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Introduction

Way back in 1995, our then-publisher Christopher Taylor wrote in his Introduction to the very first edition of Port Technology International:

"Three years ago when the publication of Port Technology International was first conceived, it seemed a monumental task, and so it has proved. After much hard work, the end result is a forum through which the entire industry can express views and share successes, while specifically providing equipment suppliers with the opportunities to showcase their products."

Just over 15 years later, PTI's aims and purposes remain the same – to create a place where academic research, technical white papers, and briefings on new products intersect, and build a platform of practical, useful knowledge for the port director and terminal operator.

Needless to say, our industry is in a rather different situation to the one it experienced during the buoyant, optimistic mid-1990s – but the pace is hotting up again. Maersk Line's new 18,000-TEU 'Triple-E' container vessels are due to begin commercial operation from 2013, and pose an ultimatum for ports: boost berth productivity now or pay later. For ports, this will, of course, mean necessary upgrades, and Maersk Line writes in this edition (page 13) on what the new vessels require of port infrastructure and how they will affect the ports industry as a whole.

Leading by example, the UK's Port of Felixstowe will be one of the few European ports of call for the Triple-E vessels. I recently spoke to David Gledhill, CEO of Hutchison Ports (UK) Ltd., about what preparations the Port was making in order to service this new generation of container vessel (full interview on page 132).

Felixstowe has recently been equipped with the largest container cranes of their type, "capable of handling ships with containers stowed 24-wide on deck", which is all part of the Port's drive to maximize operational performance and help "the world's major shipping lines secure economies of scale."

You can continue to keep up-to-date with daily developments in our industry by logging on to our new-look website **www.porttechnology.org**, which features our quality news content, our full free-to-access Journal Archive, and our brilliant Equipment & Services Directory. To make keeping abreast of port news even easier, our e-newsletter now goes out twice a week – sign up on our website.

Finally, may I say a big thank-you to all our authors, partner companies and organizations. If PTI is, as Chris Taylor originally put it, a "forum" for the industry, then that forum needs to be filled with as many different voices as possible – thank you all so much for working with and supporting us.

I sincerely hope you enjoy our very special 50th edition – and here's to 50 more!

Holly Birkett
Editor edit@porttechnology.org

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The International Association of Lighthouse Authorities (IALA), established in 1957, gathers together marine aids to navigation authorities, manufacturers and consultants from all parts of the world and offers them the opportunity to compare their experiences and achievements. IALA encourages its members to work together in a common effort to harmonise aids to navigation worldwide and to ensure that the movement of vessels is safe, expeditious and cost effective.

www.iala-aism.org

The International Association of Airport and Seaport Police (IAASP)

The International Association of Airport and Seaport Police (IAASP) is a worldwide, non-governmental and non-profit association dedicated to mutual co-operation in setting the highest standards of safety, security and law enforcement regarding the transportation of persons and property through air and seaports, across boundaries and other terminals. It was recognised in the late 1960s that there was an urgent need for police and other law enforcement agencies to develop a faster means of exchanging information and intelligence internationally. In 1969 the IAASP, the oldest and largest international police association of its kind, was formed, bringing together representatives of police, other enforcement agencies and the transportation industry in the movement of passengers and cargo at airports and seaports around the world. For the first time, a professional approach to policing airports and seaports was possible worldwide.

www.iaasp.net

The World Customs Organization (WCO)

As the only intergovernmental organization with a unique Customs focus, the World Customs Organization (WCO), with its headquarters in Brussels, was established in 1952. It currently has 169 members across the globe, at all stages of economic development, who collectively process approximately 98% of world trade. The WCO is particularly noted for its work in areas covering the security and facilitation of the trade supply chain; the development of global Customs standards, the simplification and harmonization of Customs procedures, trade facilitation, risk management, integrity promotion, valuation, origin, the Harmonized System goods nomenclature, and sustainable Customs capacity building initiatives. Being the global centre of Customs expertise, the WCO provides an ideal forum for Customs administrations and their stakeholders to exchange experiences, and share best practices on a range of international Customs and trade issues.

www.wcoomd.org

The International Maritime Pilots Association

The International Maritime Pilots Association is a forum for the exchange of information. Its main objective is to provide a representative voice for pilots in international maritime forums, particularly at the International Maritime Organisation (IMO), an agency of the United Nations, and the International Maritime Law-Making body. Consultative status at the IMO was formally granted in November 1973, and since that time IMPA delegates have played a very active role in the work of the organisation.

www.impahq.org

The International Cargo Security Council (ICSC)

The International Cargo Security Council (ICSC) is a professional association of cargo transportation and security professionals from the entire spectrum of cargo security: air, truck/rail, maritime, and intermodal. The ICSC has four objectives: To improve cargo transportation security through voluntary government and industry efforts; to serve as a central clearinghouse for the collection and distribution of information relating to trends, techniques, and efforts to prevent cargo-related crimes; to provide a platform to address transportation industry matters relating to security of cargo; and to assist and support voluntary and self-help initiatives by government, transportation centres, and industry cargo security interests to develop effective efforts and programmes to combat cargo loss.

www.cargosecurity.org

AIM

AIM is the global trade association for automatic identification and mobility technologies. AIM members are providers and users systems that capture, manage and integrate accurate data into larger information systems. As a not-for-profit industry organization, AIM's mission is to stimulate the understanding and use of the technology by providing timely, unbiased and commercial-free information.

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International Harbour Masters Association (IHMA)

The objectives of the International Harbour Masters Association (IHMA) are to promote safe and efficient marine operations in port waters and to represent the professional standing, interests and views of harbour masters internationally, regionally and nationally.

www.harbourmaster.org

The Coasts, Oceans, Ports and Rivers Institute (COPRI)

The Coasts, Oceans, Ports and Rivers Institute (COPRI) was founded in 2000, as one of the American Society of Civil Engineers' (ASCE) seven technical institutes. COPRI works to advance and disseminate scientific and engineering knowledge to its diverse membership, which is engaged in sustainable development and the protection of coasts, oceans, ports, waterways, rivers and wetlands. COPRI works to enhance communication and co-operation among our more than 3,000 members, both domestic and abroad, and the industry as a whole by advancing our members' careers, stimulating technological advancement and improving professional practice. With 16 technical committees, COPRI provides members with the opportunity to change the face of the industry, from actively developing policy change to developing standards and technically sound programs such as conferences and workshops. COPRI's committees are comprised of all members of the profession including: engineers, academicians, planners, elected and appointed officials and more.

www.coprinstitute.org

CEDA

Members of CEDA are drawn from Europe, Africa and the Middle East. The Western Dredging Association (WEDA), serving the Americas, and the Eastern Dredging Association (EADA), serving the Asian and Pacific region, are autonomous sister associations which share the aims of CEDA. The three sister associations from the World Organisation of Dredging Associations (WODA). CEDA who are the Central Dredging Association promote the exchange of knowledge in all fields concerned with dredging. They enhance contacts between the various groups from which members are drawn and between the dredging fraternity and the rest of the world, enhancing understanding of dredging works from both theoretical and practical viewpoints. They also co-operate with other international organisations to safeguard the interests of the dredging profession.

www.dredging.org

The International Association of Dredging Companies (IADC)

The International Association of Dredging Companies (IADC), headquartered in The Hague, is a trade organisation with more than 50 main and associated members in the private dredging sector, all of which operate sizeable fleets and are active in the world market. IADC companies have been involved with every major international dredging project of the last century. Their objectives are to advance fair trade practices and standard contracts to establish sound environmental practices, and to publish and encourage the publication of information about technological advances in the dredging industry. IADC works to attract worldwide recognition for the dredging industry in general and to increase the public's awareness of the significant contributions of dredging towards economic growth and prosperity.

www.iadc-dredging.com

The International Association of Ports and Harbours (IAPH)

The International Association of Ports and Harbours (IAPH) is a worldwide association of port authorities whose principle objective is to develop and foster good relations and co-operation by promoting greater efficiency of all ports and harbours through the exchange of information about new techniques and technology, relating to port development, organisation, administration and management. Promoting co-operation among ship owners, shipping lines and other parties, the IAPH have been granted consultative status as a Non-Governmental Organisation from the following United Nations Agencies: International Maritime Organisation (IMO), United Nations Conference on Trade and Development (UNCTAD), Economic and Social Council (ECOSOC), United Nations Environmental Programme (UNEP) and the World Customs Organisation (WCO).

www.iaphworldports.org

The Ports and Terminals Group (PTG)

The Ports and Terminals Group (PTG), based in London, is the UK's leading ports trade association. PTG's mission is to help facilitate its members' entry into, or growth of their businesses in, overseas markets; and in doing so assist port organisations and governmental authorities worldwide to undertake port development and expansion on a build-operate-transfer or similar basis.

