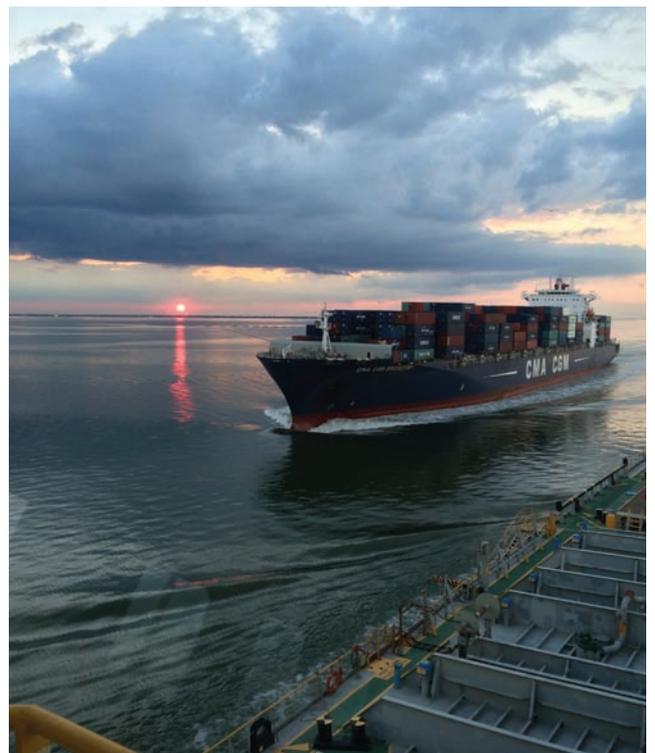
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# Panama Canal dig unearths hidden treasures

Richard Joy, *Editorial Assistant, Port Technology International, London, United Kingdom*

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As the work on the Panama Canal Expansion winds down to completion in January 2016, scientists have revealed a historical trove of artefacts that were discovered during construction. A plethora of archaeological and paleontological treasures has been discovered as workers blasted through ancient earth and foraged around in the thick Panamanian vegetation.

Reports claim that the find includes the fossilised remains of up to 3,000 invertebrates and 500 vertebrates, as well as more than 250 plants, and perhaps most amazingly, the remains of a forest consumed

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Top: Palaeontological dig on the shores of Lake Gatun; Bottom: Restoring a 16th century Spanish dagger.



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Some of the Pre-Colombian arrowheads discovered.

by flames following a volcanic eruption.

Specialists brought in by the Panama Canal Authority have identified the remains of camels, crocodiles, sharks and the bones of an array of animals believed to be millions of years old.

According to researchers who analysed the area and the findings, the most interesting element was the age of the earth beneath Panama. Evidence discovered during the canal excavation proved that the Panamanian land mass began forming around 20 million years ago, despite previous estimates which assumed it was closer to three million years.

Organisms have been found from early epochs which show that the land emerged gradually as ocean waters receded to form the famous Isthmus of Panama.

Carlos Jaramillo of the Smithsonian Tropical Research Institute (STRI) has labelled the findings as "revolutionary" and vowed to continue studying climate change and the origins of the animals that migrated across the land bridge from one America to the other.

The dredging work undertaken in Lake Gatun and the subsequent excavation of tons of earth also uncovered evidence from hundreds of years of human habitation. The eras found extend from pre-Colombian, to colonial and provincial times, and onto Panama's independence from Colombia in 1903.

Among the variety of artefacts discovered were pottery shards, arrowheads and a 16th century dagger. Charting Panama's more recent history, a collection of bottles, wagons and buckets, presumably used to mix cement, were found that would have been utilised during the canal's first wave of construction and which concluded with the opening of the Panama Canal in 1914.

The Panama Canal Authority signed a contract for paleontological research with the Smithsonian Tropical Research Institute (STRI). Its work has resulted in numerous finds, including 5,377 rock and sediment items and 3,485 fossils.

# In Brief

## CMA CGM signs accord with CSCL and UASC

CMA CGM, the world's third-largest container shipping company, announced that it has signed three major agreements on the biggest worldwide maritime trades with China Shipping Container Lines (CSCL) and United Arab Shipping Company (UASC). Collectively called Ocean Three, the agreements concern the Asia-Europe, Asia-Mediterranean, Transpacific and Asia-US East Coast maritime trades. The agreements will combine vessel sharing, slot exchange and slot charter. Rotations will be optimised with calls to all the biggest Asian, European and North American ports, using trans-shipment hubs common to the three partners.

## Asia dominates port rankings

Asian ports continue to shine, accounting for nine of the top ten ranking ports and 26 of the top 50 places, according to a global ports report commissioned by the Journal of Commerce (JOC). Shanghai maintained its top-spot for the fourth year running, followed by Singapore in second and another Chinese port, Shezhen, coming in third. Only Dubai's Jebel Ali could break the Asian monopoly in the top ten as it came ninth. Europe's largest port, Rotterdam, recorded an eleventh place finish with the potential to improve its standing once the new Maasvlakte 2 terminal is completed later this year. The report also stated that should Los Angeles and Long Beach be combined, the amalgamation would rank ninth.

## British MP fears EU port control

British MP John Redwood has expressed his concerns about the EU taking control of the UK's main ports. Redwood claimed the EU wants to regulate the 47 largest ports in the UK, and that the port industry is opposed to this. He said that many backed the proposal for a debate in the House of Commons given the importance of the potential EU power grab, adding that he and like-minded politicians have informed a European

Select Committee that the whole regulation of ports needs to be stopped as it is not needed. In an article he wrote for *The Commentator*, Redwood lambasted the growing legislative tentacles of the EU operating against UK interests.

## Philippines sets penalties in bid to clear congestion

The Philippine government has passed a policy which imposes penalties and fines for any cargo containers left at the Port of Manila for five days after being cleared for transfer. Cabinet secretary Rene Almendras said that commencing October 1, 2014, charges of US\$115 per container per day will apply for cargoes that are not moved out of ports within the five day-period. Measures to reward operators who move containers quickly and efficiently are also being implemented.

## Hamriyah to receive a multi-purpose terminal

Hazel International FZE, owned by Veritas (India), will invest US\$126 million to open a complete end-to-end facility for liquid and solid cargo handling at Hamriyah Free Zone Authority (HFZA) in the UAE. The terminal will store chemicals, oils and gases and will also provide other facilities, including distillation, extraction, hydrogenation and fractionation. According to HFZA director Saud Al Mazrouei, HFZA has emerged as the second-largest hub for petrochemicals, oil and gas bunkering, and storage in the UAE.



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"During the planning process for the project, ACP made a decision to use tug boats instead of locomotives, as used for the current locks, to guide ships through the new lock chambers. This decision was made for both economical and practical reasons..."

'Design of the third set of locks', page 43



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# Panama Canal: the early years



Michael King,  
Editorial Assistant, Port Technology International, London, UK



Credit: Ferdinand de Lesseps\_PT, wikipedia.org

In 1877, Ferdinand de Lesseps was approved by the French government to build a sea-level canal across the Isthmus of Panama.

“A finer body of men has never been gathered by any nation than the men who have done the work of building the Panama Canal; the conditions under which they have lived and have done their work have been better than in any similar work ever undertaken in the tropics; they have all felt an eager pride in their work; and they have made not only America but the whole world their debtors by what they have accomplished.”

✘ Theodore Roosevelt, 26th US president, 1901-1909

The Panama Canal stands at 77km in length and takes 15 hours to traverse (eight hours are spent waiting in traffic). It is around 40m deep and 150-300m wide and remains integral to worldwide shipping today. If built today, it would cost around US\$33 billion to complete.

The Panama Canal has its origins as part of Colombia's Province of Panama.



Philippe Bunau-Varilla (commons.wikimedia.org)

Philippe Bunau-Varilla: by 1903, a new treaty was negotiated by French businessman Philippe Bunau-Varilla, giving the US perpetual rights to build a canal across the Isthmus of Panama for an annual payment of US\$250,000.

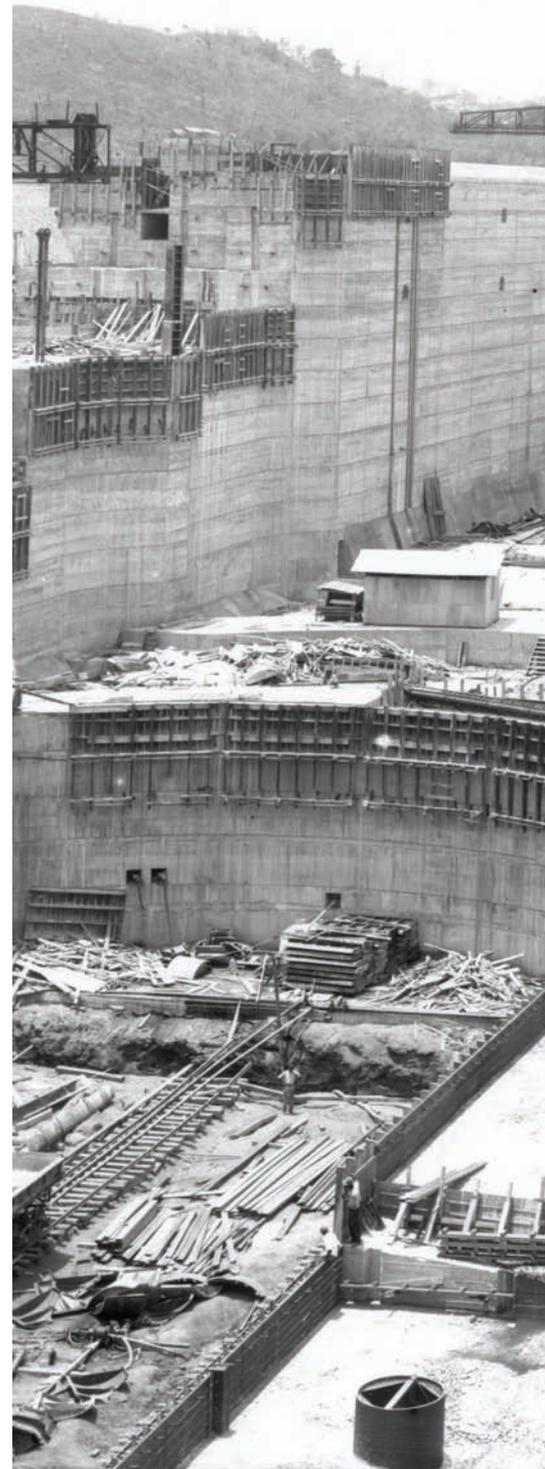
However, when Colombian authorities rejected US plans to build a canal across the Isthmus of Panama, the US supported a revolution, which led to Panama's independence in 1903.

## The first attempt

In 1875, under Colombian control, a US investigative team comprising 100 men began surveying Panama in search of a practical canal route. The search was deemed to be ill-fated, as the prospect of building a canal across Panama was too expensive.

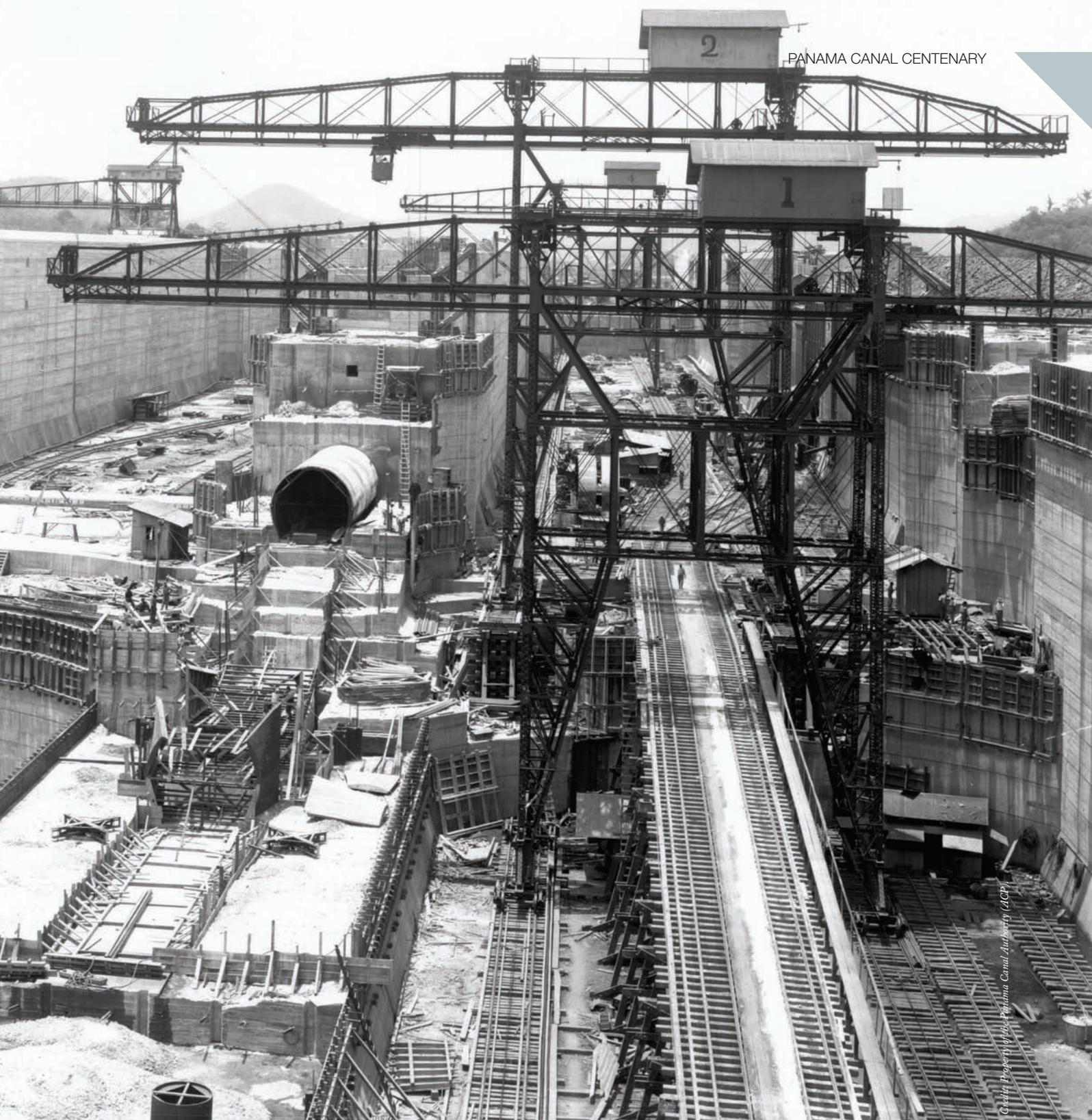
## The second attempt

Two years later, a French team of surveyors completed their own survey, and the French government approved diplomat Ferdinand de Lesseps plan to build a sea-level canal, costing around US\$250 million.



Excavation began in 1882, but was not making sufficient progress. Workers had contracted yellow fever, leading to the death of around 400 people in 1884 ✘ a 226% increase from the previous year.

In the subsequent four years of excavation, work on the canal was not as productive as originally planned. Violent confrontations occurred between Panamanian and Jamaican workers, resulting in a further 25 deaths, and only a few metres (out of the hundreds required to reach sea-level) had been dug

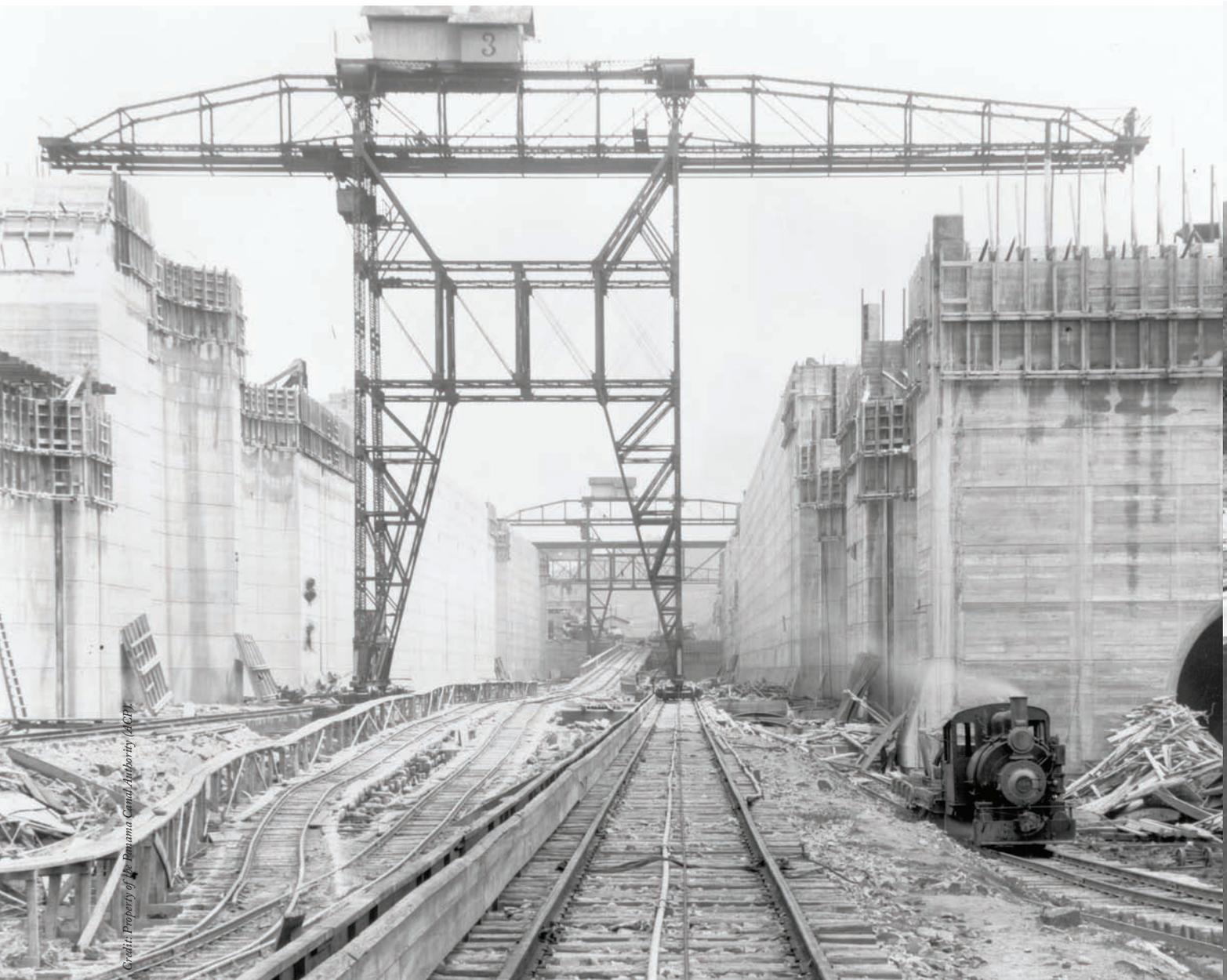


*Credit: Property of the Panama Canal Authority (ACP)*

Top: Looking North, general view, upper locks (1912); Right: Looking South, general view, lower locks and east chamber (1913).



*Credit: Property of the Panama Canal Authority (ACP)*



Credit: Property of the Panama Canal Authority (ACP).

Pedro Miguel looking North, East chamber (1911).

out of the canal.

Despite best efforts made by the French, De Lesseps ran out of money to fund the project; his company went bankrupt and the project was abandoned in 1889.

### The third attempt

Around the time of Panama's independence in 1903, a new treaty was negotiated by French businessman Philippe Bunau-Varilla, giving the US perpetual rights to build a canal across the Isthmus of Panama for an annual payment of US\$250,000.

Excavation began again in 1904, under

Theodore Roosevelt's new Isthmian Canal Commission (ICC) in order to see through the construction of the Panama Canal.

By November 1904, the workforce had reached 3,500 and malaria had been identified as the cause of 70% of workers' illnesses. Another outbreak of yellow fever hit workers over the next two months, causing labourers to resign and return to the US. As a result, productivity was low, leading to the resignation of chief engineer John Wallace.

July 1905 saw the arrival of the new chief engineer, John Stevens, who called for state-of-the-art equipment to help

with excavation. He realised that, due to a faulty railway line, spoil could not be transported away at the same rate as the canal was being dug. Consequently, the excavation was stopped in order to focus on the repair of the railroad.

By mid-1906, new tracks had been built along the Panama railroad, meaning that more spoil could be transported away from the site. With a workforce of around 22,000, the canal was beginning to make steady progress. This was further augmented by the ICC, which had set up recruiting agencies in order to attract European workers. Around 12,000 contracts had been issued and the work



*Credit: Property of the Panama Canal Authority (ACP).*

The first transit 'SS Ancon in upper west chamber, Miraflores (1914).

ethic of unskilled Spanish labourers was helping to increase productivity on the project.

With the introduction of a new railroad, Stevens began to feel as though his expertise was no longer needed on the canal. He described the canal as 'a big ditch' in a letter to Roosevelt in February 1907 and this subsequently led to his resignation.

After the appointment in 1907 of a new chief engineer, George Goethals, the workforce totalled 46,000 men. A variety of leisure activities, including the introduction of a YMCA-club had been set up to fuel productivity. These

developments had clearly worked because during January 1908, around two million cubic metres had been excavated  $\approx$  approximately 400,000 cubic metres more than the previous month.

The Panama Canal was finally completed in 1914 and officially opened for trade in the same year. The cost to transport goods was set to 90 cents per cargo ton, and by 1939, annual traffic had surpassed 7,000 ships.

With the arrival of channel lighting in the 1960s, transportation through the canal was available 24 hours a day. Annual traffic had risen continuously during the 40s, 50s and 60s, and by the 1970s,

around 15,000 ships were using the canal every year.

However, in recent years, the canal has not been sufficient to accommodate the larger ships. Currently, the largest ships that can sail through the canal are the Panamax vessels. To increase capacity, work has begun on a canal expansion project. Once this project has been completed, it will allow the passage of larger (12,000-13,000 TEU) 'new-Panamax' ships to sail through the canal.

Sovereignty was handed back to Panama during the late 1970s, and the canal is now managed by the Panama Canal Authority.



# The third lock expansion



Richard Joy,  
*Editorial Assistant, Port Technology International, London*

In a 2006 national referendum, the Panamanian people voted in a majority of 80% in favour of expanding the Panama Canal. Positioned in its strategic location balancing trade between the Atlantic

and Pacific Oceans, an expanded canal promises at least 45,000 additional jobs and to inject a massive boost into the local economy, with income estimates ranging between US\$5-6 billion a year

for Panama. To understand the sheer scale of the canal in the context of global commerce, it is worth bearing in mind that approximately US\$9 trillion transits the canal on an annual basis, with the



Property of the Panama Canal Authority (ACP)

The expansion of the Panama Canal (Third Set of Locks Project) will double the capacity of the Panama Canal by allowing more and larger ships to transit.

canal interlinking 1,700 ports in 160 countries.

Since its inception, the canal has allowed the eponymous Panamax-sized vessels to travel through its waters. However, in an evolving industry which now uses increasingly large megaships, and with ever-increasing demand for use of the canal which causes bottlenecks and lengthens waiting times, expansion was paramount, especially if Panama wanted to move into the future with potentially the most important and lucrative trade canal in the world.

Søren Skou, CEO of the world's biggest cargo shipping company Maersk Line, has spoken of the expansion, indicating how a large waterway is vital in providing supply-chain efficiencies for both developing and emerging economies, with Panama taking the necessary steps to continue writing the history books for the next chapter of international trade.

And that next chapter is not far off. By December 2015 the canal is primed to have two new sets of locks - one on the Pacific side and one on the Atlantic side of the canal - each equipped with

three chambers, and each chamber having three water-saving basins. The added locks mean a new transit lane will be in place specifically for New-Panamax ships, which have been specially created to achieve maximum capacity through the expanded canal, and that is a figure is almost triple the figure that is currently possible. Given the current expanding economic climate, the expansion arrives at an ample time for Panama, with the canal countenancing a multitude of challenges.

Nearby Nicaragua recently awarded a 50-year concession to the Hong Kong-

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Property of the Panama Canal Authority (ACP)

The impressive Centennial Bridge spans the Canal.

based international infrastructure development firm HKND to construct a canal through the country, with Nicaragua, and by extension China, seemingly intent on rivalling the Panamanian centenarian.

However, estimated costs for the Nicaraguan project already top a dizzying US\$40 billion, and that is not even including the locks that would be vital for such an operation in order to tackle Lake Nicaragua, which lies 32.6m above sea level (compared to the 26m of Lake Gatun in Panama). With the additional environmental issues and the significant risks of earthquakes, the Nicaragua Canal appears to be light-years behind the Panama Canal in realisation.

Closer to home, during construction, the Panama Canal Authority (ACP) encountered some friction with Grupo Unidos por el Canal (GUPC), the firm hired to implement the expansion, leading to delays which threatened the construction of the project due to a claim of unforeseeable concrete design changes.

However, discussions were held, and agreements were made to see work firmly back on-track with the first set of massive lock gates installed in their chambers this July.

With the completed canal on the horizon, the massive potential to boost throughput with the promise of bigger vessels arriving has triggered ports on the eastern and southern coasts of the US which currently accounts for a staggering 70% of container traffic that passes through Panama at present into dredging, digging and modernising port, terminal and harbour facilities.

US ports in the states of New York, South Carolina, Maryland, Virginia, Florida, Georgia and Texas have all seen or are witnessing redevelopments in an effort to become the cutting-edge exclusive ports that mega-ships can dock at now they have an option to bypass the US west coast.

While at Jacksonville Port, Florida, in 2013, President Obama outlined how new super-tankers, capable of holding three

times the amount of cargo, will soon be coming through the canal and how he desired that the super-tankers call-in at Jacksonville. He actively argued that if the US wanted its workers and businesses to compete in a global market then its ports have to be ready to receive super-tankers.

American natural gas producers are also eager to utilise the canal in the post-expansion era as it would allow them to easily export fossil fuels to Asian countries. A study commissioned by the US Government suggests that despite only 6% of the global LNG tanker fleet being capable of using the canal at present, that figure is expected to rocket to around 90% post expansion.

US vice-president Joe Biden has identified the pertinence of this, stressing how important it is for the US, as energy production throughout the Americas grows, with Panama set to play a critical role in bridging energy supplies in the Atlantic with a growing demand in the Pacific.

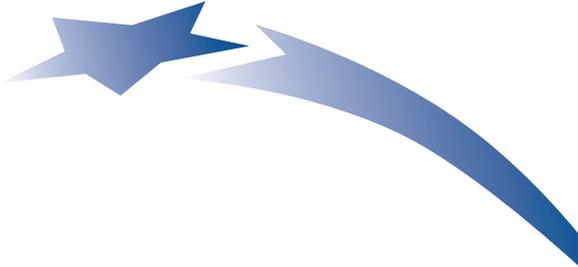
The reverberations of the expansion are also being felt way beyond the US,



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Top: Installing the lock gates on the Atlantic side of the canal, as at July 31, 2014; Bottom: Works on the Pacific side (photo taken November 2013)



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Property of the Panama Canal Authority (ACP)

A tight fit in one of the existing canal locks.

with the Cuban government inspired to develop its deep-water Mariel Port in tandem with the Brazilian Government, and the China Harbour Engineering Company having a framework agreement to build a new port on the Goat Islands near Kingston, Jamaica.

Robbert van Trooijen, chief executive for Latin America and the Caribbean at Maersk Line, has spoken of the impact the expansion promises to have on his area of the world, outlining the positive developments in port infrastructure across the region, with more investment along the Panama Canal area during the last two years than the previous five. Key projects are underway in the US, Panama, Colombia, Mexico, Dominican Republic, Costa Rica, Peru and even countries like Cuba and Venezuela, as investment in port infrastructure continues to grow to accommodate the expected increase in tonnage that will navigate the region.

The ramifications of the expansion

not only mean increased trade and cargo shipments arriving, but also carry a knock-on effect in which the local areas around the deep-water ports are impacted with the growth provided by higher imports and exports. Real estate has become a premium around the redeveloping ports as well as prospective warehouse space, with international commerce giant Amazon announcing with developer Duke Realty a project to construct a one million square-foot distribution centre around the Port of Baltimore.

### Preserving nature

The Panama Canal winds its way through a rich, natural landscape. A vast array of colour and wildlife sits on the banks of the canal, and understandably, environmental questions have been raised concerning the impact of the expansion and prospective trade on the area.

As the locks currently use water from Lake Gatun, the levels of which can

reduce during the dry season, questions had to be addressed concerning how onerous a third set of locks would be. In response, innovative water-saving basins have been designed adjacent to the locks which can recycle the water used in each of the three lock chambers. The basins are capable of conserving up to 60% of water used per transit, and vitally, a policy of reforestation is in place to nourish any negatively-affected areas during construction to keep the natural landscape bursting with vigour and life.

In the global context, the expansion of the canal will act as a catalyst for environmental efficiency as it will see vast LNG vessels travelling through and bringing greener fuel across the east-west divide much faster, thereby boosting the LNG network.

By 2016, the global shipping network could strike a very different picture with the Panama Canal set to perpetuate its standing as the vital vein of worldwide trade.

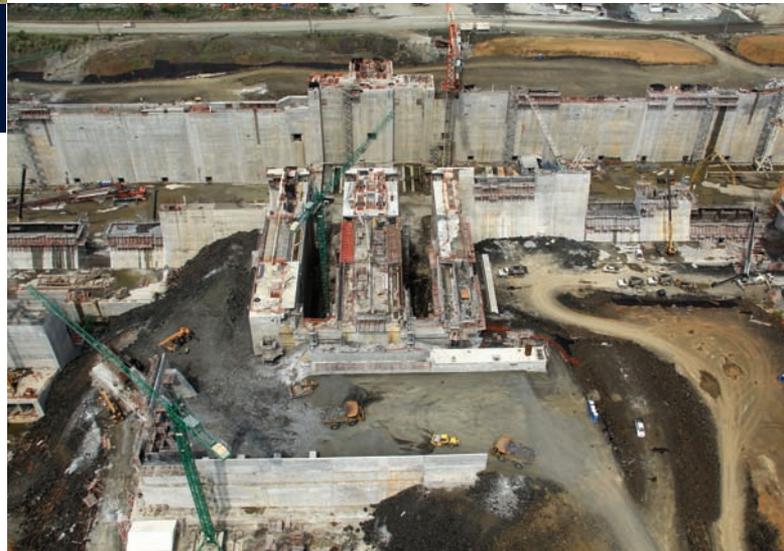
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# Panamax and beyond: the story of ship sizes



Richard Joy,  
Editorial Assistant, Port Technology International, London

As the Panama Canal has historically been such a vital passageway in the development of global trade, the size of the original canal locks have given root to a ship size-specification that was long the standard for global shipping: the Panamax.

The Panamax (see diagram) is defined by having a beam (the width of a vessel) of 32m, allowing it to just squeeze into the 33.5m Panamanian locks. This size of ship was crafted in the 1980s after the mass development of the TEU (twenty-foot equivalent unit) container in the previous decade; the combined factors of a boom in international trade and a nascent globalised capitalism rendered the containership an ideal form of cargo movement.

Therefore, the size specification for a ship regarding its capacity is measured by the amount of TEU it can hold, and by the mid-80s, the Panamax could haul up to 4,500. However with trade branching all over the globe, there was a desire to get even bigger yet.

Creating the post-Panamax was a risk. Draft (how deep a ship extends underneath the water) was an issue, as was capacity at ports; and also, whether the infrastructures at ports could handle the post-Panamax loads and the fact that shippers would have to redefine global trade routes. However, yet again, demand from a global market rendered the post-Panamax a reality, and by the millennium ships of up to 8,000 TEU had been established on service routes around the globe.

## Catering for larger ships

The increasing size of vessels has meant that ports and harbours have had to be dredged in order to be capable of accepting the ever-increasing ship sizes. The risk of not meeting these demands

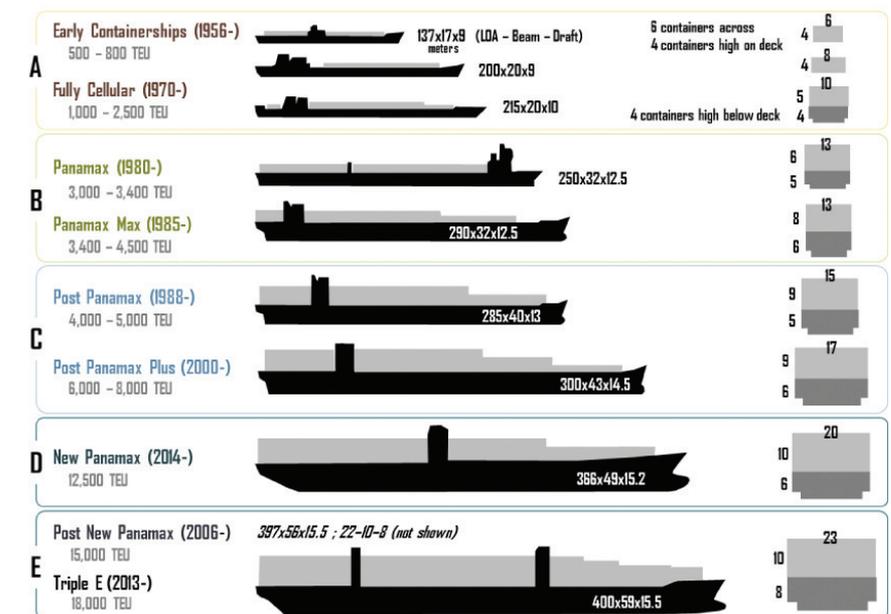


Diagram showing the growth in ship capacity from early containerships in 1956 to today's Triple E class. Source: Ashar and Rodrigue, 2012

means potentially being left out of the most prominent supply-chains.

The ports that benefitted from the increase in ship-size became established as the world's biggest and busiest ports due to the unique capacities they could accept. But that was until the Panama Canal Expansion was announced, which has meant that post-Panamax ships would finally have the capability of traversing the canal, allowing the ports once excluded by trade routes to be potentially at the centre of trade. Nowhere is truer of this than the US, where the once dominant west-coast ports are now under pressure from the south and east-coast ports which can now accept trade from the Pacific Ocean.

The expansion has also inspired a new creation; the New Panamax, a ship meeting the new dimensions of the expanded canal and offering up to 12,500 TEU capacity, likely to serve the Americas and the Caribbean from European and Asian originations.

Beyond the Panama Canal, Maersk launched a 15,000 TEU 'E-class' in 2006 - a type now referred to as 'post-New Panamax'. In 2013, Maersk launched the staggering 18,000 TEU 'Triple E', and shipping contractors plan to go even bigger, with rumours circulating that a plan is in the pipeline to construct a 'Malacca Max', a ship capable of hauling up to an incredible 30,000 TEU.

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# Design of the Third Set of Locks



Greg Hillebrenner, Vice-president MWH and Design Manager Panama Canal Expansion Third Set of Locks project

As the Panama Canal celebrates its centenary in 2014, a new set of expanded locks is being built near the existing locks at the Atlantic and Pacific entrances of the canal. After 100 years of operation the condition and performance of the existing locks is still impressive and significant as they will continue to operate even after the completion of the new third set of locks (TSL). The newly designed TSL will allow for the passage of larger post-Panamax cargo ships that

can carry approximately three times as many containers as the existing Panamax ships can when traversing the canal.

The new locks have been designed by a joint venture (JV) led by MWH Global (US) that also includes TetraTech (US) and Iv Groep (Netherlands). The JV, contracted to design-build contractor Grupo Unidos por Canal (GUPEC), has designed a new set of locks that have applied many of the lessons of the first canal in order to build a new set of locks

that will address the needs of the Canal for the next 100 years.

## A layout for the next 100 years

Both the existing and new Atlantic and Pacific locks move ships between the ocean and Gatun Lake and back to the ocean in three nearly equal steps at each end of the canal, a total vertical distance of approximately 26m. This is accomplished using the principals of gravity, with no pumping of water



Rendering of the Third Set of Locks project from the Pacific entrance. Joint venture design led by MWH Global (US) and including TetraTech (US) and Iv Groep (Netherlands).

involved, controlled by a sequence of hydraulically-operated valves that convey water from Gatun Lake through the lock chambers to the ocean.

Availability of the locks for passage of ships is extremely important and critical to the success of such a large and heavily-trafficked canal. To accomplish this reliability, the current locks use two parallel lanes near each ocean entrance. In addition to providing for an efficient movement of more ships, this arrangement also provides a redundancy to the system that allows maintenance to be performed on one set of chambers while allowing the other set to be fully operational.

For the new set of locks the owner, Panama Canal Authority (ACP), decided on a single-lane layout to reduce construction costs and also to avoid having to construct additional water sources to support the operation of the canal system with the new locks. The TSL chambers are approximately 50% wider and longer than the existing locks and are built to accommodate post-Panamax ships. The current locks consist of two parallel sets of three chambers, each 33.5m wide by 305m long, whereas

the TSL's single set of three chambers are each 55m wide by 427m long. And to accommodate a greater draft for the larger ships, the chamber wall heights have been increased to 33.5m from the current 26m.

The single-lane design requires that the TSL have built-in redundant features to allow minimal downtime for maintenance. The TSL scheme has been designed to ensure continuous availability for 99.6% of the time. Achieving such high levels of reliability necessitated a detailed evaluation of all equipment and maintenance requirements, as well as ensuring that a robust, proactive maintenance schedule was in place.

One important redundant feature implemented for the TSL is having two identical rolling gates at the ends of each TSL lock chamber. Each gate can be completely retracted into a recess in the concrete structure; once closure panels are put in place, the recess can be dewatered to allow maintenance on one gate, under dry conditions, without interrupting the operations of the TSL.

Additional redundancy would be provided by future construction of a fourth set of locks as envisaged by ACP that would allow for temporary

maintenance shutdowns of the TSL and potentially accommodate the passage of even larger ships.

### Conserving water

The source of water for both the existing and new lock systems is Lake Gatun, created by Gatun Dam located at the Atlantic entrance of the canal. When designing the TSL, the team had to make the most efficient use of available water within the Lake Gatun watershed so as not to require the construction of an additional source, such as a new dam and reservoir. To avoid such an eventuality, ACP opted to incorporate Water-Saving Basins (WSB) into the design of the TSL project. Comprised essentially of a local water-storage reservoir for each chamber, covering an area of approximately 10ha, the WSB is subdivided into three smaller sub-basins at different operational levels.

Utilising wheel gate-type valves to control flow in both directions for filling and emptying the lock chambers, the gravity operation of the WSBs allows for nearly 60% of the water required for each lockage to be reused. This allows the TSL to use approximately 7% less water for a total lockage than



Rendering of TSL Atlantic side showing lock gates in the closed position.

Property of the Panama Canal Authority (ACP)



The new steel lock gates are 30m high, 58m long, between 8-10m wide and weigh up to 4,400 tons.

Property of the Panama Canal Authority (ACP)



Preparing to place the gates into position, August 2014.



Property of the Panama Canal Authority (ACP)

The two recesses into which the sliding gates are retracted for opening/closing operations and for maintenance.

the existing locks, even though the new chamber size is much larger. The net quantity of water used for a complete transit (ie, both Atlantic and Pacific lockages) and discharged to the ocean is reduced to 180 million litres (equivalent to approximately 70 Olympic-sized swimming pools) for the TSL when the WSBs are used, as compared to 200 million litres for the existing locks without WSBs. The TSL can also be operated without using the WSBs during maintenance periods or when the water level in Lake Gatun reaches too high a level during the rainy season and ACP desires to release additional water to the ocean to lower the lake level.

### Choosing a lock gate

The current locks use a traditional mitre gate, which was the standard type of gate used for lock structures at the time the existing locks were constructed. The existing locks contain two mitre gate leafs at each location, weighing up to 700 metric tonnes each, that must either be removed by a large floating crane or have the lock chamber dewatered to allow in-situ maintenance in the dry.

ACP undertook a thorough evaluation of the types of gate to be used on TSL,

given its wider lock chambers and the increased need for redundancy and performance of maintenance activities. Following extensive research into locks globally, ACP decided to incorporate rolling lock gates into the TSL, as opposed to the mitre type used on the existing locks.

Given the stringent 99.6% reliability requirements for the TSL, combined with a wider and deeper chamber, and increased seismic and fatigue criteria, ACP decided to use rolling gates operated by a motorised drive mechanism, each of which can be opened or closed in 405 minutes. There are a total of eight new gates at each lock complex, two at each of the four lock heads (for redundancy) that form the three lock chambers.

These new, enormous steel gates are on average around 30m high by 58m long. Depending on their location and due to different loading conditions, the gates have a width of 8m-10m and weigh 3,000-4,000 metric tonnes. Integral flotation chambers and the effects of buoyancy mean that the operating weights of the mostly submerged gates are around 10% of their gross dead weight, or 330-440 metric

tonnes. The 16 new lock gates have been fabricated by Cimolai in Italy and are being shipped to Panama in groups of four aboard a ship specially designed to safely transport the large gates across the Atlantic Ocean. On reaching Panama, half of the gate total will then be transported individually by barge through the existing locks and canal to the Pacific site.

### Tug boats replace locomotives

During the planning process for the project, ACP made a decision to use tug boats instead of locomotives, as used for the current locks, to guide ships through the new lock chambers. This decision was made for both economical and practical reasons – too many locomotives would have been required to guide the larger post-Panamax ships. In addition, locomotives over the decades of use have proven to be costly to both purchase and maintain.

To assist the tugs, post-Panamax ships are required to be fitted with special bow thrusters. The TSL chambers will also have continuous rubber fenders installed along their walls to protect the ships and walls from damage.







Aerial view of the construction at the Pacific site, August 2014.

### An efficient filling and emptying system

In the existing lock chambers, water is introduced and evacuated via a bottom-filling/emptying system comprised of 100 round openings in the floor of each chamber. But the new TSL filling and emptying system utilises side-filling – a series of 20 port openings (each measuring 2m by 2m) are located at the base of the lock walls along each side of a chamber. Water is supplied to these ports through a secondary culvert supplied with water from the WSB (60% of total) and an interconnection to the main culvert connected to Lake Gatun (40% of total). This new system can fill or empty each chamber in 17 minutes when using the WSB and 10 minutes without using the WSB.

### First time seismic criteria

Not much was known about seismicity across the Isthmus of Panama during the design and construction of the existing locks. Studies for the new TSL in 2004 determined that there existed a potentially significant seismic risk for the project and, therefore, stringent design criteria for seismicity should be included in the designs for the new locks. While there

are no active faults in the direct vicinity of the Atlantic site, the Pacific site required special design for four faults that crossed the project – three for Borinquen Dams and one for the TSL Upper Chamber. Higher seismic requirements for the new locks involve resisting large, lateral earthquake design forces that require the use of reinforced concrete, as opposed to the mass concrete used in the existing lock system. Due to the different seismic risks determined for the Atlantic and Pacific sites, the new Pacific Locks Complex concrete structures require approximately 30% more reinforcement than the Atlantic Locks Complex. A total of nearly 220,000 tons of concrete reinforcement steel for the TSL project is required, as compared to the unreinforced mass concrete used for the existing locks.

### Concrete requirements

When determining the criteria for the new locks design, ACP placed a stringent requirement that all concrete should have a service life of 100 years; it should also withstand the variability of water salinity, ranging from fresh water to high-salinity seawater, and also the resulting corrosion of any steel reinforcement in the concrete. These were not factors for the existing

locks, which were constructed using mass concrete without reinforcement.

Water salinity in the lock chambers varies across the project – it is lowest at the freshwater intake from Lake Gatun, and highest at the ocean entrances of the canal. To provide an economical design with reduced potential for cracking, while also providing the required corrosion protection for reinforcement, a 60cm-thick structural marine concrete mix that is more dense was used as an outer ‘skin’ for the lock structures. This denser mix was used to encapsulate the reinforcement in areas exposed to contact with water and to surround an interior mass concrete mix that contained a lower cement content to reduce heat generation. Multiple concrete mix designs were developed by the contractor for the structural marine concrete to accommodate the variable salinities of the water that exist throughout the length of the lock chambers. Sophisticated thermal analyses were performed to determine the required maximum placement temperatures needed to reduce the potential for cracking due to the large temperature gradients and excessive drying shrinkage. Lower placement temperatures for the



## About the author

Greg Hillebrenner is vice-president of MWH Global. He has been serving as design manager for the Panama Canal Expansion's Third Set of Locks project since April 2013. Prior to assuming this position for the MWH-led design joint venture, his initial assignment on the project beginning in 2009 was deputy design manager, primarily responsible for design management of the new Pacific Locks Complex. Hillebrenner has extensive experience as a project manager, design manager, project engineer and civil/structural engineer for all phases of the design and construction of large water resource projects. He has a Bachelor of Science degree in civil and structural engineering from the University of Illinois at Champaign-Urbana.

## About the organisation



MWH Global is the premier solutions provider focused on water and natural resources for built infrastructure and the environment. Offering a full range of innovative, award-winning services from initial planning through construction and asset management, MWH partners with clients in multiple industries. Its nearly 8,000 employees in 35 countries spanning six continents are dedicated to fulfilling its purpose of 'Building a Better World', reflecting its commitment to sustainable development. MWH is a private, employee-owned firm with a rich legacy beginning in 1820.

## Enquiries

[www.mwhglobal.com/panama-canal](http://www.mwhglobal.com/panama-canal)

A very busy construction site.

concrete were achieved by introducing ice water at the batch plant during the mixing process.

### Impacts of previous excavations

Between 1939 and 1941, the United States began excavations for a new set of locks; however, with the onset of World War II, construction was put on hold and later abandoned after the war ended. These previous excavations at each site significantly affected the design and construction of the TSL, but in different ways. At the Atlantic site, the previous excavations benefited the project, as it was possible to align the TSL chambers within the existing excavation. This allowed the new chambers to be excavated by widening and deepening the previous excavations to accommodate the larger dimension required for the TSL.

At the Pacific site, however, the opposite situation existed and the previous excavations negatively affected the project expansion. Due to physical space limitations at the site, it was not possible to locate the chambers for the TSL within the existing excavations. Not only was it necessary to excavate completely new lock chambers, it was also required to remove the water and soft muck that had accumulated in the

previous 30m-deep excavation and backfill it with rock and earth fill to the ground surface to allow construction of the WSBs, operations buildings and access roadways. Once the project is complete, however, the TSL Complexes at each site will appear nearly identical.

### Summary

It is difficult to describe in such a short article all the similarities and differences between the existing and new locks. However, the author hopes the reader has been given a useful insight into the design and construction of this immense feat of engineering. For 100 years, the existing locks have proved durable and have performed beyond expectations, thereby setting the benchmark to be met or exceeded by the new TSL. As the tools available for analysis and design have become much more sophisticated since the original design, so have the expectations and requirements for a service life of at least 100 years. This requirement, combined with the reliability factor of 99.6%, has pushed the design envelope to a new level, such that the Panama Canal Expansion's new TSL sets new standards for the future design of navigation locks throughout the world.

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# Global Issues



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# Trade-offs and their economics



Allen Funston, *Consultant,*  
*Ausenco, Vancouver, Canada*

Cost-benefit analysis is a relatively straight-forward exercise for large discrete choices in natural resource supply chains such as transportation modes and site locations. When average or typical operations are well understood, the benefits of one choice over another can often be very one-sided, making the best choice obvious. However, we have found through the dynamic modelling of complex supply-chain logistics that many of the most impactful decisions relate to variability and are more continuous in nature. We call these decisions 'trade-offs' and evaluating them economically can help you optimise your investment once you have exhausted your present assets' capabilities.

## What is a trade-off?

A trade-off is a decision of 'how much?' or 'how many?', rather than 'which one?' or 'go/no go?'. Here are just a few examples of trade-offs and the real economic risk they present if they are either too conservative or too aggressive:

- **Storage capacity:** Insufficient storage capacity shuts in pipelines upstream and downstream, delays trains and ships, or forces plants to be shut down, resulting in millions of dollars in lost capacity or missed opportunity. However, additional tanks, stockyard lines, and storage buildings can cost upwards of \$20 million each. How much storage capacity do you build?
- **Fleet size:** Insufficient fleets underperform during surges in demand, resulting in missed deadlines, lost customers and unsustainable revenue. However, excessive fleet capacity is unnecessarily expensive: unit trains can cost \$15 million each and chartering a ship can cost \$50,000 per day. How many locomotives, railcars, and ships do you buy or lease?

- **Equipment redundancy:** If you drive high utilisation on all of your processing assets, you will lose capacity and revenue every time there is a delay. Although installing spare equipment can mitigate these impacts, it can be wasteful and expensive in the extreme. What baseline utilisation do you plan for? How many hot and cold spares can you justify?
- **Optimal inventory levels:** Given fixed storage capacity, you have a choice of the average inventory level you keep. High inventory levels avoid shutting in downstream systems but frequently shut in upstream systems, and vice versa. Inventory carrying costs and the associated reduction in your working capital also need to be considered. How much inventory should you keep on average?

Each of these decisions helps reduce the impact of expected variability from seasonal volume surges and unit loads (trains, batches, and ships). Of course, we assume you have already tried to minimise unexpected variability due to breakdowns and unplanned delays. While seasonal and unit-load variability remain necessary in many supply chains, they can cause you less grief if you estimate how much to expect and invest accordingly.

## How do the economics work?

Trade-offs generally exhibit increasing net profits up to modest levels of investment in equipment and diminishing returns thereafter. Consequently, there is typically an investment level beyond which marginal profit is negative (ie, the capital costs of one more unit exceed the net present value of the revenue that the unit generates).

Figure 1 presents a sample economic trade-off graph that considers 10 motors in parallel production lines with spares to offset the variable breakdowns.

The x-axis shows the number of spare motors. Throughput increases as spare motors are installed to cover the occasional breakdown. However, the system's throughput begins to plateau once four spares are on hand; that is, there is 'sufficient coverage' for the variability. As a result, the cost of the fifth spare (and each subsequent one) outweighs the net present value profit of its lifetime throughput. You can observe this effect in two ways. Firstly, note that the total NPV profit is maximised with four spares and it decreases thereafter. Secondly, note that the marginal NPV profit per motor is negative beyond four spares.

One other observation about throughput is also worth noting. The fifth and subsequent spares still increase throughput, it is simply that their contributions are not enough to justify the investment. We recommend that you operate at your system's 'practical capacity', the throughput that maximises profit. Just because you can increase throughput, does not mean that you should.

## Using trade-offs to make economic decisions

First, make sure that your existing system is as profitable as you can make it. Note that maximising profitability is not the same as minimising costs. Most supply chains have significant low-cost improvement opportunities. We have found that analysis of detailed historical operating data is a good first step to identify them. In a system with low-cost improvement opportunities, a trade-off mindset may not be your best first option; it may be possible to both improve performance and scale back on spending simultaneously. Tools to achieve these ends include Lean Six Sigma, Total Quality Management (TQM), and Theory of Constraints (TOC).



Capesize vessel moored at LNG berth, Peru

### About the author

Allen Funston is a professional consulting engineer at Ausenco who has optimised and planned multi-billion dollar organisations' natural-resource supply chains across six continents. Passionate about generating and sustaining measurable value through data-driven techniques such as dynamic simulation modelling, Funston has also pursued an MBA to integrate rigour into the development of his clients' global corporate strategies.

### About the organisation

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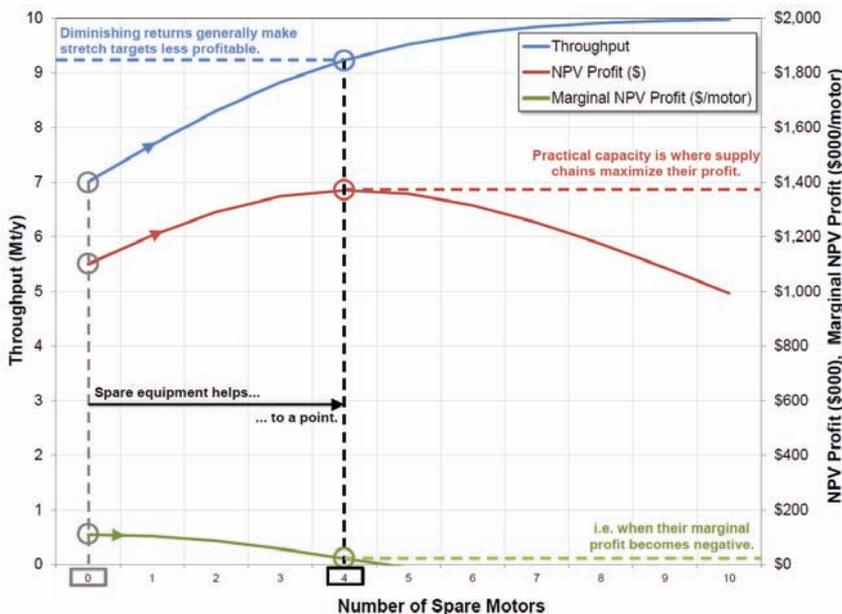


Figure 1 – Economic Trade-off (ten-motor example)

However, once you are convinced that capital investment is necessary to reach your company's economic goals, evaluating continuous trade-offs will help you right-size your investment. When selecting an economic analysis tool, we recommend Dynamic Simulation Modelling because it

is reliable, data-driven and risk-based.

If you have found this article helpful, feel free to visit our website at <http://www.ausenco.com/simulation#> for more information on our open-source simulation software, consulting services, and publications.



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# The Ukrainian crisis: impact on the regional port system



Kateryna Grushevska and Prof Theo Notteboom  
ITMMA, University of Antwerp, Belgium

Edition 61 of Port Technology International (February 2014) featured an article on 'Dry bulk cargo in Ukrainian ports'. During the past months, the events in the Ukraine have hit world headlines. In this contribution, we discuss how current and recent events and developments in the Ukraine and the Black Sea region are affecting Ukrainian ports.

## Turbulent times in Ukraine

After the referendum in Crimea on March 16, 2014, the Autonomous Republic of Crimea became a part of the Russian Federation on March 18, 2014. This event incurred a complete change of legislative and regulatory institutions for ports and railways which previously

were a part of the Ukrainian state-owned and centrally regulated transport network. Moreover the tensions in the eastern and southern part of Ukraine are threatening the present integrity of the state.

The European Union and the US continue to put pressure on Russia to help solve the clashes with pro-Russian rebels in the east of the country. The political situation in Ukraine was influenced by the presidential elections on May 25, 2014, won by Petro Poroshenko.

In late June 2014, Ukraine and the European Union signed a free-trade pact. Just like Georgia and Moldova, Ukraine has the ultimate goal of entering the EU. However, the EU has made no promise it will allow entry to Ukraine. The signing

of the pact is a key action as Ukraine's former pro-Russia president Viktor Yanukovich turned his back on signing the EU agreement in November 2013. His position in favour of closer ties with Russia prompted months of street protests that eventually led to the Ukrainian crisis. The recent events in Ukraine might even turn out to be more significant to the country than the independence from the Soviet Union in 1991.

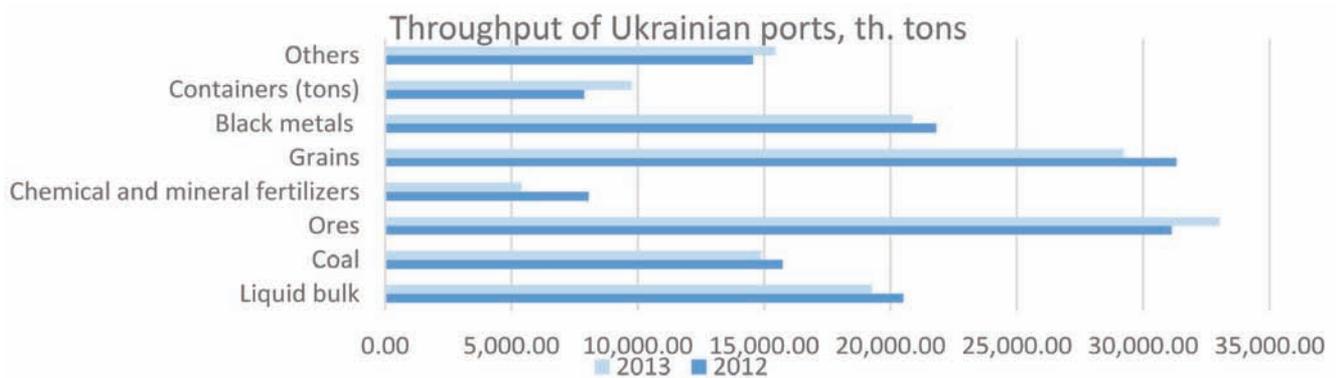
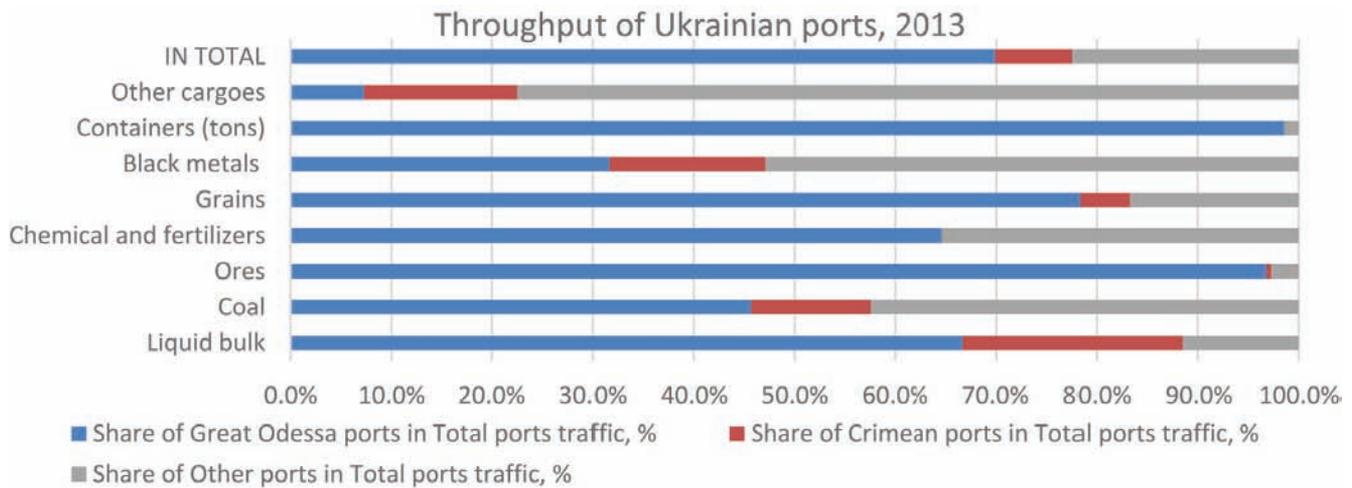
During the past half year, the Ukrainian economy destabilised with the local currency devaluating by about 35%. The heavy industry activities in the east of Ukraine (Donbas and Poltava Region) are facing hard times. Russia-Ukraine trade relations are also affected by the recent turmoil. In a reaction to the trade agreement between EU and Ukraine, Russia has threatened to withdraw the duty-free treatment that Ukraine currently benefits from as a member of the Commonwealth of Independent States (CIS) free trade agreement. If Russia would start to impose customs duties, Ukraine's exports could be heavily affected (particularly base metals, grains, machinery, equipment and food). Despite the crisis, Russia remains a key trade partner of Ukraine: 24% of its exports are related to Russia. A way out for Ukraine would be to re-export EU products to Russia thereby avoiding possible Russian duties.

## Cargo impacts on Crimean ports

The Ukrainian port system is feeling the full impact of the crisis. This section describes the expected intra-Ukrainian cargo-flow shifts; more precisely, which cargoes are more likely to be rerouted to continental Ukrainian ports and which will stay bounded to Crimea.

Figure 1: Ports of Black Sea





Top: Cargo through Ukrainian ports expressed as a share of other regional ports;  
Bottom: Throughput of various cargoes through Ukrainian ports.

There are five ports in Crimea: Yevpatorya, Sevastopol, Yalta, Feodosiya and Kerch. Several factors affect cargo traffic rerouting in these ports:

- There is a clear reluctance of foreign cargo owners to send cargo via these ports. They will most likely prefer more stable Ukrainian ports such as Odessa, Yuzhnyi or Illyihevsk. The main cargoes handled in Crimean ports were grains (mainly in Avlita port for the global traders such as Kernel, Luis Dreyfus etc) and metals by SCM holding (in Avlita).
- Crimea is facing challenges with hinterland connections. The only way to avoid a transit via Ukraine is by ferry via Kerch port to Taman and Caucasus port of Russia.
- The plans for the Kerch bridge have been revived (estimated cost about RUB50 billion or US\$3 billion) and the construction is expected to take three to four years. However, no real investment plans were officially published.
- The capacity of Kerch port is very low because of several reasons: (i) the current daily loading/unloading capacity is about 50 wagons; (ii)

there are about 200km of one-direction, non-electrified railway. Assuming that in over four years there will be a bridge connecting the Crimean territory with the continental part of Russia, the maximum capacity of the whole transportation corridor (Taman-Kerch-Feodosia) will reach 12-15 trains per day (Centre for Transport Strategies (CFTS)).

- Russia's deputy prime-minister Rustam Temirgaliev recently communicated that the ports of Feodosiya and Yevpatorya are going to be closed, and a new road will be constructed between Yalta, Alushta and Feodosia. These developments among others are expected to be included in the 'Project of Territorial Planning of Crimea', presented to the government of the Russian Federation for final approval on June 1, 2014. The reasoning behind the closure of these two ports, as explained by Crimea's minister of transport Yuriy Shevshuk, is that the cargo handled in Crimean ports was mainly to/from the continental part of Ukraine. As Crimea has become

literally isolated from the continental part of Ukraine, the future port volume prospects are low, unless the political relations between Ukraine, Russia and Crimea improve.

The prevailing cargo type for Crimean ports was oil fuel and oil products (4.2 million tons in 2013). The ports involved in the liquid bulk handling were Kerch (1.9 million tons), Feodosiya (2.1 million tons) and the remaining share was shipped via Sevastopol. Most of the oil and oil products were transit cargoes, originating from Russia and Kazakhstan. About 15 million tons of liquid bulk (exports of Russian oil and oil products) are handled offshore in the Kerch strait. As it concerns cargoes with a Russian and Kazakh origin, it is likely that these cargoes will continue to be handled via Crimean ports. However, port operations at Feodosiya have a big probability of being suspended due to new governmental policy.

Experts believe that 7% of the metal products of SCM holding that were handled in Avlita (private terminal in Sevastopol port) will be redirected to Odessa/Yuzhnyi ports (see also [www.cfts.org](http://www.cfts.org)). The redirecting of these

metal cargoes to ports in the Azov Sea (Berdyansk, Mariupol) is less viable, because of their limited draft and ice conditions in winter time. Moreover the passage via Kerch strait is operated by the Russian pilotage agency, and all shipping activities are affected by the political agreements between Ukraine and Russia.

According to experts and business representatives from Ukrainian ports, the grain terminals on the continental part of Ukraine have enough capacity in place to welcome the rerouted grain flows previously handled in Crimean ports. The main terminals are located in the Great Odessa region (ports of Odessa, Yuzhnyi and Illichevsk). The total terminal capacity amounts to 50 million tons per year with a draft of 18-20m.

There are several Crimean ports handling sand and cement: Sevastopol Fishery port, Yevpatoriya, Yalta and Kerch. There might occur complications with the export of construction materials (mainly sand) with a Crimean origin at the local company Suesta which operates via its private port in Kamyshovaya bay in Sevastopol Fishery port (800,000t tons exported per year). In the surroundings of Kerch port there is a private cement factory owned by Altkom said to be owned by Aleksandr Tyslenko. Moreover, this factory has a dedicated deep-sea terminal for handling four million tons of cement per year. Cement is not officially recorded in the statistics of Kerch port. So, when it comes to the export of cement and sand the ports may still remain at the same level because of the locational proximity and transport costs, though the enterprises owned by Ukrainian businessmen are expected to be affected. Note that people having businesses in Crimea cannot be citizens of Ukraine, except if they are Crimeans. Recently the Ukrainian parliament accepted a law on 'the rights and freedoms of citizens in the temporarily occupied territory of Ukraine'.

The only port that received considerable import cargoes was Yevpatoriya. It mainly deals with ro-ro cargoes (about 33,800 cars were handled in 2013). Apparently these cars will not enter via Crimea anymore, because of the isolated and limited consumer market and because of the recent intention of the local government to stop all cargo operations in Yevpatoriya port.

### **Russian cargo transiting at Ukrainian ports?**

Russia remains an important country for the Ukrainian port system. Russian cargo (export) through Ukrainian ports

amounted to 27 million tons in 2013, or about 18% of total Ukrainian port traffic. This figure includes 11 million tons of Russian coal and ore (about 25% of total coal and ore traffic in Ukrainian ports). The port of Illichevsk handles almost all ferro-volumes with a Russian origin (1.8 million tons). Most other Russian cargo passes via the Great Odessa ports. The container flows transiting to/from Russia and handled by Ukrainian ports are very small mainly because of the customs bureaucracy in Ukraine.

For many years, Russia has developed plans to build a new Greenfield port, ie Taman, in the eastern part of the Black Sea. The port should be operational in 2020. Given the recent Ukrainian crisis, it now remains unclear whether Russia will go ahead with the plan to build Taman Port or, alternatively, might opt for a further development of the port of Sevastopol in Crimea. Recently, the Russian Federation president's economic advisor warned that they are currently reassessing the infrastructure investments for this year (US\$3 billion or RUB100 billion). These investments were initially planned for the Taman port construction and the bridge construction over the Lena River. A decision on the infrastructure investments will be taken soon. In our view, the large Taman project seems to be more important for the Russian Federation. The port is planned to have a draft allowing vessels of up to 150,000 DWT, a total capacity of 50 million tons in Phase 1 (ultimate capacity is about 100 million tons), facilities for dry bulk, general cargo and containers, no weather delays (unlike Novorosiysk) and rail and road connections (unlike Novorosiysk).

The implementation of the Taman port project will facilitate the process of diverting Russian cargo out of Ukrainian ports. It will also facilitate the introduction of direct calls to Russian ports. This development can even generate a cargo shift from Baltic gateway ports to Black Sea gateways in view of reaching the Russian hinterland, particularly since sailing from the East to Taman port would require 12 sailing days less than to Baltic ports. It is important to mention that 60% of the Russian population is closer to the Black Sea than to the Baltic Sea. During the USSR era, 70% of USSR cargo was shipped via Black Sea ports (with Odessa and Illichevsk now being part of Ukraine). It seems the Black Sea ports, particularly Russian ports, will regain their key position to accommodate Russian cargo.

### **About the authors**

Kateryna Grushevska joined the University of Antwerp's ITMMA in 2013 as a PhD student under the BACKIS scholarship programme of the European Commission. She holds an MSc in Transport and Maritime Economics from ITMMA. Her research activities at ITMMA particularly focus on ports and logistics in the Black Sea region.

Theo Notteboom is president of ITMMA (an institute of the University of Antwerp), professor at the University of Antwerp, a part-time professor at the Antwerp Maritime Academy, and a visiting professor at Dalian Maritime University in China and World Maritime University in Sweden. He published widely on port and maritime economics. He is the immediate past president of the International Association of Maritime Economists (IAME), chairman of the board of directors of the Belgian Institute of Transport Organisers (BITO, an institute of the Belgian Federal Government) and co-director of PortEconomics.eu.

### **About the organisation**



PortEconomics is a web-based initiative aiming at generating and disseminating knowledge about seaports. It is developed and empowered by the members of the PortEconomics group, who are actively involved in academic and contract research in port economics, management and policy. Since October 2012, Port Technology International and PortEconomics have been partners. [www.porteconomics.eu](http://www.porteconomics.eu)

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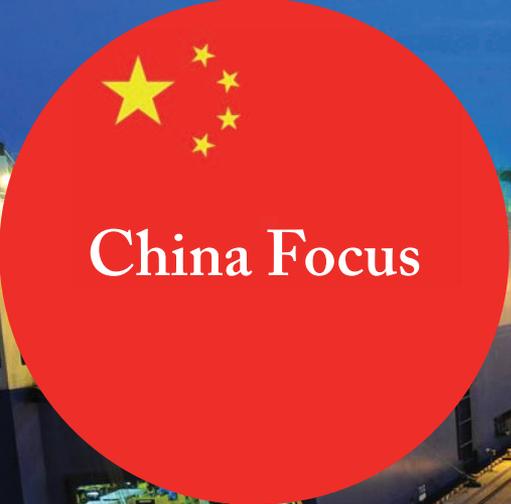
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## China Focus



"With the development of containerisation and specialised transportation, the handling business for traditional break-bulk cargoes has declined in many ports in mainland China since the end of last century."

'Break-bulk cargo ports in mainland China', page 68



# Marine heavy-lift operations in China



Liang Jinyu, Vice-general Manager, Safety Supervision Department, China Shipping Co  
Xie Jieying, Lecturer, Shanghai Maritime University

Following the international financial crisis, the global economic structure changed dramatically. The traditional global market was subdivided into segments in accordance with consumer requirements. Therefore, when conventional fleets such as tankers, bulk carriers and containers were struggling for survival, the heavy-lift transportation market developed rapidly.

Heavy and bulky cargo items such as generators, locomotives, drilling rigs and container cranes have brought about revolutionary changes in cargo handling and marine transportation. New methods and tools have been introduced into the marine industry. In this article, the author gives a brief introduction about the market for marine heavy-lift operations in China,

as well as cargo operation practices and current heavy-lift fleets in the country.

## Market for heavy-lift operations in China

After China joined the World Trade Organisation (WTO), its market share for industrial products rose from 10% in 2000 to 25% in 2008, accompanied by an explosive increase in export and processing trades in European and American Markets. During the past decade, considering the changing government strategies and the rapid development of equipment manufacturing in China, Chinese companies won numerous overseas construction projects. As a result, the export of heavy-lift equipment, such

as large-scale industrial devices and large vehicles, has increased rapidly. Meanwhile, many large-scale projects were started in China's inland and coastal waters: the Three Gorges project, West-East Natural Gas Transmission project, high speed rail, not to mention marine gas exploration, nuclear power, petrochemical and civil aircraft manufacturing – all needed a large quantity of large-scale devices and so gave rise to the growth of exporting and importing heavy-lift machinery via land and sea transportation.

## High-speed rail

On October 2 2003, China's first high-speed rail was inaugurated with a design speed of 200km/h; by 2013, the high-speed network

SEMI-SUBMERSIBLE				
SHIP'S NAME	TAI AN KOU	XIANG YUN KOU	HUA HAI LONG	XIA ZHI YUAN
	KANG SHENG KOU	XIANG RUI KOU		
LXBXD	156X36.2X10M	216.7X43X13M	182X43.6X11M	192.5X41.5X12M
DWT	20620/20248	48000MT	30000MT	38000MT
DFT SUBMURGED	19M	26M	23M	23M
DECK SPACE	126X26.38M	175X43M	144X43.6M	134.4X41.5M
DECK CAPACITY	18T/M2	25T/M2	20T/M2	18T/M2
SPEED	14KTS	14KTS	12KTS	13.5KTS
BUILT	2002/2003	2011	2012	2012

Table 1 COSCO Semi-submersible vessels

HEAVY LIFT			
SHIP TYPE	DA TYPE1 X8	DA TYPE2 X8	DA TYPE3 X4
LXBXD	179X28X14.8M	166.5X27.4X14.2M	153X23X14.1M
DRAFT	9.2M	8.5M	9.1M
DWT	28000MT	28450MT	16957MT
SWL	350X2MT	200X2MT	250X2MT
SPEED	15.2KTS	15.2KTS	15KTS
BUILT	2013/1014	2009/2011	1998

Table 2 COSCO heavy lift vessels



Figure 1 (left): Transportation of wind turbine tower; Figure 2 (top): ZPMC crane carrier.

encompassed 10,000km and by 2020, it will expand to more than 15,000km.

### Nuclear power

China's nuclear technology has reached an advanced level internationally. Up till 2013, China already had 33 nuclear power reactors on 7 separate sites and another 28 under construction. The additional new reactors are planned with a total investment of more than CNY390 billion (US\$63.4 billion), providing more than 30,000,000kW by 2015.

### Wind power

In 2010, China became the world's largest wind-power provider and by 2016, it will generate up to 100GW, rising to 200GW by 2020. Offshore wind farms are located in Jiangsu province, Shanghai and Zhejiang province. By the end of 2013, China had installed 3.9GW of offshore wind capacity. Moreover, Harbin Electricity and General Electric (GE) have established a joint venture wind power company, engaged in manufacturing and installing powerful wind-turbine generator systems in intertidal areas, as well as on land and sea. The sector looks set for further development in the coming years.

### Hydropower

The Three Georges Hydropower station is the biggest hydroelectric station in the world with a total investment of CNY95.46 billion (US\$15.5 billion). As the leading manufacturer of China's hydroelectric equipment, Harbin Electricity (HE) has provided more than 300 hydroelectric units for up to 200 hydropower stations in China and provided 80 hydroelectric units for 26 stations abroad. Considering China's sustainable development strategy, the capacity of hydropower is still expected to increase, especially in the west of the country.

### West to East gas pipelines power station

There are many gas power stations along the east coast of China. In 2003, Harbin Electricity and General Electricity worked together to produce F-class heavy gas

turbines and an integrated gasification combined cycle device in Qinhuangdao, which were both adopted by the West-East Gas transmission project.

### Steel structures and pressure vessels

China's shipbuilding output has ranked third in the world for 10 consecutive years and every year a big proportion of semi-finished boats and hulls are exported to other countries such as Japan, South Korea and Netherlands.

Recent years have seen many petrochemical projects in China approved and under construction, such as Nanjing FSF, Shanghai Caojing Chemical Industry Zone, and Guangdong Huizhou Chemical Industry Zone. China First Heavy Industries can produce petrochemical and coal liquefaction heavy containers, as well as nuclear reactor pressure vessels based on large-scale hot-wall hydrogenation reactors for all kinds of domestic projects. Moreover, a large number of vessels are imported from Germany, Italy and other countries to make up for shortages.

### Construction machinery and port machinery

Recently, China's construction machinery industry has blossomed into a number of well-known brands, such as Sany Heavy Industry and Xuzhou Construction Machinery Group (XCMG). Sany has become the world's biggest manufacturer of machinery for concrete, and its excavating machinery has broken the monopoly of foreign firms to become the top brand in China. Its other products, such as port machinery, piling machinery and crawler cranes, have become the first domestic brand to fully replace the foreign brands in China. Sales of large tonnage loaders and rollers from XCMG have been ranked first for three consecutive years in the world, while it has been the world's highest selling crane brand for nine consecutive years. Moreover, XCMG has set up many manufacturing bases in other foreign countries such as Germany, Brazil, Poland, India, Uzbekistan, Iran, South Africa and the Netherlands.

Today, the large container machinery

market is a very hot topic within the marine industry. China's Shanghai Zhenhua Port Machinery Company has become the world's largest container machinery export enterprise, accounting for more than 70% of the global port equipment production market. Considering the challenge of increasing container vessels and higher efficiency terminals, there is still a huge potential market for all kinds of cargo handling equipment globally.

### Marine equipment

Currently, the annual income of China's marine engineering equipment manufacturing industry is more than CNY30 billion (US\$4.9 billion), accounting for nearly 7% of world market share.

Recently, the deepwater semi-submersible crane platform 'OOS Greta' designed and built by China CIMC was delivered to Rio de Janeiro, Brazil. In the first half of this year, China undertook 81 orders for all kinds of marine engineering equipment including 11 jack-up drilling platforms, three semi-submersible drilling platforms, three drilling rigs, three production platforms and 59 offshore support vessels with a total contract value of US\$7.9 billion.

After 'Offshore Oil 981' was put into operation in the South China Sea, the first deepwater semi-submersible drilling platform 'Offshore Oil 982' invested by China Oilfield Services is now under construction in Dalian. Offshore Oil 982 is a semi-submersible drilling platform with a length of 1,525m and a maximum drilling depth of 9,144m, which can be applicable for offshore oil as well as gas exploration and development operations in deep sea waters up to 1,500m depth. It is one of the most advanced sixth generation drilling platforms in China and is expected to be delivered and put into operation in 2016.

### Heavy-lift fleets in China

A heavy-lift operation has three components: cargo handling, transportation and installation. The major heavy-lift methods are Lift on/Lift off, Roll on/Roll off and Float on/Float off.



Thanks to China's surging vehicle exports to other countries, its heavy-lift fleets have grown rapidly in the past decade. The leading companies for heavy-lift operations include China Ocean Shipping Co (COSCO), China Shipping Co, Chinese-Polish Joint Stock Shipping Co (CHIPOLBROK) and Shanghai Zhenhua Heavy Industries Co (ZPMC Shipping).

### COSCO

COSCO Shipping has the world's largest fleet of specialised carriers and multipurpose vessels. Until now, its heavy lift fleet has carried hundreds of tons of construction materials as well as hydropower equipment to about eight Latin American countries. The company's China-Latin American route has seen rapid growth in maritime vehicle transportation, especially the increasing vehicle trade with Latin American countries such as Brazil, Uruguay and Argentina. Last year, COSCO signed a two-year contract to transport more than 1,000 rail products to Brazil and Argentina.

One of COSCO's biggest shipping assignments this year was a two-year contract to transport more than 1,000 rail products including locomotives, trams and passenger cars to Brazil and Argentina. Recently, it signed a cooperation agreement with Shell Rijswijk in the Netherlands, which means it has become a carrier of heavy-lift cargoes for Shell. The agreement demonstrates that COSCO is playing an important role in the global special-purpose vessel market with its heavy lift fleets. Until now, COSCO has operated six semi-submersible vessels (Table 1) and 20 heavy-lift vessels (Table 2).

### Chinese-Polish Joint Stock Shipping Co (CHIPOLBROK)

CHIPOLBROK was the first foreign-invested joint venture in China, registered in 1949. The company has worked as an Asia-Europe break-bulk cargo carrier and gained a good reputation and skills for the transportation of complex cargo and heavy lifts. In 2000, the company changed its strategy from a break-bulk carrier to heavy lift and project cargo, ordering six new vessels of 30,000 DWT with cranes of 640 tons maximum lifting capacity. The total investment in heavy-lift fleet was up to 2.3 billion Yuan (US\$374) at that time. Now, the company has a heavy-lift fleet with 19 modern multi-purpose cargo vessels accounting for 80% of the entire CHIPOLBROK fleet. Moreover, the company is still in the process of expanding its fleet in order to be a global leader in heavy-lift carriers. Another two heavy-lift vessels of 32,000 DWT

were ordered by the company and were scheduled to be delivered by the end of 2015.

### ZPMC shipping

Shanghai Zhenhua Shipping Co (ZPMC Shipping) is a subsidiary of Shanghai Zhenhua Heavy Industry Co (ZPMC). ZPMC shipping has engaged in the ocean transportation of port machinery and super heavy-lift cargos and now operates a heavy-lift fleet of 23 vessels, including four semi-submersible vessels, a port construction equipment carrier and 17 crane carriers. ZPMC Shipping's crane carriers are converted bulk carriers and tankers. Nowadays, not only container cranes but also other heavy cargos such as bridge sections are also transported by ZPMC ships to other countries. As ZPMC is looking forward to new opportunities to sell its high quality products all over the world, more heavy-lift vessels are expected to join the fleet in the coming years.

### Conclusion

At present, due to the huge overcapacity in Chinese conventional heavy industries such as iron and steel, petrochemicals, automobiles and wind power, Chinese companies are still focusing on exporting these products. Considering the high demand for specialist high-level manufacturing industries such as vehicles and specialised devices, those Chinese companies with technical and cost advantages have great potential to export their products to other countries, as well as replace imported products within the domestic market. With the further development of the 'Midwest' of China, there will be more new projects coming into operation, as well as large-scale items imported into the country. Therefore, China must constantly improve its cargo handling technology and logistic facilities for heavy-lift transportation so as to satisfy the increasing demand from consumers.

In addition, leading companies such as COSCO, CHIPOLBROK and ZPMC Shipping are now playing an important role in heavy-lift operations in China. Their heavy-lift fleets not only provide services for domestic construction but also for construction projects abroad. Considering the increasing demands from some developing countries, these companies are all making efforts to expand their capacities and fleets. Therefore, this gives plenty of room for foreign investment and cooperation, as well as for the introduction of new technology. More heavy-lift specialists are in urgent need of Chinese companies to compete for market share in marine heavy lift operations.

### About the authors

Liang Jinyu is a captain and senior economist. He is also a member of China Logistics Association and worked in the shipping industry for more than 20 years. He has been general manager at China Shipping Jumbo Heavy Lift Co, China Shipping Car Carrier Co, and Orient Highway Car Carrier Co. In 2013, he was appointed vice-general manager of safety supervision at the Department of China Shipping,

Xie Jieying is a lecturer in the navigation department of Shanghai Maritime University. Apart from being a teacher, she is also a certified deck officer. In 2013, she received a Master's degree in Maritime Safety and Environmental Administration from World Maritime University in Malmo, Sweden. She is now a doctoral candidate in vehicle operation engineering. In recent years, she has engaged in maritime cargo operations education, including containerisation and modern cargo operations, as well as 'stability and trim' for students in SMU. She has actively taken part in related studies and projects involving marine terminal operations and environmental protection.

### About the organisation



Shanghai Maritime University (SMU) is a multi-disciplinary university with a special emphasis on shipping,

logistics and ocean science. The history of SMU can be traced back to 1909 at the end of the Qing Dynasty and the university has been honored as a "cradle of international shipping specialists". At present the university runs 19 doctoral programmes, 59 master's degree programmes and 45 bachelor's degree programmes. SMU has over 20,000 full-time students, including 17,000 undergraduates and over 3,000 postgraduate students. In the MOE evaluation of undergraduate education in 2004, SMU was awarded an "A" (Excellent). SMU has always attached much importance to exchange and cooperation with overseas institutions, and has established close ties with over 70 overseas universities and academies.

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# Break-bulk cargo ports in mainland China



Dr Yin Ming, Associate Professor of International Shipping Management, Shanghai Maritime University

Break-bulk or general cargoes usually refer to those that can be counted piece by piece. According to the forms of their packing, break-bulk cargoes can be sorted into packed cargoes and unpacked cargoes, the former refer to those which are transported in bags, packages/bales, cases/cartoons/crates etc, while the latter refer to those which are transported either unpacked or those that cannot be packed.

With the development of containerised transportation, most traditional break-bulk cargoes nowadays are transported in containers. Consequently, fleets and ports for break-bulk cargoes are undergoing a process of decline all over the world. Mainland China is also witnessing the same change, although the absolute number of its general berths for break-bulk cargoes is still increasing (Table 1). Also in Table 1, we can see that the percentages of general berths for break-bulk cargoes keep decreasing, from 20% (322/1602) of year 2011 to 18.95% (345/1821) of year 2013.

In terms of the China Ports & Harbors Association, which was founded in 1981, among its over ten departments and branches including those for container cargoes, oil, cruise ships and so on there is no branch for break-bulk cargoes.

## Developing trends

Before the commencement of containerisation and some other special techniques for cargo transport and handling, break-bulk cargoes played a significant role in the shipping and port market in mainland China. In pace with the booming of container transport, Ro-Ro (roll on/roll off) transport and some other special means of transport, the market share of ports for break-bulk cargoes begins shrinking and fragmenting. Figures 1, 2, and 3 show the throughput percentages (in tons) of different types of cargoes in ports of mainland China in the past three years.

As mentioned above, most traditional break-bulk cargoes are carried in containers at present, as long as they are feasible for containerisation, which can also be proved by the tremendous progress of China's container fleet and terminals in recent decades. Other special cargoes are handled in progressively professional ways, eg more and more vehicles, as commodities, are carried on board mega Ro-Ro vessels and handled at specially-equipped Ro-Ro terminals. Awkward cargoes, sometimes also known as project cargoes, the sizes and/or weights of which take them beyond the capacity of containers, currently still rely

on the traditional way of port handling, with the help of modern, jumbo port machinery.

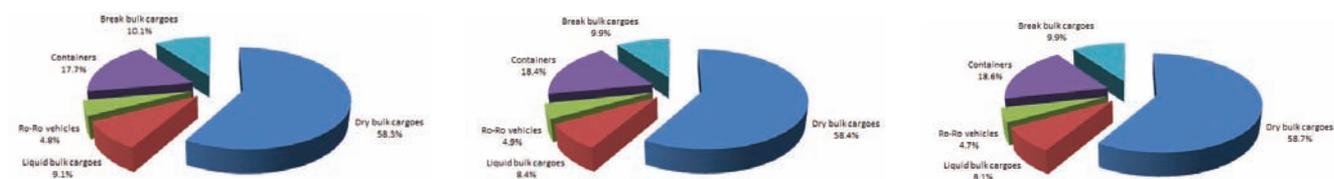
## Major problems and solutions

The emergence of modern logistical techniques has posed big challenges for the development of traditional break-bulk cargo ports. In mainland China, many break-bulk cargo ports are confronted with problems and difficulties, eg outdated operating techniques, huge differences in cargo packing, polarisation of the port's human resources, and low port charges and profit rates. Taking into account such typical problems, pertinent solutions are put forward.

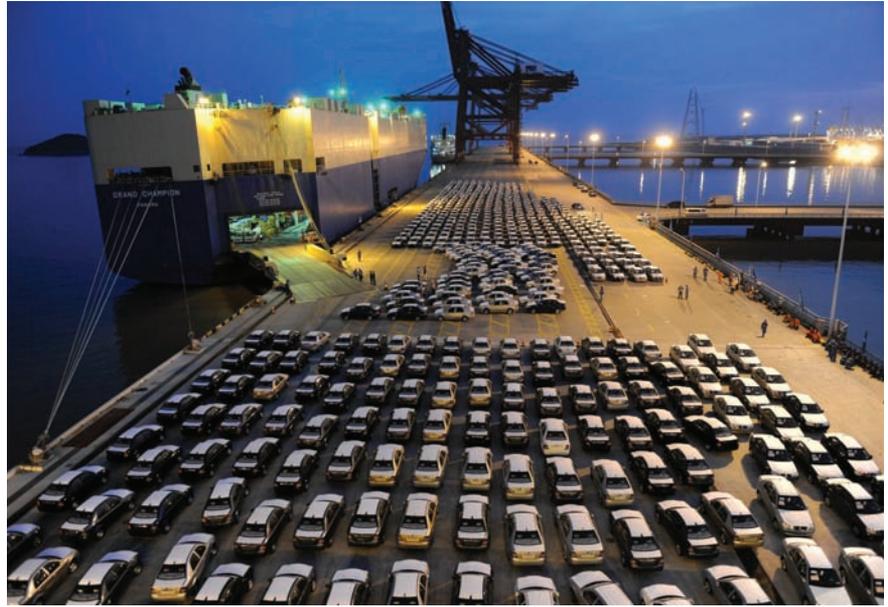
First, advanced semi-automatic or automatic handling techniques should be properly updated, information management systems should be duly developed, and experience from automatic container terminals should, with time, be introduced.

Second, standardisation of packing, groupage and unitisation should be encouraged, which can considerably reduce port labour intensity, make full use of port machinery, increase port operating efficiency, shorten the turnover period of vessels and vehicles, facilitate tally and taking- or handing-over of cargoes

Sources: China Ports Year Book 2011, 2012, and 2013



Figures left to right: Figure 1. Throughput percentages of different types of cargoes in ports of mainland China, 2011; Figure 2. Throughput percentages of different types of cargoes in ports of mainland China, 2012; Figure 3. Throughput percentages of different types of cargoes in ports of mainland China, 2013.



Top left: A container terminal in mainland China; Right: A Ro-Ro terminal in mainland China; Bottom left: Handling project cargo

Sources: China Ports Year Book 2011, 2012, and 2013

Types of berth	Numbers in recent three years		
	2011	2012	2013
Professional berths for specified cargoes (eg. containers, coal, ore, crude oil, liquid chemicals etc)	942	997	1062
General berths for bulk cargoes	338	379	414
General berths for break-bulk cargoes	322	340	345
Total	1602	1716	1821

Table 1 Numbers of different types of berths in mainland China (2011-2013)

in ports and decrease the probability of cargo loss and damage.

Third, more attention should be paid to the training and full utilisation of human resources, and simultaneously, scientific evaluation systems should be established to monitor employees' performance. Personnel mastering the comprehensive theory and practice of port management and logistics should be deemed a port's most valuable property.

And fourth, national reform of port charge mechanisms should be pushed forward to make the pricing of port operations return to the market; and port enterprises should strengthen their internal management systems of port charges to promote standardisation and institutionalisation.

### Summary

With the development of containerisation and specialised transportation, the handling business for traditional break-bulk cargoes has declined in many ports in mainland China since the end of last century. Most

of China's imported and exported break-bulk cargoes are stuffed into containers before they are carried. Awkward cargoes are handled as project cargoes by professional and jumbo port machinery, the function and/or size of which are far beyond traditional port cranes. As a new growth point, Ro-Ro business for the loading and discharging of vehicles as commodities has drawn more and more attention from many port operators in mainland China.

The transformation of traditional ports for general break-bulk cargoes becomes quite critical for their survival. Container terminals, Ro-Ro terminals, and specially-equipped docks for project cargoes are the most popular candidate schemes. For future development, a distinguishing and unique feature is necessary for all ports that want to maintain their break-bulk cargo business.

### Acknowledgement

The author wishes to thank China Ports & Harbors Association for its assistance and for providing data and information.

### About the author

Dr Yin Ming is associate professor of international shipping management at Shanghai Maritime University. He has published dozens of papers and books relating to the port and shipping industry.