ICHCA International

ICHCA International represents cargo-handling interests in the international field and is the only one to do so. It was founded in 1952 and for many years was run as an Association. The acronym stands for International Cargo Handling Coordination Association but in 2002 it became incorporated and took the name ICHCA International Ltd. Its role is to speak for cargo-handling interests at an international level and to consult, inform and advise its members accordingly. It has a worldwide membership and is a recognised Non-Governmental Organisation (NGO) with ILO, IMO, ISO and UNCTAD. It also liaises closely with other international bodies such as IAPH. It works through a number of panels and groupings and publishes a bi-monthly electronic newsletter, an annual publication "Cargo World" and many authoritative advice and guidance documents.

www.ichca.com

Contents

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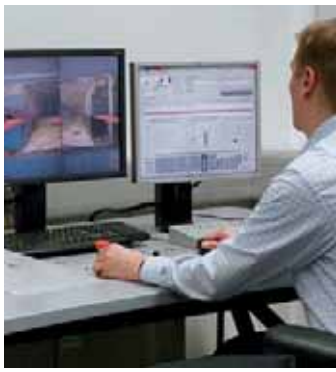

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Contents

Contents

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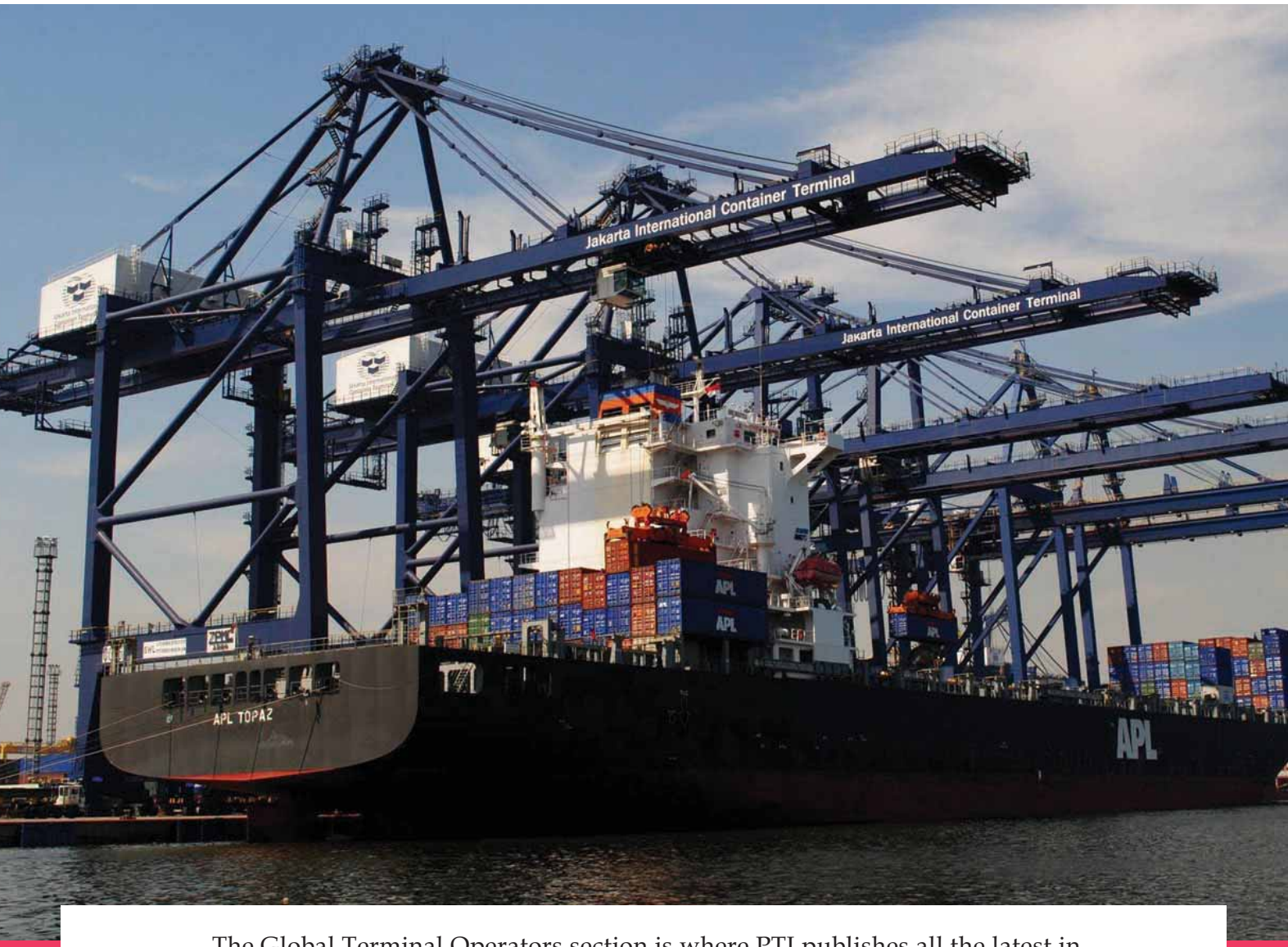


The Global Terminal Operators section is where PTI publishes all the latest in research and development occurring in terminal networks worldwide.

The section is supported by leading terminal operator networks including APM Terminals and DP World, who regularly publish articles detailing their progress and innovations. In addition, our supporters circulate the journal among key members of their staff as a reference source for use during research, product procurement and keeping abreast of industry news.

Global networks in the container terminal operating industry

Part 2: The future direction of terminal networks

Dr. Theo Notteboom, President of ITMMA, University of Antwerp, Antwerp, Belgium, & **Dr. Jean-Paul Rodrigue**, Hofstra University, New York, USA

Part One of this series on 'Global Networks in the Container Terminal Operating Industry' (see edition 49 of *Port Technology International*) discussed the internationalization and consolidation in the container terminal industry, the nature and history of global terminal operators and the extent to which global terminal operators show a truly global presence. In Part Two we focus on strategic issues and the future direction of these terminal networks.

In recent years the container terminal industry has been confronted with several challenges, including economies of scale in maritime shipping and competition from new entrants, in particular from container carriers, logistics companies and investment groups.

The year 2008 was a turning point for the container terminal operators as the final quarter saw unprecedented volume declines due to an emerging world economic and financial crisis. The contraction in global container port throughput in 2009 amounted to approximately 12%. In the recent financial/economic crisis, terminal operators have done better than shipping lines as they faced fewer difficulties in managing their assets during the economic downturn. Also, early entrants like PSA and HPH have performed better than late entrants who have had to pay premiums to be in the game (e.g. DP World). The changed economic situation means that terminal operators have adopted a more cautious assessment of future prospects. In spite of expected future growth, global container terminal operators are involved in a range of rationalization strategies and show a much greater rationality in choosing where to make new investments.

Changing to a lower gear?

Terminal operators are now more open to consider cancellation or postponement of terminal acquisition or construction projects, which tend to be the most capital intensive and risky decisions. This is the most straightforward strategy as a global terminal operator stops its geographical expansion and portfolio diversification strategy to reassess regional growth potential.

While there is a lack of transparency about global operator plans, as it remains a highly competitive business, press releases make clear that quite a number of capacity expansion projects were being shelved, deferred or cancelled as a result of the economic crisis. For instance, in 2009 the Philadelphia Regional Port Authority postponed the bidding process for the design and construction of a new container terminal in the former Philadelphia Navy Yard. Shanghai International Port Group (SIPG) decided to postpone the taking of a minority shareholding in the APM Terminals facility in the port of Zeebrugge in Belgium.

The economic crisis has also served to delay the second phase expansion of Tanger Med (the proposed TC3 and TC4 terminals) in Morocco. TC3 was planned to be used by Maersk and operated by its sister company APM Terminals, but the group decided to keep it under review. The plan for TC4 is still on track albeit with a timeline pushed back from initiation in 2012 to 2014 and with some structural changes in terms of management (i.e. PSA International has withdrawn from the project).

The London Gateway deep-sea port and logistics park on the banks of the Thames, which was originally due to open in 2010, is now set for completion in 2014. The construction of the new Jade Weser Port in Wilhelmshaven is proceeding according to a revised plan with a delayed opening date in August 2012. Rotterdam World Gateway, a 4 million-TEU terminal now under way at Maasvlakte 2 and also led by DP World, incurred a small delay of six months for completion expected in 2014. In view of minimizing risks, a growing number of large terminal projects are set to open in phases according to market demand.

The market also witnesses outright divesture where a holding or terminal operator is forced to relinquish parts or the whole of its assets, mostly because of bankruptcy. Assets are therefore sold to other holdings or operators, particularly those judged to be profitable. For instance, in 2009 the financial holding Babcock and Brown went into receivership. Part of its portfolio included container terminal assets, some of which were acquired by Euroports.

Renegotiation of existing concession agreements has become more common practice as terminal operators seek to renegotiate terms with a port authority in view of traffic expectations failing to materialize. This particularly concerns minimum traffic clauses where a global terminal operator pays a penalty if the terminal fails to handle a specific annual volume. The latest concession agreements try to anticipate to future tensions in this field by including variable throughput guarantees (i.e. the imposed volume guarantees are adjustable subject to a number of factors), or by replacing fixed throughput guarantees with minimum investment levels.

A rational expansion and consolidation of the terminal portfolio

Terminal operators more than ever pay attention to the careful selection of good locations. Terminal investments are subject to a thorough risk assessment taking into account the characteristics in the regional market (capacity situation, market growth, and so on), tariff uncertainty, fee structure, licenses and permits, and nautical and inland accessibility. Commercial banks remain cautious and have become more demanding on terms and project characteristics. Only very good projects will raise the needed funds. Many of the hot spots are in emerging markets, as these port systems offer a higher growth potential and are further opening up to international interests. Ample examples are found in South America, Africa, India and Southeast Asia.

An increasing number of terminal operators are selling stakes in terminal assets for financial relief, but where the terminal operator keeps its role as an operator. This commonly involves a financial holding seeking an opportunity to acquire terminal assets while leaving the existing terminal operator managing

the terminal. For instance, Citi Infrastructure acquired in 2010 a 75% stake in DPW's Australian portfolio composed of five container terminals.

The terminal market is also witnessing increased consolidation of a regional terminal portfolio, where a global terminal operator may divest from a terminal to consolidate its activities in others. This leads to the opportunity to rationalize a cluster of port terminals. In July 2010, APM Terminals Virginia was leased to Virginia International Terminals (VIT), which is the terminal operating branch of the Virginia Port Authority. The agreement will lead to a rationalization of the terminal facilities with the transfer of container activities from the Portsmouth Terminal to the two major facilities managed by VIT; Norfolk International Terminals and the newly acquired APM Terminals Virginia.

Equity swaps are used, particularly in the case of shipping companies, to rebalance their portfolio to better reflect their shipping network configuration. Instead of divesture, two terminal operators swap equity within their respective portfolios without the need to provide capital. In July 2010, APM Terminals and CMA-CGM agreed to an equity swap concerning their respective terminals in North America and Europe. In exchange for its 20% stake at the Mobile Container Terminal, CMA-CGM got APMT's 61% stake at Nord France Terminal International, totaling a total of 91% ownership when adding to its existing 30% stake. With this 20% stake APMT took full control of the Mobile terminal since it was already controlling an 80% stake.

The above trends lead to a growing complexity in ownership structures in view of minimizing risk, spreading the investment burden and maximizing commercial potential. Various and complex equity sharing agreements representing different stakes in regional markets are linked with expansion strategies to reinforce a presence in existing markets or to expand into new ones.

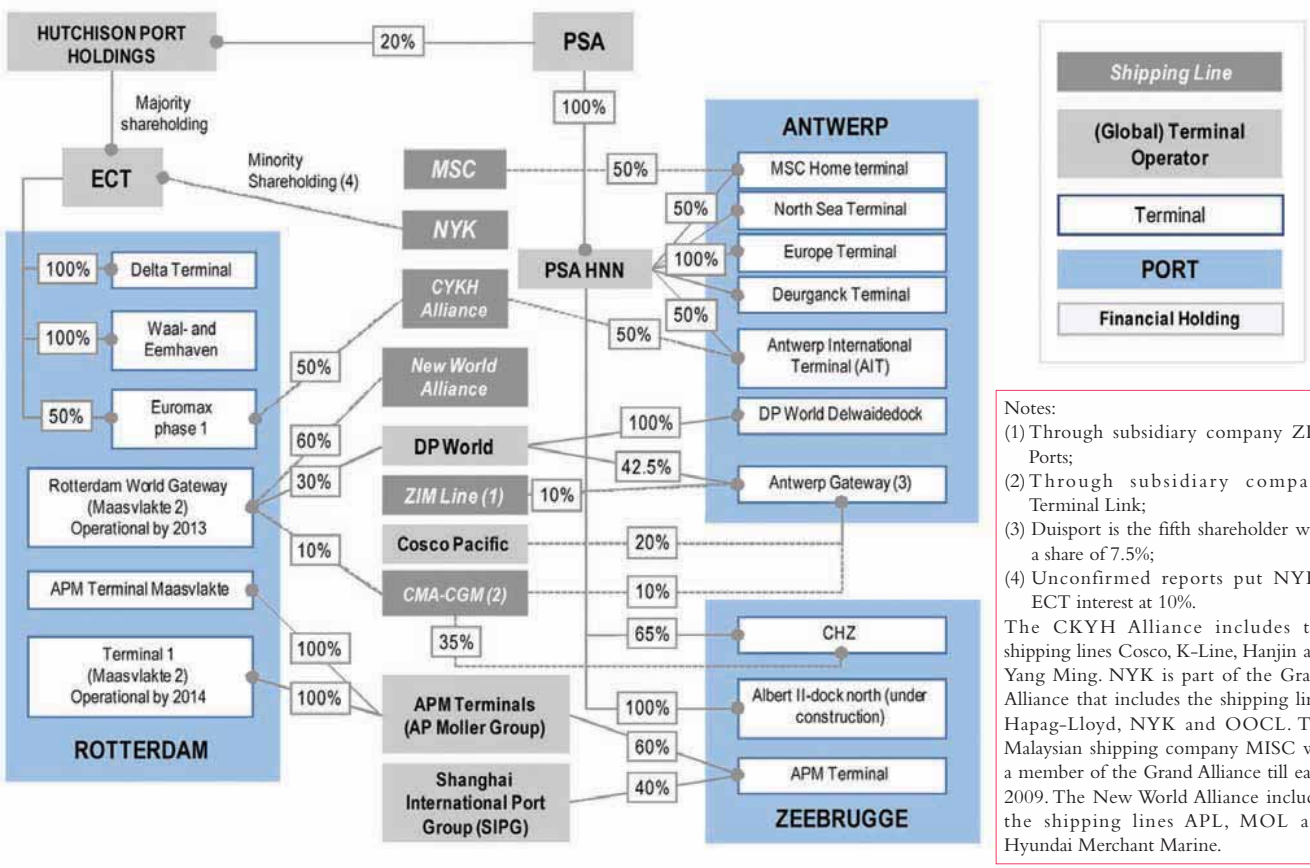
Figures 1 and 2 illustrate that these complex arrangements lead to highly complex market structures at a regional level. Even the largest operators commonly have regional stakes in others' assets, such as PSA's 20% stake in HPH. Global finance and global container terminal operations are intractably linked with interdependent leverage; the port holding uses finance to leverage its capital investment opportunities, while financial institutions are using port holdings to leverage their rate of return as well as the book value of their assets.

Yet, terminal operators are quick to cater to growth potential by mitigating future development projects. As the economy recovers and future prospects revised, terminal expansion projects that were shelved will be brought back in the pipeline. Still, it is unlikely that the construction and acquisition boom of 2000-2007 will reoccur.

Dealing with dynamics in liner shipping networks

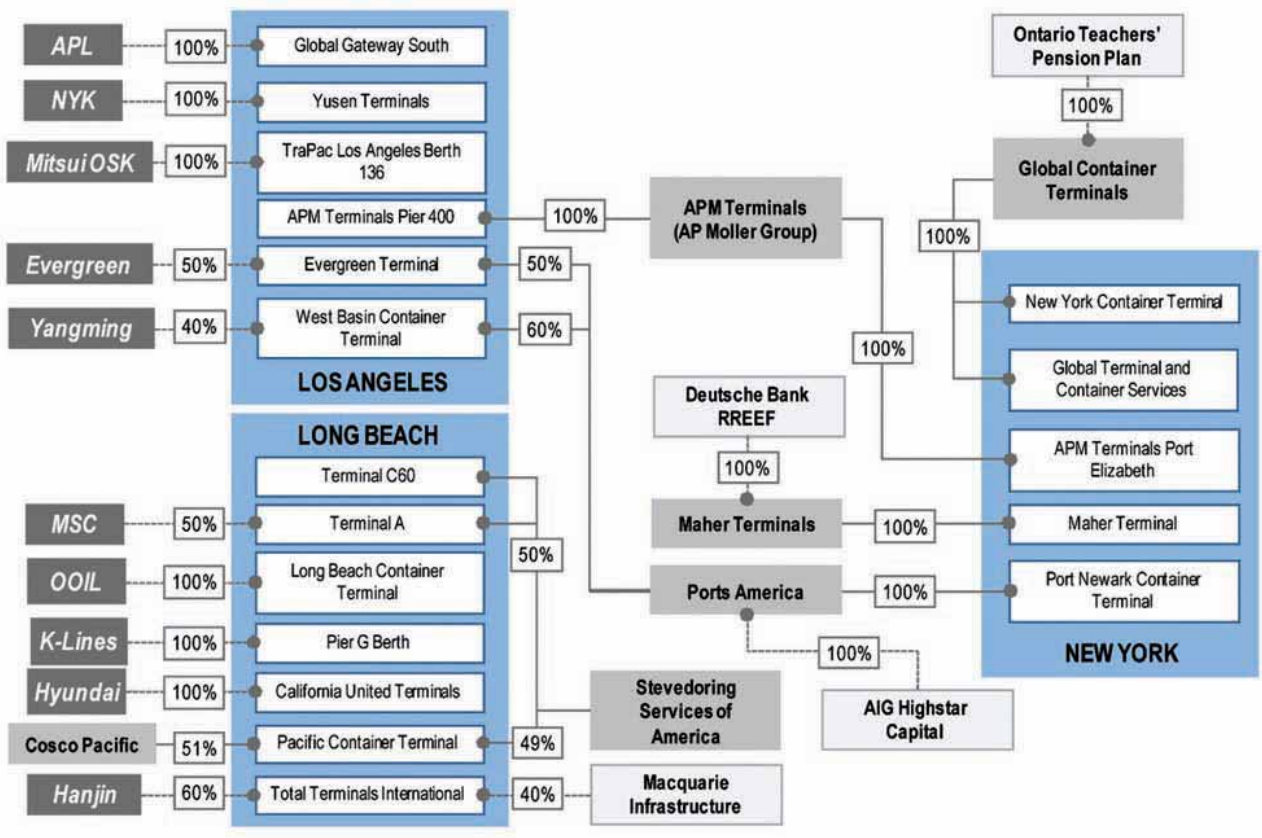
Global terminal operators must also contend with the rationalization/reorganization taking place in other parts of the transport chain, with implications on their operations. A salient example concerns slow steaming practices in maritime shipping that are imposing a new operational environment for terminal operators, but also upstream (suppliers) and downstream (inland ports) the supply chain.

Slow steaming ties a greater quantity of containers in transit, involves longer delivery times and does not appear to improve schedule integrity, which are all issues that global terminal operators must contend with. It is expected that the issue of schedule unreliability will become even more important in the future, as liner service networks are becoming more complex. Guaranteeing schedule and transit reliability to global supply chains will have an ever higher price. Low schedule integrity



Source: own elaboration based on company information.

Figure 1. Inter-firm relationships in selected container ports of the Rhine-Scheldt Delta – situation in early 2010.