### About the organisation



Shanghai Maritime University (SMU) is a multi-disciplinary university with a special emphasis on shipping, logistics and ocean science. The history of SMU can be traced back to 1909 at the end of the Qing Dynasty and the university has been honored as a "cradle of international shipping specialists". At present the university runs 19 doctoral programmes, 59 master's degree programmes and 45 bachelor's degree programmes. SMU has over 20,000 full-time students, including 17,000 undergraduates and over 3,000 postgraduate students. In the MOE evaluation of undergraduate education in 2004, SMU was awarded an "A" (Excellent). SMU has always attached much importance to exchange and cooperation with overseas institutions, and has established close ties with over 70 overseas universities and academies.

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# Doing training Confucian style?



Dr Yvo A Saanen, *Managing Director TBA, Delft, the Netherlands*

What I hear, I forget  
What I see, I remember  
What I do, I understand (Confucius)

Confucius already knew that learning by doing is the only way of effective learning; and learning is needed in our industry. As the demand for productivity continues to rise, and the complexity of systems and operations increase – not least driven by automation and the introduction of even more systems – people need to be trained to be effective at what they do.

This article discusses people controlling operations through the various systems present, ie planners, supervisors, dispatchers. How can they become better trained applying Confucian style learning?

## Room for improvement

The need for training starts with the current efficiency gap. What can we

gain if our operational control staff is better trained? ('Operational control staff' is a term we shall use to describe the staff planning the work (yard, vessel, rail), supervising the execution, solving incidents, and allocating and directing equipment in real-time).

When we started our training programmes at TBA, we never envisaged that the efficiency gap could be as large as we now know it to be. Having put hundreds of operational control staff through our training programmes, we found that by improving their capabilities and applying best practices, average productivity levels could be increased by as much as 30%.

We also found that the difference between the worst performer and the best performer is typically in the range of 50-60% in achieved productivity levels. Finally, we found that with the

use of more automated tools – in many cases already licensed but poorly used – the consistency and performance of operations could also be substantially increased.

The most common training methods today in the maritime industry are on-the-job training and classroom training, mainly through a standard and potentially tiresome series of PowerPoint slides. The effectiveness of this training method has proven to be less than 10% (regarding what people can remember from the material presented).

## Learning by doing

Therefore, the time has come to start learning by doing. Depending on the trainees and the objectives of the training, we have developed training programmes in various forms; these range from three days to whole weeks, where trainees are confronted with plan preparation, planning, and work-execution-type jobs that are similar to the ones they have to perform in live operations. Tasks range from setting up the yard, planning discharge containers, decking export receivables coming in through the gate, determining how much equipment shall be deployed in the upcoming shift, allocating equipment in real-time to yard locations, planning the crane split, the quay crane-work queues, etc. In principle, this covers the entire range of duties of operational control staff.

## Feedback after every iteration in typical KPIs

After each training cycle (typically we follow multiple cycles to enhance the learning experience), a feedback session follows. The feedback is based on the actual KPIs they achieved (eg vessel productivity, quay-crane productivity, yard-crane productivity, operational costs, truck turn-time), as well as on the

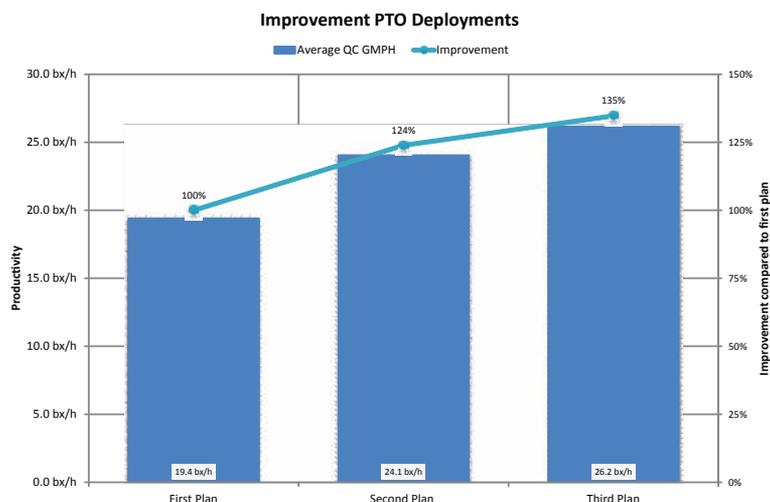


Figure 1: Results of improved planning skills of trainees. The result is the average of approximately 100 trainees, all doing the same iterative training programme. In between the planning exercises, short classroom training sessions were held, with feedback given on trainees' previous planning attempts. On average, the performance increased by 35% from the initial to the final results.

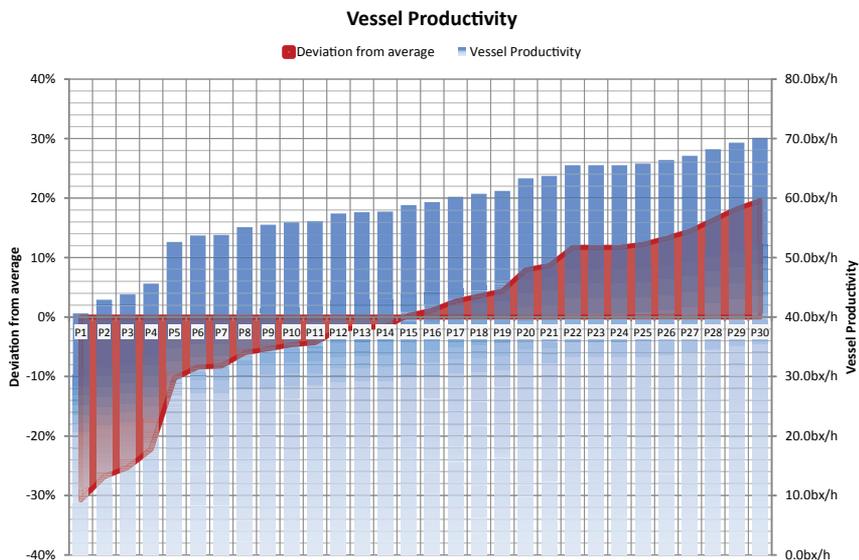


Figure 2: This graph illustrates an example of a training session with 30 vessel planners (P1 – P30), and their individual results, planning two vessels with 3 QCs each. The best planners achieved average berth (vessel) productivities of 60-70 containers per hour, while the worst planners only achieved 40-50 containers per hour – under exactly the same circumstances. Same yard, same equipment, same drivers. Just their plan to make the difference. This is typical of the wide range of results we find with our ‘near-to-live’ training sessions.

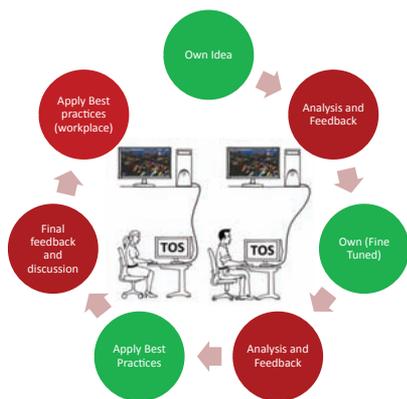


Figure 3: The cycle followed in the training. In an iterative way, trainees find out how to apply best practices in their plans, and receive in each iteration feedback about their solutions

assessment of what they did (assessed by one of our trainers). In order to create the KPIs, our terminal emulation tool CONTROLS is run (overnight) to get the results for each trainee in a comparable way.

### Competition element as motivator and fun factor

The last but essential element in the

training is competition. Plans are made either individually or in groups. After every submitted or executed plan, the KPIs are compared, and trainees or teams of trainees are extremely motivated to be the best in the class. As there is a level playing field, each trainee or team of trainees has equal chances to prepare the terminal in the most cost-efficient or productive way, without excuses. Every team works under exactly the same circumstances, with the same resources.

### From ‘gamification’ to certification

Today, training in the form of games is a well-received and highly appreciated method. However, we expect that this can and will be brought to the next level. Operational control staff can be tested before being deployed in live operations. With well-developed and configured scenarios, they can be trained and then tested in their capabilities to deal with uncertainty, dynamic events, peak loads, and all kinds of other circumstances that make work in a terminal so challenging. This could lead to certified vessel planners, yard planners, and supervisors, and as such bring accreditation to the profession, as well as higher standards, and most likely better performing container terminals.

### About the author

Dr Yvo Saanen is managing director and founder (1996) of TBA, a leading terminal design and simulation company in the Netherlands. He is in charge of all port and terminal-related projects globally in terms of their planning and optimisation by means of simulation and emulation. Dr Saanen holds an MSc in systems engineering and a PhD in the design and simulation of robotised container terminals, both obtained from Delft University of Technology. In addition, he is a lecturer at Delft University, Lloyd’s Maritime Academy and the Institute of Maritime Economics and Logistics (Erasmus University Rotterdam) teaching simulation and logistics and, at various institutions, lectures on terminal design by means of simulation.

### About the company

Netherlands-based TBA is a leading international provider of consultancy and software. Its product and service portfolio concentrates on marine terminals and intermodal container terminals. Key services are terminal planning using simulation, support of complex software (TOS) implementations and TOS fine tuning using TBA’s emulation tool controls, and training of terminal planners. TBA is also the leader in equipment control software (ECS) for automated terminals; it has supplied TEAMS, TBA’s Equipment Control Software to Euromax in Rotterdam, CTA in Hamburg and Antwerp Gateway. Forthcoming supply contracts will include APMT Rotterdam, Rotterdam World Gateway, and Long Beach Container Terminal. TBA’s clients include all major terminal operators worldwide and many local port operators. TBA’s subsidiary DBIS delivers total software solutions for bulk terminals.

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# Harbour approach channels & design guidelines



Dr Mark McBride, *Manager,*  
*Ships Group, HR Wallingford, UK*

Ensuring the continued safety and efficiency of ships transiting channels requires designers and naval architects to better understand the handling and manoeuvrability of both existing and new generation ships in shallow and restricted waters. In particular, PIANC, the World Association for Waterborne Transport Infrastructure, wishes to provide the best

possible advice on the issues of horizontal and vertical dimensions relating to shipping channels and manoeuvring areas.

Consequently, PIANC recently published 'Harbour Approach Channels & Design guidelines', a report from its Working Group 121 (previously MarCom Working Group 49). This report provides guidelines and recommendations for

the design of vertical and horizontal dimensions of harbour approach channels, manoeuvring and anchorage areas within harbours, along with defining restrictions to operations within a channel. It includes guidelines for establishing depth and width requirements in addition to vertical bridge clearances.

The report supercedes and replaces the

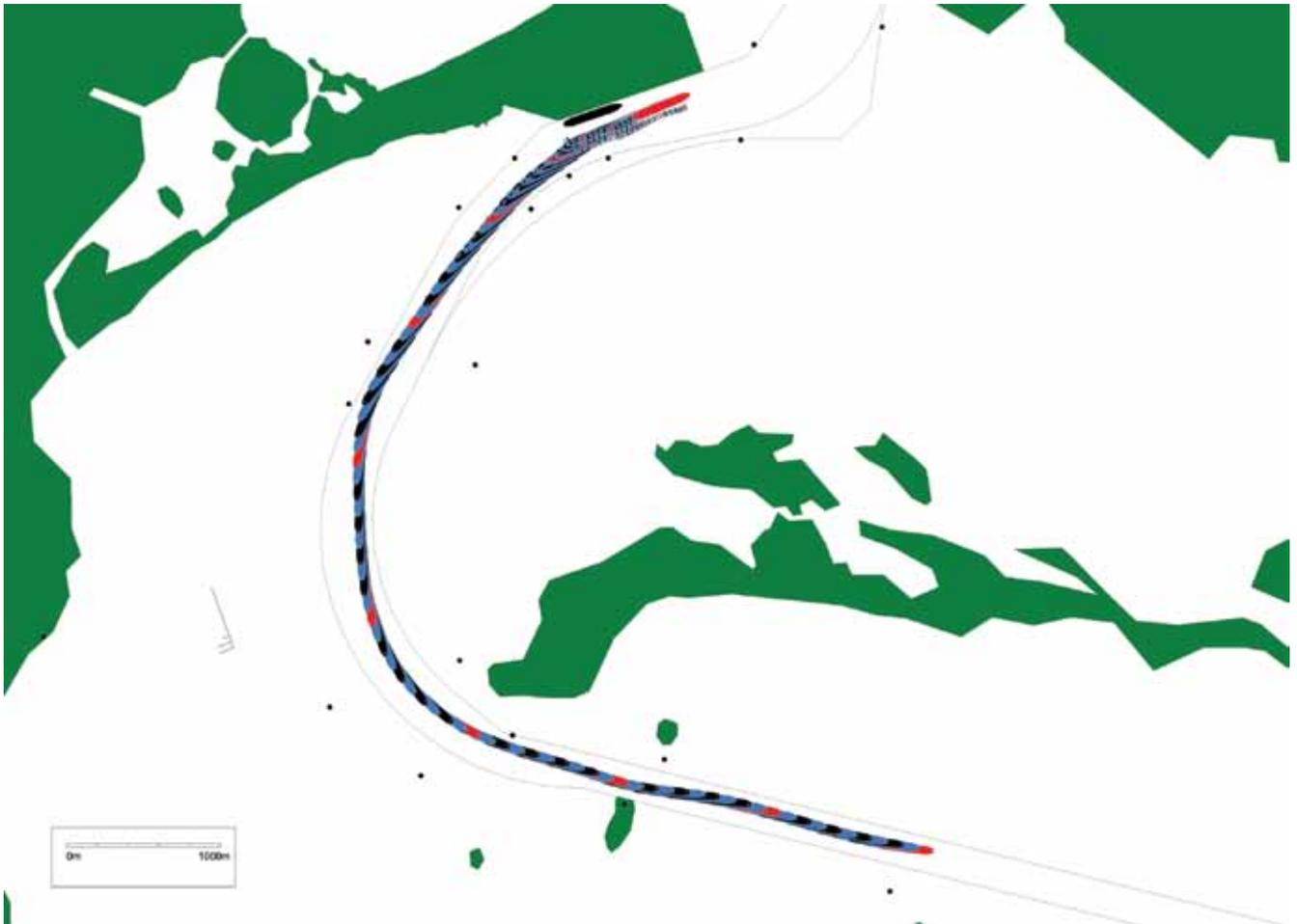


Figure 1. Complex channel design requires robust design techniques.

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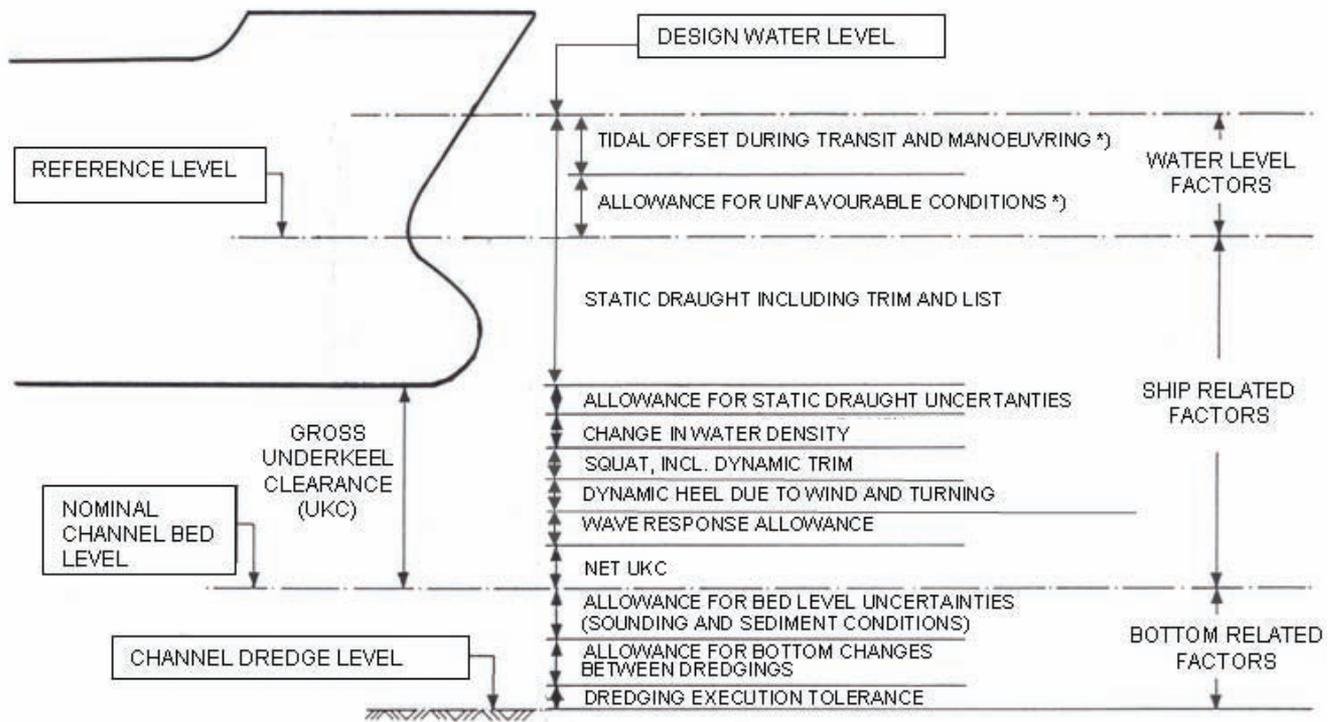


Figure 2. Channel depth design components.

joint PIANC-IAPH report 'Approach Channels – A Guide for Design', which was published in 1997 (from PIANC MarCom Working Group 30). This report was widely accepted worldwide by port designers.

The new report has been compiled once more in close cooperation with IAPH (International Association of Ports and Harbours), but also with IMPA (International Maritime Pilots Association) and IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities).

### Historical context

The design of approach channels and fairways was first considered by PIANC in a report published by Working Group 2 of the PIANC International Oil Tankers Commission (IOTC) in 1972. Some years later, this work was reviewed by Working Group 4 of the PIANC International Commission for the Reception of Large Ships (ICORELS) in a report published in 1980. The subject was most recently considered by the joint PIANC-IAPH Working Group PTC II-30 in co-operation with IMPA and IALA. Their findings were published, first as a preliminary set of concept design guidelines in 1995, followed by the 1997 final report 'Approach Channels – A guide for design'. This quickly became the world's definitive reference for maritime channel design.

### Updated guidelines

In 2005, Working Group 121 (WG121) was created with 20 members from 12

countries, including three members from the previous Working Group 30 (WG30). It was to review, update and, where appropriate, expand on the design recommendations as presented in the WG30 report of 1997. In doing so, the Working Group considered recent developments in simulation and other design tools, along with the sizes and handling characteristics of new generation vessels. In addition, further attention was given to the design of the vertical dimensions of channels than had previously been provided.

The overall report was completely restructured to present the vertical and horizontal aspects separately, with conceptual and detailed design techniques presented in each main chapter.

The new report can be purchased from the PIANC website or for PIANC Members, it can be downloaded free of charge at <http://www.pianc.org/edits/articleshop.php?id=2014121>.

### Methodology

#### Aims and objectives

The aim of the updated guidelines was to provide the best international practice for the design of approach channels that was available to the port engineering community. The goal was to produce a practical set of guidelines, which are easy to understand and apply. However, as with the previous version of the guidelines, their use still requires proper engineering judgement.

The main objectives of WG121 were to review, update and, where appropriate,

expand on the design recommendations on vertical and horizontal dimensioning as presented in the WG30 report of 1997. Recent developments in ship design, better understanding of ship manoeuvrability and behaviour in waves, and further research in ship simulation and modelling required a comprehensive update to the 1997 report.

The Working Group paid particular attention to:

- Vertical motions of ships in approach channels (due to squat, wave-induced motions, dynamic effects, etc.);
- Air draught for vertical clearances under bridges, overhead cables etc;
- Horizontal dimensions of channels and manoeuvring areas;
- Simulation of ships in channels;
- New and future generation ship dimensions/manoeuvring characteristics;
- Wind effect on ship navigation and manoeuvring;
- Human errors and project uncertainties;
- Environmental issues, and
- Safety criteria, assessment of levels of risk and appropriate clearance margins.

All sizes of approach channel for commercial shipping were considered, as the problems of catering for small coasters in a small port may be as great as those for a large tanker at an oil terminal.

### Revised report

The new WG121 guidelines update the conceptual design techniques presented in the previous WG30 work for both

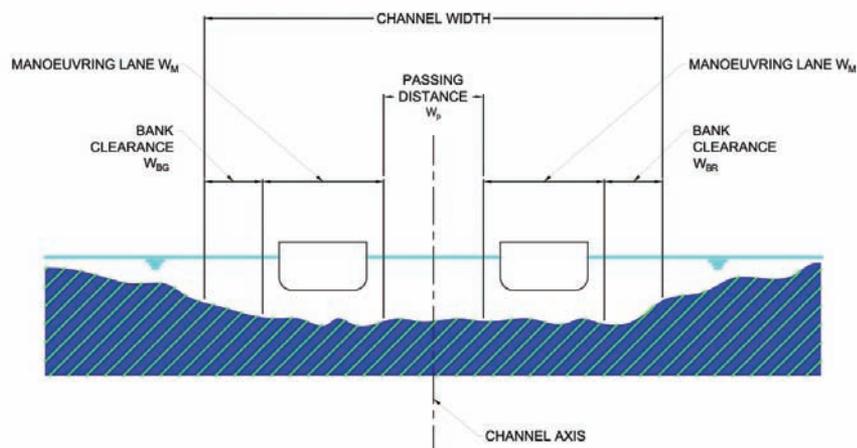


Figure 3. Channel width design components.

recommendations for the design of horizontal and vertical channel dimensions, and for manoeuvring area dimensions within harbours. These include consideration of many factors, including design vessels, operational limits, risk, economic and environmental considerations, support craft requirements, and aids to navigation.

### About the author

Dr Mark McBride is the manager of the Ships Group at UK-based HR Wallingford and has over 25 years of experience in port and maritime design related work. He has been involved in numerous projects regarding the design of approach channels, turning circle and manoeuvring areas, berth locations, ship mooring analysis, and operational simulation studies examining optimisation of transportation networks, berths and storage facilities. He was the Chairman of PIANC Working Group 121 which produced the report described in this paper. In addition, he is the author of many technical papers on port operations, ship navigation and mooring-related topics.

### About the organisation

PIANC is the World Association for Waterborne Transport Infrastructure. It provides a forum where professionals around the world join forces to provide expert advice on cost-effective, reliable and sustainable infrastructures to facilitate the growth of waterborne transport. Established in 1885, PIANC continues to be the leading partner for government and the private sector in the design, development and maintenance of ports, waterways and coastal areas. As a non-political and non-profit organisation, PIANC brings together the best international experts on technical, economic and environmental issues pertaining to waterborne transport infrastructures. Members include national governments and public authorities, corporations and interested individuals.

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horizontal and vertical dimensions. The horizontal dimension guidelines include revised and updated allowances for channel width design, along with providing mention of Spanish ROM and Japanese MLIT standards, which need to be applied in those particular countries. The vertical dimension sections were also revised and updated with additional methods and examples to illustrate the techniques. The new guidelines provide:

- Conceptual design empirical methods:
  - o Channel width  $\times$  um of ship beams, modified version of previous WG30 method;
  - o Chanel depth  $\times$ he w initial estimate method and 'intermediate' calculation methods;
- Guidance on detailed design methods;
- Emphasise that results of conceptual design empirical methods are not a final design;
- Expect conceptual design to be conservative, and
- Optimise using detailed design methods described in the guidelines.

Much of the effort of WG121 was focused on detailed design guidelines, and in particular, probabilistic design and risk aspects, reflecting the requirements of modern engineering design principles.

The vertical dimension guidelines include further discussion and examples for predicting vertical ship motions due to waves that include deterministic, statistical and probabilistic methods. They also include sections on squat and muddy channel beds, which have been updated based on recent research and developments. In addition, with recent accurate (PDGPS) measurements of ship squat and calibrated theories, squat can now be predicted with more accuracy and this information is incorporated in the new guidelines.

Another aspect was the recent

development of Post and Ultra-Post-Panamax container vessels (with capacities of up to 18,000 TEU), large car carriers, and QFlex- and QMax-size LNG carriers. These vessels have specific characteristics (high windage, larger bulbous bows, wider transom sterns, minimal parallel mid body/flat of side, etc.), which may require specific risk mitigation measures that can have an impact on access channel design and operation. The new guidelines take these new design changes into consideration.

Furthermore, the use of advanced numerical models of wave propagation and ship response to waves, along with ever realistic ship manoeuvring simulation, have become common practice in port engineering design. The new guidance includes more details and examples of their use.

Capacity simulation models can also be used to evaluate the safety of port infrastructure and are described with an example. Today, there is a more continuous range of tools available, so that each type of simulator/simulation can be used in different stages and detail of channel design.

Recent developments have led to a more integrated approach for environmental aspects for channel design. In the previous approach, the conceptual design was first completed and was then used as the basis for the Environmental Impact Assessment (EIA). After completion of the EIA, detailed design was undertaken, which led to long and interrupted design periods. Now, the EIA study is integrated with both the conceptual and detailed design stages, which leads to a faster design process, with environmental aspects being taking into account throughout the engineering design process.

### Conclusion

The new WG121 harbour channel design guidelines provide best practice



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# Dredging the Mersey for Liverpool2 container port development



Douglas K Coleman, Programme Director,  
Peel Ports, Liverpool, UK

Liverpool, on the River Mersey in north-west England, has been a major port for almost 300 years and the area has undergone many changes during that time to accommodate trends in shipping. The Port of Liverpool is already the UK's largest transatlantic port and is home to one of the UK's biggest container terminals. Now Peel Ports, as owner and operator, is investing £300m (US\$500 million) to ensure the Port of Liverpool can accommodate around 95% of the world's container fleet, especially with the widened Panama Canal opening in 2015.

The overall construction programme has several main features:

- A quay wall, 854m long, with a quay surface at 12.7m aCD, between the southwest corner of the Royal Seaforth Container Terminal and along the low water edge of an intertidal area known as Seaforth Triangle;
- Dredging in front of the quay wall (to 16.5m bCD) to create a 62m-wide berth pocket that will allow post-Panamax vessels to berth in this area;
- Reclamation of approximately 12ha of intertidal area behind this new wall (using approximately 2.2 million cubic metres of material dredged from the

berth pocket and approach channel deepening works); and

- Dredging areas of the approach channel that are shallower than 8m bCD down to this depth, with the total area for deepening around 3.71km<sup>2</sup> and an average 1.1m depth of dredge.

## Dredging the channel

To carry out the work, which began in July 2014, Peel Ports appointed the family-owned Van Oord business, which operates a global fleet of more than 100 dredgers and specialised marine plant.

The programme involves increasing the navigable depth from 6.9m bCD to 8m bCD producing an estimated volume of five million cubic metres of dredged material. The arisings will be put to use in the up-filling of the intertidal zone within the Seaforth triangle which forms the new Liverpool2 deep water container terminal. The balance of dredged materials will then be returned to nature and deposited at the offshore licensed disposal sites.

The channel is divided into three main dredging areas: Queens Channel, Askew Spit and Crosby Channel.

- Queens Channel has the largest

quantity and also the deepest layer thickness to be dredged at approx 1.17m.

- Askew Spit has a layer thickness of around 1m to be removed and is characterised by being mainly toe-line work on the inside of Askew Bend.
- Crosby Channel has the lowest layer height of material to be removed.

A trailing suction hopper dredger is used to remove soft silts while a cutter suction dredger is used to dredge coarser granular materials. Areas of rock and firm clay are excavated by backhoe.

## Planning the works

A key requirement in planning the works was being able to reuse some of the arising for another part of the Liverpool2 development programme. These have to be delivered in specific windows for the construction and only with material that meets the required standard.

This requires very close liaison between the project teams on plans and schedules, testing to ensure the material is meeting the required standards and providing information regarding potential additional sites for material to be used at the Seaforth Triangle, as the latter can emerge during the

Below: Dredging vessels in action; Right: A view on board the Ham 316 taken while working in the Mersey





Liverpool2 current site location



Proposed site of Liverpool 2

dredging process.

Even before dredging began, boreholes, vibrocores and any further ground information was entered into a 3D soil model at Van Oord's head office in Rotterdam. This model combined grain size, silt content and layer thickness of the deposits to create a map of the most promising areas to guide the dredging crew.

The dredging vessel was on-site a month before works were due to begin, allowing time for the Van Oord team to trial all quality assurance procedures and communications protocols, both of which are critical to the smooth delivery of the works. During that time, trial dredging also took place in the areas covered by the programme.

Much of the volume of material to be removed is from a weather-exposed area (Queen's Channel) and is disposed of at offshore sites which are also weather exposed. As a consequence, the most weather-exposed areas are being dredged during the summer to reduce programme risk. Work has begun from the 'outside in', starting with Queens Channel, then Askew Spit and lastly Crosby Channel. This will always provide the opportunity to continue dredging inside the channel during adverse weather conditions.

### Firing range and port operations

One unusual feature of the works is that there is a nearby rifle firing range operated by the UK's Ministry of Defence (MoD). The facility, at Altcar, carries out live firing, requiring close communication with the MoD to ensure the safety of the vessels and avoiding disruption to the range's activities.

As well as this, there are other demands inevitably created by working in a busy port environment. The programme of work includes flexibility, especially on the disposal and placement at Formby Point and Taylor's Bank, to minimise the impact of the work on others.

### Environmental impact assessment

Typically, any construction activity of this type would undergo an Environmental Impact Assessment (EIA), which would then be used to produce an Environmental Statement (ES) for formal consultation

with statutory consultees, the public and other interested parties.

Major consultees in this development included various public bodies such as the Marine Management Organisation (MMO), local authorities, Natural England and the Environment Agency, as well as the Centre for Environment, Fisheries and Aquaculture Science. The Environmental Statement produced through the EIA was an essential component of being able to secure a marine licence from the MMO as well as a number of other consents.

Before the EIA begins properly, there is a screening phase to determine if an EIA is required, and assuming so, there follows a scoping stage to consider what should be included. This development had previously been subject to an EIA and Environmental Statement in 2005 when it was previously proposed. As a result of this, some aspects of the development and its potential impact could be considered in terms of the previous assessment, where there had been no significant changes during the intervening period.

The EIA process considered the development as a whole, as opposed to just the dredging, with a number of mitigating measures and agreements being put in place before work began in order to satisfy the MMO and other regulatory bodies.

In the case of dredging, the EIA identified that it would have a negligible impact on water levels and tidal currents, sediment and water quality, and surrounding coastal defences and training walls. However, there was also agreement reached on routine measures to avoid any impacts, such as zoned disposal, trial placements and monitoring of dredged material.

As a further example of mitigation measures, there are a number of special environmental considerations in the area that include migratory fish and birds on the foreshore. To minimise disturbance to them, Van Oord is following a specific methodology for sensitive sites, for example, not directly shining lights onto the water or foreshore. Although not a particularly noisy operation, this is also monitored, with control measures put in place to deal with increasing noise levels.

### About the author

Douglas K Coleman, one of the UK's most experienced project directors, was appointed by Peel Ports in 2012 as its programme director for the Liverpool2 development. Before joining Peel Ports, Coleman was project director at Forth Ports for six years, where he was responsible for construction development across the Group's extensive land and property assets. His career also included nine years with Capita, where he was ultimately Scottish regional director. His main responsibilities were the delivery of multifaceted infrastructure and regeneration projects, specialising in brownfield site development works. He has also previously worked overseas in the Middle East and North Africa.

### About the organisation

Peel Ports is Britain's second largest group of ports, handling 70 million tonnes of cargo every year. Peel Ports owns five major gateways across the UK. The Peel Group is one of the leading infrastructure, real estate and investment enterprises in the UK. Its diverse network of businesses ranges from ports to airports, land to leisure, media to hotels, wind farms to biomass, and a portfolio of investments in major public companies. The company has 66 Sites, 2,400ha acres, 5.54 million square metres of potential space, US\$6.67 billion of potential built investment value, 28 rail connections, seven ports, four airports and three strategic partners.

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## Port Tyres



"However, 20% of a vehicle's fuel consumption originates in the rolling resistance of its tyres. The right tyres can reduce operating costs by up to 10%, underlining again their crucial role in efficient harbour operations."

*“We believe that innovation through R&D, as well as continuous process improvement ☒ both in business and in production ☒ is a key to facing any challenge, whether now or in the future.”*

### Exclusive Q&A

Prabhash Subasinghe, Managing Director,  
Global Rubber Industries,  
Colombo, Sri Lanka



#### Outline your key products and their applications in ports globally.

Global Rubber Industries' (GRI) key products for ports are Bombcart XT, Ultimate XT and Globestar industrial solid and press-on band tyres. Ultimate XT is a premium solid tyre that uses advanced compounds developed to ensure maximum comfort, reliability, safety and the longest-possible tyre life. It has the highest abrasion resistance and tensile strength, the lowest energy consumption and the coolest running temperature. Ultimate XT is built for high-performance and is perfectly suited for harsh working conditions.

Bombcart and Globestar are standard three-stage solid tyres that have performed better than expectations. They

have a centre core that provides a soft ride and reduces driver fatigue. These tyres run with reduced heat build-up and energy efficient, lower rolling resistance. All our products are built with natural-rubber compounds that ensure good resilience and high tensile strength. Our tyres are used in terminal/port trailers, Ro-Ro trailers, as well as lift trucks at ports.

Solid tyres from GRI are built with advanced natural rubber compounds that make them perform better than tyres in the same categories from our competitors. We benchmark our products with the best in the world and develop compounds with superior properties to optimise performance of our tyres. We have also established a progressive quality

management system that ensures our tyres are of supreme quality.

Our premium tyres perform brilliantly in the most severe operating environments. Our tyres have proven their advantage with low maintenance cost and longer life.

#### Where are your markets?

GRI is a leading industrial solid-tyre manufacturer in Sri Lanka ☒ the largest producer of high-quality solid tyres in the world. We have been supplying tyres to original equipment and replacement markets in more than 50 countries worldwide since 2002. We have sales offices and warehouses in the US, France, Germany and the Netherlands. Our state of the art factory in Sri Lanka employs the latest technology and the highest

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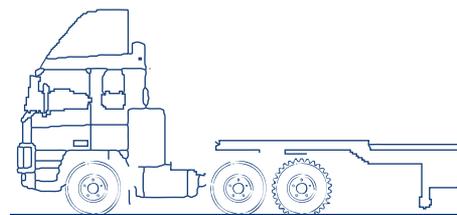
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quality norms to produce some of the finest solid tyres in the industry.

We supply solid Bombcart tyres which are used on terminal/port trailers at the port of Seattle, Washington state, and the ports of San Pedro and Long Beach in California. Our terminal/port trailer tyres are also under testing in Singapore Port (PSA). We also supply press-on band tyres for the Ro-Ro trailers used at ports in Scandinavia. Furthermore, we supply our industrial tyres for use on forklift trucks at ports in the Netherlands and Belgium.

GRI is built on passion to identify new markets and to develop new products. Recording impressive business growth over the past few years, GRI has expanded its operations and is dedicated to delivering high-performance tyre solutions to the global materials-handling industry.

#### **How does the type of rubber affect the performance of the tyre?**

GRI tyres in port applications comprise natural rubber formulas; this is in contrast to the synthetic rubber formulas that are not acceptable in these severe applications. Natural rubber is much more forgiving with regard to heat dissipation; each tyre can breathe more easily and maintain correct deflection curves on Bombcarts at 140,000 lb capacity – this is extremely important to reduce tyre failure. GRI makes tyres for port applications with a special compound formula based on natural rubber which meets all operational requirements, such as heat build-up due to heavy loads, working on rough surfaces and the ability to cope with heavy weather conditions.

#### **Outline your key growth areas, whether by product focus or location. Are you conducting any interesting product developments or R&D?**

Our key growth areas are Asia, South America, Africa and the Middle East. We are optimistic about the economic and trade growth in each of these countries and regions. The growth in prospects in ports such as Singapore, Hong Kong, and ports in the Middle East is very promising. We are also focusing our efforts in Australia and have recently opened our own GRI distribution point in Brisbane,

We continuously carry out R&D work on raw materials, processes and on the products with respect to performance,

while maintaining environmental friendliness. Raw material substitutions are usually done with regard to improving quality and performance. Process improvements are done with the objective of reducing operator dependency and improving work safety. Product development and innovation is based on customer responses and analysing market trends. Continuous test results from our laboratory and field tests drive our product development.

Our initiatives and endeavours have powered GRI forward to rapidly become a globally-recognised leader and world-class company. We have grown our business through wider global outreach, strengthening business partnerships, increasing manufacturing capacity and developing a compelling product portfolio. We are determined to advance further with more innovations to fulfil demand in the material handling industry. GRI has won several awards for business excellence. The most recent was the overall Bronze Award of the National Business Excellence Awards 2013 in Sri Lanka. We will continue our pursuit of excellence, producing some of the best solid tyre in the industry and striving for greater success.

#### **Describe the sort of testing that your tyres undergo**

GRI uses the latest technology – we test our tyres against the best solid tyres in the world under dynamic and static conditions. Our tyres are subjected to routine testing using a standard endurance testing machine, and also performance-evaluated through field tests done locally and abroad.

Global Rubber Industries practises a compressive testing procedure for raw material evaluations, selections and monitoring. Every consignment of raw materials is subjected to ‘incoming testing’ under the ISO 9001:2008 quality management system. All rubber compounds are tested 100% for rheological and physical properties, such as tensile strength, elongation, modulus, hardness, etc. Finished tyre samples from each product category are subjected to destructive testing while all tyres are passed through the ultra-sonic test to ensure a perfect bond between different layers of the tyre. In each tyre, hardness is measured and recorded to ensure the correct degree of cure; tyre samples are subjected to ‘endurance tests’

routinely, using a standard endurance testing machine. In addition to the above laboratory tests, we carry out field tests on the actual usage of all GRI tyre-brands to monitor performance.

We believe that innovation through R&D, as well as continuous process improvement – both in business and in production – is a key to facing any challenge, whether now or in the future. GRI will relentlessly push the boundaries of technology advancement.

#### **How have environmental regulations impacted your business?**

It is necessary to obtain an environment protection licence (EPL) from the Central Environment Authority for any industry operating in Sri Lanka. EPLs are issued on condition that our processes do not emit any toxic gasses or dust to the environment, while maintaining noise below permissible levels – measured on site on a regular basis. And because our process is a dry process, we do not generate any liquid effluent.

Since we use bio-mass-operated steam boilers, there are no toxic gas emissions from our industry. No dust particles are generated in our process, hence environmental regulation has not impacted negatively on our business.

We produce our own natural rubber compounds with fabrication technology that is of the highest standards, empowering GRI to compete with the best in the world. We also maintain a strict green policy on waste management and raw materials. GRI continues to move forward to meet the ever increasing demands of the industry while keeping our commitment to protecting our environment

#### **If you could, what one thing would you change, nationally or globally, that you feel would be of benefit to either your company or the port industry generally?**

Nationally, I would encourage and support a Free Trade agreement between China and Sri Lanka. At present, the governments of Sri Lanka and China are finalising a free-trade agreement. The ability to provide Chinese ports with world renowned, high-quality solid tyres from Sri Lanka will be a huge benefit to our industry, our company and also to Chinese ports. Therefore a free-trade agreement between our two countries would be greatly beneficial to our industry.

*“Our key growth area is in the development of all-steel radial tyres for various applications, including for ports.”*



## Exclusive Q&A

Rajiv Poddar, Joint Managing Director  
BKT Tyres, Mumbai, India



### What are your key products and outline their applications in ports globally?

BKT's key products in port applications are:

- A) 18.00-25 Port King Plus is a BKT flagship tyre for port applications, designed especially to meet the specific needs and requirements of port equipment and to enhance port economics. It comprises a highly wear-resistant tread compound coupled with exceptionally high tread depth, all of which offer an edge over competitors with respect to service hours and performance. It is designed to be used on reach stackers and is used in almost all the leading ports globally.
- B) 18.00-25 Container King is very much identical to Port King Plus with respect to its features, however it has better performance. Its wider centre-area offers additional stability to the machine which is one of the major requirements of a reach stacker application; the extra tread weight provides additional service hours.
- C) 21.00-25 XL Grip is designed to

meet the requirements of rubber-tyred gantry cranes (RTGs). It has very high load capacities and also a heat- and cut-resistant tread compound. It is used in most of the busy and leading ports globally, such as Singapore Port (PSA) and others. We have also developed a new tyre, the 18.00 R25 Portmax PM-90. This has an all steel radial casing with rigid sidewalls for operator comfort, multi-layer steel belts for high stability and excellent puncture-resistance, an extra-deep tread for longer life, and a specially-designed tread pattern to minimise individual lug movement.

### What is your company philosophy and how does it manifest itself in your products/trading?

Our philosophy is to 'offer the best quality product to market, at the most reasonable cost'. When it comes to R&D and quality control, the team ensures that only the best-quality tyres are produced and shipped. It is a 'no compromise philosophy' and the results are far-reaching.

### Where are your markets?

More than 95% of our production is exported to more than 130 countries worldwide.

### Do buyers and suppliers of port equipment understand the link between on the one hand rubber composition and tread, and on the other hand, economy, longevity and performance?

Most of our buyers know the number of service hours and performance levels they require, and they can calculate the cost per hour of the tyre in service. However, only very few know how to do this with the tread, rubber composition and other features of a tyre. This is where the technical training team of BKT comes into the picture, with its various presentation modules used for in-depth training of end-users.

### What should buyers and suppliers of port equipment be aware of to ensure the best tyre is chosen for the right application?

Buyers are expected to be aware of the factors that will reduce their operational costs. These include:

- A thorough knowledge of their machines and their applications,

# W



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requirements and expectations. For example, one must not use regular-depth tyres for reach stackers as the tyre wear will be very rapid, resulting in increasing frequency of tyre changes. The downtime of a reach stacker in a port is very costly hence it becomes uneconomical to resort to regular-depth tyres. Buyers should opt for an extra-deep tread tyre and for a highly wear-resistant tread compound to increase the life of the tyre, which will reduce the frequency of tyre changes and make the operation more economical;

- Similarly, for RTG cranes, one must use a regular-depth tyre. RTG crane tyres are subjected to extremely high loads and pressures; their life span (regular depth) is not less than five years, but if one uses a deep tread then it may go up to beyond 10 years. However, a longer life-span increases the risk of separation in tyres due to the extremely high loads and pressures that alternate with 'relaxation', hence it is better to use a regular tread-depth tyre;
- Also, it is important to take care of tyres during service and maintenance, such as continually maintaining correct inflation pressures and interchanging tyres at regular intervals.

#### **How does the type of rubber affect the performance of the tyre?**

Certain applications call for a specific tread-rubber compound. For example, reach-stacker tyres undergo very high 'squirming', hence tyres for that application must have a highly wear-resistant tread compound.

#### **In these port applications, how does the behaviour of a solid tyre differ from that of a pneumatic tyre?**

Solid tyres offer a major advantage as they do not get punctured and hence can offer uninterrupted service. However, pneumatic tyres have several other benefits when compared to solid tyres: the higher cushioning effect means better

riding comfort. Shocks are absorbed by pneumatic tyres, whereas solid tyres do not absorb shocks to that extent; being heavier than pneumatic tyres, solid tyres increase the total weight of the machine, causing higher fuel consumption; and the rubber mass in solid tyres being very high means that the chances of failure due to heat built-up are also high compared to pneumatic tyres. Furthermore, solid tyres have a higher rolling resistance.

#### **Describe the sort of testing that your tyres undergo.**

We perform cut-tyre analysis, endurance testing, determination of rolling circumference and static loaded radius, among others.

Currently, we are using outdoor testing tracks and venues for rigorous field-testing of our tyres. However, during this year, our own testing-track spread across an area of about 30 acres will be ready at our new and upcoming tyre plant in western India. This will enable us to keep continuous track of tyre performance and implement the same into our production process in real time.

#### **Outline your key growth areas. Are you conducting any interesting product developments or R&D?**

Our key growth area is in the development of all-steel radial tyres for various applications, including ports. PM-90 will be our new range of Port Radial Tyres, slated to be commercialised during this year.

#### **What major challenges are you facing supplying tyres to container terminals globally?**

One of our major challenges with our ports and terminals customers globally is inadequate knowledge of the tyre, and the requisite care and maintenance. By overcoming the above deficiencies, we can further enhance customer satisfaction.

#### **The industry globally is now emerging from the downturn which began in 2008. What lessons have you learnt from this period and how will it benefit you?**

The downturn in the industry never really affected BKT, to the extent that other suppliers were affected. Our CAGR (Compounded Annual Growth Rate) for the past decade has been over 35%. This came down marginally. However, based on the strength of our products' consistent quality and reasonable pricing, customers have preferred BKT tyres, even in these constrained times. We have realised that even during a downturn, there is no need to panic and downgrade your product quality to suit the temporary needs of the time, as quality and consistency win in the long run.

#### **If you could, what one thing would you change, nationally or globally, that you feel would be of benefit to either your company or the port industry generally.**

Enhancing the knowledge level of global customers will certainly benefit our company and the port industry in general. It would benefit BKT as it would demonstrate that the real mettle of the organisation is in maintaining quality. It would also benefit the port industry in general, as overall productivity would increase, thereby saving global costs.