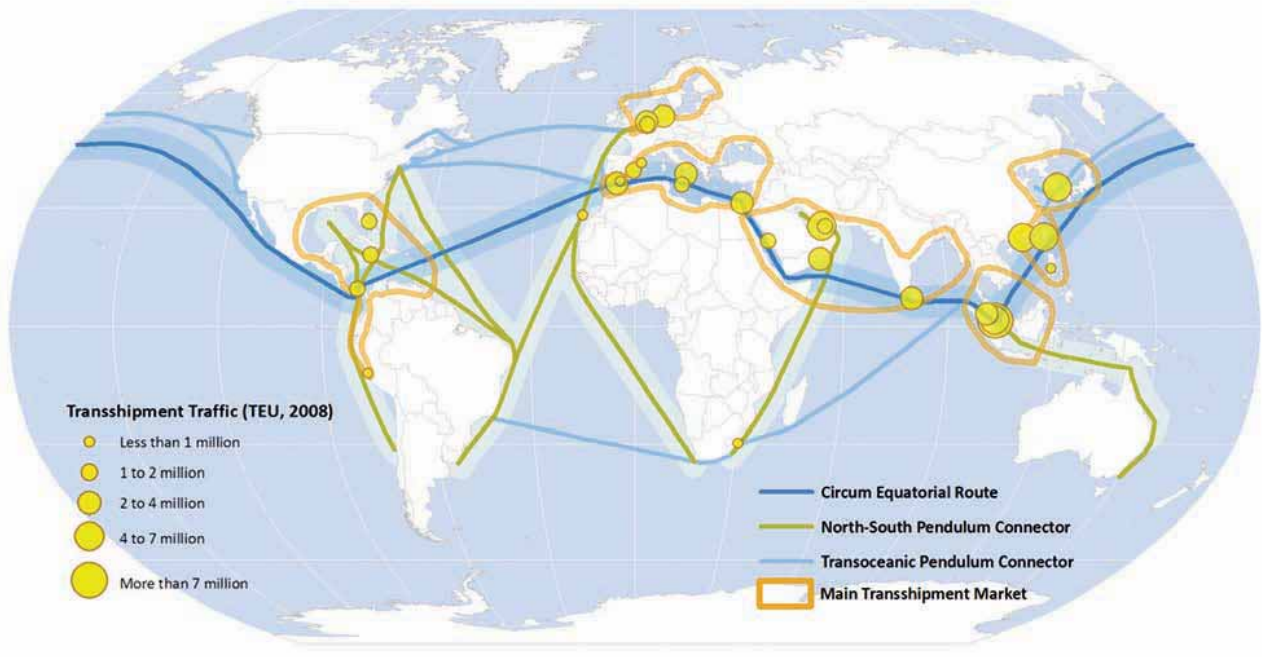
Source: own elaboration based on company information.

Figure 2. Inter-firm relationships in selected container ports of North America – situation in early 2010.

is a serious challenge for terminal managers as their planning and terminal management tools can only work optimally when the ship arrivals can be forecasted rather accurately (based on allocated slots). Vessel delays compound to delays in inland freight distribution.

A changing economic geography, larger vessels, new liner service configurations and new long-distance trade corridors challenge container terminals in terms of vessel turnaround time, liner service connectivity and synchronization, and efficient terminal capacity deployment. Global container terminal operators are particularly involved in the setting of hubs servicing main transshipment markets within an emerging global shipping network composed of transoceanic and north-south pendulum connectors (Figure 3). The expansion of the Panama Canal is likely to incite the setting of a circum-equatorial route and renewed transshipment activity.

The performance requirements for a global hub and gateway terminals on mainline vessels are moving to a sustainable



Source: Transshipment data from Drewry Shipping Consultants.

Figure 3. Emerging global shipping network and transshipment markets.

ship output of at least 5,000 moves per 24 hours and a ratio working time to time at berth of 90%. Such volumes pose huge demands on container crane density per vessel, the ship-to-shore gantry crane output productivity (40 moves per gross hour or more), yard equipment and on the required stacking area. The associated peaks make the hinterland transport issue more complex.

Moving into inland freight distribution?

Next to a booming transshipment and interlining market, the future of containerization will largely depend on the land side, particularly on efficient intermodal and transmodal operations. At a regional scale, the process of integration between maritime and inland transport systems increasingly results in a number of penetration and modal shift strategies where each mode is used in its most cost- and time-effective way. These configurations can ease the pressure on deep-sea container terminals by moving the sorting function inland, thus increasing the efficiency of existing terminal facilities and the overall throughput. As terminal operators are urged towards a better integration of terminals in supply chains and shipping lines are acquiring container terminal assets worldwide, leading terminal operating companies are developing diverging strategies towards the control of larger parts of the supply chain.

The door-to-door philosophy has transformed a number of terminal operators into logistics organizations and/or organizers/operators of inland services. Not every terminal operator is integrating by acquiring or setting up separate companies or business units. In many cases, effective network integration is realized through better co-ordination with third-party transport operators or logistics service providers. The services offered include warehousing, distribution and low-end value-added logistical services (e.g. customizing products for the local markets).

Particularly in Europe, a number of terminal operators have integrated inland terminals in their logistics networks or have a direct involvement in rail and barge operations. Maersk Line wants to push containers into the hinterland supported by its terminal branch APM Terminals and its rail branches.

HPH-owned ECT in Rotterdam has followed an active strategy of acquiring key inland terminals, acting as extended gates to its deep-sea terminals, for example, a barge and rail terminal in Venlo (the Netherlands), DeCeTe terminal in Duisburg (Germany) and TCT Belgium in Willebroek (Belgium).

DP World is following a similar strategy to streamline intermodal operations on the Seine and Rhône axes, while the large terminals of Antwerp Gateway (open since 2005) and London Gateway (future project) are both linked to inland centers in the hinterland. Terminal operators can play an instrumental role in bringing together intermodal volumes of competing lines and as such create a basis for improved or even new intermodal services.

The globalization strategies of terminal operators are accompanied by the regionalization of their hinterlands in areas (e.g. Western Europe) where market situations and opportunities justify such a strategy. In other regions, global operators have been extremely hesitant to vertically integrate. Two main factors hold back full vertical integration of operators. First of all, global terminal operators do not wish to enter business segments in which their own customers have a presence in order not to compromise their business relations. Secondly, particularly in the case of Asian conglomerates, sister firms perform activities in other segments of the supply chain such that when taking a conglomerate perspective, the entire business group has involvement in all aspects of the supply chain.

The setting of global networks in the container terminal operating industry has been a prevalent trend in the last two decades. Global terminal operators reflect well the geographical and functional complexities of global supply chains. While the focus has been at a close integration with global shipping networks either as gateways or transshipment hubs, terminal operators are increasingly looking at the immediate hinterland as a strategy to consolidate their business.

Part One of this article was published in edition 49 of 'Port Technology International', which can be viewed in our online Journal Archive: http://www.porttechnology.org/journal_archive/edition_49

ABOUT THE AUTHORS

Prof. Dr. 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 also President of International Association of Maritime Economists (IAME) and Chairman of the Board of Directors of Belgian Institute of Transport Organizers (BITO), an institute of the Belgian Federal Government.

Dr. Jean-Paul Rodrigue is a professor at Hofstra University, New York. His research interests mainly cover the fields of economic and transport geography as they relate to global freight distribution. Area interests involve North America and East and Southeast Asia, particularly China. Specific topics over which he has published extensively about cover maritime transport systems and logistics, global supply chains and production networks, gateways and transport corridors, international trade and regional development.

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PORT FOCUS

"The Triple-E's enormity is actually in its bulk. The Triple-E's vastly expanded inside cavity gives it 16% greater capacity than *Emma*, despite relatively little change in the length and width."

'Berth productivity will have to keep up with shipping's super-sized revolution', page 18.

Berth productivity will have to keep up with shipping's super-sized revolution

Maersk Line's new 18,000-TEU Triple-E vessels will not only revolutionize shipping, but also port infrastructure

Maersk Line, Copenhagen, Denmark

Think of a container ship as long as the Empire State building and as wide as an eight-lane motorway that is able to carry more than 860 million bananas or 18 million flat-screen televisions in 18,000 containers. That will be the world's largest vessel – the 'Triple-E' – the sheer scale and capacity of which will revolutionize international container shipping.

Maersk Line, the world's largest container line, signed a contract in February to buy 10 Triple-E vessels, with an option for 20 more, from Daewoo Shipbuilding and Marine Engineering of South Korea in a deal that could be worth US$5.7 billion.

The ships will be delivered from 2013 to 2015 and will have 16% more capacity than *Emma Maersk*, the world's largest vessel currently in operation. Moreover, 50% less carbon dioxide (CO_2) will be emitted per container moved compared to the industry average on the Asia-Europe trade.

The 10 new Maersk Line Triple-E vessels currently on order will come into commercial operation from 2013 onwards.

The purpose behind the creation of Triple-E vessels

The vessel's purpose is encapsulated in the name: Triple-E – Economy of scale, Energy efficient and Environmentally improved. Its enormous capacity enables Maersk Line to move the greatest number of containers possible for its customers in the most energy efficient way, with the smallest CO_2 footprint. Combined with an energy saving propulsion system, its size is a major factor in its industry best efficiency and performance.

Maersk Line considers the timing opportune to order these new vessels as the annual market growth for Asia to Europe (westbound) trade is expected to be in the 5-8% range during 2011-2015. The Triple-E vessels, which will ply this trade lane from 2013, are symbols of Maersk Line's growth ambitions and its visible industry leadership in terms of environmental responsibility.

The Triple-E's economy of scale

The Triple-E will be the longest and widest container vessel. The reality is that the visible dimensions of the ship – only four meters longer and three meters wider than *Emma Mærsk* – do not fully convey its capacity.

The Triple-E's enormity is actually in its bulk. Through feats of engineering, the Triple-E's vastly expanded inside cavity gives it 16% greater capacity than *Emma* (equivalent to 2,500 containers), despite relatively little change in the length and width.

The Triple-E is designed to transport more cargo without adding engine power compared to *Emma Maersk*. Unlike *Emma Mærsk*'s more typical V-shaped hull which limits container capacity towards the bottom of the 'V' in the cargo holds, the hull of the Triple-E is more like a U-shape. An additional row of containers was also added to the Triple-E, giving it 23 rows across its width compared to *Emma*'s 22. The more spacious hull and extra row provides additional capacity for 1,500 containers.

Additional container space has been created in the vessel by moving the navigation bridge and accommodation superstructure five bays forward, and the engine room and chimney six bays back in what is called a 'two-island' design. With the more forward navigation bridge, containers can be stacked higher in front of the bridge (approximately 250 more) without losing visibility; and approximately 750 more containers fill the space behind the bridge above deck and below deck using the space created by the engine room's position further to the back of the vessel.

Energy efficient and environmentally improved design

Its size is remarkable, and yet the most impressive and important attributes of the Triple-E cannot actually be seen. The Triple-E class of container vessels will emit 50% less CO_2 per container moved than the industry average for vessels operating on the Asia–Europe trade. Its design is optimized to sail with the maximum possible cargo load while at the same time reducing the impact on the environment.

"Reducing our CO_2 footprint is a top priority for us and also our customers who depend on us in their supply chain, and a growing number of consumers who inform their decisions with this information," says Søren Stig Nielsen, Head of Sustainability for Maersk Line.

TABLE 1: TRIPLE-E'S BUILD SPECIFICATIONS

Length:	400 metres
Height (above baseline):	73 metres
Beam (breadth):	59 metres
Maximum draft:	16 metres
Deadweight:	165,000 metric tonnes
Reefer container capacity:	600
Top speed:	23 knots

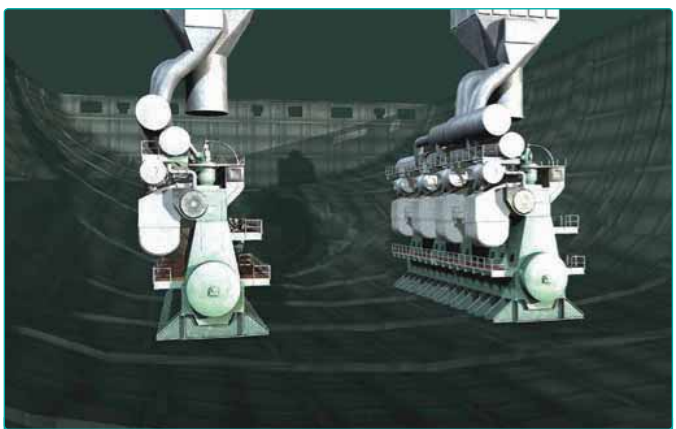
The Triple-E vessels have a U-shaped hull, which accounts for much of the 16% increase in capacity in comparison with the *Emma Maersk*, which has a V-shaped hull.

Despite its size, the Triple-E is no gas guzzler: the vessels use approximately 35% less fuel per container moved than the 13,100-TEU ships being delivered to other container shipping lines in the next few years for service on the Asia–Europe trade.

One major reason for its superior efficiency is what is happening in the Triple-E's engine room. The Triple-E is designed for a top speed of 23 knots, compared to *Emma Mærsk*'s top speed of 25 knots. That tiny difference in maximum speed lowers the power output needed from the engine by 19%, which allows for slower revolutions in its engines and far greater fuel economy.

The Triple-E also has two slow running engines ('ultra-long stroke') and two large propellers, a combination called 'twin skeg'. The reason for using this combination is that Maersk Line studies found that using two of these slower running engines to turn two propellers results in further energy savings of 4% compared to a one engine/one propeller design.

Further boosting the efficiency of the vessel further is a waste heat recovery system situated in the engine room, which captures and reuses heat and pressure from the engine's exhaust that would normally escape as wasted energy. Reusing this waste heat increases the power to the engine by 9%, reducing fuel consumption by 9%.



The Triple-E vessel's two slow running engines and two large 'twin skeg' propellers reduce energy by 4% compared to a one engine/one propeller design.

The role of container ports

The arrival of the Triple-E will raise the bar for ports. Over the last few years several major ports in China, South-East Asia and Europe have developed their infrastructure in order to accommodate larger ships. While major individual terminals have berths that can fit a 400-meter long vessel with a draft requirement of 16 meters, there is significant room for development in terms of capabilities and performance.

For instance, the wide beam of 53 meters on a Triple-E vessel will need to be matched by improved outreach of quay cranes in some ports. In addition, the height at which most cranes can operate today is a roadblock in utilising the top tiers of current vessels such as the *Emma Mærsk*. As the complexity and scale of ship-to-shore operations continues to grow, maintaining and in fact improving the turnaround time becomes increasingly important.

Tommy Nilsson, Head of Terminal Strategy at Maersk Line explains: "Today, having the right capacity and capabilities is integral to the long-term growth and success of ports. Ensuring that the nautical infrastructure, quay design, cranes and operational layout match the specifications of future vessels is needed for ports to get ahead of the curve."

Adding to his comments on right-sizing, Tommy also highlights the need for optimization: "For over 10 years now, berth productivity has fallen behind what is required to serve the average call size of container vessels. Crane productivity has also progressed on a fairly flat curve. This trend is of course very concerning as we prepare to launch the next generation of 18,000-TEU ships. Maersk Line's message to vendors is clear: higher productivity is no more a nice-to-have but a need-to-have. Otherwise ports will become the bottlenecks to growth. To overcome this challenge, container ports must by all means invest in improvements that will drive both productivity and energy efficiency in the immediate future."

ABOUT THE COMPANY

In addition to its fleet of over 500 vessels, managing a fleet of 3.2 million TEUs worldwide, **Maersk Line** has around 16,900 employees, and employs around 7,600 seafarers. The Line is represented in 325 offices around the world, in over 125 countries.

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Dry ports and the maritime hinterland: gaining momentum

Dr. Jean-Paul Rodrigue, Hofstra University, New York, USA, & **Dr. Theo Notteboom**, President of ITMMA, University of Antwerp, Antwerp, Belgium

The setting of dry ports

The evolution of inland freight distribution can be seen as an ongoing development of containerization and intermodal transportation. Modal availability, capacity and reliability of regional inland access all have an important role to play in shaping this development. As maritime shipping networks and port terminal activities become better integrated, the focus shifted on inland transportation and the inland terminal as a fundamental component of this strategy. Thus, after a phase that relied on the development of port terminals and maritime shipping networks, the integration of maritime and inland freight distribution systems has favored the setting of what has often been labeled 'dry ports'.

Using the term 'dry port' to define an inland terminal is open to debate since many inland terminals are in fact 'wet' given their direct access to inland waterway systems. Moreover, the inland location can effectively be a port if a barge service is concerned, but fundamentally cannot be considered a port if it involves a rail terminal. Thus, there seems to be no consensus on the terminology resulting in a wide range of terms including dry ports, inland terminals, inland ports, inland hubs, inland logistics centers, inland freight villages, etc. The reason for this lies in the multiple shapes, functions and network positions these nodes can have. Regardless of the terminology used, three fundamental characteristics are related to an inland node:

- An intermodal terminal, either rail or barge that has been built or expanded.
- A connection with a port terminal through rail, barge or truck services, often through a high capacity corridor.
- An array of logistical activities that support and organize the freight transited, often co-located with the intermodal terminal.

It can thus be seen that the functional specialization of dry ports has been linked with the clustering of logistical activities in the vicinity and have become excellent locations for consolidating a range of ancillary activities and logistics companies. In recent years, the dynamics in logistics networks have created the right conditions for a large-scale development of such logistics zones.

Driving forces: pushing economies of scale inland

Each dry port remains the outcome of considerations pertaining to modal availability and efficiency, market function and intensity as well as the regulatory framework and governance. Their emergence underlines some deficiency in conventional inland freight distribution that needed to be mitigated. On top of the list is real estate where many deep sea terminal facilities have limited land available for expansion. This favors the intensification of activities at the main terminal and the search of lower value locations supporting less intensive freight activities.

Capacity issues also appear to be one the main drivers of dry port development, since a system of inland terminals increases the intermodal capacity of inland freight distribution. While trucking tends to be sufficient in the initial phase of the development of inland freight distribution systems, at some level of activity, diminishing returns such as congestion, energy and empty movements become strong incentives to consider the setting of inland terminals as the next step in regional freight planning. Inland locations tend to be serviced less by intermodal transportation than coastal regions. Through long distance transport corridors, inland ports confer a higher level of accessibility because of lower distribution costs and improved capacity. These high-capacity inland transport corridors allow ports to penetrate the local hinterland of competing ports and thus to extend their cargo base.

In addition to standard capacity and accessibility issues, a dry port is a location actively integrated within supply chain management practices, particularly in view of containerization. This takes many forms such as the agglomeration of freight distribution centers, container depots, customs clearance and logistical capabilities. The dry port can also become a buffer in supply chains, acting as a temporary warehousing facility often closely connected to the warehouse planning systems of nearby distribution centers.

Modal availability and capacity of regional inland access have an important role to play in shaping the emergence and development of dry ports. Each inland market has its own potential requiring different transport services. Thus, there is no single strategy for a dry port in terms of modal preferences as the regional effect remains fundamental.

Three functions within transport chains

Dry ports service three major functions. The first is one of a satellite terminal located in proximity to a port facility. It accommodates additional traffic and serves functions that either have become too expensive at the port such as warehousing and empty container depots or are less bound to a location near a deep-sea quay. A number of satellite terminals only have a transport function transshipping cargo from rail/barge to trucks and vice versa, as is the case for the 'container transferium' concept of the port of Rotterdam or the Gateway Access Point (GAP) concept in Belgium.