#### **How have environmental regulations impacted your business?**

In 2009, European regulations such as REACH required all products entering the EU to be free from carcinogenic oils. BKT realised this immediately and changed its entire oil sourcing so as to be compliant with this regulation. This has increased our overall production costs but each product leaving BKT plants for any country is now free of such oils.

#### **How are you being affected by cheaper, Chinese-manufactured tyres?**

We are not affected very much. Chinese products being cheaper, it becomes a difficult choice for anyone. However, when service and performance are examined at the economic level, the customer does not resort to Chinese products as these do not offer any value for money.

# Tyres: the silent champions of port logistics



Ralf Krieger, *Head of Product Development and Product Industrialisation of Industrial Pneumatic Tyres, Business Unit Commercial Specialty Tyres (CST), Continental, Hanover*

Tons of freight in containers, enormous gantry cranes and cargo ships waiting to be loaded are the daily routine in harbours. To successfully master a port's operation, a complex substructure of reach stackers, tractors, trailers and heavy-duty forklifts is needed – not forgetting the thousands of tyres needed to keep them running. But if these vehicles failed as a result of a punctured tyre, it could spell disaster for a port and its functioning as an international logistics business hub.

Efficiently-functioning vehicle fleets are vital for the smooth running of port operations. As vehicle substructures transport the bulk of daily loads, tyres play a crucial role and this is more clearly appreciated if they ever should fail. Tyre punctures and related accidents on heavy-duty vehicles cause lengthy interruptions in the entire logistics chain. Vehicle downtimes cost time and money, and they also have negative effects on the environment, due to waiting vehicles and ships, detours and the extra transport necessitated.

Tyre failures in ports are not rare: among other things, incorrect tyre pressures, oil and chemicals frequently cause tyre damage. These substances not only make the ground slippery, resulting in restricted manoeuvrability and braking performance, but can also alter the characteristic features of the tyre. The result is cracking and a porous tread compound. The tyre can become soft and even disintegrate. With incorrect tyre pressure, the carcass can become damaged and lose its stability. Lower- or higher-than-recommended tyre pressure results in uneven wear and thus lower mileage. In summary, these factors are a threat to safe and reliable vehicle operation.

Port fleet-managers often struggle with other challenges that go much deeper. The crux of the matter is that many of the tyres used on harbour vehicles are simply not designed for the hard-working conditions

found in such environments. The ground is highly abrasive and there are often potholes, bumps and foreign objects, all of which have a major impact on a tyre's durability. As a result, only a fraction of the tyres used on harbour vehicles reach the end of their projected service life, irrespective of whether they are used on huge rubber-tyred gantry (RTG) cranes or on smaller forklifts.

## Fleet managers' high demands

All these aspects make tyres one of the most critical success factors for any logistic business within a harbour. Due to the high potential costs associated with tyre failure and underperformance, reliability in a variety of changing conditions, high operating safety and efficiency have always been priorities that fleet managers demand from the tyre industry. For harbour fleets, the main consideration is fuel cost, with tyre replacement cost in second place. However, 20% of a vehicle's fuel consumption originates in the rolling resistance of its tyres. The right tyres can reduce operating costs by up to 10%, underlining again their crucial role in efficient harbour operations.

But what do fleet managers need to consider when choosing between the comprehensive varieties of tyres on the market? For the optimal choice of tyre, fleet managers first need to differentiate between each vehicle type and its operational area. For example, gantry cranes often turn on the spot under high load which puts tremendous stress on tyres, resulting in frequent punctures. An exceptionally robust tyre construction that reduces wear, casing damage and tread stress-cracking is needed here. On the other hand, reach stackers and forklifts have a high risk of overturning: they are exposed to various loads, frequently heavy, as well as uneven surfaces, which can have a dramatic impact on the vehicles' balance from lateral movements up to subversions.

Tyres on such vehicles therefore need to offer high tilting stability that is achieved through a robust tyre construction and strong sidewalls.

Besides low wear, long tyre-life, reduced vibration and high mileage, we must also consider energy efficiency. An increasing number of vehicles in port operations are already driven electronically. The lower the rolling resistance of the tyre, the less energy has to be expended to move the vehicle. Increased battery life also means cost savings. To further minimise costs in the medium- to long-term, fleet managers should also equip their fleets with tyres from one portfolio to reduce maintenance expenditures and enhance their fleet's overall operating performance and stability. Also, the continuing trend toward sustainability and optimised environmental performance adds another aspect that harbour fleet managers have to bear in mind when running successful port operations. Tyre manufacturers are therefore challenged to offer customised products and systems that fulfill all the criteria demanded by port operators.

## Success factor: standardised yet customised manufacturing

To live up to the high expectations and demands of port logistics, the ongoing optimisation of standardised manufacturing processes is a key success factor for tyre manufacturers when considering the special requirements of a business segment such as harbours. This includes, among others, the ongoing development of new technologies, the application of new materials and the optimisation of products regarding sustainability across the entire product life cycle. The successful life cycle of every tyre begins in the R&D laboratories and departments of leading global tyre manufacturers such as Continental; this is followed by manufacture in factories worldwide.



Above: Vehicle downtimes cost time and money due to waiting vehicles and ships, detours and extra transports. That is why reliable, safe and efficient tyres are essential for harbour fleet managers; Right: To minimise costs, it is advantageous for fleets to be equipped with tyres from the same range in order to reduce maintenance expenditure and enhance the fleets' overall operating performance and stability

Harbour vehicle type	General requirements
Trailer Tractors	Frequent acceleration High mileage Frequent turning
Reach stacker Heave-duty forklifts Empty container handler	High stability
Straddle carrier	High stability High resistance to damage
Crane vehicles Automated guided vehicles	High stability Frequent turning Low rolling resistance

Figure 1: Tyre requirements of different vehicles

With their longstanding experience from other business segments, these global leaders have the best qualifications and means to adapt and develop technologies for highly specialised harbour fleets. For example, Continental recently developed a new technology for application in ports which combines the benefits of cross-ply and radial-ply tyres, and features solutions with excellent driving stability, high damage-resistance, a high reliability and a low rolling resistance. Overall, to secure high-quality tyres that are able to cope with the challenging conditions in harbours, it is imperative to have established standardised production processes with ongoing process control.

### Overcoming daily harbour 'enemies'

Against the backdrop of recent market estimates – the global port business will double its capacity from 600 million TEU to 1.2 billion TEU in 2024 – it is important for port operators and their suppliers to

overcome the daily challenges from typical harbour 'enemies', such as the oil and chemicals mentioned earlier. Choosing high-quality tyres customised for their application and environment is one basic measure. Regarding oil and chemicals, the mixture of the tyre is essential. Fleet managers should choose tyres with a mixture that is highly impervious to oil and other liquid chemicals. Leading tyre manufacturers also recommend that harbour fleet managers regularly check their tyres for damage and cracks. They should also maintain the tyre pressures of their vehicles at least once a month, since small pressure losses cannot often be identified through visual examination alone. Doing so significantly lowers the risk of tyre damage.

In summary, ports form the crux of world trade and, with a prosperous future ahead, tyres can be key to business success. Port operators who correctly anticipate customer demand choose these hidden champions to minimise costs and enhance the smooth running of their entire port operation.

### About the author

Ralf Krieger is head of product development and product industrialisation of industrial pneumatic tyres, business unit Commercial Specialty Tyres at Continental, Hanover. In addition to his longstanding experience in this business sector, he has a comprehensive background in product development and product industrialisation at Continental. He studied mechanical engineering with a specialisation in automotive engineering at TU Hanover, Germany.

### About the organisation

Continental is one of the world's leading automotive suppliers and tyre manufacturers. The Tyre Division has more than 42,000 employees and 22 production and development locations worldwide. The broad product range and continuous investments in R&D make a major contribution to cost-effective and ecologically efficient mobility. Continental is also the only tyre manufacturer to offer a complete range of industrial tyres. For over a century, Commercial Specialty Tyres (CST) has been successfully manufacturing specialty tyres in the core areas of Industrial Material Handling, OTR Material Handling and Underground Mining. It is the first manufacturer to offer port fleets a complete tyre portfolio that also minimises costs.

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# Wireless tracking, monitoring and streamlining operations



Robert Estes, Global Sales and Technical Communications,  
Globe Tracker, Melbourne, Florida, US

The Globe Tracker Yard and Terminal Infrastructure Network enhances yard and terminal operational efficiency and provides a communications link with customers to facilitate value-added services. Strategic placement of Globe Tracker Infrastructure Communications Units throughout the yard or terminal, produces, in-effect, blanket coverage of the area. These Infrastructure Communications Units (ICU) continuously communicate with each other. They also communicate with GT Communications Units installed in assets, containers, trucks, ITVs, reach stackers, chassis etc, located in the coverage area. This continuous communication allows the yard operator to determine the exact real-time location of every GT-enabled customer and yard asset in the coverage area. Additionally, these GT-enabled assets can communicate real-time events, such as temperature alarms and door status changes directly to the asset owners – the yard's customers. These real-time alerts can be passed to the terminal operator, thus allowing for optimisation of terminal and yard operational efficiency, and provision of value-added services to customers.

Globe Tracker's solution extends beyond marine terminals to inland hubs, container depots, rail yards, intermodal yards and logistics staging areas, where operations require tracking and cargo integrity/security. Owners and freight forwarders will be able to achieve proof of delivery and verification of cargo security from origin to final destination.

## Features and benefits

Globe Tracker's Yard and Terminal Infrastructure offers the following benefits:

- It is the most cost-effective asset-tracking and monitoring solution for yards and terminals, with its inexpensive 'cloud' services and

hardware guaranteed and maintained under GT Total Care;

- Unmatched coverage with penetrating Sub GHz radio technology; locates and communicates with assets even in multiple rows and stacks;
- Optimises container and trailer-flow through terminals and yards, saving time and money, and improving equipment operating efficiencies;
- Features yard and terminal alerts, including asset arrival and departure, movement within the yard and terminal, interchanges between cranes, chassis, trucks and lifts, geo-fence position alerts, power on/off, etc;
- Geo zones within yards and terminals track containers through pre-cleared, customs-cleared, maintenance and other areas defined by the operators;
- Accurate asset positioning within yards and terminals' X, Y and Z planes;
- Asset event alerts such as temperature alarms or door open are communicated through the GT I-Network to the asset owner and shared in real-time with the yard/terminal operator through GT's Trade Data Exchange Network, and
- Improved logistics and exchange verification through GT's Trade Data Exchange Network and I-Networks.

## How it all comes together

Rational tracking and monitoring of containers and other assets in yards and terminals requires reliable full 'field of interest' coverage and real-time communications at a reasonable total cost. GPS, optical, cellular and Wi-Fi solutions all require compromises, and are currently expensive, in both initial and long-term cost, due to maintenance and service disruption impacts. The Globe Tracker Yard

and Terminal Infrastructure Solution offers unparalleled real-time communications coverage at a fraction of the initial out-of-pocket cost and many times that advantage over time with GT Total Care warranty.

GT Comm. Units entering a yard or terminal recognise and connect themselves to the area's infrastructure network. Once connected, the GT Comm. Units change their operating profile to 'Infrastructure Mode'. In Infrastructure Mode, the units collect and report data from their associated peripherals and real-time events to their owner's remote server through the infrastructure network. These real-time events are shared, at the asset owner's discretion, with the yard or terminal operator through Globe Tracker's Trade Data Exchange Network for appropriate action.

The GT Infrastructure Network also monitors Sub GHz devices deployed by the yard or terminal operator to track their operations, movements, position changes, process flow, various operator-deployed sensors, etc. It is the GT Infrastructure Network and proprietary GT triangulation algorithms that provide the X- and Y-positioning and precision to within one metre.

## The Globe Tracker eSeal

The Globe Tracker eSeal works as a peripheral to the GT Communications Unit, the industry's most advanced real-time tracking and monitoring communications device. The GT eSeal is designed to be inserted into the lock loops of a container or truck trailer door, have its locking cap attached by trusted personnel and then continuously report its real-time closed status to its associated GT Communications Unit as it moves through its supply chain journey. The GT Communications Unit reports this status

to its owner for inclusion in the container's or trailer's trip report.

### The Globe Tracker eSeal – features and benefits

- Single-close and multiple open and close versions, both with guaranteed 70+ days of battery life, confirmed by LED each time the eSeal is closed;
- Easy 'no tools required' installation; insert the eSeal shaft through the lock loops, attach the end cap, watch for the activation LED to light;
- Continuous real-time door lock loops monitoring;
- Customisable eSeal alerts and reports;
- Real-time eSeal status data is incorporated into the GT communications unit data;
- Historical eSeal status data with GPS location and time stamp is saved to the asset owner's database;
- eSeal data can be seamlessly shared with customers, supply chain partners, customs and border protection agencies, and
- End-to-end, real-time electronic surveillance for containers, trailers, rail cars and air cargo containers.

### Small, inexpensive and smart

The Globe Tracker eSeal is installed on the outside of a cargo container or truck trailer through the lock-loops on their doors. Removing the eSeal to separate the lock-loops and open the cargo doors requires the eSeal's 'cap' to be removed. The eSeal will be available in at least two versions, a 'close-once' version and a 'multiple-open and close' version that allows the eSeal to be opened and closed multiple times.

The Close-Once eSeal is installed by inserting its lock-rod through the lock-loops of the door and 'snapping' its cap onto the end of its lock-rod. The eSeal is opened by removing the eSeal's cap from the end of the eSeal's lock-rod such that the lock-rod can be extracted from the door's lock-loops. The eSeal's cap is removed from the lock-rod by breaking it off the end of the eSeal's lock-rod or by cutting the lock-rod itself.

The Multiple-Open and Close eSeal is installed similarly but is opened in a non-destructive manner such that it can be reclosed again. All of these actions are recorded in real-time by the eSeal and through its associated GT Communications Unit and are sent over the SAAN to the asset owner. The GT Communications Unit can be set-up to monitor eSeal data and within the context of other certain parameters and information – such as whether it is able to communicate with an authorised GT Infrastructure Network or

not – can initiate an immediate push signal, sending an eSeal alert through the GT SAAN to the asset owner.

Both eSeal versions are associated with specific assets, containers, truck trailers, etc. through the GT SAAN by their asset owners. Both eSeals are physically rugged, waterproof, meet IP67 requirements, and are capable of operation in temperatures ranging from -40°C to +70°C.

### eSeal benefits:

- eSeals have a guaranteed 70+ days active battery life and a one-year shelf life;
- Ruggedised IP67 waterproof enclosure assures continuous performance;
- The shaft of the barrier-type bolt seal is made of 5/16in (8mm) diameter steel;
- eSeals reliably communicate with their associated GT Communications Unit's 433 MHz radio subsystem using Globe Tracker's open-license proprietary Sub GHz communications protocol;
- The eSeal's steel lock mechanism, steel bolt shaft and electronics are encased in impact-resistant plastic housings;
- A large integrated event log helps to ensure that eSeal events are not lost; and,
- Temperature operating range is between -40°C and +70°C.

Part two of this article will look at **GT Comm. – the Globe Tracker Communications Unit**

### About the organisation

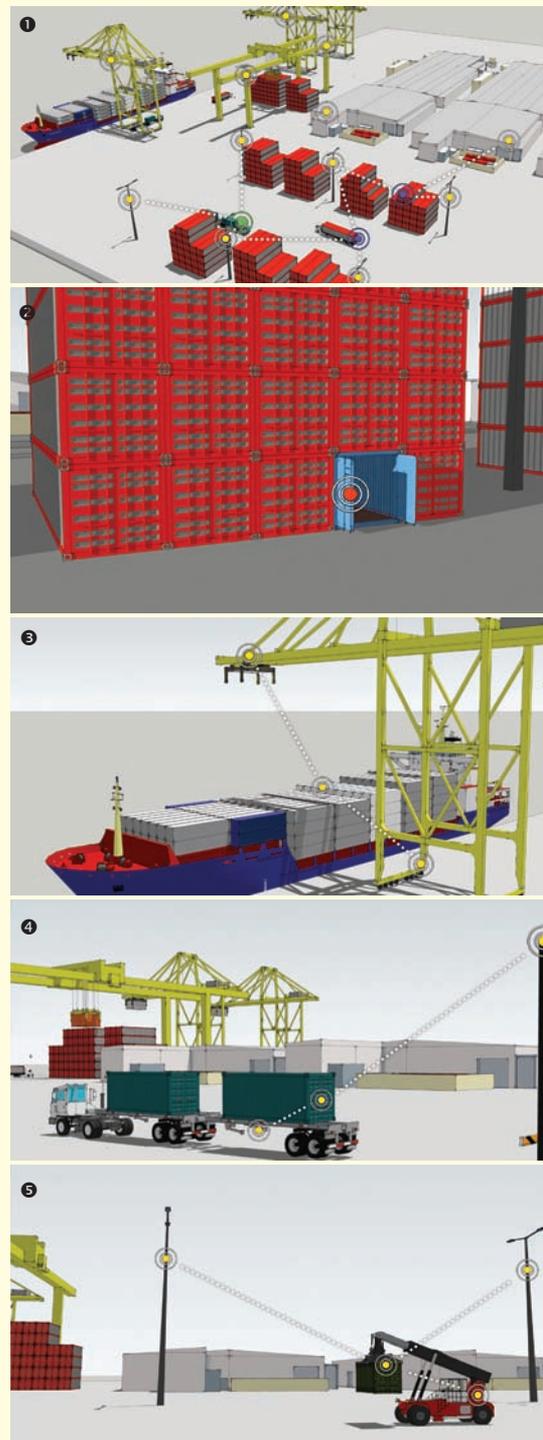
Globe Tracker International is a privately-held Danish company specialising in supply chain visibility and profitability. It is a leading provider of data sharing, data analytics, and global asset tracking and monitoring services and equipment. Globe Tracker opened a development centre in Beijing, China, in February 2007, and now has offices and development centres in Qingdao, China; Toronto, Canada; Copenhagen, Denmark; Reykjavik, Iceland; and Melbourne, Florida, US.

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1. Multiple GT Infrastructure Units are installed across terminals, yards, warehouses and depots to ensure blanket Sub GHz communications coverage for GT Communications Units and Sub GHz peripherals entering their field of coverage; 2. GT eSeals, installed in container door lock loops, also monitor and report real-time open/close events; 3. GT eSeals on containers can communicate with terminal infrastructure while still on the vessel; 4. GT multi-use eSeals can be installed, in seconds, on a container, either when unloaded from a vessel or when passing through a terminal gate; 5. GT eSeals can provide Lat/Long location to within 1m accuracy anywhere in the terminal.

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# High productivity with a new concept crane



Paul Duponcheele, *Technical General Manager,*  
*Grup TCB, Barcelona, Spain*

Grup TCB, through its subsidiary TCEECE in Turkey, commenced operation of the container terminal situated in Nemrut Bay, close to Izmir, in 2009. In Turkey, jetty piers 25 to 40 metres wide are standard, allowing vessels to be berthed on both sides. This explains why jetties are operated mainly by means of mobile harbour cranes (MHC), and this is how TCEECE began to offer its services to the shipping lines.

A MHC is a flexible machine, which can achieve good productivity in small feeder vessels, up to 20 moves per hour, and can shift easily from one side of the pier to the other. However, the MHC has to face many disadvantages compared with ship-to-shore gantry cranes (STS) as regards to productivity, as STS cranes aim for 30 moves per hour.

## Placement considerations

When you handle containers on a jetty pier, traffic jams are an issue to be considered, as you have a bi-directional flow of terminal tractor (TT); and hatch covers must be placed properly to minimise disturbance. Also, considering the space needed by a MHC, it is easy to see that there is a limit of placing up to four MHC on a jetty; otherwise congestion might occur.

Thus, due to the cascade effect of the container vessels in the Aegean area, and concern with offering higher productivity to its clients, Grup TCB raises the following question: how best to place STS cranes on a jetty?

The first idea consisted of placing STS cranes on both sides of the jetty, which meant removing the back reach of these cranes, as they will need to pass each other

in a back-to-back configuration. As every deployment has to be done in phases, Grup TCB's first thought was to place two STS cranes with no back reach on one side of the jetty, and operate on the other side with its current Liebherr MHC LHM 500.

In a second phase, it was planned to widen the jetty from 40 to 57 metres to fit two additional STS cranes on the other side.

Thus, in its final phase of deployment, TCEECE would have up to four STS cranes, two on each side of the jetty. On the previous drawing, it can be seen that the hatch cover (limited to 12 metres) would be placed on a platform situated above the portal beam of the crane, producing a fluid traffic flow.

However, a new drawback arose, related to capital expenditure. Widening a jetty along 350 metres requires a considerable amount of money, without forgetting that even if the terminal is willing to widen the jetty, its handling activity would be close to saturation. Then it starts to be a concern to have one side of the jetty not available while the construction is going on.

Moreover, coming back to the cascade effect of the container vessels, shipping lines are not only expecting good crane productivity, but also adequate crane intensity, which combining both factors means good vessel productivity: this is what customers need. Obviously, only two STS cranes on one side might not be sufficient, thus obliging the terminal to make an additional investment. Consequently, Grup TCB dropped this concept, and focused its research on trying to find solutions to increase vessel productivity with lower investment.

## A new idea

A few months later, a new idea was raised: the 'double boom' STS crane. At first sight,

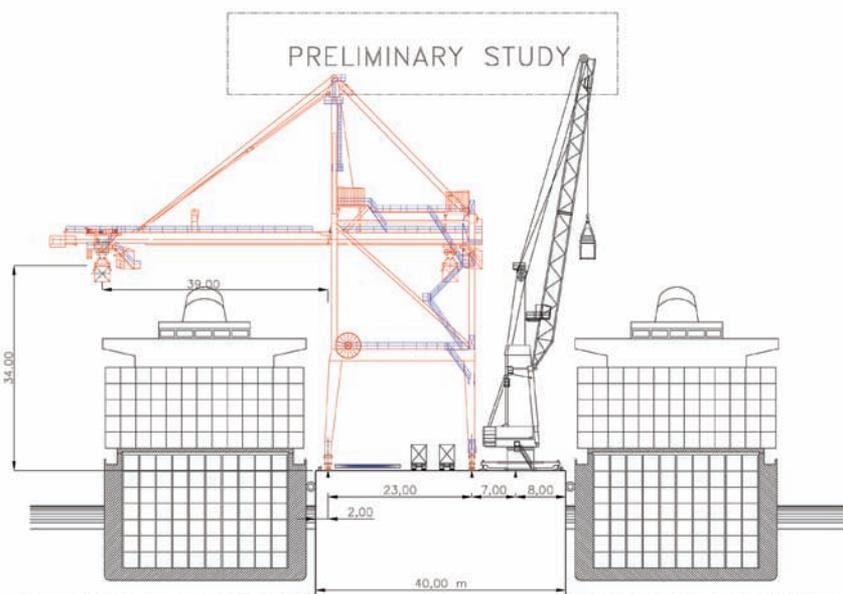


Figure 1. The initial placement plan.



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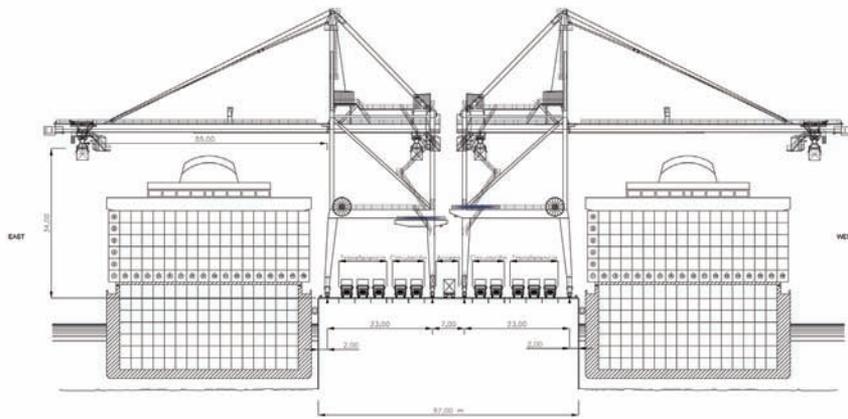


Figure 2. The second phase placement plan.

it seems that the main disadvantages of MHC and STS without back reach were solved. There would be no need to widen the jetty. Less investment in equipment was required — in the final stage, four cranes will be positioned on the 350-metre jetty, thus allowing up to four cranes at the same time on one vessel. The average vessel productivity would then exceed 100 moves per hour. Both sides of the jetty could be used at the same time. Fluid traffic flow of TT would be achieved, as the crane is designed with a 36-metre span for a 40-metre wide jetty. More space would be available to fit the hatch cover above the portal beam of the crane, up to three elements 16 metres wide. So there is no

traffic build-up on the jetty.

Grup TCB organised some internal meetings with its operation specialists from its network of terminals, in order to analyse the result of different scenarios and simulations carried out by the technical department of the company. Additionally, Grup TCB requested an outside opinion from a Canadian consultant, and all conclusions pointed in the same direction: this was just the crane TCEEGE needed.

#### Making the idea a reality

Meanwhile, different meetings were held with the major crane manufacturers. Very quickly, Liebherr was appointed by Grup TCB to develop this new machine, as they

had the right profile to develop a prototype of this magnitude, and were able to offer aftersales service, as some fine-tuning would be expected. During the design phase, Liebherr brought all its knowledge to bear to solve various technical challenges; such as ensuring that the crane was able to work with either boom, the other one being in the raised or lowered position, which means the main hoist is placed on the trolley and a double festoon ensures the electrical supply. Turning the cabin was possible to ensure the crane driver always faces the vessel, whichever boom it is travelling on. A displaceable platform above the portal beam was needed to accommodate up to three hatch covers. This platform was placed on the opposite side of the crane to allow the shortest handling cycle of the container.

Regarding TT traffic, the flow is quite different from the traditional one below a standard STS. As mentioned above, TT traffic enters and exits the jetty through the same access point, so a two-way traffic road has to be painted in the centre of the jetty. We call it a two-way 'pit lane'. Below the crane, close to the berth and on both sides, two lanes are marked and are used as 'pit stop' positions. Figure 4 attempt to explain the details of this flow, and using the words 'pit lane' and 'pit-stop', the drivers' union has quickly assimilated the concept.

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### About the author

Paul Duponcheele has a mechanical and industrial engineering diploma from the French school ICAM (Institut Catholique des Arts et Métiers), and spent 18 years plying his trade as a equipment and procurement director at an international construction company, where he was central to their engineering projects involving dams, tunnelling, road and maritime infrastructure. He became technical director of Grup TCB in 2009 and heads up the design and construction, equipment and IT departments.

### About the organisation

Grup Maritim TCB is a global reference in the design and efficient management of port terminals. It currently operates 11 maritime container terminals in Barcelona, the Canary Islands, Valencia and Gijón (Spain), Paranaguá (Brazil), Havana (Cuba), Progreso (Mexico), Buenaventura (Colombia), Nemrut Bay (Turkey), and will soon add Puerto Quetzal (Guatemala) to this list. The company also boasts two intermodal service subsidiaries (TCB Railway Transport and TCV Railway Transport), as well as five rail terminals — Barcelona, Valencia, Gijón, Zaragoza and Valladolid. Grup TCB places special emphasis on optimising its internal resources and on the organic development of its activities, which it achieves thanks to the implementation of cutting-edge technologies and the qualified training of its personnel, guaranteeing operational quality and maximum sustainability and respect for the environment.

In 2013 the company achieved revenues of €400 million, while its activities in port terminals exceeded 3.7 million TEU of containerised cargo, in addition to 136,000 TEU carried by rail.

### Enquiries

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Website: [www.gruptcb.com](http://www.gruptcb.com)

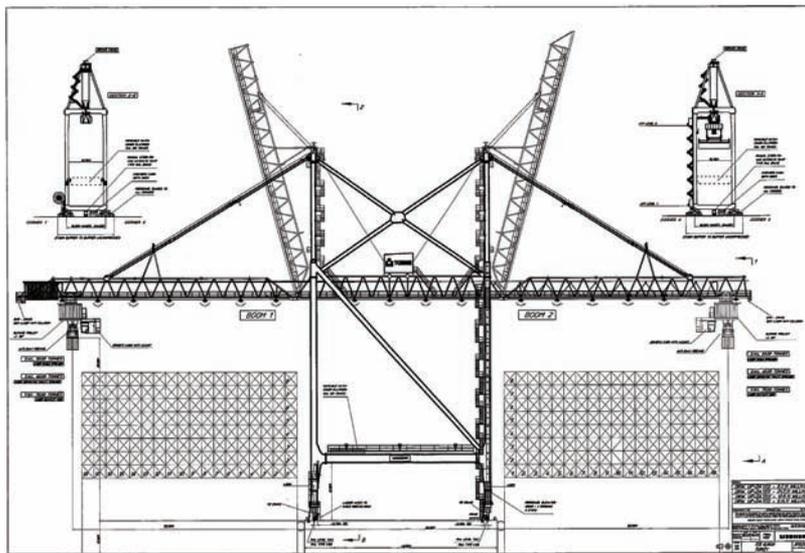


Figure 3. The 'double boom' STS crane.

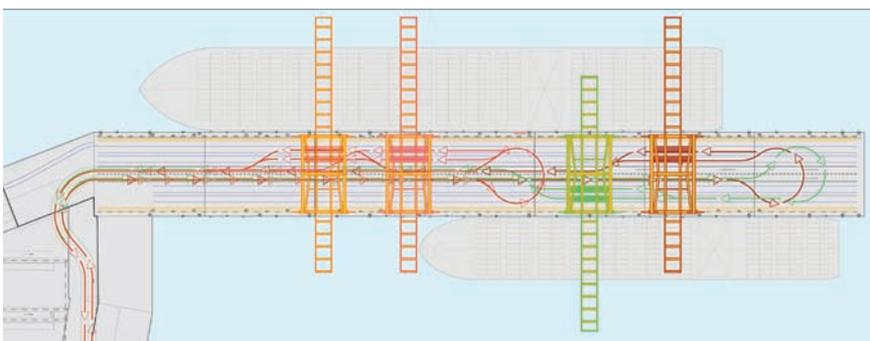


Figure 4. The traffic flow for the new concept.

of space under the crane, more precisely below the hatch cover platform, which allows the placing of twist lock boxes, a small forklift or other light vehicle. Currently TCEEAGE is operating two double-boom cranes, and in the near future, as the container traffic volume at the terminal increases, additional double-boom cranes will complete the fleet.

Has Grup TCB found the right crane to operate a modern container vessel on a jetty pier? Time will tell, but so far TCEEAGE is well known in the east Mediterranean, thanks to this concept coming into fruition. Now other terminals in Turkey are requesting quotations for the same crane from different manufacturers. Is TCEEAGE showing the way?



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# MGT: Reliability through innovation, sustainability and collaboration



Michael Fratianni, *President and CEO of MGT, Montreal, Canada*

In early 2014, Montreal Gateway Terminals Partnership (MGT), the largest operator at the Port of Montréal, achieved a smooth transition in leadership from Kevin M Doherty to Michael Fratianni. While the longtime collaboration of the two men facilitated the transition, the real story is their shared vision for optimising cargo facility operations. The following details both the goals and the steps taken to achieve that vision.

## Environmental sustainability

MGT has a longstanding commitment to corporate sustainability and environmental conservation. MGT took an early and active stance in promoting programmes for environmental conservation and was the first terminal to join Green Marine, a joint Canada-US initiative aimed at implementing a marine industry environmental programme throughout North America. The voluntary programme has rapidly gained a reputation for credibility and transparency, and for challenging participant companies to improve their environmental performance beyond regulatory compliance.

MGT was also the first privately-held container terminal operator in North America to obtain ISO 14001 environmental management certification (and the only privately-owned container shipping terminal in Canada with both ISO 14001 and Green Marine certifications). Established by the International Organisation for Standardisation, the ISO 14001 standard follows a 'plan, do, check, act' framework for organisations to identify environmental impacts, set goals for reducing their carbon footprint, institute best practices and operational controls for meeting targets, and check progress through internal and

external audits.

Recently, MGT constructed a special storage area for refrigerated containers ('reefers') and installed nearly 400 new electrical reefer plugs that allow temperature-controlled containers to run on hydroelectric-generated energy rather than diesel-generated energy. This initiative reduced operational costs for diesel fuel, as well as maintenance, since hydroelectric power sources are nearly maintenance free. It also had profound consequences for MGT's green goals. The new electrical plugs save up to 1.3 million litres of diesel fuel per year. They also reduce greenhouse gas (GHG) emissions by an estimated 30% over the old plugs. As part of the conversion process from diesel to hydroelectric, MGT is also planning to refit its rubber-tyred gantries, which offer similar environmental benefits.

In addition to a significant reduction of GHG emissions, these initiatives should reduce the carbon footprint of crews and materials. Investors have speculated that MGT's high profile within the port industry may lead to other operators emulating such conversions, thus multiplying the effect.

## Identifying opportunities for collaboration

Critical to the success of any port is the ability to identify and act on areas that are ripe for improvement. In the case of MGT, this included dwell time, turn-around time, and flexibility surrounding the timing of deliveries and receipts.

Leaders at marine terminals are in a unique position to monitor and manage the efficiency of freight transport and delivery even after it leaves their port. Vessels may arrive at the terminal and be quickly unloaded, but if there is not a

smooth coordination between the arrival of the boxes and their collection, time is lost. From an efficiency and service point of view, the last thing anyone wants is for import containers to be stored at the terminal for several days. Waterfront property is limited and fluidity is an absolute necessity.

Thus, MGT and leaders from the port, the railways, the trucking community and receiver warehouses came together to facilitate a dialogue. By proactively engaging in the alignment of the supply chain — shippers, rail, trucking, and receivers — MGT has achieved a clockwork operation in which containers reach their destination in as little as 24-36 hours without delay. In 2013, this benefitted approximately 775,000 TEU or 57% of the total container traffic in the Port of Montreal handled by MGT.

## Pushing technological progress

MGT takes an aggressive approach to technological and environmental innovation, with the philosophy that innovation thrives on collaboration. The most recent major innovation completed is the implementation of a new Navis N4 Terminal Operating System to help MGT optimise terminal productivity and empower further enhancement of service delivery, reinforcing its position as a leader in the industry.

By consolidating all systems on one platform, the Navis implementation enables MGT to modernise its IT infrastructure, optimise terminal efficiency, and facilitate ongoing logistics innovations. In short, it makes MGT more competitive by improving security, safety and productivity, while minimising unproductive moves. That, again, serves to reduce CO2 emissions.



## About the author

As president and CEO of MGT, Michael Fratianni oversees all aspects of operations including carrier relations, business development, expansion, safety and the terminals' impact on the local economy and job growth. During his tenure, the terminals have attracted new carriers, increased cargo multi-fold, and more than quadrupled capacity from 30 acres to 140 acres; generating a significant increase in jobs and tax revenues for the city of Montreal. Fratianni chairs and directs such well-known industry associations and advocacy groups as the Mariner's House, the Marie-Clarac Hospital Foundation, the Maritime Employers Association, CargoM, the St. Lawrence Economic Development Council (SODES), the Maritime Data Center, the Association of Certified General Accountants (CGA), the Montreal Board of Commerce and Trade, and the Montreal East Chamber of Commerce and Industry.

## About the organisation



Montreal Gateway Terminals is the leading cargo container facility at the Port of Montreal, the second-largest port in Canada. MGT's strategic positioning is closer to key European ports than terminals along the US east coast and unmatched service delivery and capacity have earned the operator long-term committed relationships with the world's leading carriers. MGT's two container terminals are efficiently serviced by both CN and Canadian Pacific Railway, which have direct links to major American rail carriers. MGT is also connected to the network of highways that lead directly to markets in Quebec, Ontario, and western Canada, as well as the US, providing reliable, cost-competitive inland transportation.

## Enquiries

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One of the most important lessons MGT learned during the implementation process is that success does not rely solely on further improvements of technology, but rather bringing people and business up to speed on the appropriate use of the technology to fit defined business needs and objectives. The team recommends specific steps: identifying critical success factors, involving key end users in the process, and ensuring the team has adequate knowledge and commitment to make decisions and execute.

### Delivering added value

MGT is also creating a facility that will specialise in the cleaning and containerisation of agricultural products for international markets. Created by CanEst Transit, a new company founded by La Coop Fédérée, Transit BD, and MGT Holdings, the facility is being modernised at a value of C\$22 million, including the installation of new conveyors, scales, and other equipment. It is scheduled to open in August of 2014.

Part of a strategy at the Port of Montréal to provide value-added services to customers and attract new clients, CanEst Transit is strategically located adjacent to the container terminals in the port. This unique positioning gives the facility the advantage of receiving deliveries of grain by rail, through a dedicated rail service, and by truck on port roads designed for unrestricted weight classes. Agricultural products will come from Quebec, Ontario, western Canada,

and the American Midwest, with a loading capacity of eight containers per hour, and two different products simultaneously.

CanEst Transit will be able to store, clean, sift, package and containerise agricultural products, as well as handle bulk or bagged grain and by-products. Once containerised, agricultural products will be transported by truck to local markets, or directly to the Port of Montreal's container terminals for onward transit by vessel to the international markets that the port's container lines serve, including Western and Eastern Europe, the Mediterranean, North Africa and Asia.

Leveraging existing infrastructure and the port's vast storage capabilities, the facility will have an initial storage capacity of 68,000 tons distributed among 56 silos of 900 tons each and 35 silos of 300-500 tons each. This unmatched capacity allows CanEst Transit to seamlessly receive and store 14 rail cars of grain products simultaneously, while fully preserving product identity throughout the process, ideal for maintaining the traceability of all products.

### Looking ahead

MGT expects that its commitment to innovation will position it for continued success as the terminal operations industry increasingly favours reliability, consistency and velocity as key differentiators among the service providers. MGT also believes that tighter collaboration among supply chain partners is inevitable and urges other marine terminals to take accountability for driving this process.

# How DP World Vancouver decreased container topples without sacrificing productivity



Alan Peterson, TMEIC Global Sales Leader - Crane Systems

With more than 65 terminals spread across six continents, DP World is one of the largest marine terminal operators in the world. Container handling generates more than three quarters of its revenue, representing the company's core business.

Located on the south shore of Burrard Inlet, in the inner harbour of downtown Vancouver, Canada, DP World Vancouver is a key gateway port for the trans-Pacific trades between Asia and the Pacific Northwest. Not only does the terminal serve the local market for British Columbia, it also provides direct daily intermodal rail connection to the important markets of eastern Canada and the midwestern US.

DP World's Vancouver Terminal was the company's first operation in North America and is part of Canada's largest and most diversified port, Port Metro Vancouver – one of the fastest-growing container ports on the continent. As a result of this remarkable growth, container cargo through Port Metro Vancouver is expected to more than double over the next 10 years from 2.8 million TEU handled last year.

In March 2004, DP World Vancouver invested \$148 million in a now finished expansion. Because of this expansion effort, the terminal has more than doubled container-handling capacity to almost 800,000 TEU, added three super post-Panamax container cranes, doubled on-dock rail to 8,000 feet and added 19 rubber-tired gantries (RTGs).

In an effort to reduce operator error and damage to containers, DP World

Vancouver enlisted the help of TMEIC, a leader in safe and efficient port automation, to supply the Maxview Smart Move System on two of the aforementioned RTG cranes in October 2013.

## How Maxview Smart Move System works:

The Maxview Smart Move System is a laser-based stack profile and operator landing assist system tailored to RTG and RMG cranes. By efficiently regulating hoist and trolley speeds during operation, the system reduces the need for spreader repair and the chance of container stacks toppling over, both of which can be costly and time consuming. According to common industry experience, up to 40% of crane maintenance costs and downtime are attributed to spreader repair.

In automated stacking environments where this technology is employed on RMGs, spreaders can go for years without damage due to hard impact. The same is now available for RTGs, and has quickly proven to be very effective.

Maxview Smart Move reduces damage and operating noise as well as improves yard crane productivity. To do so, the system creates a slowdown envelope around the spreader, and limits the hoist and trolley speeds when hard contact is imminent. A laser scanner and Maxview software modules are used collectively to observe the area under the crane and update the profile of containers and possible other obstructions that could

cause hard contact or container topples.

"My personal objective for this project was to have it be invisible to the operators. I didn't want them to even know it was there. It's basically there to keep an eye on the situation and only intervene when the operator isn't looking or slips up. The system's primary objective is to prevent container topples and the two upgraded RTGs have not had any such incidents since the system has been live," DP World Vancouver manager, engineering and maintenance, Joel Werner, said.

In addition to the profile of containers and obstructions under the crane being updated constantly, the Maxview system also tracks the spreader position (hoist position and sway), and continuously compares the distance between the spreader plus load and all objects in the stored profile.

The profiles can be made available to the crane operator on the Maxview Smart Move Crane Management System (CMS) screen. Or as in the case at DP World Vancouver, CMS can be accessed by maintenance personnel from the E-house or remotely. This simple interface is provided to the crane operator in order to increase his or her visual awareness of containers and objects below the crane. Along with the visual of the profile, the CMS screen also indicates the status of the system.

Easy to install and maintain, the Maxview Smart Move System benefits ports by reducing container damage claims as well as wear and tear on the



Top: Port photo: DP World Vancouver; Insert: TMEIC's Maxview Smart Move™ system is a laser-based stack profile and operator landing assist system designed to reduce damage and operating noise, and increase your yard crane productivity.

spreader, head block and wire ropes. The system has a proven, flexible, open design and helps to decrease operating noise level at the port.

DP World takes a customer-centric approach and is constantly investing in terminal infrastructure, facilities and people, working closely alongside customers and business partners, striving to provide quality services when and where they are needed. By working with partners like TMEIC, they are realising their goal to provide quality services while also achieving safer terminal operation.

“DP World Vancouver has had a long-term partnership with TMEIC and has been utilising their laser scanning systems for over six years on our quay cranes. The TMEIC team has a proven track record in delivering innovative technologies that are supported well and make sound commercial sense,” Werner said.

Werner also revealed that DP World Vancouver is happy with the success of the two RTG cranes and now has plans

to outfit the whole fleet of RTGs with the Maxview Smart Move System.

TMEIC is quite pleased with the acceptance that DP World in the Americas has given Maxview Smart Move, and it looks forward to continuing a strong vendor/partner relationship with DP World.

DP World's choice of TMEIC's crane automation expertise for several of the world's newest terminals will give it tremendous potential for advancements in efficiency and safety in Vancouver.

#### About the author

Alan Peterson has been involved in technical sales since 1978, joining first Westinghouse and then GE in 1989. Initially responsible for supporting heavy industry, container port and shipbuilding in Virginia, US, Peterson transitioned to TMEIC in 2006, and has since been working full-time in the marine terminal marketplace. Container terminal automation and advanced lifting equipment technologies are his speciality.

Currently acting as Global Sales Leader for the Material Handling Business Group within TMEIC, his responsibilities include managing a global sales force and helping to shape the strategic direction of the business.

#### About the organisation

TMEIC Corporation's Material Handling business based in Roanoke, Virginia, US, has a long, successful history in the crane industry through its supply of equipment and systems throughout the world. Through engineering, experience, and cutting-edge technology, the company continually improves industrial motor and drive systems by developing the latest equipment, and integrated solutions in response to industry needs.

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# Automated reefer monitoring at CTSP



Maxim Maximov, Sales Director,  
Solvo, St Petersburg, Russia

In the spring of 2014, Container Terminal Saint Petersburg (CTSP) launched its automatic reefer monitoring system. This consists of equipment and software from Emerson Refcon, integrated with Solvo.TOS container terminal operating system. Solvo, the leading Russian systems integrator in the field of logistics, has successfully completed the given turnkey project in tandem with partner Emerson Climate Technologies - Transport Solution.

## Automated management of the reefer yard

Management of the reefer yard is the basic function of all state-of-the-art terminal operating systems. The given functionality can be included in the basic version of the system or can be realised in the form of a separate add-on module. In any case, it must automate at least three main processes which distinguish the reefer container storage zone from the other zones at the container terminal – connecting reefers to the power supply, disconnecting reefers and carrying out scheduled container monitoring.

Information about the required temperature for the reefer container is sent from the management system based on documents (bills of lading, waybills, truck visit requests), which are automatically loaded via the electronic data interchange module Solvo.EDI or entered by the forwarders through the Solvo.web portal. When the container is at the terminal, the management system will issue tasks to the reefer mechanics to connect, disconnect and monitor the containers.

The automation of these processes makes it possible to avoid problems with connecting reefers to the power supply, prevent power-cord disruptions, and reduce load-loss due to scheduled monitoring. Container terminal managers can receive information about the reefer yard and reefer mechanic performance via the Solvo.TOS user interface at their work station or remotely in the browser window via the internet.

Reefer mechanic tasks are issued either in paper format with subsequent recording of task completion via the work station, or in electronic format at the data capture terminals. These DC terminals can work in batch mode by being connected to the work station or in real time where data is sent over WiFi, GPRS. As seen in previous Solvo projects including CTSP, reefer mechanics typically work with the latter DC type radio data terminals (RDT).