Satellite terminals can also serve as load centers for local or regional markets, particularly if economic density is high, in which case they form a multi-terminal cluster with the main port they are connected to through regular rail or barge shuttle services. For gateways with a strong import component, a satellite terminal can also serve a significant transloading function where the contents of maritime containers are transloaded into domestic containers or truckloads.

A major intermodal facility – load center – granting access to well defined regional markets that include production and consumption functions is the second function assumed by dry ports. It commonly corresponds to a metropolitan area where a variety of terminals serve concomitantly intermodal, warehousing, distribution and logistics functions. These tend to take place in logistics parks and free trade zones. The dry port is thus the

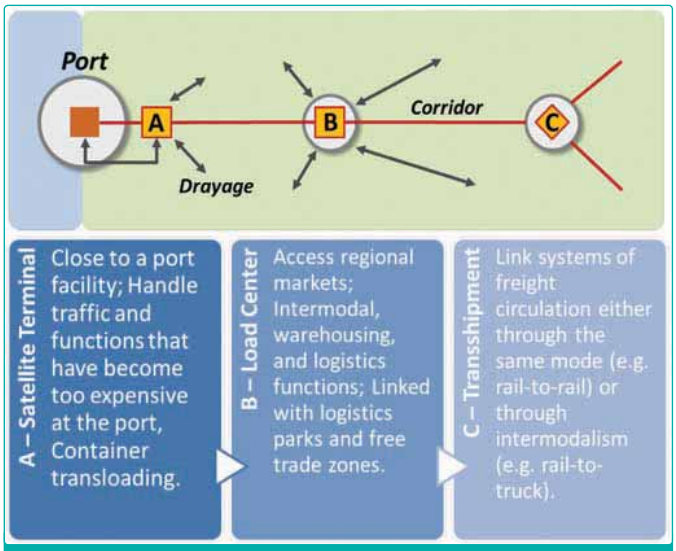

Figure 1. Types and functions of dry ports.

load center of a regional market. If the load center has a good intermediary location, such as being along a major rail corridor, then freight distribution activities servicing an extended market will be present.

The third function of a dry port is one of a transshipment facility that links large systems of freight circulation either through the same mode (e.g. rail-to-rail) or through intermodalism (rail-to-truck or even rail-to-barge). In the later case, the inland terminal assumes the role of a load center. The origin or the destination of the freight handled is outside the terminal's market area, a function similar to that of transshipment hubs in maritime shipping networks. Such transshipment terminals are often found near country borders in view of combining administrative processes linked to cross-border traffic to value-added logistics activities. Although this function remains marginal in most parts of the world, ongoing developments in inland freight distribution, where the scale and scope of intermodal services are increasing, are indicative that transshipment services are bound to become more prominent.

These functions are not exclusive, implying that dry ports can service several functions at once. For inbound or outbound freight flows, the dry port is the first tier of a functional hierarchy that defines its fundamental (activities it directly services) and extended (activities it indirectly services) hinterlands.

Dry port is the name, co-location is the game

Several dry port projects are set on the principle of co-location between an intermodal operator and a commercial real estate developer or a local public development office. Logistic zones tend to occupy a large amount of space to accommodate existing and anticipated freight distribution activities. Most co-located projects occupy at least 250 acres and several projects are well above 1,000 acres. Larger projects tend to have lower land acquisition costs. Also, since co-located projects involve two or more large players, they are able to tap into capital pools with better conditions than a smaller actor. For instance, CenterPoint Properties, one of North America's largest developer of logistic zones, is owned by the pension fund CalPERS (California public employees' retirement fund), enabling access to long-term capital. Another important aspect is that a co-located logistic project enables the joint planning of facilities.

A co-location project enables actors involved to focus on their core competencies, creating multiplying factors. For example, the rail company can focus on terminal development and operations, while the real estate promoter can develop and manage the freight distribution facilities. Both the terminal operator and freight distribution activities at the logistic zone are their respective customers, implying that both partners have vested interests in the efficiency of their operations. The possibility of joint marketing where the logistic zone is promoted as a single intermodal package is also common since the terminal is sold as a value proposition to potential customers.

A co-location project offers notable operational advantages for drayage, not just because of close proximity, but because trucks can have a priority access through the terminal's gates. Drivers are able to perform more deliveries per day and the reliability of these deliveries improves. Intermodal transportation assets are capital intensive and there are pressures to increase their utilization level to achieve better returns on investments. Containers and chassis tend to be the assets that are the most prone to such strategies, namely through the setting of chassis pools and empty container depots. Finally, a co-location project offers the possibility to jointly plan information systems for terminal operations and the related supply chains, creating a dry port community system where users can have access to real time information about the status of their shipments. Both terminal operations and their related supply chains benefit.

How dry ports interact with their regional markets remain fundamental as it defines their modal characteristics, their regulatory framework and their commercial opportunities. Depending on the geographical setting and the structure, governance and ownership of inland transport systems, dry ports have different levels of development and integration with port terminals.

Europe: dry ports as part of ports' hinterland strategy

It is in Western Europe that the setting of dry ports is the most advanced, with a close integration of port terminals with rail shuttles and barge services. Since a good share of the European market is inland, a growth in international trade required the setting of intermediary locations inland to help accommodate larger flows between ports and their hinterland. Many dry ports have become fully-fledged logistics zones.

A large concentration of dry ports can be found around the Rhine-Scheldt delta (Figure 2), which is Europe's most important gateway region with a total container throughput of 22.2 million TEU in 2010, and where the function of satellite terminals is prominent. Almost every European port has an inland terminal strategy as a way to secure hinterland traffic.

Rail-based dry ports are found throughout Europe, often linked to the development of logistics zones. Depending on the European country considered, these logistics zones are known under different names: 'platformes logistiques' in France, the 'güterverkehrszentren' (GVZ) in Germany, 'interporti' in Italy, 'freight villages' in the UK, 'transport centres' in Denmark, and 'Zonas de Actividades Logisticas' (ZAL) in Spain. The rail liberalization process in Europe is supporting the development of real pan-European rail services on a one-stop shop basis. All over Europe, new entrants are emerging while some large former national railway companies have joined forces (cf. Railion). Rail terminals in Europe are mostly built and operated by large railway ventures. The largest rail facilities have bundles of up to 10 rail tracks with lengths of maximum 800 meters per track. Rail hubs are typically equipped to allow simultaneous batch exchanges (direct transhipment) through the use of rail-mounted gantry cranes that stretch over the rail bundles.

In northwest Europe, barge transport is taking up a more prominent role in dealing with gateway traffic. Barge container transport has its origins in transport between Antwerp, Rotterdam and the Rhine basin, and in the last decade it has also developed greatly along the north-south axis between the Benelux and

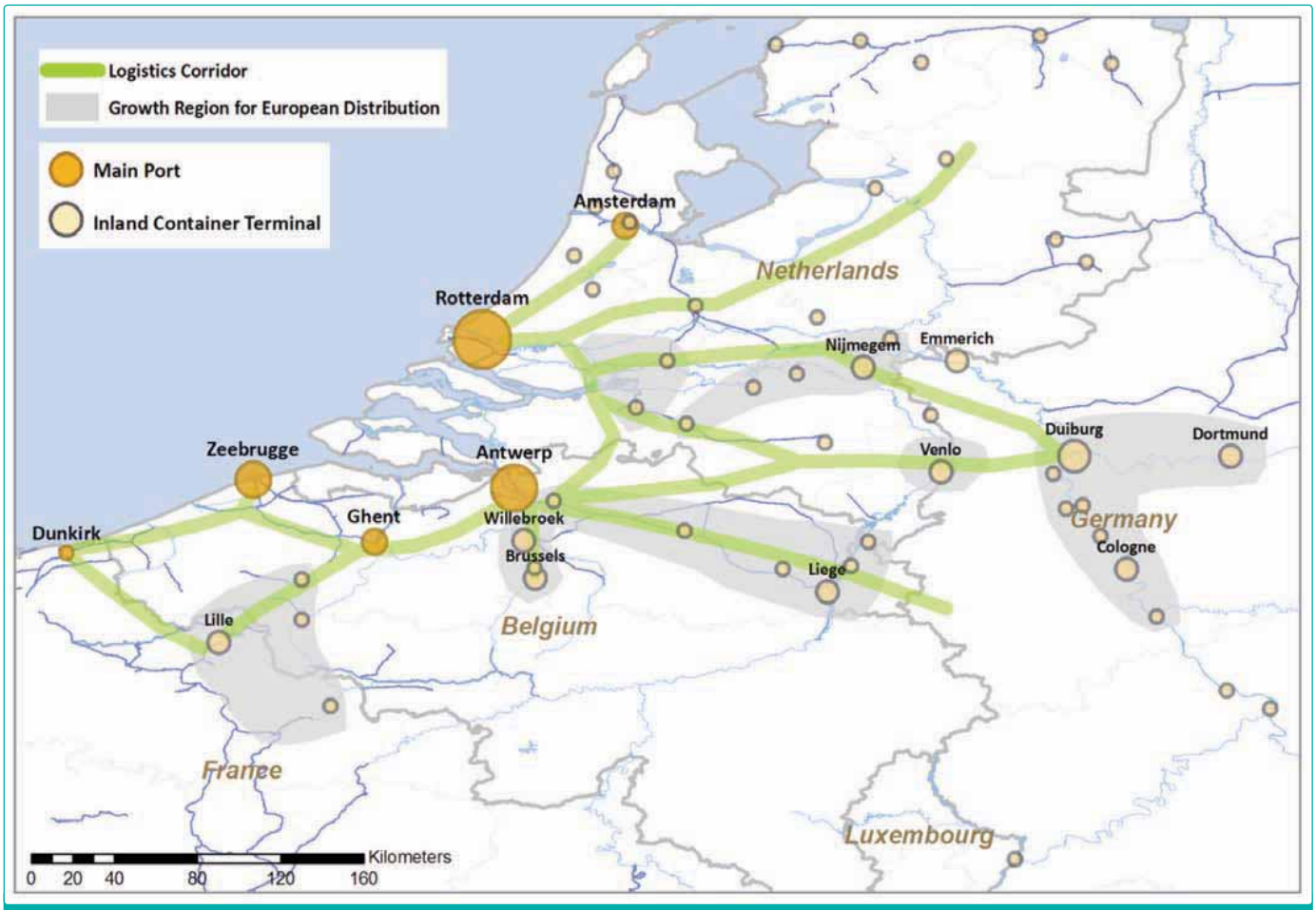

Figure 2. Dry ports and Logistics Zones around the Rhine-Scheldt delta.

northern France. Antwerp and Rotterdam together handled nearly 5 million TEU of inland barge traffic in 2010 or about 95% of total European container transport by barge. Promising barging developments are also found on the Seine between Le Havre and the Paris region, in the Rhône/Seine basin between Marseille, Lyon and Dijon, on the Elbe and the Wester in Northern Germany and on the Danube river out of the port of Constantza. Fluviomar recently started barge services on the Po River connecting the Port of Venice with Mantua and Cremona, near Milan.

North America: dry ports and long distance trade corridors

There have been dry ports in North America since the development of the continental railway system in the late 19th century. Their setting was a natural process where dry ports corresponded to metropolitan areas commanding a regional manufacturing and resource base. Although exports were significant, particularly for agricultural goods, this system of dry ports was mostly for domestic freight distribution. With globalization and intermodalism two main categories of dry ports have emerged in North America. The first is related to ocean trade where dry ports are an extension of a maritime terminal located in one of the three major ranges (Atlantic, Gulf and Pacific) either as satellite terminals and more commonly as inland load centers (e.g. Chicago). The second category concerns inland terminals mainly connected to NAFTA trade that can act as custom pre-clearance centers. Kansas City can be considered the most advanced inland port initiative in North America as it combines intermodal rail facilities from four different rail operators, foreign trade zones and logistics parks at various locations through the metropolitan area. Like Chicago, the city can essentially be perceived as a terminal.

Several recent logistic zones projects in North America are capitalizing from this advantage, where the planning and setting of a new intermodal rail terminal is done concomitantly with a logistics zone project (Figure 3). This partnership fundamentally acts as a filter for the commercial potential of the project as both actors must make the decision to go ahead with their respective capital investment in terminal facilities and commercial real estate. Compared to Europe, North American dry ports tend to be larger, but covering a much more substantial market area.

Asia: dry ports as satellite terminals or load centers?

For Asia, coastal population concentrations and export-oriented development strategies have not been prone to the setting of dry ports. Several container depots have appeared inland as a way to improve the availability of export containers within manufacturing clusters (e.g. South Korea, Thailand, India), but containers are mainly carried by truck.

In China there is the potential for a network of dry ports to emerge. Strong dry port development is taking place on the Yangtze river all the way up to the upper stretches near Chongqing, some 2400km upstream from Shanghai. Intermodal rail development faces the strong focus of the existing rail network on passengers and dry bulk commodities. As the Chinese economy moves towards a more extensive internal market, intermodal rail and barge traffic will increase.

Eventually, another system of dry ports is likely to emerge in Southeast Asia, particularly along the Mekong. In light of the North American and European experiences, the question remains of how Pacific Asia can develop its own dry port strategy. The unique geographical characteristics of the region are likely

Figure 3. Main trade corridors, dry ports and selected co-located logistic zones in North America.

to rely much on the satellite terminal concept and inland load centers in relative proximity. In this context, the European example is more suitable. However, the setting of long distance intermodal rail corridors within China and through Central Asia is prone to support the development to the inland load center system common in North America.

The development of dry ports around the world has clearly underlined an emerging functional relation of port terminals and their hinterland. Based upon their regional setting, dry ports assume a variety of functions with co-location with logistical zones a dominant development paradigm. While the interest in dry ports has increased we have to be aware that no two dry ports are the same. Each dry port is confronted with a local/regional economic, geographical and regulatory setting which not only define the functions taken up by the dry port, but its relations vis-à-vis seaports. Best practices can only be applied successfully if one takes into account the relative uniqueness of each dry port setting.

ABOUT THE AUTHORS

Dr. Jean-Paul Rodrigue is a professor at Hofstra University, New York. His research interests mainly cover the fields of economic and transport geography as they relate to global freight distribution. Area interests involve North America and East and Southeast Asia, particularly China. Specific topics over which he has published extensively about cover maritime transport systems and logistics, global supply chains and production networks, gateways and transport corridors, international trade and regional development.

Prof. Dr. 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 also President of International Association of Maritime Economists (IAME) and Chairman of the Board of Directors of Belgian Institute of Transport Organizers (BITO), an institute of the Belgian Federal Government.

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PORT PLANNING, DESIGN AND CONSTRUCTION

FEATURING FINANCE

"Port planning and optimization studies recommended that development of a new outer harbor, with nine new container berths suited to the largest container ships, would be the optimum solution."

'Meeting the challenge: expansion of the Port of Colombo', page 30.

Effective simulator training comes from a high degree of practical training transfer

Having the right technology isn't everything – the key to successful simulator training is all about putting the know-how into action

Cathrine M. Steenberg, Head of Simulation and Information Technologies Department & **Peter K. Sørensen**, Head of Training, Ports & Human Factors Department, FORCE Technology, Lyngby, Denmark

As ship sizes increase and ships become more and more complex, the people involved in shipping have to develop their skills. FORCE Technology has more than 25 years of experience in providing advanced maritime training to the shipping industry, and their wide range of training courses targets experienced navigators and pilots as well as freshly graduated junior officers.

The effect of simulator training depends on the pedagogical methods, the accuracy of the ship models and the simulator set-up. The software used in the simulators is, of course, very important as it sets the level of realism experienced in the training exercises. FORCE Technology uses the in-house developed software SimFlex which is based on the most accurate mathematical model – the DEN-Mark1 model – within maritime simulation. Peter K. Sørensen, Head of the Training, Ports & Human Factors Department explains: "In the last 50 years, we have tested more or less every ship type and design in our towing tanks and wind tunnels. The data collected and accumulated from these tests is the backbone of our mathematical models. This means that the training performed in our simulators is very life-like when it comes to maneuvering of the ships under all kinds of weather conditions. This is very important in relation to achieving as high a degree of practical training transfer as possible."

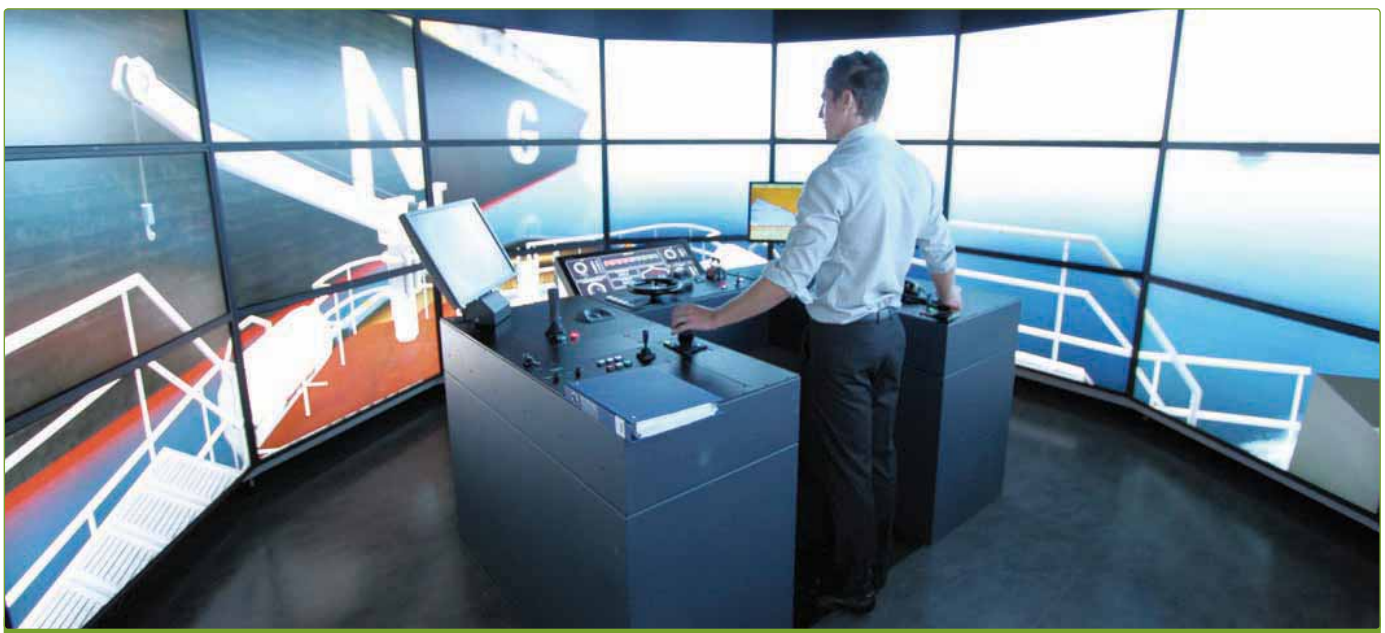
The value of simulator training can be measured from the degree of training transfer the participants experience. However, the degree of training transfer is not just about making the training as realistic as possible. At FORCE Technology, the degree of training transfer is boosted through a continuously refined approach based on pedagogical learning principles and structured debriefing sessions.