However, even with all of the advantages of having automated reefer container processing, shortfalls still exist. This includes, for example, delayed detection of damage or an incorrect temperature mode set for reefers as well as human error.

## Automatic reefer monitoring systems

Besides raising the reefer processing efficiency, the removal of negative influences from the automated process scheme will, among other advantages, make it possible to implement a fully-automated reefer monitoring system. These systems can be divided into two classes: systems whose equipment requires separate connections to the reefer container, and systems that do not require any additional actions other than a full-time connection of the container to the power supply.

First-class equipment can include a special autonomous block connected to the reefer, which sends monitoring data across the wireless network. The reefer mechanic or the tallyman must connect this block to the container as it arrives at the terminal or when connecting the container to the power supply, and then disconnect it or remove the container from the terminal. The advantage of this approach is the ability to monitor even when the container is not connected to a power supply. The downside of this approach is the need for terminal personnel to perform additional actions, resulting in increased equipment loss (if it is not removed as the container departs) or damage, power supply connection problems,

loss of wireless signal, etc. This class also includes systems with additional equipment that is connected via a power cable. They lack the aforementioned advantages and, unfortunately, have the same shortfalls.

The second class of system supports the transfer of data directly via reefer power-supply cables. This is achieved using special equipment, no-contact retrieval of high-frequency information from supply cables – induction signal sockets. The Emerson Refcon system falls under this class of automatic reefer monitoring which will be described in detail below.

## Benefits of automatic reefer monitoring systems

The main advantage of using an automatic system is undoubtedly preventative monitoring. The system signals when there is a problem with the reefer container even before the load can be damaged. And since reefers are commonly used to transport high-value products, only a few instances of damaged goods will be reason enough to implement the given solution.

The next argument in favour of an automatic reefer monitoring system is the reduction in operating and payroll costs. Reefers stored at container terminals must be monitored on a regular basis. The frequency of monitoring varies across different terminals and can also depend on the agreement made with the container owners. But, as a rule, this period can range from two to six hours. A large workforce of reefer mechanics must also be constantly available to service a terminal with a large number of reefer containers. By removing the need to conduct monitoring with personnel, it is possible to reduce the number of workers needed to carry out this task and so decrease monthly operating costs.

By excluding personnel from monitoring operations, human error is also reduced. The system will never allow a container to slip through and will never specify incorrect temperature data.

For the personnel, the system presents



some clear advantages in terms of work safety. Any container terminal is a high-risk zone. This danger exists for personnel at every step from cranes to lift trucks. Automatic reefer monitoring is carried out by personnel without stepping out of the office. This is why the number of work-related accidents is significantly reduced when using this system. It also presents other advantages such as improved record keeping and accountability, remote management of reefer installations etc.

### Emerson Refcon: how it works

Practically all new reefer containers from leading manufacturers from the turn of the century have equipment with special modems collecting data from the container's sensors and power installations, which can be sent via power supply cables.

The given process is regulated by the international standard ISO 10368:2006 'Freight Thermal Containers. Remote Condition Monitoring.'

In particular, these modems are installed on the reefer installations Thermo King, Carrier, Daikin, Mitsubishi and Starcool. Currently, around 60% of all reefer containers are equipped with modems a figure that is constantly growing.

During Emerson Refcon implementation at the container terminal, response equipment is placed in transformer substations making it possible to receive information from the modems and relay it to the management system in the required format. This equipment includes inductive signal sockets which, when placed on power supply cables, can read the high-frequency information from the modems. The sockets, most importantly, send information via special commutators to leading Refcon stations that also consist of modems similar to the ones installed on the containers.

The monitoring system performs a periodic audit of all containers in order. Communication between the system and each container takes around two minutes. This is why the full monitoring cycle for all containers can be quite lengthy, but does not exceed one hour. It depends on the number of containers and the configuration of equipment at the container terminal.

Information regarding the required temperature and the location for the container is received by the Emerson Refcon system from Solvo.TOS. Correspondingly, all collected information

about the container status is sent by Refcon back to Solvo.TOS. If the container is not equipped with a modem then its monitoring operations are conducted automatically, as described above.

If problems arise, such as the disruption of power supply or an incorrect temperature mode, the system will issue a corresponding notification, which will be displayed in both Solvo.TOS and Refcon user interfaces and can also be sent to involved subscribers via email or SMS.

It is thought that major container terminals with a reefer plug count of over 500 can benefit most from such solutions. However, in its near 20-year history, there have been many cases when it was implemented on smaller terminals even those with a plug count of no more than 50.

The Emerson Refcon system is successfully operating in over 70 container terminals worldwide and on 2,500 container vessels of leading shipping lines.

### Automatic Monitoring System Implementation Project at CTSP

Container Terminal Saint Petersburg became the first and only terminal in Russia, where such a state of the art system was implemented. The main driver of this decision was the constant growth of freight turnover. This is why the main goal was the establishment of quality monitoring and servicing of reefers without involving in-house reefer mechanics.

Most of the reefers arriving at CTSP are transported by MSC line. It is expected that soon, the number of reefer containers equipped with modems will reach 95%. This is why the share of manual monitoring at the terminal will become very small and thus, achieve the established goal.

The system described above was installed for 1,225 reefer plugs that are currently operating at the CTSP terminal. Solvo completed the given project as a turnkey solution, which included project design, delivery and software installation and integration. The project was fully completed in four months.

While it is still too early to give a verdict, it can be said that already two instances of reefer installation breakdown were averted, thereby avoiding any loss or damage of cargo.

We are hopeful that the given solution will take off in Russia and other stevedoring companies will follow the example of CTSP to raise the efficiency of their business.

### About the author

Maxim Maximov graduated from the Baltic State Technical University in 2000 with a master's degree in management systems, specialising in computer processing of information. He later focused on logistical process automation, working at various manufacturing and IT companies. Up until 2002, he headed the software-engineering department in the Petrsoz industrial group and then worked as a project manager at Kompas in the field of ERP and MRP development. In 2004, he became project manager at Solvo, where from 2006 until 2013 he headed the analytics and consulting department. He took over as sales director in 2013. In 2011, he became one of the founders of Russia's only Logistics Museum and is now its managing director.

### About the organisation



Solvo is the leading Russian provider of high-end supply chain execution solutions to help optimise container and break-bulk handling, as well as warehouse logistics. As an independent software developer, it specialises in warehouse and terminal operations management and automation, and offers a number of comprehensive solutions. These include integrated warehouse management, integrated terminal operating and document management systems, and yard management systems and other software. All the company's software solutions are validated by the renowned Fraunhofer Institute of Logistics in Germany.

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# Flexibility at Sharjah Container Terminal



Richard James,  
Terminal Manager, Sharjah Container Terminal

Sharjah was the location for Gulftainer's first operation which started 38 years ago and holds the distinction of being the first purpose-built container terminal in the Arabian Gulf. Starting with a single berth serving geared vessels by just a handful of men, one of whom still works at the terminal today, Sharjah Container Terminal (SCT) has grown into a thriving facility which will pass the 400,000TEU milestone for annual throughput later this year and boasts five quayside cranes operating at very competitive productivity rates.

## Main equipment

The terminal now has four designated berths totalling 760m and an available depth of 12.5m. The two Liebherr ship-to-shore (STS) gantry cranes are supplemented by three mobile harbour cranes (MHC), two Gottwald GHMK 7608s and one Liebherr LHM400, which in various configurations can be combined to best suit each vessel caller. Although a faster individual rate is typically achieved with the STS cranes, using the MHCs allows for working adjacent bays which is often required for the average size of vessels that call and can give rise to better overall berth productivity. These MHCs can also benefit from use of the twin-lift spreaders for loading and discharging 20ft containers.

The five quayside cranes are supported by four RTG stacks for loaded import containers and four container yards, one designated for loaded exports, and three others for empties. At present, the four RTG stacks are serviced by five cranes, one for each of the lanes and a fifth used to assist in a busy stack as required. In 2012, all units were retrofitted to enable electric power operations which achieved a substantial reduction

in carbon emissions. With traffic volumes having grown – 14% up on the first half of the year – a need to augment these stacks with additional units has been identified and is included in the Terminal's development plan.

## Traffic flows

Reviewing last year's commercial data, 85% of Sharjah's traffic flow can be considered as full in-bound containers of predominately consumer goods from the Far East, with the empties needing repositioning. The remaining 15% was the reverse with exported goods destined for Iraq, Ethiopia or the major east African ports. The former is carried by many of the main global shippers, such as APL and MSC, or local common feeders via Jebel Ali. The Iraq volume is carried by Sharjah-based Mag Container Line, with national carrier Ethiopian Shipping Lines operating combi vessels to Djibouti and Maersk Line's Masika Express service connecting Dar es Salaam and Mombasa with transshipment from Salalah. Only last week, UASC commenced its new Gulf India Service (GIS1) which now offers direct connection to Mundra, Karachi and Sohar in a much sought after regional loop, adding a renewed dimension to the supply chain possibilities from Sharjah.

Considerably smaller in terms of volume, yet a significant and highly profitable trade, is that of the refrigerated containers handled in the terminal. One dedicated line, operated by NYK Cool, carries these units from the Philippines while many others are shipped in from South America by lines such as CSAV. To keep in line with this rising trade, additional capacity was added two years back with 300 plug points now available from the mains

supply plus back-up provided by diesel generators.

## Development

By far the largest development to happen during SCT's 38 years was the dredging of the channel and basin from 10.5m to 12.5m. To achieve the additional depth it was necessary to sink piles ahead of the existing gravity wall, laying precast blocks and geotextile, then extending the quay outwards. The multi-million dollar development carried out by Sharjah Port Authority started in mid-2008 and took a total of eight months to complete.

The next major development, due next year, is the installation of two larger replacement STS gantry cranes. The Liebherr cranes are scheduled to arrive in Sharjah during Q1 2015. It will be at this time that the flexibility afforded by the mobiles and the supportive relationship with the Sharjah Port Authority will pay dividends as the new equipment is commissioned into the port.

## Ancillary equipment

It is not just heavy machinery that will be getting an upgrade over the next year: the process of identifying and selecting a new Terminal Operating System is well underway with a number of different interfaces that will bring significant improvements to the terminal. Online clearance has already been approved by the Department of Seaports and Customs with far greater facility due very soon.

Supporting equipment for the cranes comes in the form of Terberg Tugmaster units operated with Gaussin 50t single trailers for the movement of containers within the terminal and to the container scanning site. The twin-trailer option was considered, but found non-optimal in

Top left: Catering for deeper draught vessels is a theme of the industry and essential in a port's ability to retain key services;  
 Bottom left: Containers at Sharjah Container Terminal in the UAE; Right: 1-over-6 RTG offers greater capacity in a terminal with restricted space.



the limited space. Empty containers are handled using side lifters, all with a 7m-high capability and with a minimum 8t safe working load. Top-loader equipment is being phased out and replaced by more versatile reachstackers.

### Additional services

As well as the core activities of servicing container vessels and road vehicles, Sharjah offers a number of value-added services. An onsite Container Freight Station (CFS) with covered warehousing and ground area of 4,600m<sup>2</sup> provides a facility for the stuffing and stripping activities. There is also an in-house container repair section where inspections are conducted, as well as any repair/refurbishment work that may be required.

Gulftainer works very closely with the Sharjah Port Authority and the partnership allows MHC equipment to be utilised for heavy lifts as required. Each Gottwald can lift up to 140t from the hook and can combine to lift 196t in tandem. In August 2012, two heavy lifts, one 168t and the other 150t, were repositioned on a vessel bound for Iraq.

### Outlook

Over the terminal's history, there has been considerable growth typified by the regional economy which shows no signs of abating. As busier roads and higher transportation costs give rise to increased demand for coastal shipping, Sharjah and the other Northern Emirates' terminals stand to gain considerably by attracting more of their market share in the UAE. Of course, this will involve provision of infrastructure necessary to handle the increased volumes, which is already underway, and when matched correctly the opportunity to thrive further is clear and a worthy pursuit as part of the ongoing strategy of promoting the prosperity in the Emirate of Sharjah.

### About the author

Richard James was appointed terminal manager for Sharjah in December 2012, having joined from the Gulftainer Projects team where he worked on port and terminal developments, including the coordination of the successful tender bid for Tripoli Container Terminal in Lebanon. In his current role he is responsible for the analysis and conduct of container

operations, contributing to the Terminal's commercial activities and identifying the facility's future needs and requirements for development. Previously he worked as an operations superintendent for Forth Ports in Scotland and as a deck officer in the Royal Navy.

### About the organisation

The Gulftainer Group, privately-owned by UAE-based conglomerate Crescent Enterprises, is a rapidly expanding, dynamic ports and logistics company. Gulftainer operates and manages ports and logistics businesses in several countries, including the UAE, Iraq, Pakistan, Brazil, Lebanon, Turkey, Saudi Arabia and the USA. In the UAE, Gulftainer operates four main ports: three on behalf of Sharjah Port Authority – Sharjah Container Terminal (SCT), Khorfakkan Container Terminal (KCT) and Hamriya Container Terminal (HCT) – and one in Ruwais, Abu Dhabi, on behalf of the international plastics solutions company, Borouge.

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# Dry Bulk and Specialist Cargo Handling



"It is important for the terminal operator to have access to trained manpower and the correct handling equipment in order to ensure that the optimum discharge speed is achieved, which is crucial in most circumstances for the product to reach the end user in a timely fashion."

# Fit-for-purpose mechanical bulk handling



Fergal Buttimer, *Owner and Director,  
Buttimer Group, Ireland*

The colossal growth of international trade, increasing vessel sizes and demands on port throughput and capacity volumes over the last two decades have been as much features of dry bulk cargo transport as they have in container shipping. Population growth, industrialisation and the shifting economic geography of world trade – notably the emergence of China as a global industrial powerhouse – have meant significant demand for, and development of, modern and efficient dry-bulk terminals to handle food-stuffs, minerals, fuel, biomass and other commodities. Shifting agricultural trade routes, imbalances in supply and demand, as well as an increased awareness around food security, access to emerging markets, and geopolitical risk mitigation have all added to requirements for versatility and adaptability. Moreover, environmental regulation adds complexity for terminals near population centres, where there are concerns around air pollution, dust emissions and health issues. Added to this, broader concerns around climate change, sustainability, regional competition for trade and the changing role of states in many commodity sectors means that the context for development, design and operation of dry bulk terminals is an increasingly complex one.

## Weak links in complex systems

Despite increased demand for adaptability and higher capacity throughput, significant improvements in efficiency and utilisation have been widely achieved through innovations in terminal design, equipment design, management and operations. The need for increased throughput has led to 24-hour operation, more effective handling and multi-modal logistics integration. Increasing use of automation and software to manage and monitor terminal operations, schedule planning, equipment, and storage conditions has also played a substantial part in getting the most out of capital expenditure. One consequence, necessarily,

has been the increased complexity of process design and operations.

Bulk terminals now generally rely on more equipment in more processes, to handle more product. Increased automation, sophisticated technology and higher equipment capacities have not mitigated the risks inherent in increasingly complex mechanical handling systems. To run smoothly, all equipment and processes need to be reliable and perform consistently; a small problem in a complex system rapidly turns into a big problem. In an example from a UK bulk handling facility in 2012, a faulty discharge system on a hopper led to the discharge becoming blocked and the hopper overloading; the rapid throughput of the system meant that the problem was not identified before the hopper's structure became overloaded and collapsed, also collapsing the support structure of its loading conveyor and surrounding equipment, incapacitating the operation for a number of weeks. Weak links in complex systems have the capacity to cause significant disruption – technological advances, automation and improved management have heightened the need for reliable and robust terminal and equipment design.

## Fit-for-Purpose

At Buttimer we've been developing the principle of 'fit-for-purpose', the idea that the primary function of any design or piece of equipment is reliable performance. Rather than always opting for the most technologically advanced solution, we consider what is going to get the job done right repeatedly. The definition we work from for 'fit-for-purpose' is to 'effectively and consistently carry out the process required in the specific operating environment'. The definition, though necessarily broad, has immediate implications for both our bulk terminal process engineering projects and the production of our DOCKSOLID bulk

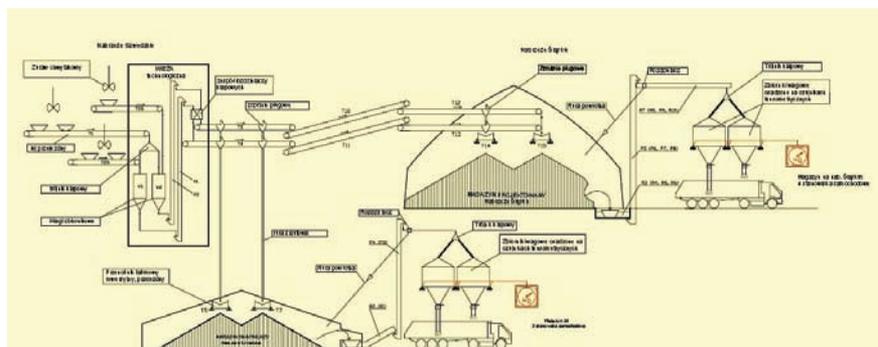
handling port equipment. Not only must the design work well, it must be adapted to the specific environment and operation required, reliable enough to perform effectively even in imperfect circumstances.

Bulk terminals are generally busy, abrasive and demanding environments; design that is fit-for-purpose is very focussed on what works in the real world. The most innovative engineering in the world is not fit-for-purpose if it fails to consider the challenges inherent in the context it will actually operate in – which may be anything from a tough climate, a sticky bulk commodity, an isolated location, to the specifics of existing operations or infrastructure, and even the skill level of the operators or local labour force.

## Warning signs

When equipment breaks down, a terminal gets bottlenecked or a process continually underperforms it is very easy to identify design and engineering that is not fit-for-purpose; unfortunately it is also too late, and expensive to rectify. The point of adopting a fit-for-purpose principal is to identify problems before they occur, and to preempt weaknesses in a terminal's operations – ideally at the conceptual design, process engineering and procurement stages.

Ensuring fit-for-purpose design and equipment requires a thorough and detailed review of the terminal, port environment and performance requirements; nonetheless, recognising a few tell-tale signs at the design or procurement phases could go a long way to prevent the more obvious mistakes. One example to consider is the equipment supplier that has not asked about the climate, humidity and port facility in which its equipment is meant to operate – equipment that has not been designed for its operating environment will not operate at its optimum. Or, a hardware process controlled by software that the operator can not adjust or reconfigure – where mechanical systems are operated by



Top left: A mobile wheel-mounted hopper for dry-bulk handling; Top right: Swinoujscie is a port on Poland's Baltic coastline; Bottom: Typical drawing of a port design incorporating hoppers.

software, operators will need to adjust both. In an example Buttimer Group came across, an Irish port procured a mobile wheel-mounted hopper with a computerised steering mechanism, but on receiving a small knock during operation, one of its wheels was knocked out of line. These types of incidents can happen in a busy environment, however the port was unable to adjust the computerised steering to re-calibrate the wheel back into line, thus leaving the new hopper completely immobile – thus useless in a multi-purpose terminal as it could not quickly get to and away from the quay. Another tell-tale sign is the lack of a fault warning system: as described earlier, in high throughput, complex systems a small problem, unidentified, quickly becomes a big problem. Also dubious is equipment that can only be repaired by a supplier-specific specialist – if a problem arises, getting an expert or proprietary replacement parts to site will inevitably extend unintended downtime. Fit-for-purpose design is not simply robust, reliable and available - in the real world – it must also be easily repaired and maintained as needed.

**Design for context**

Designing terminals and equipment fit-for-purpose shouldn't be understood as conservative design. Of course, equipment

designed for reliability and longevity will rely on well-tested concepts and a good, solid structure. However fit-for-purpose design must also meet the requirements of client and context. As the performance requirements of terminals adapt and change to the challenges discussed, so too must fit-for-purpose design. Often, designing for context can be surprisingly innovative. The challenge to ensure reliability, while increasing performance, incentivises innovation in process design with relative simplicity of mechanical design – Buttimer found this on a project it completed recently with Telesstack, designing a mobile iron ore shiploader. The high performance requirements at an isolated port pushed Buttimer to rethink the process of hatch changing and to develop a solid, reliable solution. Through an innovative wheel-drive system and robust chassis, the unit we designed can switch rapidly between straight, parallel and radial driving modes, and has the fastest hatch-change times of any mobile shiploader. In order to make our DOCKSOLID equipment fit-for-purpose, we customise each unit to the terminal in which it will operate and the products it will handle. To ensure reliable availability, all units can be maintained or repaired on site by a qualified local engineer.

In our terminal design business, our first task is to work closely with

our client to determine a rigorous performance requirement, and our second is to profile the port environment. Fit-for-purpose design becomes increasingly important as terminals have to adapt and improve to meet the requirements of new regulation, increased volume and changing cargo types. Innovative design which prizes simplicity and reliability over complexity, tailored to the terminal's operating environment, is the best way to consistently meet the challenges of the bulk logistics sectors.

**About the author**

Fergal Buttimer is the owner and director of the Buttimer Group, a diversified mechanical engineering company. Fergal also founded Buttimer Polska, the company's first subsidiary in 2005 and became director of the Group in 2012.

**About the organisation**



Buttimer Group specialises in mechanical handling processes and serves a variety of industries in its domestic markets of Ireland, the UK and Poland. Buttimer Bulk Engineering offers design and project management services for bulk port terminals globally. The Buttimer Group also produces DOCKSOLID port equipment.

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# Challenges in handling bulk fertiliser



James Luther, Assistant Commercial Manager, Nectar Group, UK

This article will look at some of the challenges in handling bulk fertiliser cargoes, particularly at discharge ports, and will highlight some of the practical solutions to overcome such difficulties. The following areas are discussed as factors contributing to the degree of success in handling fertilisers by terminal operators:

- Type of fertiliser handled and its characteristics;
- Mode of shipping the commodity and adequate controls during the sea passage;
- The main areas of concern when handling bulk fertilisers at discharge ports;
- Solutions and techniques available to deal with problems, and
- Potential benefits to the end user.

The most commonly handled fertilisers shipped in bulk to markets around the world include Urea, DAP, NPK, MOP and MAP. Typically they all show hygroscopic tendencies, however it is possible for the suppliers to add anti-caking agents to reduce the affect that moisture has on the material. Some, such as DAP, are more prone to 'lumping' than others and this will require additional handling techniques.

## Handling problems

From a terminal operator's point of view, the timely discharge of vessels without incurring demurrage costs or cargo degradation during the discharge is an important consideration. However the discharge operation of such cargoes is just one element of the logistics cycle that stretches from shipper to the end user. The problems that a terminal operator experiences at the point of discharge could potentially emanate from shortcomings throughout the treatment of fertilisers along the logistics chain prior to reaching

the port of discharge. Such shortcomings leading to deterioration of cargo quality and/or cargo losses present a variety of problems for all parties involved in the logistics chain.

For a terminal operator, handling fertilisers in a developing port where resources to remedy such problems are limited or are not available could mean that discharge operations will prove to be very costly.

There are three key stages in the logistics cycle of handling fertilisers from shipper to end user and careful consideration is the key to maintaining integrity of the cargo throughout. These are, the preparation and shipping of the cargo; the handling of the cargo at the discharge port, and the direct or indirect delivery to the end user from the port.

At the first stage, the shipper has a responsibility to ensure that the physical characteristics of the cargo offered at the loading facility from the plant is exactly what is contracted for. Any processes that assist the fertiliser to maintain its free-flowing properties – such as prilling of urea cargoes – need to be carried out carefully prior to shipping. The quality of the process, as well as proper inspection and validation of the process prior to approval of the cargo for loading, are important steps in maintaining quality.

## Monitoring cargoes

The hygroscopic properties of many types of fertilisers are inherent, and in order to minimise the effect of such properties, cargo temperatures and atmospheric conditions at the load port need to be carefully monitored during the loading process. Care should be taken to interrupt loading operations where critical tolerance levels are reached. Cargo temperature

and atmospheric conditions need to be monitored throughout the loading operation prior to closing the hatches in order not to create conditions upon arrival at the discharge port where the fertiliser continues to draw in moisture as it cools down and loses its free-flowing properties, making it very difficult to handle.

It is equally important for shippers to provide the master of the ship with detailed cargo data sheets, as well as specific instructions on the care of the cargo during the sea voyage. These specific instructions relate to the ventilation and temperature control during the sea voyage, and it is crucial they take into consideration the different climate conditions between the load and discharge ports. The ship should not only carry out such instructions but record parameters on a daily basis throughout the voyage.

## Handling

Upon arrival at the discharge port, the condition of the fertiliser on board the vessel will significantly affect the quality and speed of the discharge operation. For cargoes that retain their free-flowing properties, it is important to ensure that weather conditions are monitored carefully during the discharge operation, especially during the rainy season at discharge ports. Timely opening and closing of hatches in order to minimise moisture absorption is important during the discharge.

It is important for the terminal operator to have access to trained manpower and the correct handling equipment in order to ensure that the optimum discharge speed is achieved, which is crucial in most circumstances for the product to reach the end user in a timely fashion. Stevedores need to work the hatches evenly during the discharge operation to minimise 'walling'



Top: Nectar's bagging machines incorporate large amounts of stainless steel to assist in handling fertilisers; Left: Prompt onward transportation is key to preventing cargo degradation

of the commodity along the bulkheads of the vessel. It is also important that equipment such as bulk hoppers ☒ if the product is handled in bulk directly from the vessel, or mobile bagging equipment if the commodity is bagged alongside the vessel ☒ are suitable for the job. Many types of fertilisers are highly corrosive to handling equipment; the use of stainless steel on surfaces that make contact with the fertiliser increases the lifespan of the handling equipment and assists in maintaining high performance levels during the discharge operation of fertilisers.

If the fertiliser has lost its free-flowing properties upon arrival at the port of discharge and where cargo handling facilities and equipment are limited, the discharge operation could potentially become a protracted affair causing major problems for the participants, including the terminal operator. Depending on the state of the cargo upon arrival, it may be necessary to employ heavy trimming equipment, such as excavators, to break up cargo in the holds in order to facilitate grab discharge. In many developing ports and terminals, such equipment may not be readily available and normal trimming equipment such as bobcats or lightweight front-end loaders may not be suitable to handle the cargo. In such circumstances,

the use of mechanical trimming equipment may also be required throughout the discharge operation, rather than the normal practice of final trimming towards the end of the discharge for each hold. This in turn leads to escalated costs for the parties involved.

It may still be necessary to crush lumps of fertiliser on top of the bulk cargo hoppers in order to maintain cargo flow, even after using mechanical trimming equipment in the holds. Such practice not only significantly affects the speed of the discharge operation but is also undesirable: it is not a safe practice to have personnel on top of hoppers during the discharge operation.

If the fertiliser is directly bagged after passing through the bulk hoppers, non free-flowing cargoes also affect the weight accuracy of bags produced outside the normal parameters of +/- 0.5% on average. Receivers rely on delivering accurately weighed, good-quality fertilisers to end users, but this might be negatively affected if the aforementioned problems arise.

Finally, if cargo is delivered indirectly, then it is important that the storage facilities used have adequate protection both from the elements and any possible contaminants, in order to maintain the quality of the bulk or bagged cargo.

### About the author

Assistant commercial manager James Luther joined the commercial team at Nectar Group in 2011 to support the development of Nectar's key markets. In the last 3½ years he has spent much time travelling in West Africa, India, Sri Lanka and Bangladesh, experiencing the nuances of port developments and gaining an insight into the issues surrounding these locations first hand. He is currently due to complete his Institute of Chartered Shipbrokers PQE focusing on operational aspects.

### About the organisation



Nectar Group operates a range of handling equipment in ports around the world with specific focus on handling dry-bulk products such as fertilisers. Over the past 42 years, the Group has handled millions of tonnes of bulk fertilisers primarily in developing ports. Nectar Group has over four decades of experience, providing innovative and cost-effective solutions for cargo handling in the fertiliser and other dry-bulk sectors. The company offers a full range of sophisticated bulk handling, bagging, logistics and storage services in numerous locations throughout the world and also operates a bulk terminal in East Africa. Nectar Group is also a member of the Society of Maritime Industries (SMI) — the voice of the UK's maritime engineering and business sector promoting and supporting companies within the industry.

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## Oil, Gas & Chemical Handling



"The US 'shale gale' has necessitated re-routing of LNG destined for North America to European and Asian markets, with impact on prices. Indeed, gas prices have stayed low for three years so far."

'LNG dynamics will drive new port activity', page 122.

# Singapore LNG bunkering safeguarding standards and regulations



Phil Ryan, *London Offshore Consultants – LNG, (Singapore)*

Due to forthcoming Emission Control Areas (ECA) and Sulphur Emission Control Area (SECA) regulations, the necessity for clean and justifiable propulsion systems for ships is imperative. To ensure compliance, numerous options are available with one being liquid natural gas (LNG).

LNG worldwide is renowned for its exceptional safety record. The main reason for this is due to the prevailing strong standards, regulations and the commitment to a culture of risk-management. The key factor to the LNG industry's safety awareness is the ability to recognise methods of protection to ultimately minimise any likelihood of any consequences. With industry regulations and standards, it is possible to have a strong foundation for a safe operational environment in LNG services.

The safe process of LNG operations such as shipping is directed by government-regulated protocol for the purpose of safe control. This has been developed over time by distribution of experiences and development of best practices and standards which has resulted in a safer standard within the LNG industry. By means of strict observance to these codes, standards and regulations have led to the high safety record.

However, although it is vital that regulations, standards and codes are adhered to, it is only the correct hiring and training of qualified personnel that will meet  $\square$  and in particular cases exceed  $\square$  these regulations.

## Background

With this period of eco-friendly awareness on a global scale, traditional energy sources are in a decline due to the new regulatory controls. The progression towards the fuel of the future  $\square$  liquid natural gas (LNG)  $\square$  has been discussed considerably throughout the past few years. But with

the upcoming environmental regulations in 2015, the time has come for action. Not more so than in Singapore, where the country's recent aspirations in liquefied natural gas, including LNG bunkering, has highlighted the fact that it intends being the frontrunner but not at a cost  $\square$  and that includes the safety aspects.

The Lion Republic's stability has always revolved around clear economic and societal principles, and its ability to identify the imperatives of governance to ensure successful guidance. These imperatives include the need for proactive leadership, to optimise available resources, adapt relentlessly and remain relevant in an ever-changing world. In short, to continually examine and evolve its pivotal role in the world.

An example of Singapore living up to the standards it set itself comes directly from its responsibility to meet the energy needs of its own populace. Just 10 years ago, a disruption of natural gas import flow caused serious interruption to electricity supply which resulted in the loss of 30% of power systems. There was an outcry at all levels, from parliamentary to grassroots.

With high accountable standards of governance at stake, the Singapore government engaged decisively and proactively: its main focus became reliability of supply.

A year later, Singapore announced plans to dispense with supply problems and construct the nation's very first LNG receiving terminal. With such aspirations, Singapore could apprehend both its own growing demand and broaden its horizons via supplementary natural gas sources.

An independent company was first contracted to develop the LNG terminal. But due to the global financial crisis, financing became a problem. So the government announced that, to avoid

subsequent delays, it would take over full responsibility and ownership. As a result, the Singapore LNG Corporation was established to build, own and operate the LNG terminal.

## LNG developments

Conventional transfer of LNG is normally from ship-to-terminal and terminal-to-ship. The LNG carrier is moored at the terminal and articulated arms are connected to transfer the LNG cargo. The equipment has been adapted to withstand the low temperature of the cargo ( $-160^{\circ}\text{C}$ ) but more importantly designed with safety. Prior to the understanding of storage of cryogenic liquid, serious incidents occurred, such as the failure of the LNG storage tank in 1944 in Cleveland, Ohio, US. The development of cryogenic equipment and the LNG industry was suspended for more than 20 years as a result of this failure.

As it is often said, LNG is not rocket science but in actual fact as the space programme developed, an understanding of cryogenics due to the use of liquid hydrogen ( $-252^{\circ}\text{C}$ ) and liquid oxygen ( $-182^{\circ}\text{C}$ ) was established by NASA. This progress allowed the LNG industry to cultivate the equipment for both storage and transfer. Numerous other incidents led to standards and regulations to be revised and today the LNG industry maintains an excellent safety record by combining the developments from other industries and lessons learnt from failure incidents. Control of the safety factors is due to the codes incorporated into the design and operations of LNG facilities.

## LNG equipment

LNG equipment for transfer in a conventional ship-to-ship (STS) scenario is based on conventional LNG terminal systems using the same process and safety.



LNG Carrier



LNG Cargo Tank



LNG ship-to-ship operation



An LNG transfer hose

An artist's impression of Singapore Bay as it might be



The LNG STS duplicates the functionality of the articulated hard arm, the emergency disconnection system and communications. Inclusive is the emergency shutdown (ESD) system that is designed to stop all operations in the form of an ESD-1 and quick release of the transfer lines by means of an ESD-2 process. The release is designed as a zero spill philosophy to ensure no damage to a vessel's non-cryogenic decks.

### Standards and regulations

Both the carriage and transfer of LNG within the industry have an outstanding safety record, and the safeguards associated with LNG import/export terminals are proven. While LNG bunkering involves far lower quantities and transfer rates when compared to import/exports, many of the safeguards apply to the larger LNG STS operations and terminals. Safeguards, which are developed based on a thorough evaluation of LNG-related regulations, codes, and standards, including the numerous LNG International associated regulations.

These safeguards are designed to prevent accidental releases of LNG and mitigate the consequences if releases do occur. Each safeguard plays a unique role. Some are designed to prevent certain initiating events from occurring, while others are designed to mitigate certain types of consequences and some play a role in both prevention and mitigation. They are introduced to describe their role in reducing the risk of LNG bunkering operations.

The LNG industry expansion throughout is gaining momentum and with the increase in number of ships, terminals etc. has necessitated the need for suitably qualified, experienced personnel. The exceptional safety record due to the strong standards, regulations and commitment to a risk management culture is the key factor which means that the

LNG industry's safety awareness has the ability to recognise methods of protection that ultimately minimise any likelihood of adverse consequences. With industry regulations and standards, it is possible to have a strong foundation for a safe operational environment. It is imperative that regulations, standards and codes are adhered to and it is only the correct hiring and training of qualified personnel that will meet and in particular cases exceed these regulations.

It is imperative to have in place specific training for non-LNG personnel working in LNG ship-offload operations. The emphasis must be on an in-depth understanding of the properties and hazards of liquefied gas, transfer system procedures such as cool-down and bulk offload, vapour management, cargo equipment, safety precautions, ship/shore interface and emergency procedures.

### The future of LNG bunkering

With a very strong safety record in the LNG sector, Singapore places great significance on ensuring high reliability and, as importantly, having highly trained and able professionals working in the sector. The provision of such a capable, high-calibre workforce is one area in which Singapore has few, if any, competitors.

Singapore has made its mark in the LNG industry, a strong and ambitious mark and one that is impossible to deny or ignore. With such high aspirations within the LNG industry, Singapore has identified that the key to success is safeguarding standards & regulations.

The biggest challenge to future LNG bunkering operations in Singapore is the non-LNG experience that non-LNG vessels possess, and the need to ensure that standards and regulations are maintained, with absolutely zero negotiation.

### About the author

Phil Ryan is a marine engineer and LNG consultant with London Offshore Consultants in Singapore. In this role, he undertakes survey and consultancy work relating to marine engineering and LNG in the shipping and energy sectors. He is responsible for the development of the LNG Department and ongoing business within the LNG sector, utilising pre-existing knowledge of the market.

### About the company



LOC is an independent marine and engineering consultancy and survey organisation, providing high quality services to the shipping and offshore energy industries. LOC was established in London in 1979. Since then, it has developed into an international, multi-disciplinary organisation, with offices across the world. Its team now comprises over 350 professionally-qualified personnel.

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# LNG dynamics will drive new port activity



Azfar Shaukat, *Director – Oil & Gas,*  
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The world is in turmoil, with major unrest in a number of strategically important countries. Conflicts in Iraq, Ukraine, Nigeria, Afghanistan and potential conflagrations in many other countries are affecting oil and gas supplies as well as consumer and investor confidence. The fragile world economy, painfully emerging from a well-set recession, cannot afford further energy supply interruptions and price shocks. It is no surprise therefore that energy supply security is high on the agendas of most governments and with that, diversity of supply from alternative sources of energy. Up to 2035, US\$2 trillion per year will need to be spent to meet global energy needs, with more than half on new and alternative supplies to offset declining current production and replacement of existing assets.

Natural gas has had the highest demand growth of any fuel for several years and although the availability of large quantities of cheap US coal has slowed gas consumption, displaced by the rise of domestic shale gas in the US, the demand for gas is forecast to rise to 4,000 bcm per year in 2020.

The majority of gas is transported by long-distance pipelines and these are, by definition, fixed. In recent years pipelines have given rise to increasing concerns over security of supply and diversity of supply concerns. Thus, the need for diversified and flexible gas supply has seen an enormous increase in the number of Liquefied Natural Gas (LNG) import and storage terminals being built or planned, with almost every country with a coastline having at least considered such imports.

LNG is natural gas that has been compressed and cooled to  $-160^{\circ}\text{C}$  until it becomes liquid. In this state, one cubic metre of LNG is equivalent to six hundred cubic metres of natural gas, and it is this concentration that allows large quantities of natural gas to be transported cost-effectively across the globe.

At present, there are almost 100 gas import terminals in operation worldwide, with another 150 bcm of LNG storage under construction. In addition, there are 29 liquefaction terminals in operation, with a further 24 planned. LNG is not new in Europe; there is already one production/export facility in Norway, and 26 established import and storage facilities. Another seven are under construction with another 35 planned. All of these will require major infrastructure, principally new maritime, storage, pipeline and power facilities.

The world LNG market has seen some major shifts in recent years. Historically, projects were built on a 'tramline' basis, with one source point and one delivery point, and a long-term contract to deliver gas in this way. More and more LNG is being traded on a spot basis, typically 20% in a year, and newer contracts are not limited to a single destination for deliveries. The US 'shale gale' has necessitated re-routing of LNG destined for North America to European and Asian markets, with impact on prices. Indeed, gas prices have stayed low for three years so far. Renewables are continuing their rapid growth worldwide, rising 16% in 2013 overall and 24% just in the Middle East, and these will continue to encroach on the market for new gas-fired generation, even though renewables do not contribute substantially to base-load. To some extent the Fukushima disaster offset the downward pressure on LNG prices but producers are facing a number of 'whammies' from depressed demand due to financial crises and renewables, competition from new producers, sharply-rising production costs, and resistance from buyers to lock-in to traditional long-term contracts.

Australia is already on track to overtake Qatar as the world's largest LNG exporter and new export projects are being developed in Mozambique, the Mediterranean and possibly the US itself,

among many. China, the world's largest energy consumer, has twice as much recoverable shale gas as the US so could have an even more dramatic effect on the LNG market in the Asia-Pacific region if it were to significantly develop its reserves. Russia, the world's largest gas exporter and oil producer, is due to supply gas to China in the largest contract ever signed, a US\$400 billion dollar deal. Natural gas will therefore continue to play an increasing prominent role in world energy supply.

Many proposed LNG projects will be Floating Storage and Regasification Units (FSRU). These vessels obviate the need for a conventional onshore storage terminal and have the potential for quicker implementation. The FSRU is moored offshore near a demand centre or major gas pipeline, and re-gasifies the liquid gas by heat exchangers typically using sea water, then exports the gas to shore by a subsea pipeline. These LNG terminals require much less marine infrastructure than conventional terminals. The FSRU is replenished by Ship-to-Ship (STS) transfer, where an LNG tanker berths adjacent to the FSRU, pumps across LNG and then leaves. The STS operation has limitations in terms of sea states and winds and thus FSRU deployments are dependent on favourable ocean and meteorological conditions. FSRUs can, in practice, take longer to implement than the theoretical minima and do not necessarily enjoy cost advantage over conventional onshore terminals, since the vessel, which typically comprises 80% of the cost of an FSRU project, is a converted LNG carrier. Also, onshore terminals can be expanded by building more tanks whereas individual FSRUs cannot be enlarged and thus further vessels need to be brought in to increase capacity, which makes FSRUs more applicable to smaller volume requirements.

Thus, it is clear that more and more ports will consider LNG import projects



### About the author

Azfar Shaukat is director of oil and gas at Mott MacDonald. He is a professional engineer with over 30 years' oil and gas experience with international consulting firms and major operating companies. He specialises in strategy, master planning, transaction support, project development and performance across the petroleum chain. Shaukat has led major projects, including liquefied natural gas for governments, oil and gas operators, project developers and investors. He regularly contributes to industry journals and speaks at and chairs high-profile oil and gas conferences.

### About the organisation



Mott MacDonald is a global engineering and management consultancy with over 16,000 staff operating in over 140 countries. We are completely independent and impartial, and have successfully executed some of the world's most prestigious projects. We employ more than 9,000 technical staff and provide world-class services in the transportation, energy, water and environment, and buildings and infrastructure sectors. The consultancy's oil, gas and petrochemicals unit, comprises more than 1,400 staff providing the full range of technical and commercial services including project development support, due diligence, conceptual and detailed engineering, project and contract management, site supervision and commissioning. The group has been involved in the development of many of the world's onshore LNG production and transportation projects and continues to invest heavily in developing its LNG services to meet the demands of a growing market, including floating LNG production and floating storage and regasification units.

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as countries strive to improve the cost and reliability of their electricity supplies and their environmental performance, objectives which natural gas seems most likely to meet. In each case, there will need to be assessments on whether the projects should be onshore or offshore, where they should be located, how to manage the environmental and social impact,

connections to the consumers, and so on. There will also need to be consideration of the maritime operations in particular locations, including safe separation of the LNG vessels, which may require amendment to existing regulations or new ones. Therefore, investment in ports worldwide to cater for new LNG imports will be required for decades to come.



VTS,  
Navigation,  
Mooring and  
Berthing



"As experience in ports increases, best practices will continue to emerge; more ports will begin to incorporate geospatial processes and data into their efforts to mitigate the impact of events and allow them to resume operations to ensure that cargo capacity can be rapidly restored."

'Geospatial technology for faster emergency response', page 139

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# Piloting challenges for neo-Panamax ships on the Houston Ship Canal



Captain Jonathan Samuel, *eNavigation Committee Chairman, Houston Pilots*  
 Captain JJ Plunkett, *Port Agent for the Houston Pilots*

Many experts believe that the opening of the improved Panama Canal in December 2015 will bring ever larger container vessels to Gulf Coast ports in general, and Houston, US, in particular. The potential economic bounty that these ships could bring has prompted terminals and port authorities to plan, identify funding and invest in an infrastructure to accommodate this next generation of container ships. Likewise, the Houston Ship Pilots, as leaders in navigation safety and innovation, began planning nearly four years ago to overcome the challenges to navigational safety that the next generation of container ships will present.

## Overview of Houston Ship Channel

The Port of Houston is no ordinary port. It is consistently ranked first in the US in foreign water-borne tonnage, first in US imports, first in US export tonnage, and second in the US in total tonnage; it also has the second-largest petrochemical complex in the world. While there are over 20,000 ship movements along the 83km of the Houston ship channel (HSC) every year, there are over 125,000 inland tow movements as well. The larger beam vessels generally utilise the first 43 nautical miles of the HSC. This section has a channel width of 161.5m, making the HSC a unique shipping environment that combines a narrow channel with a substantial shipping and high inland tow-traffic density.

## How Houston pilots handle large vessels

Presently Panamax, Aframax, and the larger Suezmax (50m-beam ship) call on the Port of Houston. Any vessel over 36.6m beam is considered a widebody

vessel on the HSC and vessel length is restricted to 304.8m in length overall. To safely handle these vessels in a 24/7, two-way traffic environment, various navigational and safety guidelines are in place. These include daylight restrictions in some instances and maximum combined beam and draft limitations for ships meeting on the HSC. The Houston Pilots act as defacto harbour master or port scheduler; its 24/7 dispatch officer adjusts sailings and arrivals to prevent these wide-body ships from meeting in critical areas of the 161.5m-wide main channel.

As state licensed pilots, the Houston Pilots accomplish their mission of safely navigating these wide-body ships to and from their desired berths by striving to be the best trained and equipped mariners in the world.

## Pilot training

Initial training to become a Houston Pilot is a gruelling three-year process. The first six months includes piloting vessels under a senior pilot's supervision. After this time period, new pilots start off with smaller vessels and are gradually increased to a larger gross tonnage and draft incrementally each month. During their time off, they handle larger vessels (over their assigned tonnage) under the supervision of senior pilots again, being evaluated every time. Two senior pilots are utilised to supervise training on the wide-body ships. Trainees are also required to complete a training trip to every wide-body berth in Houston. The Houston Pilots have a comprehensive, continuing education programme that allows them to seek out training worldwide at a multitude of maritime training centres. Refresher 'core classes' can be taken every four years including manned, model ship handling,

emergency ship-handling, bridge resource management for pilots, and fatigue mitigation.

## Electronic navigation tools

Each of the Houston Pilots carries a Portable Pilot Unit (PPU) when boarding a vessel. For safety reasons they do not depend upon the ship's electronics alone. Instead, they carry their own hardware and software. Because they carry the same equipment every day, they are familiar with how to use it, its accuracy, and its limitations. The PPU system consists of a rugged laptop, software specifically written for ship pilots, a GPS, a rate-of-turn sensor, and an AIS device. The PPU is a more advanced version of the ship's ECDIS, providing the pilot with updated navigation charts and a plethora of traffic management and ship-handling tools. The PPU benefits the pilot by increasing safety, situational awareness, and decision speed.

To make these features effective in a narrow channel, you need to utilise an accurate positioning system. The Houston Pilots utilise DGPS with these PPU's to gain sub-meter accuracy when navigating. Each pilot carries his/her own DGPS/GPS antenna that is temporarily mounted outside with a clear view of the sky. In addition, each pilot is equipped with a rate-of-turn (ROT) device (also referred to as a swing meter) that provides accurate ROT information to the PPU (along with an AIS interface) utilising professional-grade gyro technology. This enables the pilot to fine-tune his ship handling skills during a turn or bend in the channel and assists the PPU software in generating an accurate, future-predicted position of the vessel.

The pilots utilise a secure, cloud-based network solution over the internet

A large container vessel on the Houston Ship Channel.



that publishes the positions of pilots in Houston to the other pilots, independent of AIS. This provides for accurate positioning between two vessels with pilots aboard, with update rates of about one second. This is crucial when vessels of this size are caught in unexpected periods of restricted visibility. This also enhances pilotage operations while addressing privacy concerns.

### Preparing for neo-Panamax vessels

Although neo-Panamax vessels exceed the current widebody and length criteria discussed previously, the Houston Pilots have been aggressively preparing for the

introduction of newer, larger vessels (up to 335.3m length and 45.7m beam) calling on the Port of Houston. Simulations have been funded and completed on full mission bridge simulators at the US Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi, and at the Maritime Institute of Technology and Graduate Studies in Baltimore, Maryland. These simulations included meeting situations on the channel and surge-and-sway simulations for vessels moored nearby while these larger ships pass.

Considering the 335.3m x 45.7m-size vessels would eventually be eclipsed by the neo-Panamax vessels (365.7m x 48.7m), the Houston Pilots started two

more initiatives that included funding the development and construction of a neo-Panamax 1/25th-scale ship model. This model ship not only accurately exhibits the same manoeuvring characteristics of a neo-Panamax container ship in a shallow confined channel, but also reveals the obstructed visibility from the conning bridge common with this type of ship.

The auxiliary channel to one of the container berths in Houston has also been modelled at the training lake in Covington, Louisiana. Pilots are able to conduct manned model training in this scaled version of the Houston Ship Channel with a neo-Panamax-size vessel. To enhance pilot training and analysis of



manoeuvres, the model is also fitted with a centimetre-accuracy RTK positioning system.

In addition to the manned model, the Houston Pilots initiated a collaborative agreement with a local college to purchase and operate a full-mission ship bridge simulator. The simulator, along with the manned model, will be used for both pilot training and to provide data for the future HSC and container terminal dredging so that they may eventually receive the neo-Panamax vessels. The tested data will help to produce new channels that are safe, and cost effective for the Port of Houston.

The Houston Pilots Rules & Safety Committee members have travelled to Savannah, Georgia, where some of the neo-Panamax-size vessels have already started arriving. They have conducted ship rides on these vessels and interviewed both onboard masters and local pilots to help ascertain manoeuvring aspects of these vessels, as well as increased mooring tug requirements for vessels of this size in restricted waterways.

### Going forward

The Houston Pilots have invested significant funds and man-hours to prepare for the eventual arrival of neo-Panamax vessels. Ideally, the 161.5m main channel should be widened (dredged) to accommodate these extremely large vessels. Interim dock modifications and dock dredging are already underway at some of the container berths in Houston, however there are no plans to widen the main channel at this time.

Further study will be required to see if safety restrictions can be put in place at all to receive these vessels at the Port of Houston. This may include updated weather criteria and further, maximum, combined beam restrictions between larger vessels; and possibly one-way traffic. Traffic management may also be required so that all commerce will be minimally impacted by the arrival/departure of these vessels.

As state-licensed pilots, the Houston



Pilots remain committed to accomplish their mission of protecting the public interest by considering all safety aspects

for the arrival of any large vessel even if that may be contrary to economic interests.

### About the authors

Captain Jonathan Samuell currently serves as eNavigation committee chairman for the Houston Pilots. He is also the representative for the Houston Pilots on the American Pilots Association NAVTECH committee. He is also an active Houston Pilot, conning vessels in and out of the Port of Houston on a regular basis. Captain Samuell holds an unlimited Master Mariner's license as well as an endorsement as offshore installation manager unrestricted. He has more than 22 years working at sea.

Captain Plunkett graduated from the Coast Guard Academy in 1987 and has Masters degrees in Chemical Engineering, and National Security and Strategy. His 24 years in the US Coast Guard include serving as part of the US delegation to the IMO, responding to numerous high consequence oil and chemical spills as Federal On-scene Commander, and acting as captain of the port in Port Arthur, TX. He retired from the Coast Guard in 2011 and currently serves as port agent for the Houston Pilots.

### About the organisation



The Houston Pilots serve a crucial role in ensuring safety of vessels at the Port of Houston by boarding all ships departing or bound for Houston. They take direct command of these vessels or transfer directions to a ship's captain while navigating the 83km-long Houston Ship Channel. The primary responsibility of a Houston Pilot is to protect the public interest by facilitating the safe and efficient movement of vessels in State of Texas waters along the Houston Ship Channel and Galveston Bar. This includes not only the safety of the vessel they are conning, but also safeguarding all of the port's assets, including the docks, linemen, lineboats, tugboats utilised in docking/undocking, and facilitating the safe flow of commerce along the Houston Ship Channel.

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# An evolving industry



Richard Hepworth,  
President, Trelleborg Marine Systems

San Francisco was the venue for the 33rd PIANC World Congress, which took place in June 2014. One theme featured particularly heavily – quality and the need to ensure the highest standards across our industry.

The issue of quality in marine fenders is one that Trelleborg has discussed for some time. The company has suffered in the past due to competitors who would undercut it on price, but who did not operate with transparency about the quality and performance that is absolutely essential in the supply of mission-critical equipment.

These more unscrupulous suppliers tended to be trading houses that supplied products ‘off the shelf’ and had a bad habit of applying PIANC ‘certification’ across the board, without evaluating and understanding the factors that affected performance – such as rubber compound composition and the mixing process.

To produce the same quality as that supplied by the more premium players, and at a lower cost would not have been possible. Aside from anything else, the price of raw rubber has risen – but there has been no change in the pricing structures of low-cost suppliers.

At the Congress, Trelleborg spoke to a number of people that were inclined to agree with it. These stakeholders were representative of the industry as a whole. The company also spoke to specifiers who were finding the same thing, members of PIANC who were also concerned, even some of Trelleborg’s competitors – many agreeing this is happening and that it is having repercussions for their business. Of course, there were one or two suppliers who disagreed. Either way, the market is reacting. The fact that the market is evolving is extremely positive, and it seems that other manufacturers are now operating with more transparency.

## Prioritising quality

Last year, Trelleborg designed a Rubber Compound Specification which is freely available for specifiers to copy and paste in order to stipulate and, critically, substantiate quality requirements for their projects.

This year, we are finding that other high quality suppliers are keen to do the same; however, the low-cost competitors cannot. Trelleborg has seen at least one other example from another premium manufacturer who has implemented quality control practices that prove the formula and properties of their products, and invite customers to check their claims.

This is just one of the ways we have started to see an about turn in the market. We have also started to see clients up-specifying projects – upfront purchase cost is no longer the deciding factor. Quality and technical knowledge are now being prioritised, and there is greater awareness that specifying and ensuring quality upfront will translate to better value over the whole product lifecycle.

We have also experienced an occasion where a low-cost competitor beat us on price to supply a contract initially, but after the award, the customer discovered they could not meet quality requirements and performance, giving us the chance to tender again.

It seems that more and more customers are finally convinced of the importance of considering rubber compound composition, and subsequently, quality. They realise that taking this approach will mean savings over the life of the fender, while reducing the risk of damage to both vessels and port infrastructure itself.

We do not want to eliminate competition – it is healthy. But we do want to ensure there is an accurate standard available, so that specifiers can be assured that they are considering like for like, and standards are driven up overall.

## Modulus considerations

The mixing of rubber with carbon black (reinforcing filler) is just as important as the rubber compound composition in guaranteeing performance, as we are investigating at the moment. We are currently working on a project to gain a deeper understanding of what impacts the ‘modulus’ of a fender. Modulus is technically defined as the ratio of stress and strain, and is a much more effective measurement of a fender’s energy absorption capacity than the traditional ‘hardness’.

Under load, stress is generated inside a fender and change of shape (strain) occurs. Suppliers should have a range of different compounds available, with different modulus values, to meet different performance requirements. This, naturally, introduces complexity into the manufacturing process and leads to added costs.

## Quality and performance

For a particular rubber formulation, even down to the equipment used for mixing, the temperature and sequence of mixing (mixing cycle) all impact the modulus – and therefore, affect the performance and fatigue life (lifecycle) of the fender. We are now looking into how the requirement for bespoke compounds translates into practice across the market, and whether there is a deep enough market understanding of the importance of the manufacturing process in optimising fender performance. We are already doing some testing on fenders that have been produced using different processes and equipment, and we will be sharing the findings later this year.

In the meantime, the market can no longer continue to be complacent about the issue of rubber quality. To prove the issue, we undertook a comprehensive testing programme towards the end of last year, which evaluated fenders currently in



Trelleborg's Super Cone fenders have applications in ports globally.

## Rubber specification

By far the most important factor affecting fender performance is rubber type and rubber compound composition. However, the behaviour of rubber under stress is unique, so it is essential that precisely the right formulation is specified and critically, finds its way to the final product to ensure a long and robust service life.

In marine fenders, three key factors – velocity factor, temperature factor and longevity – are affected by rubber grade and compound formulation.

The properties of fenders vary dramatically depending on their composition; rubber compound composition should be built into specifications in order to guarantee performance and lifecycle.

The model specification (left) is intended to guide specifiers in ensuring the correct rubber compound composition and physical properties required to optimise performance and guarantee longevity.

TEST	STANDARD	SPECIFICATION
Density	ISO 2781	Max 1.20 g/cc
Polymer %	ASTM D6370	Min 45%
Carbon black % (N3** type)	ASTM D6370	Min 30% (see note below)
Ash %	ASTM D297	Max 5%
Rubber filler ratio		>1.2

*Note: For softer fender grade the following specification is applicable:  
E0.7 - E1.0: Min 20% - E1.1 - E.8: Min 25% - E1.9 - E3.1: Min 30%  
Please refer to the Trelleborg Marine Systems catalogue for more information.*

Specification for chemical composition for rubber compounds (NR/SBR based compounds)

use at ports around the world. Quality was measured in a number of ways, including rubber density and rubber-to-filler ratio. There were some shocking results: in some cases, fenders in-situ at ports globally did not comply with the claimed specifications.

As an industry, we have suffered over the past few years, but the outlook is optimistic. We have a chance to improve how we operate going forward through strategic purchasing with an eye on quality. With the market beginning to do something of an about turn, and the importance of rubber compound composition gradually beginning to be understood and specified, the next time we run a testing programme like this the results should be much more positive.

For more information on Rubber Compound Composition in marine fender systems, download the whitepaper:

<http://trelleborg.tecs1.com/RubberSpecification2013>

## About the author

Richard Hepworth is a chartered mechanical engineer. Having studied for his degree at the University of Manchester Institute of Science and Technology, he now holds the position of business unit president for Trelleborg Marine Systems. Before moving to Dubai last year to spearhead a new, centralised Trelleborg Marine Systems headquarters, Hepworth spent a number of years in Singapore, establishing an effective, integrated sales and production network. Hepworth has over 20 years' experience working in the offshore and marine construction industry and has held a number of roles both within Trelleborg and other large engineering companies in these sectors, covering engineering, project management, sales, business development and general management.

## About the organisation

Trelleborg Marine Systems designs, manufactures and installs bespoke

fender systems, docking and mooring equipment, oil and gas transfer technology and vessel efficiency technology for marine environments all over the world.

Trelleborg works with specifiers on a project-by-project basis to determine best-fit solutions and supply fully integrated systems to fulfil even the most demanding specifications. Whether the project calls for equipment for a single berth, or an entire port, in-house design coupled with manufacturing and installation expertise ensures operational performance is maximised and long-term maintenance is minimised – keeping whole life costs low.

## Enquiries

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# Vessel Traffic Services:

## their role in efficient port operations



D Rostopshin, *Senior Product Manager, Shore-based Systems, Transas Marine*  
S Rostopshin, *Head of Coastal and Port VTS, St Petersburg, Russia*

The International Maritime Organisation (IMO) defines Vessel Traffic Service (VTS) as the service implemented by a competent authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. Therefore the efficiency of vessel traffic is one of the main tasks in VTS operations. But from a practical point of view, how can VTS affect the efficiency of port operations in addition to increasing the safety of navigation?

The International Association of Lighthouse Authorities (IALA) is the main organisation responsible for developing international recommendations for VTS and divides regular VTS duties in three different categories.

### Providing information

The first and most simple service is the Informational Service (INS). This serves to ensure that essential information becomes available in time for on-board navigational decision-making. Generally under this service, VTS operators provide vessels with all information related to a port's operations or to navigational safety. Even such a simple service allows an increase in port efficiency as such information can consist of position, identity, intention and destination of vessels, and amendments; also included are changes in information concerning the VTS area, such as boundaries, procedures, radio frequencies, reporting points, meteorological and hydrological conditions, maneuverability limitations of vessels and much else. Using this information, the team on the bridge can optimise its own passage in order to improve passage time, avoid dangerous situations and thereby improve port performance.

### Managing traffic

Another and more advanced service provided by VTS is the Traffic

Organisation Service (TOS). TOS is a service to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the declared VTS area. Examples of this service could be planning or prioritising vessel movements, establishing a system of traffic clearances, organising the allocation of space, following special routes or time slots, observing speed limits, etc.

In carrying out their duties, VTS operators monitor a developing situation and interact and coordinate with the vessel traffic. Thus, the operator should be the key person providing cooperation between all stakeholders on the bridge and port teams.

A typical vessel call to a particular port usually starts with a request from the vessel agent which includes vessel particulars, the quantity of onboard cargo and the estimated time of arrival. A special planning department reviews such requests and includes them in the port plan. The daily port plan is one of the most important documents for ports and services and can typically involve pilotage services, terminal operators, tug operators, border police, customs and many others. Delays or conflicts between available resources in a busy port are unavoidable so minimising them is important if the efficiency of the port is to be increased.

VTS operators organise traffic management in a safe and efficient way, based on the daily plan and taking into account a whole host of factors, including current traffic density, pilots, berth and tug availability, as well as port limitations such as tidal level, weather conditions, temporary restrictions and others. VTS personnel can monitor vessel deviations from the initial sailing plans and, when working closely with the bridge, can give the crew a recommended arrival time in order to avoid congestion and delays.

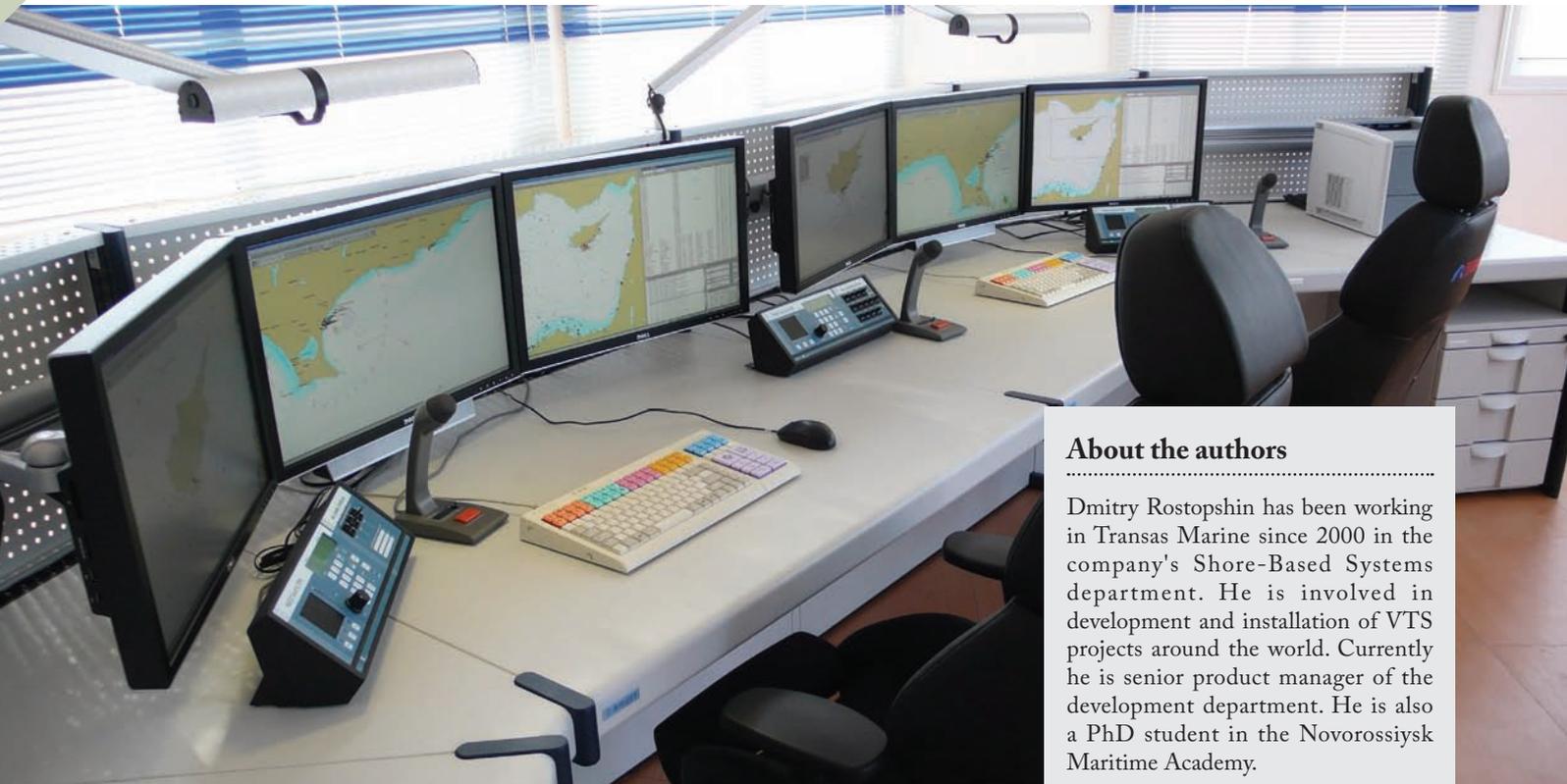
### Navigational assistance

The most advanced offering VTS can provide to vessels is the Navigational Assistance Service (NAS). NAS provides essential and timely navigational information to assist in the on-board navigational decision-making process and to monitor its effects. Such a service could be provided, for example, when there is poor visibility, bad weather conditions, there is a risk of grounding or collision, or for assistance to anchoring, etc. Naturally, the main role of this service is to ensure the safety of navigation which can affect port performance through delays, and even incur financial losses in the case of a major navigational accident.

In discussing VTS services, it is necessary to mention the technical tools that can help improve the efficiency of a VTS operator's work.

### IT to the rescue

For many years, vessel calls were associated with large amounts of varying paperwork. But recently, the development of modern information technologies has allowed the transition from paper to electronic forms and provides all stakeholders with a common platform containing all the necessary information. An example is the Transas Port Management and Information System (PMIS). PMIS contains a distributed database engine and all interaction between the parties is arranged via this database, i.e. the agent can fill-in all necessary forms for vessel calls via a web interface. Notification of the planning team with new requests will be received via e-mail from the database. During the planning stage, Transas PMIS will automatically detect conflicts (for example, an already-occupied berth or pilot) and will not allow an improper allocation going to the user. Finally, the prepared plan will once again be broadcast automatically to stakeholders, and every pilot or tug operator can connect to the same database at any time and get



Top: VTMS of Cyprus operator station;  
Bottom: VTMS of Orkney Islands, UK,  
operator station.

their own plan for daily operations. This means that all participants work in the same environment and with the same information. This minimises the risks of misunderstandings and the propagation of incorrect information. Additional restrictions established in the database help to avoid human error, which can often happen when paper documentation is used.

### e-Navigation

The modern concept of e-Navigation provides even more possibilities to all participants, as it is focused on berth-to-berth navigation. For instance, as part of this concept, the vessel's sailing plan is sent to the VTS centre and can be confirmed by the VTS operator while the vessel is still moored at the previous port. Dozens of confirmed sailing plans will automatically create a preliminary plan of port operations. Deviations from such plans can be detected at an early stage

and allow a change to be made to the schedule of port operations in a flexible and efficient way.

The possibilities within NAS are mostly based on the performance of modern VTS equipment. As NAS directly affects on-board decision-making, this requires very strict criteria for the quality and accuracy of VTS sensors. VTS radar equipment should provide the VTS operator with reliable and accurate data in all weather conditions. Creating such a state-of-the-art VTS system could be challenging from both financial and technical points of view, but the benefits from advanced VTS, especially in busy ports, are also obvious.

Of course, the training of VTS operators is also an important factor. For efficient VTS operations, all personnel should be properly trained according to the latest international recommendations. This is a factor that should not be forgotten when establishing a VTS system.

### Summary

Advanced VTS systems can provide a Traffic Organisation Service and a Navigational Assistant Service based on modern technical solutions. Investment in VTS can benefit not only navigational safety at the port (which is undoubtedly a huge advantage), but also provides benefits to port stakeholders when it improves port operations, minimises delays and conflicts through the proper coordination of traffic in the VTS area.

### About the authors

Dmitry Rostopshin has been working in Transas Marine since 2000 in the company's Shore-Based Systems department. He is involved in development and installation of VTS projects around the world. Currently he is senior product manager of the development department. He is also a PhD student in the Novorossiysk Maritime Academy.

Sergey Rostopshin graduated from the navigational department of Saint Petersburg State University of Water Communication. After sea-going service with Russian and Dutch shipping companies, he continued working on-shore as a VTS operator in the Port of Saint Petersburg. After a few years he was promoted to the position of head of the VTS Subcentre. Presently, he is head of Coastal and Port VTS Saint Petersburg.

### About the company

Transas Group is a world-leading developer and supplier of high technology solutions for the transport, oil, gas and security industries. With more than 200 VTS installations worldwide, Transas continues to focus and develop its expertise in a wide range of sectors: vessel traffic management, coastal surveillance, offshore and renewable energies, and other industry sectors. Transas' highly flexible and scalable solutions are suitable for nearly all ports and harbours, complying with international standards and ensuring maritime safety and navigation efficiency, as well as protecting the marine environment.

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# Reducing VTS operator stress



Todd Schuett, *Training Manager,*  
*Kongsberg Norcontrol IT, Norway*

This paper on VTS (vessel traffic service) operator stress explores the relationship of stress to workload, stress-management strategies, and how cooperative human-machine systems can reduce stress. The trials detailed and the solutions offered are the result of work conducted by maritime group 'Designing Dynamic Distributed Cooperative Human-Machine Systems' (D3CoS) – a research project funded by the ARTEMIS Joint Undertaking. The goal of D3CoS (which concluded February 2014) was to create methods, tools, and techniques for developing distributed, cooperative, human-machine systems that reduce development costs and time. The project asked questions such as 'how can machines 'cooperate' with users during stressful and high workload situations that will result in higher safety', and 'what tasks can a system take on to ease the burden on operators?'

## Why reduce operator workload?

In VTS areas that are not busy, operators may experience what is called 'underload,' meaning there are periods of inactivity that can lead to boredom and distraction. Here, organisations are not looking for ways to reduce workload, but rather to increase it. Some VTS areas, such as Singapore, Rotterdam, Hong Kong and the Dover Straits are remarkably busy. Other VTS centres are expanding their area of responsibility, which will increase operator workload, while not increasing staffing levels. But for those individuals who work in, or whose organisation is responsible for either a very busy area or a very large area, managing operator workload is important. Operators need to identify and respond to critical situations but if they are overloaded with tasks – no matter how appropriate to their responsibilities – they might not be alerted to circumstances that require their attention.

## Why reduce stress?

In the short term, being stressed can make one more alert. Stress in an emergency situation can be a positive thing. Too much stress, however, can potentially lead to several negative consequences. In the short term, when stress has accumulated over a period,

it can lead to headaches, bursts of anger, physical pain or discomfort, poor judgment, fuzzy thinking, and loss of precise motor skills. In the long term, stress can lead to a number of illnesses, including depression, anxiety, heart attack and stroke. The well-understood consensus is that experiencing stress in appropriately engaging situations is necessary and good, but if stress persists over a long period, the effects are overwhelmingly negative. Stress levels, therefore, should be managed and relieved in VTS operators to ensure safe shipping.

The need to reduce stress and the effects of stress in operators are well-known. It is why operators rotate positions in the Dover Channel Navigation Information Service and why the Maritime Port Authority of Singapore hands over operations to another operator every 45 minutes for its busiest VTS areas. It is also why the IALA VTS operator course V-103/1 Module 7 teaches VTS operators about the causes of stress and how to manage it.

## How is operator workload and stress connected?

Some people point to the composition of traffic as a stressing factor. The berthing of a supertanker is more stressful than the berthing of a small container vessel, one harbourmaster noted. Others point to task type, not task load. A collision in one's area of responsibility creates more stress than multiple VHF requests for weather data, for example. The D3CoS project carried out trials with real VTS operators to understand the relationship between workload, type and stress.

These trials consisted of simulated VTS control tasks. They were conducted in two rounds, with experienced maritime traffic operators from Halifax, Canada and the Norwegian Coastal Administration acting as the VTS operators. They were instructed to control a specific area and execute realistic tasks with physical responses measured by connecting the operators to monitoring equipment. Operators also finished a post-testing questionnaire and the trials were recorded by video and audio. The operators completed four scenarios,

each scenario increasing in workload, from an under load scenario, progressing to an overload scenario. Operators were asked to take ship reports by VHF while managing a traffic separation scheme with crossing ferry traffic as well as a precautionary area. Each scenario (task) lasted 10 minutes.

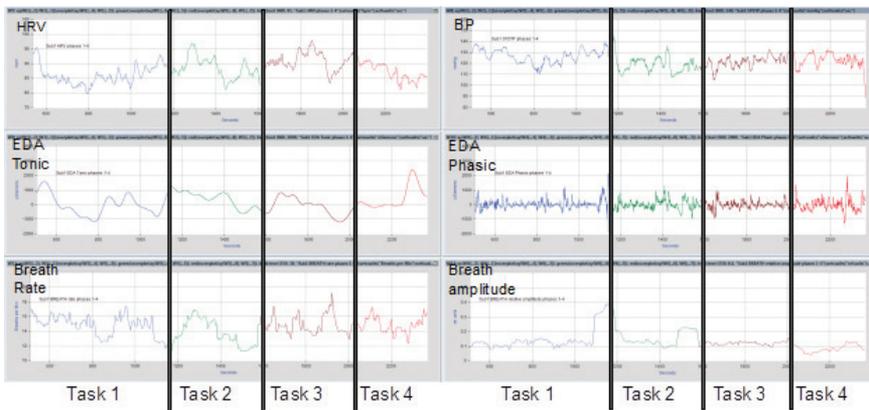
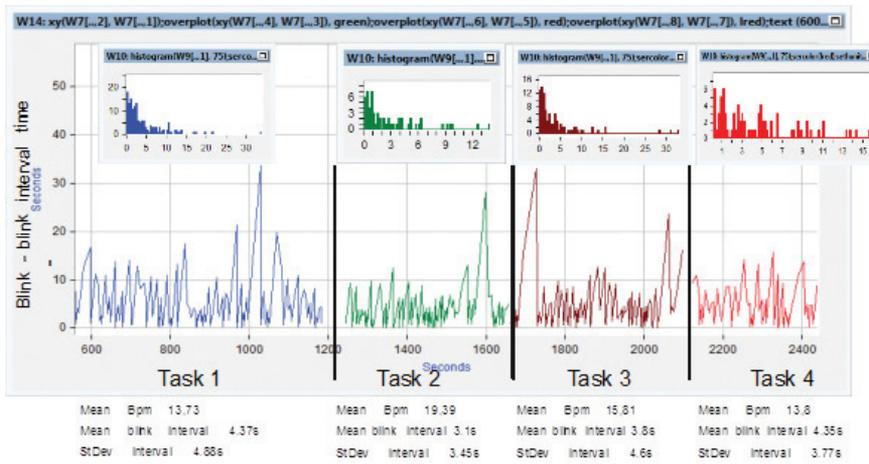
Figures 1 & 2 show the analysed data for one of the operators based on activities that are commonly understood to indicate a subject is under stress, such as blood pressure and breathing rate. Workload rises from task 1 to task 4.

The trials found that when task load increased, so did the measurements that indicate stress. The operators' attention became increasingly narrow as stress levels increased, resulting in dangerous situations being missed, and in one case, a (simulated) collision was not identified.

## Technology developments

With the project establishing a link between workload and stress in the VTS environment, it moved on to the development of prototype technologies that could be used to reduce workload and therefore reduce stress – cooperative human-machine systems. Automation was key to the developed system as it can reduce the level of VTS operator involvement needed to send standard information such as vessel conflict and weather data, which in turn reduces the operator workload. The maritime group developed a means of communication between a shore-based VTS system and a ship-based system; specifically a portable pilot unit (PPU). This technology was used to develop an advanced Vessel Path Planner. Comprising an active VTS system (supplied by Kongsberg Norcontrol IT), a path planning server (developed by BMT), and a Marimatech PPU, the Vessel Path Planner works as follows:

- The pilot onboard a vessel requests a path from the VTS centre;
- The VTS operator draws a path for the vessel on the VTS system chart;
- The path planner receives the path and validates it based on chart data;
- If valid, the path planner sends it to the PPU;



- The PPU displays the path and continuously sends the position of the PPU to the VTS;
- The VTS fetches forecast and current weather data for the path, which the pilot can access at any time directly from the PPU by tapping on that part of the path;
- Any warnings or conflicts detected by the VTS along the path, such as potential collisions, are immediately sent to the PPU.

Once the path is established and validated, the rest is automated. The VTS operator is not required to find and report

weather data to the pilot, and should the VTS operator become engaged in a critical situation, any warnings relevant to the pilot are automatically communicated. Workload is reduced, and with a reduction in workload, stress is reduced.

### On-going research

The cooperative human-machine system is a beginning. It is a prototype, and more research and development is needed to understand precisely what situations or criteria create high levels of operator stress. Kongsberg Norcontrol IT, as a maritime domain awareness software and VTS

technology developer, with installations at many of the world's busiest ports and waterways, is well positioned to develop innovative new solutions in this area.

Top (Figure 1): Blinking activity into the four task-load phases – blink per minute and blink-blink interval. Courtesy of Sergio Fonda, associate professor, University of Modena and Reggio-Emilia, Italy; Middle (Figure 2): HRV - blood pressure – EDA – breath, during the four task-load phases. Courtesy of Sergio Fonda, associate professor, University of Modena and Reggio-Emilia; Bottom: The advanced Vessel Path Planner, comprising an active VTS system (supplied by Kongsberg Norcontrol IT), a path planning server (developed by BMT), and a Marimatech PPU.

This paper was presented at IALA 2014 in May 2014, giving the company the opportunity to show some of its work within D3CoS, which will be put to use in future research projects and the VTS systems it develops.

### About the author

Todd Schuett has been Kongsberg Norcontrol IT's training manager since 2000 and Kongsberg's project manager on D3CoS. A graduate from the University of Chicago, he has instructed hundreds of VTS operators from all corners of the earth and is an expert in the challenges and diversity found in port and coastal VTS operations across the globe.

### About the company



### KONGSBERG

Kongsberg Norcontrol IT maritime surveillance solutions improve the safety, efficiency and security of maritime transportation and its infrastructure by providing optimal situational awareness. Its solutions are in service with the world's leading maritime coastal organisations, most successful port authorities, and safest offshore operators. Kongsberg Norcontrol IT's innovative solutions and market-leader status have been earned through experience from over 240 projects, ground-breaking research and development, and challenging and cutting-edge projects.

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# The advent of autonomy



Wilko C Bruhn, research associate, Fraunhofer Center for Maritime Logistics and Services CML, Hamburg, Germany

Stories of ghost ships sailing the oceans without a living soul on board have been around for as long as mankind has crossed the seas. But what used to be a cock-and-bull story for centuries will now become reality. At a time where unmanned drones fly around the globe, public railway transportation systems run driverless in numerous cities and self-steering cars are on in-situ trial runs, unmanned and autonomous ships can no longer be perceived as unrealistic.

## Intelligent ships

MUNIN, a collaborative research project funded under the European Commission's 7th Framework Programme, is developing a concept for a merchant ship able to conduct intercontinental voyages without any crew on board. The overall vision comprises a fleet of ships which are guided to and from port by an on-board control team and released to self-controlled operation for the open-sea passage. This temporary crew will disembark and return to their home port which is somewhat comparable to deep sea pilotage services already existing today. The fleet of autonomous and unmanned ships will be constantly monitored by a shore-based control station manned with skilled operators and engineers. Even though there will be the possibility of human intervention, the ships are designed and equipped in a way that allows them to solve unexpected problems by themselves. This comprises issues of weather routing and operation in rough seas, as well as small object detection and collision avoidance.

The introduction of autonomy in merchant shipping is surely not at hand and without a doubt will require a certain effort from all parties involved in maritime transport. Yet, the idea offers tremendous opportunities for the industry.

While automation at sea is still at a conceptual phase, automation in ports

is already several steps ahead. Beyond the ever-improving distribution of data, automated cargo-handling has already found its way into many terminals. Gantry cranes load and unload ships while transport vehicles and portal cranes take care of the optimal distribution and storage of cargo – automation of these processes has limited human involvement to a necessary minimum. Such applied technologies are widely accepted, having already proven their suitability on an every-day basis.

Mobile internet availability, as well as the establishment of DGPS and AIS, is greatly improving the safety of ship navigation and communication in coastal and harbour waters. Application of further technologies such as real-time tidal prediction systems, berthing assistance systems, as well as load monitoring systems for ship mooring lines, represent already existing opportunities for further automation.

## Designing the autonomous ship

The first and most obvious step will be to develop the design for an unmanned and autonomous ship. Accommodation facilities for much smaller crews staying only for relatively short periods will be necessary. During these times of conventional operation, a navigational bridge and an engine control-room for ship handling purposes need to be set up. Thus, up to this point, there are no significant modifications to be expected. Nevertheless, the technical equipment on board will have to be much more sophisticated compared to devices and machineries deployed today. Expectations toward the standard of performance, reliability and efficiency are much higher as there will be nobody to repair malfunctioning equipment. Furthermore, a system of highly accurate navigational sensors embedded in a holistic autonomous ship controller is necessary

to compensate for the lack of human perception. Such an advanced sensor system will be able to produce much more precise and reliable data than that available today. Much of the technology needed to enable unmanned shipping can also be used to support crews on conventional ships. This will of course be to the greater benefit of maritime traffic's overall safety.

## The right operatives

To implement the concept developed by the MUNIN project and to enable human interaction with the autonomous system, additional services are required. A shore control centre has to be set up, operating as a supervisory entity conducting the tasks of monitoring and controlling a fleet of autonomous ships. As autonomous merchant ships become more and more accepted, their deployment will increase, as will the number of such ships. Trained staff needs to be available to maintain safe ship operation in restricted and confined coastal waters. On-board control teams will consist of navigators and engineers handling the ship in coastal waters as well as during port approaches and departures.

These services demand staff qualified beyond STCW standards, preferably with personal knowledge of the respective sea areas. While shore control centres are likely to be located in places relevant to the industry, such as at Houston, London and Singapore, the on-board control teams will be based directly in respective ports as well as close to major shipping lanes.

## Maintenance and servicing

During port stays, an unmanned and autonomous ship will have different service requirements for port facilities compared to conventional ships. As machinery reliability has been identified to be one of the major issues to be solved,



Diagram showing MUNIN's vision of the unmanned and autonomous ship system and its individual components

a main focus within the MUNIN project is on system redundancy and preventive maintenance. As there will be no engineer on board to repair a malfunctioning rudder pump or to exchange a damaged piston ring, solutions will have to be found to ensure that the ship will be able to safely continue its voyage regardless. As a technical breakdown is not acceptable, a preventive maintenance concept will be installed. Some of the related tasks will be carried out by members of the on-board control team, but others will be too complex to be conducted during the relatively short periods of manned operation. Inevitably, this will lead to a demand for new maintenance services and, thereby, create new business opportunities. Thus, the introduction of autonomy in shipping will push the industry towards the development of what might be called a cyber-physical shipyard. Single devices, individual ships, entire fleets, shipping companies, manufacturers and maintenance providers will be connected via a data infrastructure to monitor components so as to ensure utmost reliability throughout the product cycle.

### Information exchange

Entity interconnectivity is perceived to be a key enabler toward autonomy in shipping. Such a system can only be run successfully if all relevant data is reliably available where it is needed, when it is needed. Currently, many ports are setting up holistic information exchange systems to streamline processes, connecting terminals, shipping companies and agencies, port authorities, pilots and other stakeholders involved in maritime transportation. This can only be the first step as individual solutions for individual ports will not be sufficient to meet future

demands. Information exchange systems on a regional and even on a global level, connecting entire port ranges, allowing for real-time tracking of ships and shipments will have to be installed to further improve port competitiveness and capacity utilisation.

Furthermore, communication links between ship and shore have greatly improved in recent years and this development is still ongoing. Thus, it is expected that the global bandwidth requirements to allow for autonomous maritime traffic will be met in ample time.

The MUNIN project will conduct a feasibility study focusing on whether or not an unmanned and autonomous ship will be able to safely conduct a deep-sea voyage. Operation in coastal and restricted waters is out of the current scope of investigation.

From this overall perspective, autonomous ship operation in narrow and congested waters seems to be the missing link within the maritime transport chain. At the same time, IMO's e-Navigation initiative is pushing forward to produce solutions for a worldwide increase of safety in commercial shipping. Several projects from numerous organisations are addressing issues such as resilient PNT, traffic data exchange, maritime spatial planning and sea-traffic management. The implementation of such concepts will without a doubt help to bridge this gap.

The launch of autonomous and unmanned ships will certainly not happen overnight. But the overall and long-term impact can be expected to be comparable to the introduction of container trades in the 1950s which has irreversibly transformed the face of maritime transportation in the years ever since.

Rather, it is expected to be a continuous, long-term implementation

process of ship- and land-based support systems dedicated to assist crews as well as to increase the safety and efficiency of shipping. This development will run in parallel with a shift of tasks and responsibilities from sea to shore ☒ something that is already being witnessed today.

### About the author

Wilko C. Bruhn is employed as research associate at Fraunhofer Center for Maritime Logistics and Services CML situated at Hamburg University of Technology, Germany. The main focus of his current work is within the fields of maritime simulation, navigational safety and sea-traffic management. A graduate of nautical and maritime studies at Bremen University of Applied Sciences, Bruhn holds a ship officer's certificate of competency and has seagoing experience on multi-purpose vessels. Specialising in ship management and maritime economics, he has further industry insight from professional experience gained in a shipping company and a classification society.

### About the organisation

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. At present, the society maintains 67 institutes and research units. The majority of the more than 23,000 staff are qualified scientists and engineers. Fraunhofer CML develops and optimises processes and systems alongside the maritime supply chain. With practically-oriented research projects, CML supports public and private port-operating clients as well as in the logistics services and shipping sectors to initiate and realise innovations.

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# Geospatial technology for faster emergency response



Captain John Holmes, *Marine Consultant, US*

Keeping a port operating is a regional and, in many cases, a national imperative. In 2002, for example, US West Coast ports were shut down for ten days due to labour disputes at an estimated cost to the national economy of US\$2 billion per day. In 1995, the Port of Kobe (Japan), then ranked fifth- or sixth-largest port in the world, was destroyed in a massive earthquake. It took two years for Kobe to recover its capacity, and even a decade later its throughput has not recovered. In the meantime the Ports of Busan (South Korea), Shanghai (China) and Kaohsiung (Taiwan) have gained significantly from Kobe's misfortune, and altered the balance of trade between those nations. These examples underscore how critical it is to rapidly resume operations at a port after it has been impacted by human induced or natural, disruptive disasters.

The assurance of business continuity at US ports, given their critical role in the national security and economy, falls under the guidelines of the Federal Emergency Management Agency (FEMA), which publishes a template for creating a Continuity of Operations Plan (COOP). This plan outlines four phases: Readiness and Preparedness, Activation and Relocation, Continuity Operations, and Reconstitution Operations. One of the most frequently asked questions that needs to be answered when preparing a COOP is 'where?': 'where is the damage?'; 'where shall we evacuate staff to?'; 'where is the master valve we need to shut off?'; 'where shall we relocate operations to?'; or 'where will we need to rebuild?'

The question 'where?' is answered with spatial information, usually represented on a map. There is a group of software and data types that help answer spatial questions, generally referred to as geospatial software and data. For ports, these can

include geographic information systems (GIS) software, satellite and aerial imagery, and image analysis software, computer-aided drafting (CAD), AIS and radar for vessel tracking, computer-aided dispatch and records management (CAD/RMS) software, command and control (C2) and physical security information management (PSIM) software, computerised maintenance management systems (CMMS), and others. Outside the world of ports, particularly in government service, these technologies are well entrenched and are used in various ways to manage daily operations and emergency operations.

The US government is a significant user of geospatial technologies in emergency management. FEMA, integrated maps, demographics, satellite and aerial imagery were taken within hours after the devastating Moore tornado had ripped a 27km-long and 3km-wide path of destruction in Oklahoma, and exposed them via a web-based GIS map viewer so citizens, business owners and emergency response personnel could assess damage remotely, without risking access to the devastated area. The Department of Natural Resources in Washington State created disaster mitigation plans related to its several potentially active volcanos using geospatial technologies and web portals. In New Zealand after the 2010 Canterbury earthquake, geospatial phone apps were perfected to capture crowd-sourced damage assessment information directly from citizens and relief workers.

Ports have been slow to adopt such tools, mostly due to reliance on local public safety agencies for small-scale emergencies, and state or national agencies for large-scale events. However, there is a growing realisation that ports are best positioned to help first responders and emergency

management agencies to mitigate the impact of an event and accelerate the resumption of operations. That is because ports are hives of activity that constitute a low priority to response agencies. The significant movement of people, goods, and infrastructure in ports is principally the domain of the ports and their tenants.

Fortunately, several trends are coming together to help ports begin to adopt these tools and methods in their disaster response, incident mitigation, and business continuity planning. The falling costs of technology, the ageing workforce that stands to retire with all its knowledge of ports, the rising computer literacy of the new generation of staff, and the examples of similar technologies from the public sector, are all helping to accelerate this adoption. This is aided by the US Government's realisation following Super Storm Sandy that port resiliency is a national imperative, and that ports are not only the nation's lifeline, they are its economic engine as well.

## Sharing information

The concept of information fusion to support port incident management and emergency response is being pioneered at the Port of Los Angeles in California. For the past five years, staff from planning, maintenance, real estate, police, environment, IT and engineering departments have been sharing spatial data, as well as linking it to other corporate information management systems, using an Esri software-based system named geoPOLA. By using GIS software as an information management resource rather than just a mapping tool, the port is able to integrate data around a common spatial base and answer complex questions posed during times of emergencies, such as the



Top: The Port of Los Angeles is using GIS to integrate data from across the port and is better prepared to respond to emergencies; Bottom left: Incident events are easily planned at the Port of Tacoma in their enterprise GIS application PortView, which integrates aerial base maps and accurate port data; Bottom right: Security staff at the Port of Oakland are able to quickly view live camera feeds from the integrated VMS in their GIS web mapping application PortView.

likely path that a spill will take through the storm drain system.

### Creating plans

The Port of Tacoma in Washington has completed the consolidation of several years of effort with GIS into an enterprise-wide system called PortView. The system is based on software from Esri, Latitude Geographics, and NorthSouth GIS, and includes several tools used by port security personnel to plan for emergency events. These tools include functionality for creating evacuation plans, resource deployments for exercises or real events, and notifications to stakeholders regarding changes in traffic patterns and terminal access.

### Assessing risk

The Port of Long Beach in California has been integrating multiple real-time technologies such as radar, sonar, AIS, CAD/RMS, and streaming social media around the Esri software platform in a system called Virtual Port. One of its main purposes is to help assess short- and long-term risk to the port using both the analytical and visual powers of GIS. Risk can then be translated into actions, whether using the port's PSIM or VMS (video management system), dispatched to field units, or communicated to regional intelligence agencies.

### Ensuring access to information

The Port of Oakland in California has also consolidated geospatial data around PortView, based on software from Esri, Latitude Geographics, and NorthSouth GIS. The port relies on outside agencies for its protection and therefore must ensure that PortView is available even during debilitating disasters. Furthermore, the port shares certain geospatial security data with its tenants and their security personnel, and wishes to ensure that the link is maintained during a disaster. Therefore, it has invested in an always-live replication of its geospatial system in a private cloud, removing the vulnerability inherent in ports that are located in seismic hazard zones, such as Oakland, near San Francisco.

### Making decisions during emergencies

Using similar technologies to Oakland, the Port of Stockton, US, has created geoPORTal, its own enterprise geospatial system which contains many emergency and utility map layers. Access to utility data in the GIS-based map viewer is critical for determining which valves to shut off to stem a spill due to a pipe rupture. However, in addition, the port designed the system so that it can also directly feed into the port's

Hiplink Mass Notification System and CommandBridge Situation Management System. In this way, all spatially-capable systems benefit from the common base map and related information.

As experience in ports increases, best practices will continue to emerge; more ports will begin to incorporate geospatial processes and data into their efforts to mitigate the impact of events and allow them to resume operations to ensure that cargo capacity can be rapidly restored.

### About the author

Captain John Holmes is a marine consultant with over 30 years of experience in positions that include chief operating officer, Fortune 500 executive, and senior-level coast guard officer. He most recently served as director of operations for the Port of Los Angeles. Captain Holmes retired from the US Coast Guard in 2003 following 27 years of service.

### Enquiries

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# Making a difference: LED floodlighting



Erik Swennen  
AAA-LUX, Founder and Senior Luminaire Designer

Dutch ports are the cornerstone of the European economy; authorities and companies are well-aware of the need to lead by example. Several ports have adopted high-power LED floodlight illumination as a solution to the many challenges they face.

The economy of many European countries is reliant on the ports of Rotterdam and Amsterdam for the import and export of goods and raw materials. Both companies and authorities operating at these ports are well-aware of the need to provide their services at speed, but without affecting the safety and security of those involved and, preferably, at as low a cost as possible.

Aware of these criteria, consultants advised the use of LED floodlights to illuminate the new railway marshalling yard at the latest container terminal extension at the Port of Rotterdam. LED floodlights have a longer life-span than conventional floodlights; this reduces the need for maintenance crews visiting the site. And the entire LED illumination solution that was supplied by AAA-LUX also allows for the lights, illumination levels and maintenance to be adjusted, changed or improved off-site without the need for crews to make a site visit.

Tei Ickenroth of consulting company Infra Engineering maintains that as the safety protocol dictates that all operations have to be shut-down when maintenance crews visit the site, the reduced need for maintenance, combined with the fact that most changes can be done remotely, all result in a significant increase in usage of the marshalling yard, reduced down-time and maintenance costs. The company no longer has to keep crews and specialised tools on stand-by.

## Wireless communication

AAA-LUX LED floodlights communicate wirelessly with a central processing unit and computer installed at the central control tower. Each LED luminaire is connected to the unique Lighting Control Management System (LCMS) that AAA-LUX supplied. Derived from the military and aircraft industries, the software – like most essential elements of the LED luminaires – is developed and maintained in-house. This enables the company to provide the quality and durability companies can expect from a firm that continuously pushes the benchmark. The software uses the 2.4Ghz band to communicate with the luminaires. Information transmitted through this band won't interfere with the controls of any device that operates in the area, while new updates to the software can be uploaded remotely. The innovative AAA-LUX illumination features have been added to a sole-proprietary base-layer protocol called LEDxLINK, which prevents any outside person hacking into the system. As the luminaires make use of a MESH-network, each luminaire is always connected to the communication grid. The LED floodlights communicate individually and spontaneously to relay and distribute information. This guarantees that no data gets lost and that all AAA-LUX LED floodlights will always provide the illumination level required.

## Improved safety

Tei Ickenroth estimates that the installation has resulted in approximately 50% savings in maintenance costs. More importantly, it has improved safety on-site. He maintains that in the past, it could take up to three months before permission was granted to enter the yard. During that time illumination levels would be below par. The resulting

poor illumination quality had a significant impact on safety at the yard.

Another point is that any approaching train-drivers do not want glare, but need to be able to see what is happening immediately. This could not always be ensured during times when lights were down and awaiting maintenance. Thanks to the new LED floodlights, the yard is now illuminated to the required standards at all times.

Improvements in safety also played an important role in the decision by Rietlanden Coal Terminal in the Port of Amsterdam, to select AAA-LUX LED floodlights. Large cranes and caterpillars drive around the terminal day and night; it is important that the terminal is well-lit so that drivers can see their colleagues clearly, as well as see where they are going, Rietlanden operational director Jeroen van Bakkum, points out. The new LED floodlights were requested by the employees themselves. When Rietlanden decided to look into a new illumination solution, a task-force was established and employees were included. This task-force soon narrowed down the list of possible solutions and suppliers.

## A world first

According to Van Bakkum, the preferences of the staff had to be combined with the requirements set by management, which was adamant that the number of masts should be limited as far as possible. Management wanted to ensure the terminal is used in an optimal way and wanted to reduce the risk of vehicles hitting the masts. As coal at the terminal is stacked up in large piles, illuminating the areas between the piles created a challenge. To overcome this, AAA-LUX came up with an illumination solution that allows the entire 300,000m<sup>2</sup> terminal to be illuminated by



Top Image: AAA-LUX LED floodlighting at the Rietlanden coal terminals; Right: Rietlanden Terminals; Far right: AAA-LUX LED floodlighting at the Maasvlakte II rail terminal, Rotterdam.



48 LED floodlights, which are installed on eight, 45m-high masts. This is a world first.

Rietlanden managed to make use of standard masts to have the lights fitted to. The dimensions of AAA-LUX LED floodlights are within the boundaries of conventional luminaires, while the weight and wind-shear characteristics are an equal match. This allows for easy retrofit of conventional floodlights, especially as no additional investment in masts or cables has to be made; nor do existing 400 VAC electrical installations have to be altered. Even the existing light switches remain in place. The lights are easy to aim and little light pollution is perceived.

Rietlanden partly funded the installation through a grant that was approved by Amsterdam Port Authority, which issues grants to installations that are innovative and contribute to its sustainability ambitions. Sustainability is an important objective for the Authority, which regards growth as impossible if it does not have a sustainability focus. The reduction of energy consumption and light pollution are important aspects in this focus.

As the Dutch government is a signatory to the EU's ambition to reduce CO2 emission by 20% by 2020, all national and local government departments and entities are encouraged to contribute to

this ambition. Grants have been made available to stimulate third-parties to follow suit, something that is not unique to the Netherlands. Many European countries have funds available to assist companies that are keen to contribute to this CO2 ambition by reducing their energy consumption. Without a doubt, governments are also keen to keep their economies in good health, knowing that costs are limited and employee safety is guaranteed.

#### About the author

Having graduated in physics from Fontys University – one of the largest in The Netherlands – Erik Swennen joined Dutch giant Philips as an engineer in optical disc technology. He later had spells at Philips Lumiled Lighting and TSM Europe. In 2005, he founded and became CEO at LEDexpert, and in October 2007, he founded AAA-LUX. With core competencies in marketing and sales, optical technology and illumination knowledge, Swennen's goal is to combine new lighting markets with LED technology – at the highest levels.

#### About the company

Netherlands-based AAA-LUX provides flexible, high-powered LED solutions to

illuminate a wide variety of applications globally. In 2009, it became the first company in the world to light a sports arena with a full-retrofit LED floodlighting system. It later became the first to light a professional soccer stadium and the first to light a harbour terminal from 45m. AAA-LUX currently has the largest production of 1500+ Watt LED luminaires in the world.

A network of highly qualified partners has been established to support end-users and to achieve the maximum return from their investment. AAA-LUX believes that new technologies are about to change the use and perception of illumination forever. Therefore, it combines these new technologies and components to design, develop and supply high-power LED floodlights and flexible lighting control management systems that provide end-users with the illumination, flexibility and quality they require.

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## Environment and Sustainability



'...the authors are analysing the structure of energy consumption in Latin American terminals to get a first, detailed understanding on the role of different container types in a terminal's energy bill.'

'Emerging reefer challenges in Latin America', page 146

# Pioneering Boskalis water quality adaptive monitoring in Southampton

Although Dutch company Boskalis Westminster has been working in the UK for around 80 years, its pioneering water quality Adaptive Monitoring technique had not been deployed until recently in British waters, when the company embarked on a project on behalf of Associated British Ports (ABP).

ABP, which operates 21 ports in the UK, awarded a contract to Boskalis for dredging parts of Southampton Water in a bid to significantly increase the draught for large containerhips visiting the DPWS Southampton Container Terminal. An important part of the tender procedure was that any contractor should be able to comply with ABP's water quality Adaptive Management Strategy (AMS), which was developed together with the Environment Agency (EA).

According to Dr Adrian Fewings, Environment Agency Fisheries' Technical Specialist, the adaptive monitoring strategy was needed to protect the population of Atlantic salmon to ensure compliance with the Shellfish Waters Directive and to ensure no deterioration of the water body under the Water Framework Directive (WFD).

Sue Simmonite, development and environment manager at ABP explains: "When ABP took the decision to proceed with the capital dredging project, it was vitally important that we implemented measures to protect water quality for a range of species, including the protected Atlantic Salmon migrating to and from the Rivers Test and Itchen, in line with the EA's requirements to maintain high quality water standards."

## In-house system

Simmonite explains: "We felt that the most effective way to ensure the water quality was to give the contractor the responsibility for monitoring it. Boskalis had its own in-house, proven system and this gave us

a lot of confidence that it had the ability to operate effectively and maintain the required quality levels. This system has been used by Boskalis before, so we knew the company was familiar with it and that was a major advantage."

Fewings says: "The scheme provides an open and transparent means to ensure the water quality in the potentially impacted zone is maintained to agreed standards. The monitoring buoys allowed us to access live data, which meant we were able to check whether thresholds were breached, and if so, ensure that the agreed actions were undertaken."

Boskalis has worked on similar projects in Germany, Melbourne, Australia and Khalifa in Abu Dhabi. In Southampton, Boskalis deployed nine specially-designed environmental buoys.

Gert Jan Peters, project manager Boskalis Westminster explains: "The contract was signed in mid-October 2013, the buoys were mobilised to Southampton in November and were operational by December 1."

Initially, the nine buoys – with one spare – were used for three months to measure the baseline values before the dredging campaign.

## Nine buoys

There is a frame fitted under each buoy, which is connected with a 40m umbilical cord. Three sensors are attached to the frame – one measuring dissolved oxygen levels, one turbidity, and one is a turbidity sensor capable of measuring a larger range – which acts as a backup turbidity sensor.

Boskalis can then 'communicate' with the buoy via a data connection and can make any necessary changes to the settings remotely. At the site office in Southampton, the chief surveyor has access to the AMS and electronic engineers monitor the network at head

office in the Netherlands. Additionally, they are assisted by an Environmental Engineer from Boskalis, who interprets the data. The engineer advises on whether a spike in the results could have been caused by dredging or another reason, and they analyse the information about turbidity levels/dissolved oxygen etc.

Peters comments: "During the initial monitoring period we could look at background levels, including the influence of the rivers Hamble, Itchen and Test, as well as the effects of passing vessels. For example, we could see the impact of the large container vessels. This showed a temporary spike in turbidity on the buoys' sensors. We compared the time and location of this 'turbidity spike' with the vessel's Automatic Identification System (AIS) data and could see the impact of larger vessels passing the buoys/sensors, which was well below the identified thresholds."

There is in fact a large variation in the background values due to the tide and natural events (e.g. storms, rainfall) and anthropogenic effects on turbidity such as the movements of passing ships. But this three-month period, combined with background monitoring that ABP had executed, gave a good indication of the natural variations that could be expected.

## Real time

Crucially for ABP, the system is in real time, stresses Simmonite. "If turbidity increases, the Environment Agency receives an email and I receive an SMS message via my mobile directly from the monitoring system. If there is an alarm we can immediately implement mitigating measures, and either call a halt to the dredging or move the vessels to another area."

Boskalis has had six dredgers working on the ABP project so far: the smallest, the Causeway, with a 4,500m<sup>3</sup>-capacity

through to the largest, the 15,961m<sup>3</sup> Prins der Nederlanden. A backhoe dredger is filling split barges and a hopper suction dredger goes from Southampton port to the dredging disposal area.

The works, to date, with both the backhoe dredger Manu Pekka and the hoppers, have not resulted in any exceeded turbidity levels.

Using this system, we are able to manage the dredging process, Peters stresses. "For example, we limit where we overflow and using the falling rather than the rising tides we limit turbidity within the inner part of Southampton Water, which is the most sensitive area for fish migration. The dredge areas are a +/-20km-long area, so we can choose the location where we dredge very carefully. If we encounter an elevated turbidity reading we have the ability to vary the dredge location or limit the amount of dredging in each work area."

### Careful dredging plan

Peters comments that this real-time system means that if the project team sees that an alarm may be triggered, it adjusts the dredging plan straight away and leaves the dredge area until the levels restore themselves. "And most importantly, ABP, our client has never had reasons for concern."

Fewings adds: "Boskalis has carried out the project in an efficient and professional manner. As expected with complex technical projects in the marine environment, there have been unexpected technical challenges. These challenges have been largely overcome by Boskalis although some important lessons have been learned for future projects."

From our point of view, Simmonite says, this technique means that the project is not seasonally restricted. "We can dredge 24/7, 365 days a year, and we have reassurance that the protected species are not being adversely affected."

Ironically, says Simmonite, there have been occasions when the dredgers have not been on site, but there have been several alarms. This is likely to be down to algal blooms and recently, the culprit setting off the sensors was identified as a particularly determined crab.

The weather is the only other thing that has been a factor. Peters explains saying the buoys largely run on solar panels but the exceptionally wet and dark winter meant there was a lack of sunlight, so it was sometimes a struggle to maintain the power supply for the buoys. Boskalis then used batteries and even put wind turbines on the top of some of the buoys. Additionally, when maintenance teams

visited the buoys every week they were often facing significant wave heights, which meant work had to stop on some occasions.

But this has not resulted in delays to the schedule and Boskalis is confident that it will finish on time. Fewings emphasises: "The water-quality standards agreed have been maintained throughout the dredging activities, so it is unlikely that impacts have been caused by dredging on the WFD water body, designated shellfish waters or to our populations of salmon."

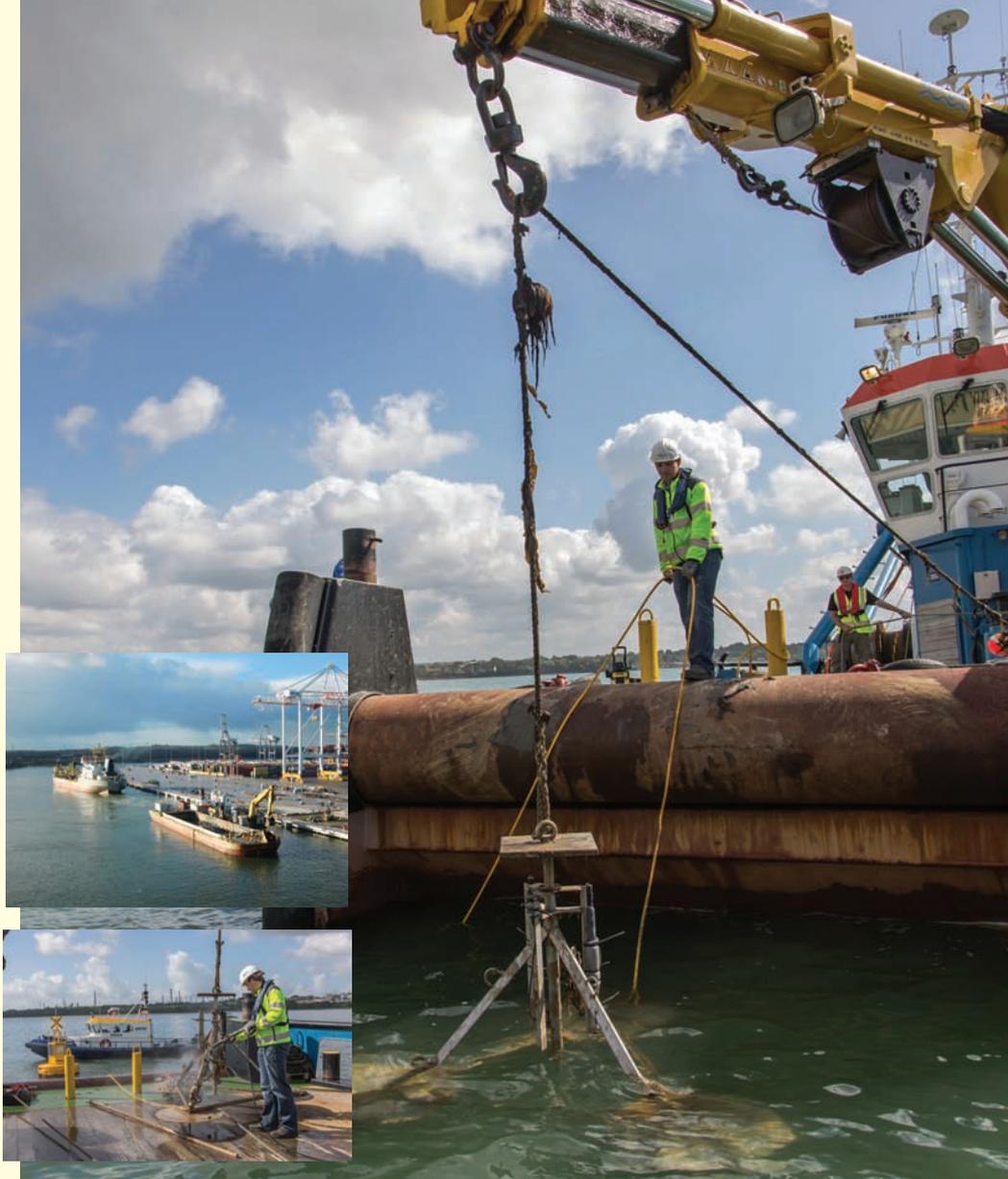
### About the organisation

Royal Boskalis Westminster is a leading global services provider operating in the dredging, maritime infrastructure and maritime services sectors. The company provides creative and innovative all-round solutions to infrastructural challenges in the maritime, coastal and delta regions of the world with the construction and

maintenance of ports and waterways, land reclamation, coastal defence and riverbank protection. Boskalis also offers a wide variety of marine services and contracting for the offshore energy sector, including subsea, heavy transport, lifting and installation (through Boskalis Offshore and Dockwise) and towage and salvage (through SMIT). It also has a strategic partnership in terminal services (Smit Lamnalco). With a versatile fleet of 1,100 units Boskalis operates in around 75 countries across six continents. Including its share in partnerships, Boskalis has 11,000 employees.

### Enquiries

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Top: Lifting of the frame from the seabed for (monthly) maintenance - cleaning;  
Top insert: Cornelis Zanen and Manu Pekka working in Southampton waters, near berth SCT5;  
Bottom insert: Cleaning the frame which supports the measurement sensors.

# Emerging reefer challenges in Latin America



Gordon Wilmsmeier and Ann-Kathrin Zotz, *Economic Commission for Latin America and the Caribbean (ECLAC), Santiago, Chile*

In an effort to create awareness of energy efficiency in international supply chains and to establish infrastructure energy-efficiency indicators, the Infrastructure Service Unit of the Natural Resources and Infrastructure Division of the United Nations Economic Commission for Latin America and the Caribbean is conducting research on energy consumption and efficiency in terminals in the Latin American and Caribbean (LAC) region and beyond.

## Background

Economic development has traditionally come with a transformation of mobility. Mobility constitutes an ontological absolute for emerging societies. Nevertheless, the emerging demand for human and goods mobility comes at a cost, and at the same time, raises demand for energy.

The traditional geography of production and consumption is changing, accompanied by a shift of industrial production. Thus, economic growth and development is leading to a new configuration and scale of supply chains and sustainability challenges.

To date, transport and freight logistics have been inherently based on the consumption of fossil fuels (ECLAC, 2013). Over recent years, the energy consumption of the transport sector in Latin America reached more than 2,000 million ton equivalent petroleum (tep), representing one third of the regional energy matrix. On average, the transport sector's share of the region's overall energy consumption increased from 27% (1990) to 35% (2010) (Latin American Energy Organization (OLADE), 2013).

Port throughput in LAC increased from 12.6 million TEU in 1997 to 46

million TEU in 2013 (est.). Paired with the expansion of container activity over the last two decades, LAC experienced a changing geography of trade. This in itself constitutes a strong increase in the trade between Asia and LAC. In the containerised industry, volumes have seen particularly high growth rates in the reefer trade (BTI, 2012). In general, containerised reefer trade has been one of the fastest growing market segments in the liner shipping industry to and from LAC. Reefer cargo requires constant refrigeration to maintain the quality of the product and thus consumes a significant amount of energy while moving in the supply chain. Hence, reefer trade poses an additional pressure on efficient energy consumption besides the energy required for regular port activities and operations.

Despite changes in scale and structure of LAC container trade, energy efficiency measures and strategies are hardly present in the region's ports and terminals. As a matter of fact, only one port, the Port of Arica (Terminal Puerto Arica (TPA), 2012) in Chile, has been certified with the ISO 50001 energy efficiency standard.

In line with efforts to increase the sustainability of supply chains, energy consumption has been emerging as an important topic as it is directly connected to the three pillars of sustainability: the social, economic and environmental dimension. A reduction in energy consumption has direct impacts on emissions, reduces costs in the supply chain and, in developing regions, contributes to energy security.

Acciaro, Ghiara and Cusano (2013) argue that coordinated energy management cannot only lead to energy cost-savings, but also a port's role as an 'energy manager' can generate new

businesses opportunities. For these reasons, port authorities and concessionaries should actively engage in the identification of energy flows and sources within their terminals (Acciaro, 2013).

Governments are increasingly focusing on, and pressing for, more climate-responsible strategies. However, these initiatives and policies usually focus on emissions as a symptom of industrial activity, but not on the causes, of which energy consumption is one. Thus, a detailed understanding of energy consumption in logistics supply chains is a necessary first step to engage in strategies and policies towards more sustainable performance. Hence the question arises:

What are the sources of energy consumption in the terminal? The authors argue that the main challenge is to identify the energy sources, usage time and assign the energy consumption to certain port operations.

While Fitzgerald et al (2011) discussed the energy consumption of on-board reefer containers, the authors are analysing the structure of energy consumption in Latin American terminals to get a first, detailed understanding on the role of different container types in a terminal's energy bill. The discussion with terminal operators identified that within the industry, there is a very limited understanding of energy consumption patterns in terminals. This new data is part of an effort to comprehend emerging production and consumption processes, in order to support and reflect upon new policy initiatives and instruments.

The research currently includes over 50 terminals in Latin America, of which 27 are container terminals, seven are petrol and gas terminals, and 16 are



Top: The authors' research currently includes over 50 terminals in Latin America, of which 27 are container terminals; Insert: Energy efficiency measures and strategies are hardly present in LAC ports and terminals.

bulk terminals located in nine different countries in the Latin American region. The figures, which are shown and analysed in the following, are based on the results from a selection of container terminals.

### Energy sources and general patterns of consumption

A reduction of fossil energy consumption through improved efficiency and electrification in ports has been perceived as part of the solution to reduce the dependence on fossil fuels in other parts of the world, but also in LAC. Currently, the majority of energy used in LAC ports is generated from fossil fuels. The analysis of the survey reveals that on average in container terminals, 36% of the energy used is electricity (Figure 1). These findings, on the one hand, show a huge potential to switch from fossil fuels to electricity and thus to reduce Scope 1 emissions. On the other hand, it indicates a significant challenge as such a conversion would have to be mitigated with investment in the energy grid and production in order to accommodate the new demand and particularly the demand peaks. At the same time, the results illustrate that the

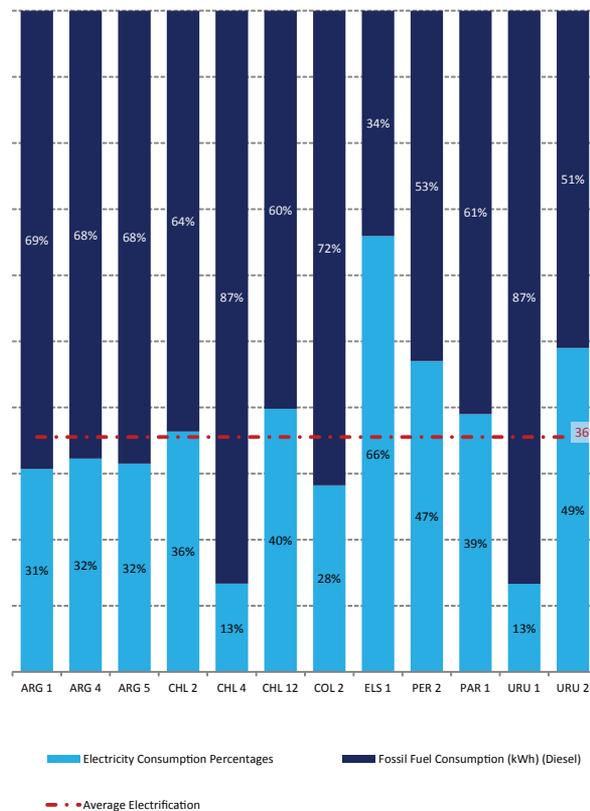


Figure 1: Comparison of electricity consumption to fossil fuel consumption in kWh.

Source: Authors' own estimations based on ECLAC/USI Energy Consumption and Efficiency Survey

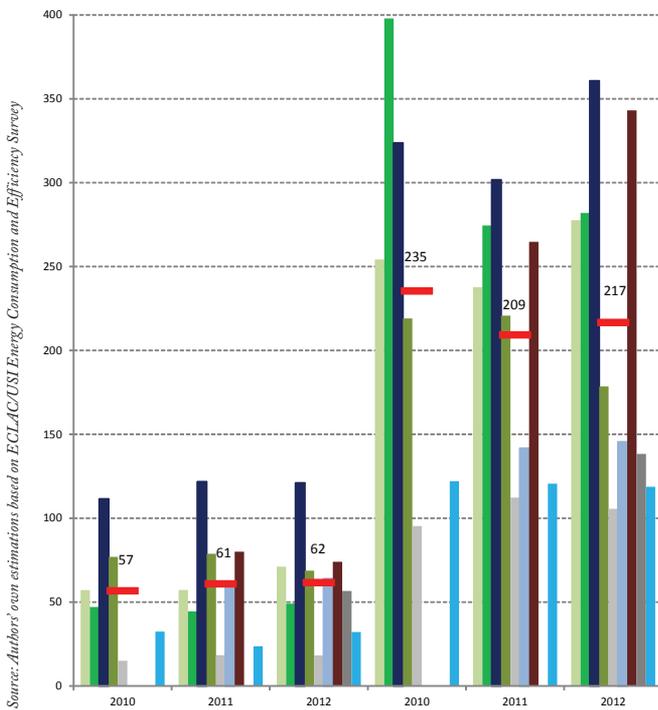


Figure 2: Dry container versus reefer energy consumption (kWh).

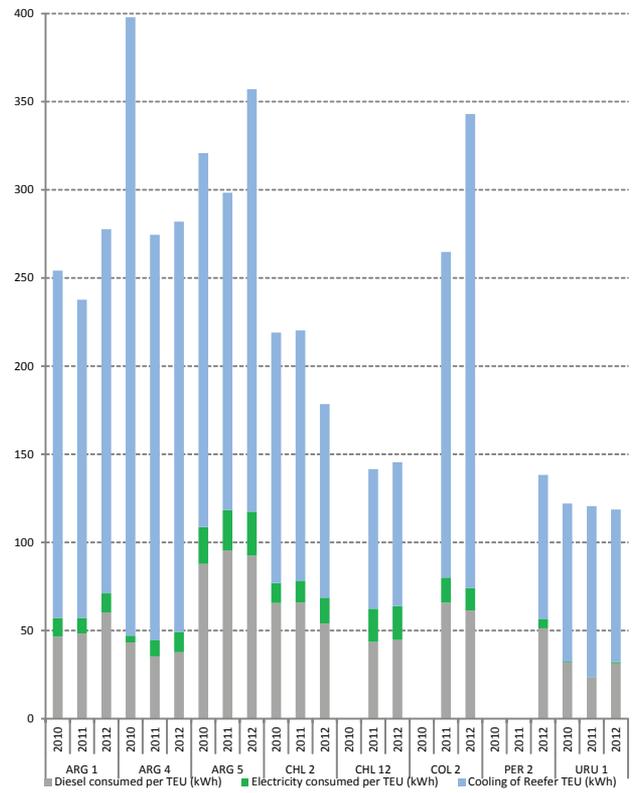


Figure 3: Comparison of diesel, electricity for general services and electricity for cooling per TEU in kWh)

Source: Authors' own estimations based on ECLAC/USI Energy Consumption and Efficiency Survey

Source: Authors' own estimations based on ECLAC/USI Energy Consumption and Efficiency Survey

share of electricity in the majority of the terminals under study is slowly starting to increase. Additionally, the distribution of energy consumption clusters can vary considerably, mostly depending on the reefer share and, during the fruit season, it can easily increase to as much as 60% of a terminal's total electricity consumption.

**The reefer challenge in energy consumption**

Between 2010 and 2011, East Coast South America (ECSA) exported more than 700,000 TEU of refrigerated containers. Of the containerised reefer exports from the sub-region, 78% were meat products, amounting to more than 400,000 TEU. Chicken (whole and breasts), is the largest meat category exported, constituting 73% of all meat exports from the sub-region, followed by bovine with 57,000 TEU (14%). Swine meat constitutes 5% of meat exports, with 19,000 TEU (APL Logistics, 2013).

Fresh fruit constitutes 10% of the containerised reefer exports from the region, with 53,000 TEU (APL Logistics, 2013). For instance, between 2009 and 2011, Chilean containerised reefer exports of fresh and frozen fruit and fish increased from around 240,000 TEU to more than 300,000 TEU, an increase of more than 25% (Base de Datos Estadísticos de

Comercio Exterior (BADECEL), 2012).

One challenge of containerised reefer cargo is its seasonality (Vagle, 2013) as it creates significant variations and peaks in energy consumption, but also the peaks determine the amount of reefer plugs required for an efficient operation at the terminal. The peak fruit season lasts only three months and thus creates an oversupply of reefer infrastructure over the rest of the year.

A further characteristic of reefer cargo is that it is not uniform and needs to be categorised as frozen, chilled and controlled atmosphere cargo, with considerably varying energy consumption patterns. As opposed to the general belief that frozen cargo consumes the least amount of energy compared to chilled and controlled atmosphere cargoes, the authors argue that the latter two require a constant energy supply as the slightest temperature variations can impact negatively on the cargo's quality. Furthermore, the authors asked:

What is the difference between the level of energy consumed by a reefer and a dry TEU, when taking into account all processes in a terminal?

Figure 2 illustrates the difference in energy consumption between these two types of containers at a macro scale, without taking into account different types of reefer cargoes. In this particular

case, energy consumption from fossil fuels and electricity was taken into account for refrigeration, terminal lighting, buildings, cranes and buildings. The calculations are based on an equation adapted from the methodology used in Buhaug et al (2009) on the comparison between reefer and dry containers.

The results demonstrated in Figure 2 show immense differences in energy consumed, comparing dry- and reefer-cargo handling among all surveyed ports and terminals. The differences resulted from the energy consumed for cooling versus non-cooling of the respective cargo.

Figure 3 shows the total energy consumption per reefer TEU over time and also demonstrates the energy used for the cooling of the unit. The results show on average a positive trend in terms of energy consumption. However, the reasons for these reductions need to be investigated at the individual terminal level to determine whether they stem from an increase in operational efficiency or are the result of technological change, the type of reefer cargo or even the conditions in which the cargo is delivered. (For a general discussion on advances in terminal productivity and technological change in LAC, see Wilmsmeier et al. 2013),

The latter was revealed in interviews with terminals. According to operators, reefer cargo is often packed and delivered

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Cavotec is a global engineering group that enables industries worldwide to improve productivity, safety and sustainability.

to the terminal in containers that are not pre-cooled. Thus, an important amount of energy is required to first cool down the units to the specified temperature. However, besides the greater need for energy, this habit also increases the supply-chain risk to the cargo, which potentially jeopardises the quality of the products and thus creates logistical extra costs at a later stage of the cold chain.

## Conclusions

The authors discuss the relevance of energy consumption as a base for identifying energy efficiency potential and carbon footprint calculations in Latin America. The research and field experiences when gathering data on the one hand disclosed the urgent need to create more awareness on the topic. On the other hand, very strong interest from terminal operators and stakeholders was received, as they became aware of the unused potential of introducing measures for improvement.

Furthermore, the findings clearly show how important it is to have a detailed understanding of energy consumption patterns and sources, and how much more research is required to gain a full understanding of these issues. Beyond identifying consumption, this first research on energy consumption and efficiency in Latin American container terminals illustrates not only the environmental, but also the economic dimension of the energy discussion, and how this can contribute to converting container terminals into more sustainable infrastructures. The results presented are not only relevant for terminal operators, but also for policy makers, port authorities and transport and logistics operators, as these figures provide opportunities to compare different terminals and countries.

By way of example, policy makers and port authorities should support ports and terminals to reduce their energy consumption and emissions in various ways, such as supporting terminals and other operators to establish 'green' technologies; developing differentiated port and terminal charges related to energy consumption; energy management for the port as a whole to allow, for example, load shedding, smart grid, (macro grid) applications; 'broker' to allow for ecologic (energy mix) and economic contracts with energy providers; and energy mix, including own energy production by for example wind farms, solar panel installations and tidal energy, among others.

Further investigation on this topic is ongoing and aims at including terminals of all kinds across the whole LAC region

and other regions, as well as to further specify energy efficiency indicators. At the same time, the dialogue with the terminal has been intensified, based on these first results, to engage in discussions on the underlying factors and determinants influencing current and past energy consumption patterns. Finally, the aim is to determine appropriate energy performance indicators and targets for container terminals for benchmarking and to

provide the basis for comparable carbon footprint calculations in the future.

The overall objective is to include this topic as a main area of concern for future development and engage in direct and continuous dialogue with authorities and terminals based on tangible results. For these reasons, we call on ports and terminals interested in participating in our research to contact us to discuss or share information, concerns and visions on this subject.

## About the authors

Gordon Wilmsmeier is an economic affairs officer in the Natural Resources and Infrastructure Division (DRNI) at the United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC); and honorary professor for maritime geography at the University of Applied Sciences in Bremen; and visiting lecturer at Göteborg University, Sweden, and Universidad Nacional de San Martín, Argentina. His publishing includes has published over 10 chapters in field-related books, over 35 refereed journal papers, 25 institutional publications as well as working papers. He is a council member of the International Association of Maritime Economists (IAME), member of the port performance research network (PPRN), member of the Sustainability Working Group of the European Freight and Logistics Leaders Forum (F&L), member of the Transport Working Group of the German Association of Geographers, and associate member of PortEconomics.

Ann-Kathrin Zotz currently works as consultant in the Natural Resources and Infrastructure Division (DRNI) at UN-ECLAC in the areas of maritime transport, sustainable and energy efficient mobility, sustainable logistics and supply chains, climate adaptability of ports and terminals, policy regulation, infrastructure investments, as well as natural resource management. She holds a master's degree in applied economics with a focus on International Trade, Finance and Development, jointly awarded by the Barcelona Graduate School of Economics, Pompeu Fabra University and the Autonomous University of Barcelona, Spain; she also has a bachelor of science degree in economics from Maastricht University, Netherlands.

## About the organisation



PortEconomics is a web-based initiative aiming at generating and disseminating knowledge about seaports. It is developed and empowered by the members of the PortEconomics group, who are actively involved in academic and contract research in port economics, management, and policy. Since October 2012, Port Technology International and PortEconomics are engaged in a partnership. [www.porteconomics.eu](http://www.porteconomics.eu)

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# Shore power for merchant vessels



Yann Duclot, Sales and Marketing Group Manager, Cavotec, Lugano, Switzerland

Lorène Grandidier, Shore Connection Marketing Manager, Schneider Electric, Grenoble, France

As port authorities and shipping lines expand investment in sustainable technologies, shore power is one of several approaches that are becoming increasingly widely used. This article provides an overview of the growth in the use of shore power at container and bulk, and oil and gas applications, as well as key recommendations to implement it successfully.

## A proven technology

Shore power, or 'cold ironing', is a proven technology that until around thirty years ago was used primarily to supply electrical power to naval vessels, privately owned non-commercial boats and yachts.

As global trade has grown in the past forty years, especially following the rapid economic growth of China and other emerging economies, the emphasis for ports and shipping lines has increasingly been on competitiveness and cost efficiency.

## Pressure to reduce costs and emissions

Because vessels using shore power have their engines turned off in port, shore power delivers economic benefits in terms of reduced fuel costs, as well as environmental benefits. Saving one Euro on the cost of transporting a shipping container, or one Euro per ton of bulk cargo, generates substantial savings over time.

Growing numbers of larger vessels, particularly at ports located close to population centres, have presented operators with environmental challenges. These challenges are now increasingly reinforced by regulatory demands to reduce emissions in and around ports. Shore power has emerged as an effective way for ports and shipping lines to reduce their environmental impact and to reduce operating costs.

## Demanding regulatory environment

From January 1 2014, half of all container

ships, reefer vessels and cruise ships calling at ports in California are required to connect to shore power. This proportion is set to increase to 70% in 2017, and 80% after 2020.

In Europe, EU Directive 2005/33/EC caps sulphur content of marine fuels at 0.1% by weight for ships berthing for more than two hours. Recognising the benefits of shore power technology, the European institutions approved in April 2014 the directive on the Deployment of Alternative Fuel Infrastructures that obliges member states to implement this technology in their ports by December 2025, unless they prove that the costs are disproportionate to the benefits. That directive will be supported by the TEN-T funding programme that can be used by ports for getting financial support while investing in shore power. In China, where pollution is becoming a major issue, the Chinese Ministry of Transport has incorporated pollution control measures including shore power in its 2011-2015 five-year plan.

## Interest, incentives and adoption

Faced with such demands, ports and shipping lines are increasingly keen to invest in systems that reduce environmental impact.

Interest in commercial shore power applications first started in the 1980s. Working closely with a small number of customers, Cavotec began work on developing its own cable management system for shore power technologies: Alternative Maritime Power (AMP). The Group's first AMP applications entered service in 1985. In California, which has been pioneering this technology in America, Schneider Electric commissioned the first electrical station for shore power in 2006.

'Early adopters' of AMP tended to require shore power systems that were safe and reliable. While this remains the case today, the wider application of

shore power technologies in merchant ports and ships has resulted in industry innovations that make such a system much more flexible. Yann Duclot, sales and marketing group manager at Cavotec, explains that naturally, there is a preference for proven, reliable systems which are readily adaptable to a variety of quayside configurations for existing or green-field ports, and new build or retrofit vessels.

The deployment of shore connection within the merchant ports has also been possible thanks to the validation of an international standard (ISO/IEC/IEEE standard 80005-1) that guarantees full compatibility between all ships and all ports worldwide.

## Collaboration, inspiration and innovation

To successfully implement a shore power system, manufacturers such as Cavotec and Schneider Electric have to work closely with ship owners, ship builders, port operators, other manufacturers and international organisations on shore power. It is also key to consider each project's special context, in order to propose a solution that perfectly matches local requirements. Thanks to their experience in this application and their worldwide presence, Cavotec and Schneider Electric have the capabilities to provide expertise and advice on factors such as electrical network and architectures, ambient conditions (humidity, temperature extremes), dust level and abrasion risk (especially at bulk application). In accordance with the international standard, the requirements of a shore power system are dependent on the ship type.

## On-board installation

On-board installation is a requirement suited to Cavotec's AMPainers containing a complete cable management system in a standard 40ft container; this

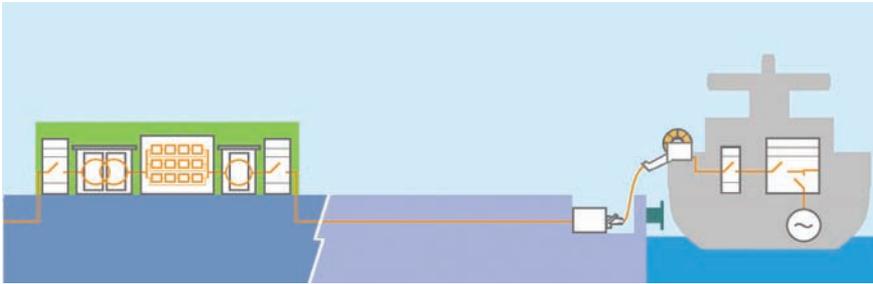


Figure 1: A typical full shore-power system for container ships

is either installed on container ships or loaded onto vessels when they arrive in port. AMPTainers can either be fitted to ships, or kept at a specific port and loaded onto vessels when needed. These units are used regardless of vessel size, age and route, further improving ROI.

Cavotec ensures a high degree of flexibility in its systems so that shipping lines that lease vessels are able to re-install equipment on other ships at a later date.

Indeed, Cavotec has supplied a large number of AMPTainer units to customers in the US, Europe and the Far East. By 2015, more than 500 container vessels in the global fleet will be fitted with Cavotec AMP systems. While new-build orders are strong, another growing market is retrofitting existing container ships with AMPTainers AMPReel systems mounted on the deck of new-build bulk vessels.

### On-shore installation

Acknowledging the busy environment around cargo and container ports, Schneider Electric has developed an all-in-one packaged solution: ShoreBoX™ integrates all required functions, including frequency conversion, voltage transformers and automation — necessary to provide electricity to the ships safely and efficiently. ShoreBoX™ is pre-engineered then tested and validated within the Schneider Electric factory, enabling a quick and seamless installation in the port.

Cavotec and Schneider Electric are currently working on a shore-power project for a customer in Indonesia where Cavotec will supply the cable management system that will be used with a Schneider Electric ShoreBoX™ system — claimed to offer considerable operational flexibility. It is said to be easily installed at new or existing ports, and requires minimal engineering.

Cavotec is also developing AMP pit systems — AMPVault — as connection points for AMPTainer units and other systems — a technique the Group says it first introduced for aircraft servicing.

These systems, built into the quay, are in use at several ports in North America

and at a variety of applications and present the benefit of providing Cavotec Easy Lift covers, a one man-hand opening mechanism that has been designed to ensure a safe, easy and fast opening while limiting the risk of injuries for the port handler.

The Port of Los Angeles and neighbouring Port of Long Beach (POLB) were some of the first ports to install AMP systems, not only at passenger berths, but also for container vessels and oil tankers. For example, Cavotec worked closely with POLB and BP to install AMP at fuel berth P400 at the port. While the oil and gas sector is not yet as mature in terms of adopting shore power as containers, Cavotec has developed systems that meet the ATEX requirements of this segment, with several already in service. However, in northern Europe, the trend seems to have started. Indeed, shore power is quite well suited to the needs of OSV (offshore supply vessels) that are berthed for quite a long time. Schneider Electric and Cavotec recently won an order to provide a low voltage shore connection system for OSV in a Norwegian port.

### A double world-first

The shore power market is very promising as the maritime sector is innovative and permanently calling for new solutions capable of supporting new technologies such as hybrid vessels. Following a two-year R&D programme, Cavotec now offers AMP systems for use with hybrid vessels. The first project for delivering AMP systems is currently under construction — fully integrated with MoorMaster automated mooring units — and will be used with the world's first battery-powered ferry in Norway.

Cavotec sees substantial potential for applications of this type, not only to power vessels, but also for automated connection operations.

Shore power is a common factor in a port's operation, as part of a strategic plan aiming at higher sustainability and efficiency, irrespective of the vessel to be powered or the site location.

### About the authors

Yann Duclot is Cavotec's group sales and marketing manager and member of Cavotec's executive management committee. He holds a Masters in marketing management from Grenoble Business School, France. He has served one of the world's largest cable manufacturers as European segment manager and key account manager and joined Cavotec group in 2007 as Middle East aviation division manager. Since 2010, Duclot has been in charge of developing the four Cavotec Group market units and defining the strategic axis for further growth.

Lorène Grandidier holds a Masters in marketing management from the Grenoble Business School, France. She has much experience in industrial marketing and is now involved in the Shore Connection activity for Schneider Electric, managing strategic marketing and institutional relationships. She is part of the T&D Europe Association and is also vice-chair of the environmental committee of the Port Equipment Manufacturers Association (PEMA).

### About the organisation

Cavotec is a global engineering group that manufactures power transmission, distribution and control technologies that form the link between fixed and mobile equipment in the ports and maritime, airports, mining and tunnelling, and general industry sectors.

Schneider Electric is a global specialist in energy management and has operations in more than 100 countries. It provides integrated solutions that make energy safer, more reliable and efficient for numerous sectors. It has more than 90 years of expertise in the maritime industry and has developed a shore connection solution that is green and reliable, and can help ports comply with local environmental requirements.

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# Dahua IP Megapixel solution secures Pescara Port



Dahua supplied a complete solution at Pescara Port in Italy, including 3MP and 2MP IR cameras and 2MP 20x speed domes.

Pescara harbour, a port at the mouth of the River Pescara on Italy's Adriatic coast, is significant for the trading and tourism around the region. The port includes a dock, a freight yard and a sea bridge that is one of the biggest cyclo-pedestrian-type in Europe. In a joint effort with Videotrend – Dahua Technology's distributor in Italy – Dahua and its megapixel solution successfully secured the contract for the Pescara port.

The problems encountered in this particular application include the unpleasant weather and high humidity of the region, which can cause the corrosion of devices and thus shorten their lifespan; in addition, the high temperatures and moisture can affect the smooth transmission of IP stream during

deployment and installation.

In order to solve the above-mentioned issues given the climate is an unalterable factor, Dahua, Videotrend and the local system integrator attempted to approach it from a different perspective – the structure. The system adopts a ring networking structure with optical fibre adopted instead of conventional star-topology; and to further guarantee an adequate bandwidth at 108Mbps for the cycling lane, the radio transmission system was configured at an access point of dual band 2.4/5.8GHz.

On the product front, Dahua 3MP and 2MP IR cameras (IPC-HFW3300P / IPC-HFW3200CP) and 2MP 20x speed domes (SD6982A / 6523H-HN) cruised into the final selection after a series of

tests. Equipped with lenses of 3.3-12mm and 8-16mm, box cameras manage to capture a wide range of scenarios under surveillance. What is more, with the help of high-efficiency IR LEDs, cameras can also render a clear night-vision effect; and as for the back-end devices, Dahua NVR, DH-SVR3016H is used as it can enable the storage of large volumes of footage, in addition to its RAID function enhancing reliability and stability of the system.

"The previous problems have been well addressed by this solution, which, at the same time is quite flexible and convenient," said Pasquale Totaro, CEO of Videotrend. "It has been over two years since the project was completed, and everything still goes well. The local officials are satisfied with this project as it not only



## Dahua Eco-Savvy 1.3Mp/2Mp/3Mp Network Cameras *DH-IPC-4000/5000-series*

Dahua's Eco-Savvy range of network cameras.

helps to achieve identifying non-essential personnel, but also makes the whole surveillance system run smoothly."

"We appreciate the client's trust and partners' efforts in this case, as we are refining our network product portfolio, and more versatile products will be launched to satisfy different requirements," said Elmer Zhang, sales director for Europe at Dahua Technology. "Take this port case for example, the speed domes installed on the bridge are IP66-rated, able to withstand the severe environment; and the accurate PTZ function helps with vehicle tracking. We are confident to provide solutions and products in various applications as we have been actively involved in different projects and have accumulated valuable experience in recent years."

### IP surveillance for outdoor port applications

A port is characterised as an open area with complex facilities, a large flow of people and potentially an aggressive climate that can create difficulties for the installation of a comprehensive video surveillance system. Designed as IP-based video surveillance systems, Dahua's two series products – including weather-proofed Ultra-Smart network cameras and Eco-Savvy network cameras – allow video to be viewed and recorded from anywhere in the port and can better solve the abovementioned

challenges and risks in port surveillance and security.

### Ultra-Smart network cameras

The Ultra-Smart network DH-IPC-8000 camera series offers 3MP in diverse designs and shapes, featuring ultra codec and smart detection. Its video analytics can better manage video surveillance, especially for outdoor applications, such as those in ports and harbours. Ultra codec includes region of interest (ROI), corridor mode, electronic image stabilisation (EIS) and scalable video coding (SVC). ROI allows cameras to enhance the image quality of the area of interest by decreasing non-ROI image quality to allow the acquisition of more computing power and bandwidth.

Corridor mode, also known as rotate mode, adjusts a horizontal scene to vertical, achieving significant cost savings because in conventional hallway scenarios, which are usually long and narrow, it usually takes a few cameras to cover the monitored area and is thus less economic and more labour intensive.

EIS ensures a clear image without the blur associated with a shaky camera, while SVC saves bandwidth and better allocates network resources by working with NVRs; in terms of video storage, it has a maximum 3/4 extra storage space, while 3/4 extra storage time could be saved. As for smart detection, Ultra-Smart series supports intelligent analytics

such as tripwire, intrusion detection, abandoned/missing, scene change, defocus, facial detection and audio detection, allowing automatic detection under rulemaking and trigger alarms, accordingly.

The first released models are HF8301E, HFW8301E and HDBW8301 in box shapes, IR-bullet and dome. The series supports max 25/30fps@3MP encoding and features in triple-stream codecs, enabling customised configuration on codec, frame rate and bit rate, depending on various purposes. Two-streaming can process 1080p resolution while the third streaming is capable of flexible usage, such as live view on mobile devices.

"Embracing intelligent functions is one of the main trends in industry," said James Wang, overseas product director at Dahua Technology. "With the rapid development of the Internet and cloud technology, video surveillance will further integrate one another and Ultra-Smart Series features new intelligent functions to provide a better, more effective performance, and a smart user experience."

### Eco-Savvy 1.3MP to 3MP network cameras

Eco-Savvy network camera series (DH-IPC-5000/4000-series) offers 1.3MP, 2MP as well as 3MP with diverse designs and sizes. The series features low consumption and low streaming, making

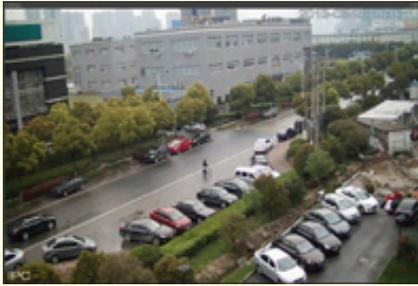


Figure 1. Comparison: 720p@4M (conventional), 720p@1M (Eco-Savvy series).



Figure 2. Superb Color Reproduction;



Figure 3. Motion Deblur - Vehicle Moving.



Figure 4. WDR Test-On,



VS Off.



Figure 5. Ultra low-light effect.



Figure 6. Smart IR Test-On



VS Off (tested with 1.3MP camera model).

this product stand-out in terms of power efficiency, and can be used for port/harbor scenarios in a broader, video-surveillance perspective. Featuring a new Ambarella chipset and in-house ISP technology, this new camera series manages to encode @1080p with bitrate 2M and @720p with 1M, which represents a 75% saving in networking bandwidth and storage compared to the existing models. In addition, the new chip features better design on power control, consuming 50% less than the previous generation cameras and allowing increased product longevity.

The Eco-Savvy series provides crystal-clear images with better color reproduction and has better detail rendering, motion deblurring and superb night-vision effects. (The following test photos are based on the performance of the 2MP HFW4200S camera)

Meanwhile, the system is coupled with 3D-NR technology, which helps to eliminate image noise in low-light conditions without creating ghosting and blurring; Dahua's patented Smart IR technology makes night vision effects even better.

In addition, with refined software, the system is more stable and efficient with stronger networking connectivity. It simultaneously supports maximum 20-user visits and 6-users@1080p preview. It ensures no packet loss up to 100m networking transmission. Besides, dual-storage backup ensures system stability.

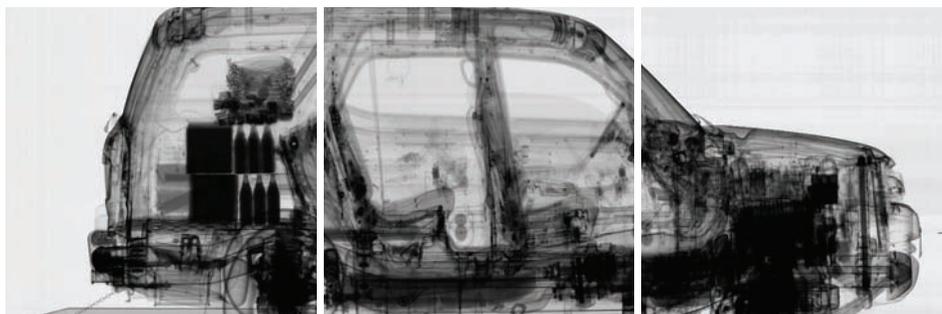
### About the organisation

Dahua Technology Co is a professional manufacturer in the field of security and surveillance. Over the past 15 years' of development, Dahua Technology has had extensive experience in the research and design of cutting-edge technology surveillance equipment. Both hardware and software are modular-designed with flexibility for different configurations, various scales of applications and future expansion. In 2013, the company was ranked ninth in the Security 50 ranking by a&s International.

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## Security, Surveillance and Detection



"The impossibility of securing all main roads, rivers and open seas means ships, trucks and trains need to be equipped to detect threats themselves."

'Threat detection and recognition: potential targets for criminal organisations', page 166

# Unified security to protect critical port infrastructure



David Lenot, *Director Transportation EMEA, Genetec*

As the largest container port in the world, the Port of Shanghai spans 3,619km<sup>2</sup> and handles over 744 million tonnes of cargo annually. If its size alone does not make it difficult to secure, the thousands of people from ships, trucks and cargo companies coming and going daily and the massive waterways leading into docks contribute to the security challenges.

Regardless of size or the types of vessels coming into harbour, ports are challenging security environments. Port security departments must rely on technology such as IP video management systems (VMS) and ultra-megapixel cameras with long-range zoom capabilities; these help keep an eye on incoming vessels, watch people moving through the terminals, and detect any suspicious activities or possible threats before they wreak havoc on operations or people's safety.

However, more international ports are also looking for better ways to improve effectiveness in their operations and response. They realise that they can achieve this by combining IP VMS with other security technologies such as access control, intercom, license plate recognition, perimeter intrusion detection, radar and vessel detection.

While most might consider security the main objective to implement such technologies, including protecting people

and assets, ports are leveraging their security investments to also improve operations. Mimicking the likes of international airports such as Amsterdam Schiphol that uses an advanced video surveillance system to dispatch more customs agents when they notice above-average passenger congestion or to adjust baggage carousel designations in case planes are delayed, ports are increasingly seeing the benefits of technology beyond security.

For ports, operational benefits might include keeping an audit trail of vessels and trucks coming to pick up and drop-off cargo, dispatching more customs officers to greet incoming passenger ships, or using video evidence to dispute liability claims or damaged property.

But how are ports implementing these technologies? And what system features help to ensure a successful and cost-efficient installation of multiple systems?

## Five systems to integrate with video surveillance

**Access control integration** ☒ Video surveillance and access control are some of the most common integrations in any security application. In a port environment, access control readers can be deployed at the main entrances, restricted areas and port facilities. Since so much technology has evolved in access control, ports are offered many interesting options such as all-in-one locks that provide a more simplified installation, wireless locks which are ideal for hard-to-reach locations, and biometric readers or handheld readers that suit more critical areas.

For instance, the Manchester Terminal, a private marine terminal in Houston, Texas, implemented a government-run security programme called TWIC (Transportation Worker Identification Credential) which provides a tamper-

resistant biometric credential to maritime workers requiring unescorted access to secure areas of port facilities. They accomplished this by adding TWIC-compliant handheld readers with identification and biometric matching software which allowed the security guards to process credentials and inspect trucks. The handhelds also allowed them to go to the ship docks and check the credentials of people coming-off ships and spot-check compliance around the facility.

**License plate recognition integration** ☒ In similar respects, synching license plate recognition (LPR) technology with access control and video surveillance, allows for monitored and gated vehicle control at the perimeter entry or at restricted personnel-only zones around the port. Port authorities can deploy fixed LPR cameras at entryways which scan vehicle licence plates and, based on a permitted list, either deny or allow entry.

These cameras can also be used to collect an audit trail of trucks coming in and out for pick-ups and deliveries. In a mobile installation, LPR cameras can be placed on a vehicle; port authorities can drive around loading docks to capture time-stamped license-plate reads and pictures of the trucks. The information can also be tied to GPS coordinates, so in the event of any liability issues, or missing goods, information concerning the truck, the time of pick-up and its location are available to dispute any false word-of-mouth claims.

**Perimeter intrusion detection integration** ☒ Much like airports, ports have huge landside perimeters to protect. Many international ports rely on technologies such as microwave sensors, fence detection sensors, buried cable detection sensors and even trip-wire analytics.

To complement perimeter detection,



Screen-grab of Genetec's Security Center software for the physical security and public safety industry

Left: Port Freeport; Right: Aerial view of Port Freeport, Texas, US.



placing high-resolution cameras that capture clear, long-range imagery is helpful. With strategic configuration, the first line of perimeter detection at the fence will prompt alerts that trigger cameras to automatically pan-tilt-zoom into the target area for visual identification. Video surveillance is then sent directly to the security monitoring centre, or even as a mobile alert to the security director's smart phone, for immediate verification and response.

**Vessel-radar integration** ☒ Massive waterways and channels leading into ports must remain open to boat traffic and cargo vessels. Because of the size and area of these bodies of water, they are particularly difficult to secure and are susceptible to vulnerabilities. Ports such as the Port of Freeport on the Gulf Coast in Texas, US, are using vessel-radar systems to identify small craft or other unsuspecting anomalies, and automate pan-tilt-zoom (PTZ) functions on video surveillance cameras to have instant video verification.

### Key criteria for successful port security

While there are many system functionalities that allow ports to tie in and efficiently manage all these systems, three key security platform characteristics will ensure their investments remain worthwhile for many years to come: 1) an open architecture; 2) unification; and 3) centralised and shared access to common devices and systems through Federation ☒ which gives ports the ability to easily share video feeds or access specific cameras located on common waterways.

For one, choosing an open architecture platform is one of the most important tactics in ensuring a future-proof investment. Most ports already have significant investments in video surveillance technologies and are not prepared to undergo a complete 'rip and replace'. This is why ports benefit from open-architecture video systems that allow them to incorporate their existing analogue or IP cameras and easily upgrade devices over time.

Open-architecture systems also avoid locking ports into specific vendors or devices, giving them complete freedom to choose the devices that best suit their applications or budgets. An open

architecture also facilitates third-party integrations with other security systems; but this is where unification comes into play. By unifying their security platform to act as a central point of information and control for all security and intrusion-related events, ports can achieve greater 'correlative' situational awareness to monitor open, widespread grounds or waterways.

A unified system is specifically engineered to manage multiple security systems in one platform from a single vendor, thereby providing both a unified interface and back-end server infrastructure that offers fluid and fault-free version upgrades. Unification also allows operators to streamline workflows within a single platform that synchs all security system management capabilities, such as monitoring, reporting, alarm management, configuration, authentication, permissions and more. All of this leads to less training, more efficient day-to-day operations, and easier investigations. When possible, considering unification over integration is always an easier, more cost-effective method to merging multiple systems.

But ports alone do not necessarily run standalone. There are typically many stakeholders that are involved in securing these critical infrastructures such as customs, coast guards, surrounding port facilities or private organisations. In a multi-stakeholder environment, it becomes important to share information. In the event of an emergency, Federation can be utilised; it also allows these multiple agencies to share the costs of equipment, offering more video coverage or data for far less cost than procuring the systems or hardware alone.

### Sailing into a unified strategy

Ultimately, many new technologies are available to ports for not only securing their perimeters and waterways but also to boost operational efficiencies and streamline processes. Whether that means combining existing technologies or adding new systems such as access control, license plate recognition, perimeter intrusion detection and vessel-radar systems, opting

for an open-architecture and unified platform with federation capabilities is the best way to ensure long-term benefits and cost savings.

### About the author

David Lenot recently joined Genetec as director of transportation in the EMEA region where he is responsible for developing tailored solutions in coordination with transport customers to help them increase security and reduce operational costs for complex projects. Lenot joined Genetec from Bosch Security Systems where he was business development manager - IP Sales - EMEA. With over a decade's industry experience globally, he has helped numerous airports, subway systems, and railway operators implement complex IP-based security infrastructures.

### About the organisation

Genetec develops open-platform software, hardware and cloud-based services for the physical security and public safety industry. Its flagship product, Security Center, unifies IP-based video surveillance, access control and license plate recognition (LPR) into one platform. A global innovator since 1997, Genetec is headquartered in Montreal, Canada, and serves enterprise and government organisations via an integrated network of resellers, integrators and consultants in over 80 countries. Genetec was founded on the principle of innovation, and remains at the forefront of emerging technologies that unify physical security systems.

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# Port Fourchon police fights crime with IT

*American Association of Port Authorities*

Throughout the US, port police departments are working more closely than ever with their IT departments as technology, such as sophisticated surveillance and monitoring systems, plays a larger role in fighting crime.

One port in particular – southern Louisiana’s Port Fourchon – is demonstrating how teamwork can pay dividends when it comes to day-to-day security issues and large-scale disaster response.

On any given day, Port Fourchon has more than 6,000 workers on land, and services around 15,000 workers offshore. Its jurisdiction covers the lower part of Lafourche Parish with roughly 35,000 residences. Its size alone creates challenges for the force.

According to Harbor Police Chief Jon Callais, the biggest day-to-day challenge is patrolling the land and water in and around the port, with more than 250 facilities and nearly 300 vessels moving through Port Fourchon each day.

Today, Harbor Police works closely with US Coast Guard (USCG) and US Customs & Border Protection. Regionally, it also works with Lafourche Parish Sheriff’s Office, Lafourche Parish Government, Louisiana State Police, the Governor’s Office of Homeland Security and Emergency Preparedness (GOHSEP), and Louisiana Department of Wildlife and Fisheries.

Harbor Police and USCG’s Area Maritime Security Group plan regular drills and exercises to train officers for a variety of crisis situations. Callais said the port also stays up to date on the latest law enforcement technologies and tools, which can help the officers do their jobs more effectively. Many of those tools, including automatic identification systems and radar systems, in-car video and computers, and 24/7 camera feeds, are available in large part because of the port’s IT department.

But most of these technologies were

not available to the port in the past. These days, it solves more crimes using cameras than with traditional patrols. For instance, all of the intersections at the port have a 24/7 camera, so if there is a crash, the camera reveals the cause without the need to interview witnesses. Cameras do not lie.

In recent years, the departments have been collaborating on another project, the GLPC-C4 Maritime Domain Awareness System, which the American Association of Port Authorities (AAPA) recently awarded its 2013 Information Technology Award. The four C’s in the system name stand for command, control, communications and collaboration – all essential functions of the system.

Harbor Police and the port’s IT department, along with Fire Central, Lafourche Sheriff’s Office, Lafourche Parish Office of Emergency Management, and the Louisiana Offshore Oil Port, all use the system to ensure decision-makers across agencies can be proactive in the case of a disaster or emergency.

After 9/11 and Hurricane Katrina, the Greater Lafourche Port Commission (GLPC) realised that it needed to bring security, emergency response and operations in to one common operating picture for greater situational awareness and interoperability with local, state and federal agencies. It therefore went looking for command and control solutions to allow it to be more proactive than reactive, explains Port Fourchon’s IT Director April Danos. She adds that in that search, the GLPC latched onto the concept of Port Wide Maritime Domain Awareness, and from that, C4 was born.

Launched in April 2010 and built in part with federal port security grants, C4 is a tool that keeps both the port’s law-enforcement technologies and assets immediately accessible for quick reference. When an incident happens, a dispatcher, or even an officer, can click onto C4 to get vital information about the facility

he or she is about to enter. For instance, if responding to a fire, C4 could warn the officer of any hazardous materials on site along with recommendations on how to respond.

The timing of the launch worked in the port’s favour, as it was able to use the system in response to the BP Deepwater Horizon oil spill, which began in late April 2010 and lasted through the summer.

Port Fourchon was at ground zero for spill clean-up, so having the tool in place saved the port time and money. Danos credits the port’s executive director, Chett Chiasson, for taking a chance on the untested system during such a high-profile disaster situation.

Chiasson is credited with having provided a great deal of support to the IT team. Considering that the BP incident came less than a month after C4’s launch, it makes the team far better prepared for major incidents in the entire port region. This is primarily because the IT team has added additional data to the system and, through regular use since 2010, has made everyone more capable of utilising its capability.

From the overarching port security perspective, C4 is the ultimate toolkit for port security. It not only provides a one-stop shop for law enforcement and incident commanders to access all sources of data available, including CCTV, AIS vessel tracking, Doppler radar vessel-tracking, map data and real-time law enforcement data; but it also offers a common platform for everyone from first responders on the ground up to incident commanders and state and federal officials. They can then delve in to as much detail as needed in times of crisis to best deploy resources, manage incidents and work together in the one common operating picture – no matter where they are.

On a day-to-day level, the C4 has a number of capabilities. When Harbor Police dispatchers receive an emergency



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Presentation at Fusion Conference Centre



US Senator Vitter visits Port Fourchon's operations room

call, they can pull up the location on camera feeds and get a visual on the facility or incident as they dispatch an ambulance. If a dock is damaged by a vessel, Harbor Police can replay the AIS and CCTV camera feeds via C4, gathering data about the incident for their report. When port tenants call in a suspicious activity to Harbor Police, that call is mapped, investigated and resolved through C4's common operating picture; the data is then saved and shared with regional response partners so that patterns and potential threats can be assessed.

The system itself is not web-based and is only shared through private networks, meaning that from a cybersecurity perspective it is more secure.

Callais explains that from a Harbor Police perspective, having the toolkit available not just to it but to all of its regional response partners means that Harbor Police is able to make decisions in real time with all of the necessary information to keep personnel, the port, and the public safe from harm, irrespective of the hazard.

In future, both Callais and Danos see

technology like C4 playing a larger role for police and security forces as the risks of large-scale natural disasters and other security threats increase.

The technology not only brings disparate data sets, sensors and sources into one common platform and picture for Port Fourchon, but it allows it to share this data with local, federal and state agencies. Danos can imagine a time when the coast guard captain of the port will have visibility into all of his/her port areas using just one computer.

And Danos already sees a number of changes that will enhance the C4 in the months to come. The port plans to add more integrated cameras at the seaport, airport and floodgates. Danos is also working with the Coast Guard and the Department of Homeland Security, which has similar technology and visited the port in March to see how they can better share information within their systems.

*This is an abridged version of an article that first appeared in AAPA's Seaports Magazine and is reproduced by kind permission of the American Association of Port Authorities*

## About the organisation



Founded in 1912, and based in Alexandria, Virginia, US, the American Association of Port Authorities (AAPA), is a trade association representing more than 130 public port authorities in the U.S., Canada, Caribbean and Latin America. Additionally, it represents more than 300 sustaining and associate members with an interest in the seaports of the Western Hemisphere. AAPA promotes the common interests of the port community, and provides leadership on trade, transportation, security, environmental and other issues related to port development and operations. AAPA also provides important seaport-related information to the public, media and policymakers about the essential role ports play within the global transportation system.

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# Eye-in-the-sky flies high

## First security drone cameras observe Abu Dhabi ports

*Abu Dhabi Ports Company (ADPC), Abu Dhabi, UAE*

Ever since its establishment in 2006, Abu Dhabi Ports Company (ADPC), the master developer of ports and industrial zones in the emirate of Abu Dhabi, has proven that innovation, latest technologies and international best practices are integral parts of the company's daily operations, corporate guidelines and procedures.

ADPC features nine of the world's most modern and largest ship-to-shore (STS) quay cranes at its flagship deep-water Khalifa Port, the first semi-automated port in the Gulf Cooperation Council (GCC) region. The company has also been the first in the region to offer award-winning cloud computing solutions for its customers who are operating their production plants in the Khalifa Industrial Zone Abu Dhabi (Kizad), right next to Khalifa Port.

### Quadcopter flies 300m high

Both, Khalifa Port and Kizad represent an initial investment of US\$6.5 billion and mark the biggest industrial project ever undertaken in Abu Dhabi. State-of-the-art infrastructures, facilities and equipment define ADPC's mega project that is being developed into one of the largest industrial zones in the world and has been initiated to diversify Abu Dhabi's economy, in line with the emirate's Economic Vision 2030.

Most recently, ADPC launched its cutting edge 'Eye in the Sky' drone camera to increase the surveillance at Khalifa Port, Kizad and ADPC's other ports in and around Abu Dhabi. The so-called commercially available Quadcopter is a remote controlled four-propeller aircraft which carries a high quality camera and a 4GB micro SD card. The aircraft measures around 50cm<sup>3</sup> and flies up to 300m high while taking 14MP stills and full HD videos.

### Radar displays distance to pilot

The Quadcopter has its own wi-fi network for data transfer and is GPS-enabled to

identify its location. It also offers position holding, altitude lock and stable hovering through a three-axis robotic stabilisation system. Furthermore, it is equipped with flight radar and displays its position in relation to the pilot, making it easy to calculate the distance to an incident, or the area and situation in question.

Sultan Al Jaber, vice-president of regulations, HSE and security at ADPC is keen to take safety and security measures to the next level. He argues that living in a world with highly advanced and reliable technical devices and automation procedures obliges ADPC to utilise such devices and procedures, not only to provide its customers with the best service offerings but also to ensure the safest and most secure work environment.

### Drone camera complements CCTV

Unmanned, remote-controlled aircraft equipped with cameras are not new and have been used by the military and police for many years. What is new is the fact that these aircraft, such as Quadcopters or drone cameras, are increasingly infiltrating our day-to-day life and have been designed for the open market. They are reasonably priced and easy to operate.

The ADPC philosophy is always to try and find new, innovative ways to enhance its services and operations, as well as its safety and security measures. The drone camera perfectly complements its CCTV cameras, of which 761 alone are focused on Khalifa Port. The drone camera helps ADPC to instantly check even difficult to access locations from various perspectives without putting any employees in danger.

### Footage viewed on mobile device

As well as incident management, including search and rescue scenarios, the drone camera can be used for 'in-doubt' situations, standard monitoring and surveys, as well as crowd management. The

footage is recorded on a memory card and simultaneously displayed in real time on an ordinary IOS or Android mobile device which is attached to the remote control. Further plans are in the pipeline to live stream footage via Wi-Fi to the port's control room.

But although things are still in the testing phase, Al Jaber is very confident that the drone cameras will significantly upgrade the company's health and safety measures. Because ports and industrial zones are very dynamic and complex surroundings, the drone cameras look set to give ADPC the necessary mobility and flexibility to monitor its premises in a most effective way.

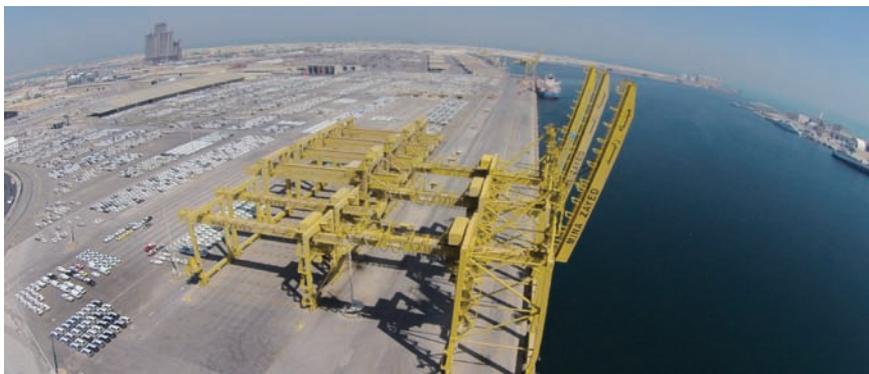
### ADPC manages nine Abu Dhabi ports

ADPC is currently managing and operating a total of nine ports in and around Abu Dhabi. Besides Khalifa Port, which handles Abu Dhabi's container traffic, these ports include Zayed Port, the emirate's oldest city port which focuses on the growing cruise business and Ro-Ro volumes, as well as Musaffah Port in the industrial town of Musaffah, southwest of Abu Dhabi.

Like every port, these ports are high-risk work areas. Numerous vessels, people and goods arrive and depart there every day. Working at height, loading and unloading heavy lift cargos and hazardous materials of which more than 30,000 shipments come into the UAE every year are only a few examples of the many safety and security hazards. In addition, ADPC is facing a further challenge: a multicultural environment.

### Communication systems follow ISPS code

Even though people from different countries come together in other ports around the world, the ports in Abu Dhabi are characterised by an even higher degree of multiple nationalities, simply because the majority of the UAE's inhabitants



Top left: A drone's eye view of Zayed Port; Top right: A Quadcopter Drone in action at Zayed Port; Bottom left: The Quadcopter flies up to 300m high while taking 14MP megapixel stills and full HD videos.

are expatriates. The Emirates have a current population of around 5.6 million inhabitants. Approximately 1.1 million are Emirati and 4.5 million are expatriates, comprising more than 80%.

Because of language barriers, different cultural mindsets and levels of understanding, the communication systems at ADPC are very complex and have been designed to overcome these challenges. The company strictly follows the International Ship and Port Facility Security (ISPS) code and ensures that these communication systems, especially in the health, safety and security arena, are in place.

**Emphasis on visual communication**

Signage in Abu Dhabi ports is dual language ☒ Arabic and English ☒ and ADPC has put a strong emphasis on visual communication through the usage of pictograms, photographs and films. Against this backdrop, the drone camera represents a new, effective visual communication tool that follows this approach.

Furthermore, ADPC has invested around US\$270,000 in the 'Day One Induction', which is a comprehensive health and safety training programme and a prerequisite to get an ADPC port gate pass. The programme targets all those who visit and work on ADPC premises, including staff members, contractors and truck drivers.

**Creating awareness of safety hazards**

The 'Day One Induction' includes several

bespoke cartoon movies which address health and safety matters in an easy-to-understand manner. The movies have been produced in Arabic, English, Urdu and Pashto and cover various subjects, ranging from general safety guidelines and incident reporting, to first aid, fire prevention, and the handling of hazardous materials.

ADPC also runs regular health and safety campaigns and workshops for all of its staff members, customers, business partners and stakeholders, creating awareness of safety hazards and teaching people how to remain healthy and how to react when facing an emergency.

**Campaigns, programmes and advanced technologies**

Some of the most recent campaigns include a 'Beat the Heat' campaign, and a 'Fire Safety' campaign, as well as a truck drivers' safety campaign called 'Be Aware and Drive with Care'. The last campaign reached more than 2,000 truck drivers who enter and leave Abu Dhabi's ports in more than 700 trucks every day.

The mix of creating awareness, conducting regular training programmes and using advanced technologies helps ADPC maintain its high standard of health and safety measures in line with international best practices. The drone camera is another new, innovative tool which will enhance these measures, so that the people's exposure to high risk situations can be further minimised.

**About the organisation**



Abu Dhabi Ports Company (ADPC) is the master developer and manager of ports and industrial zones in Abu Dhabi. It manages nine of the Emirate's non-oil and -gas ports, and is developing infrastructure to support Abu Dhabi's economic growth and diversification. ADPC's ports range from busy commercial ports to community ports supporting tourism and local industry in the Al Gharbia region of the Emirate. ADPC's flagship semi-automated deepwater Khalifa Port is adjacent to Khalifa Industrial Zone Abu Dhabi. It serves a range of industrial and logistics investors and is destined to grow into one of the world's largest industrial zones. By 2030, Khalifa Port and Kizad are expected to contribute up to 15% of the Emirate's non-oil GDP.

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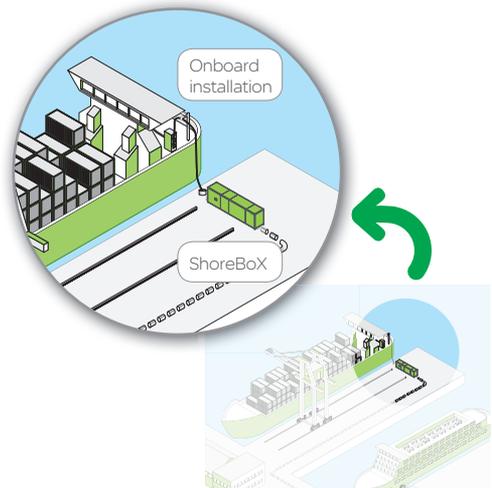
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# Threat detection and recognition

## Potential targets for criminal organisations



Maria Andersson, Senior Scientist in Sensor Informatics, Swedish Defence Research Agency (FOI), Linköping, Sweden.

Organisations that own, use or transport high value assets recognise the need to protect their goods and employees. This is especially true when they are at their most vulnerable when in remote or isolated situations, at night and when operating alone. By their very nature, trucks, trains, ships and oil rigs are all potential targets for criminal organisations. Furthermore, monitoring systems, early warning and deterrent technology have not been available to address this need at a remotely affordable cost. As a result, there has been an uneasy acceptance that in certain parts of the world, piracy, hijacking or theft are facts of commercial life. However, a refusal to accept this situation has helped to push this issue to the top of the EU agenda.

FOI is the Swedish Defence Research Agency and Technical Co-ordinator for ARENA, (Architecture for Recognition of thREats to mobile assets using Networks of Affordable sensors). The challenges in protecting high value assets on both land and at sea are considerable. The basis for a solution to the problem has been developed through the ARENA research and development project which is part-funded by the European Commission's FP7 Security Research Programme. The generic surveillance system that has been developed using an affordable system of sensors could provide robust, proactive threat detection and recognition, while being able to differentiate between real threats and false alarms across a range of environments.

Pirates, highwaymen and train robbers may all sound faintly quaint and old fashioned, but anyone involved in the transport industry will tell you that their modern counterparts are as big a threat as they ever were. There is every sign that they will remain so, as long as goods and vehicles remain vulnerable when on the move and isolated. While the threat looms large, the technology installed on vehicles to detect potential security breaches

remains crude in comparison to that now becoming available for static deployment.

A ship, a truck or a train is often highly secure while in a port or depot, being physically protected and under close surveillance, but once outside they are a relatively soft target for bands of organised and often dangerous criminals. The theft of high value, high-risk products in transit costs businesses over €8.2 billion (US\$11 billion) a year, according to recent EU figures. Since the terrorist attacks on New York on September 11, 2001, the threat of terrorism has also loomed large over the transport sector. The isolation of oil rigs means they face similar threats.

After the 9/11 attacks, the UN agreed proposals to enhance the security of dangerous goods in transport. Terror organisations have demonstrated their willingness to target mass transportation networks along with other critical infrastructure.

Over 70% of all goods transported in the EU are transported using road haulage, a transport method which carries one of the highest risks of being victim to criminal activity. Truck thieves generally steal the whole vehicle or break into trailers to take the contents, sometimes cutting panels and causing other costly damage to gain access. Drivers too are vulnerable to attack and theft. The most common place for a truck to be attacked is at an unguarded parking lot while the driver is asleep. Large cities, like London and Madrid, are the biggest hot spots, but countries like Belgium also have a problem. In the UK alone, 324,000 crimes were recorded against the transport and storage sector in 2012.

The threat is as equally pressing at sea as it is on land. Modern day piracy has presented a significant challenge since civil war broke out in Somalia in the early 1990s, with an upsurge in recent years posing a threat to critical maritime infrastructure. There were no fewer than

49 piracy incidents in the first quarter of 2014 according to the International Maritime Bureau (IMB), an offshoot of the International Chamber of Commerce which focuses on fighting maritime crime. Two of these vessels were hijacked, 37 boarded and five fired on board. Five more attempted attacks were reported. There were 12 reports off the west African coast, including the hijacking of two vessels, with 39 crew taken hostage and two kidnapped.

### Security on the move

The impossibility of securing all main roads, rivers and open seas means ships, trucks and trains need to be equipped to detect threats themselves. Advance warning offers the chance to evade, deter or repel an intruder.

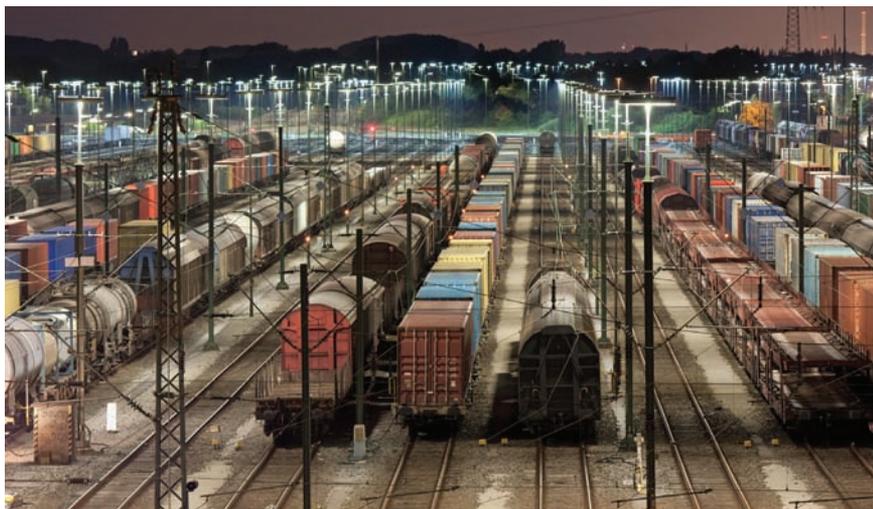
The European Commission-backed research project ARENA has attempted to deliver a solution that could work in a wide range of transport scenarios. There are currently no affordable early warning or deterrent technologies to address the threat.

FOI co-ordinated the seven-strong research partnership drawn from five EU countries. FOI's partners were leading international maritime design and engineering company BMT Group; ITTI, an IT company from Poland; hi-tech firm SAFRAN Sagem Défense Sécurité of France; electronic security company SAFRAN MORPHO; the Netherlands Organisation for Applied Scientific Research (TNO); and the University of Reading, UK.

The project concluded in May 2014 after a three-year lifespan, during which it sought to investigate a system applicable to a range of different deployments: stationary platforms relative to the land, such as a truck or train stop; stationary platforms relative to the sea, such as ships in port or oil rigs; mobile platforms relative to land, such as trucks or trains in transit; and mobile platforms relative



Transport crime is as equally pressing at sea as it is on land;  
 Bottom: Generally, trains may prove easier to protect than trucks,  
 which are often parked near innocent foot traffic.



### About the author

Maria Andersson is a senior scientist in sensor informatics at the Swedish Defence Research Agency (FOI) in Linköping, Sweden. She is also guest researcher at Automatic Control, Linköping University. Her research interests include automatic anomaly detection, sensor fusion, object tracking, machine learning and computer vision. She is deeply involved in various security research projects including projects from the EU FP7 security research programme. In these projects, which includes ARENA, she focuses on anomaly detection and event recognition.

### About the organisation



Having concluded in May 2014, ARENA will enable organisations to upgrade security on their mobile-critical assets, such as trucks, trains and ships, as well off-shore platforms, and help enhance the safety and security of people and cargo. ARENA was developed specifically to address the concerns posed by the growing threats of piracy, hijacking and theft on board mobile platforms, and provides a sensor-based surveillance system concept that will provide early identification and evaluation of incoming threats using multi-sensory data analysis from sensors attached to the assets themselves. Under the coordination of FOI, the Swedish Defence Research Agency, the project is further supported by seven project partners from five EU countries including: BMT Group, ITTI, SAFRAN Sagem Défense Sécurité, SAFRAN MORPHO, TNO, and the University of Reading.

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to the sea, such as ships at sea or oil rig support vessels.

FOI's research built upon existing work on the surveillance of public spaces. No new sensor development was undertaken. Instead, the team focussed on exploiting existing, low-cost sensor technologies like visual and infra-red video, acoustic sensors, seismic sensors and radar. It also built on other work, such as the Integrated Mobile Security Kit where a multi-sensor surveillance system is installed in a van which can be brought to a public space when needed. Another contributing technology, ADABTS (Automatic Detection of Abnormal Behaviour and Threats in crowded Spaces), addresses automatic detection of abnormal human behaviour that might signal crime is afoot. And another, called Sectonic, is a 24-hour, small area surveillance system for maritime application.

The ARENA system combined complementary sensors to reduce false-alarm rates. The task of threat-detection was broken down into four interconnected steps: object detection, object tracking; event recognition, and threat recognition. The fewer the bystanders to the vehicle, the easier the system could interpret what is going on, meaning that it would be easier to detect a threat in a quiet railway siding than when standing by a busy platform. For the same reason, trains may, on the whole,

prove easier to protect than trucks, which are often parked in places where there is innocent foot traffic.

The project also tackled the sensitive legal and ethical issues involved in surveillance and electronic security, particularly those revolving around privacy. It will be crucial to have the consent of the driver for any camera system which secures a vehicle on the basis of facial recognition. Facial recognition cameras were only used in the cab of a vehicle, so presented no challenge in respect of the privacy of passers-by.

ARENA's innovative combination of existing surveillance technology provides autonomous monitoring and situational awareness of the environment surrounding critical mobile assets, alerting personnel to threats. In achieving this goal, it has the potential to fill the yawning security gap between harbours, depots and garages, currently a cash cow for criminals and potentially a loophole exploited by terrorists.

There has been an uneasy acceptance that piracy, hijacking and thefts are facts of commercial life, particularly when trading in some parts of the world. But a growing refusal to accept this situation has helped to put the issue at the top of the EU agenda. ARENA may signal the beginning of a fundamental shift in the balance of power away from criminals, improving the safety of transport personnel, and ultimately, cutting costs for everyone.

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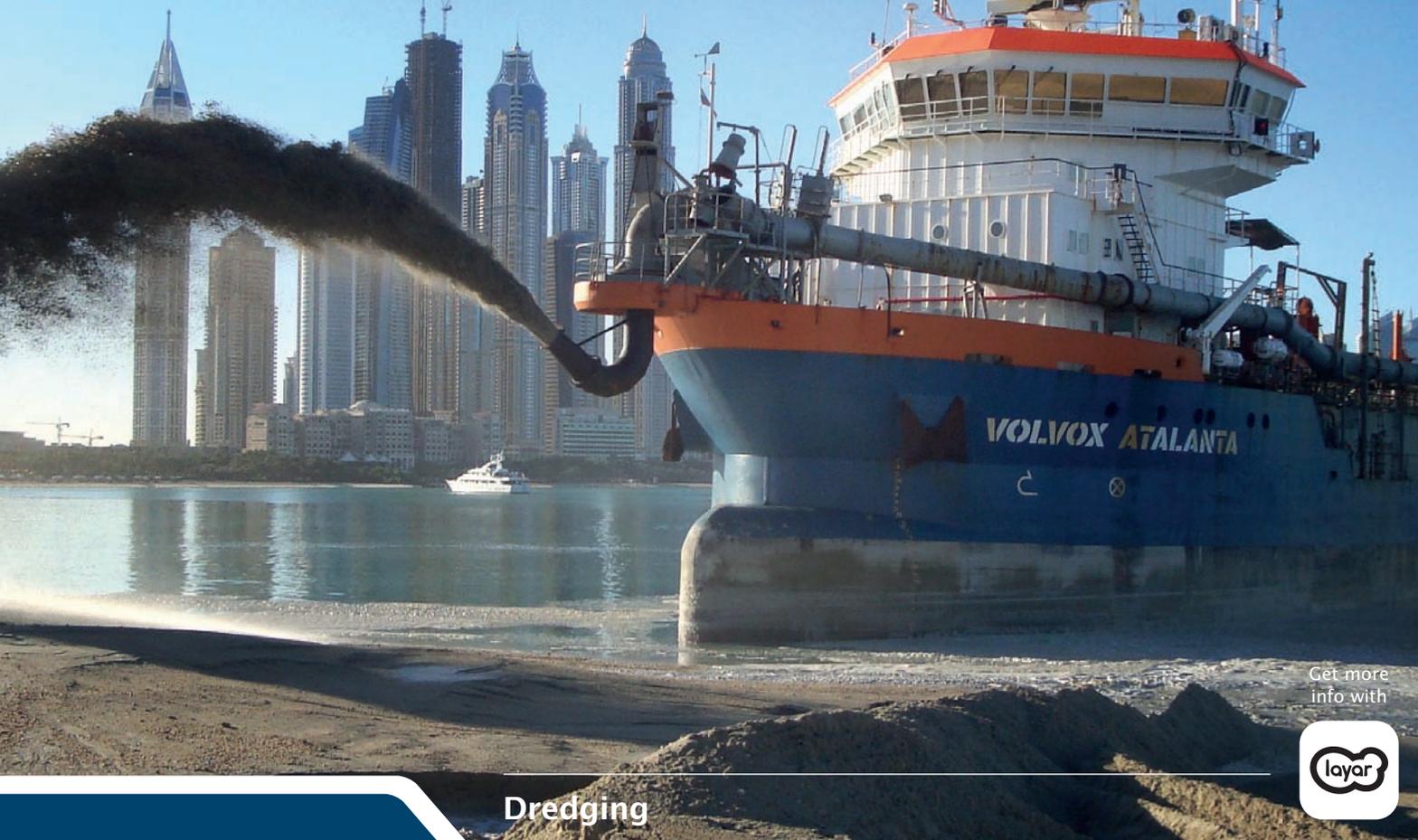
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