Together with the simulator instructors' competences, the pedagogical approach is the most important non-technical factor in achieving a high degree of training transfer. At FORCE Technology, they have been engaged in development of simulator-based training methods for many years, and their methods are now internationally recognized and used in other domains using simulators, for example air traffic controllers and power station operators. The pedagogical methods are primarily based on participant logical methods and discovery learning. All aspects of the course planning, scenario development and debriefing sessions follow structured and carefully planned methods.

The world-leading towing and salvage company Svitzer has been using FORCE Technology's training facilities for years, and today Svitzer owns five portable simulators manufactured at FORCE Technology. Christer Green, Marine Manager, Svitzer Scandinavia, told the Swedish *Shipping Gazette*: "Since we started sending our mariners on simulator training, we have shortened the training program by six months."

Rotor tugs

Beside the pedagogical principles used in training and debriefing, an important part of FORCE Technology's success within maritime training is to be found in their in-house access to advanced test facilities, including towing tanks and wind tunnels, as well as professional mariners, psychologists and naval architects.



By using advanced tug simulation tools, the overall training and familiarization program can be shortened by six months.

The SimFlex Navigator full mission ship simulator bridge.

Therefore, the hydrodynamic mathematical ship models used in the training exercises are continuously updated and refined. This is a key requirement when delivering advanced and value-adding maritime training.

At present, FORCE Technology has more than 500 vessels in their database which, combined with the flexible SimFlex software, can be used to simulate any type of vessel in any environment and integrate different types of maneuvering controls and instrumentation. Add to this the possibility of coupling several simulators, thereby including for example pilots, captains and tug masters into the same simulation, and you will drastically increase the amount of feedback and knowledge gained from the training exercises.

One of the latest additions to FORCE Technology's vessel database is a generic Rotor tug model. The hydrodynamic properties of the model are based on model tests for similar models performed in the FORCE Technology deep-water towing tank and data provided by KST B.V. The in-house developed Rotor tug complements the already existing models comprising conventional tugs, ASD tugs and Voith Schneider tugs. In all, FORCE Technology holds more than 30 tug types. This is a competitive advantage in today's market where more and more customers wish to compare different specific tug types and sizes before choosing the most efficient in relation to their operation.

IALA leads the way

In 2007, IALA issued Guideline 1058, 'Use of Simulation as a Tool for Waterway Design and AtoN (Aids to Navigation) Planning'. This guideline provides a high-level overview of the various simulation tools and how to use them. In addition, there is an outline of demands to the simulation providers, the models, the participating staff and how a simulation study should be analyzed and documented. FORCE Technology has together with the Swedish Maritime Authorities and other parties been instrumental in the development of this guideline.

The guideline has just been updated, and after approval by the IALA Council expected in June 2011, Edition 2 will be available. The new edition places an increased emphasis on, amongst others, the use of tugs in simulation, as it is recognized that waterway studies must take into consideration the maneuvering space required by tugs for berthing and for the increased use of escort tugs.

As a provider of top-class simulator training, FORCE Technology is, of course, monitoring and adjusting its training methods to comply with the latest technical and pedagogical developments as well as guidelines and regulations, thereby ensuring the highest degree of training transfer.

The pedagogical approach and the instructor's skills are the most important non-technical factors in achieving a high degree of training transfer.

ABOUT THE COMPANY

FORCE Technology is a leading technology, consulting and service company in the international market. At our Division for Maritime Industry, we offer our customers extensive services and expertise within aerodynamic and hydrodynamic model testing, numerical fluid mechanics, computer-based simulations, and specialized training. We conduct training for a number of different clients worldwide. Our pedagogical tools and simulation facilities are recognized as being among the best and most advanced in the world.

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Meeting the challenge: expansion of the Port of Colombo

The Port was almost at full capacity, so a huge expansion project was begun

Martin Mannion, **Peter Neville-Jones** & **Martin Young**, URS/Scott Wilson, Basingstoke, United Kingdom; & **Susantha Abeysiriwardena**, Sri Lanka Ports Authority, Colombo, Sri Lanka

Introduction

In 2000, the existing Port of Colombo, Sri Lanka, was expected to reach full capacity within 10 to 20 years, due to high levels of growth. This limit was recognized by the Government of Sri Lanka through Sri Lanka Port Authority (SLPA). They therefore appointed URS/Scott Wilson to prepare market forecasts for the port facilities, review existing operations to improve efficiency wherever possible, and to recommend a forward implementation program for improvement of existing facilities as well as any port expansion required.

Market study

The market study concluded that

- Colombo enjoys a strategic position close to East/West trade routes; adjacent to the Indian Sub-Continent. This pivotal location is ideally suited to serve transshipment traffic.
- 75% of the total throughput is transshipment
- The economies of the region are set to rapidly expand.
- Domestic imports/exports would increase from 0.55 million TEU in 2002 to 2.3 million TEU in 2020, and 4.3 million TEU in 2030.
- Total throughput would rise from 1.8 million TEU in 2002 to 6.5 million TEU by 2020, and 19 million TEU by 2030
- The existing port will reach capacity by 2010 (without efficiency improvement)
- Expansion would be needed for transshipment traffic and to retain hub status

Port planning and optimization

Port planning and optimization studies recommended that development of a new outer harbor (the South Harbor Development), with nine new container berths suited to the largest container ships, would be the optimum solution. This would involve a protective breakwater and reclamation to enclose a nine-berth terminal, in three phases of three berths each.

Separate optimization measures within the existing port facilities increased port capacity by some 50%, which indicated that port capacity would potentially be reached in 2015. These measures included modifications to quay lengths; crane heights/reaches, yard layout and equipment, removal of non-essential operations to the hinterland, new inland road access for trucks to new inland container depots, advice on changes to port legislation, and so on.

It was agreed that the port expansion would ideally progress with Sri Lanka Port Authority as Landlord. An Asian Development Bank (ADB) loan (US$300 million) would partly fund harbor infrastructure works (approximate cost: US$400 million), with South Container Terminal first on a Build Own Transfer (BOT) basis 35-year concession from the effective date. This follows the public-private partnership initiative business model employed successfully for the South Asia Gateway Terminal at the Port of Colombo. The operator will pay for quay, yard, equipment and topside infrastructure, and payment would be by means of annual lease and TEU royalty, while SLPA revenue would cover the ADB loan and interest. The overall project cost was estimated as US$1.6 billion.

Existing port facilities

The existing port facilities are as follows:

Jaya Container Terminal
- 4 berths along 1,290m; 12-15m depth
- Cross feeder berth
- 14 gantry cranes
- 9,800 slots; RTG operation + 4 RMGs

Unity Container Terminal
- 2 berths along 340m; 9-11m depth
- 3 gantry cranes
- 1,020 slots; RTG operation

South Asia Gateway Terminal
- 3 berths along 940m; 15m depth
- 10 gantry cranes
- 5,430 slots; RTG operation

Construction of the major US$330 million harbor infrastructure works is due to be completed in 2012 by contractor Hyundai.

Design of the port expansion

In 2003, URS/Scott Wilson was appointed as Consultant to the Sri Lanka Ports Authority to prepare designs for the development of the outer Colombo South Harbor, under joint funding from the Asian Development Bank and the Government of Sri Lanka.

Detailed fieldwork (geotechnical, metocean, environmental) followed, as well as port planning, coastal numerical modeling (wave transformation; harbor disturbance/downtime, harbor resonance, hydrodynamic, sediment, ship motion, ship maneuvering, water quality) and other planning studies were conducted, with physical modeling for final optimization and verification. An extensive environmental impact assessment was carried out, considering appropriate environmental mitigation and management measures.

The overall Colombo South Harbor development project comprises over 6km of breakwater (main breakwater 5km; secondary breakwater 1km long, enclosing a small boat harbor), and dredging of a new two-way approach channel to -20m to enclose and protect a harbor basin area of 285ha. This is sufficient for the development of three full container terminals (total capacity 7.2 million TEU), each with a quay length of 1200m and a land area of 62ha, designed for vessels up to 400m length. Dredged material would be re-used for reclamation. This will bring the total to five container terminals in the Port of Colombo, with a capacity of some 14 million TEU per annum. The Colombo South Harbor project will more than double the size of the Port of Colombo.

Project implementation

Construction of the major US$330 million harbor infrastructure works commenced in April 2008 and is due to be completed in 2012 by contractor Hyundai, using a conventional FIDIC contract. The concession for the first container terminal (South Container Terminal) will be awarded to a joint venture including China Merchant Holdings and Aitken Spence, and is due to be operational in 2013. The program allows for the handover of the SCT area to the operator after 23 months, when 2km of the breakwater will have been completed.

New approach channel

The existing entrance to the Port of Colombo is relatively narrow, and requires a sharp last minute turn, and is poorly sheltered during the SW monsoon. There is a second North entrance, which recently opened for smaller vessel traffic since the cessation of hostilities with the LTTE. Vessel moves through these entrances are increasing in number, as are main line vessel calls.

The new approach channel is 570m wide and designed for two-way traffic into the outer CSH harbor basin, for a design vessel overall 400m in length, with beam 55m, and draft 16m. As the outer approach is exposed to the SW monsoon, an under-keel clearance of 1.25m is used, giving a declared depth of 20m for the outer channel.

The CSH harbor entrance faces north so as to give shelter to vessels approaching the breakwaters in monsoon storm conditions. From the -20m contour, the approach channel alignment is to the southeast, bringing vessels to an easy bend to the CSH entrance. This southeast alignment is chosen so as to avoid an extended or hard bend, and also to provide clearance for vessels between the two SPBM moorings within Port of Colombo limits for crude oil and oil product deliveries to Sri Lanka.

In the detailed design of the channel, particular attention had to be given to several aspects to ensure both the continuation of service to the Port during construction of the CSH, and to

The 6km-long breakwater was constructed using an under-layer of dredged sand and Core-Loc™ single-layer concrete armor units.

provide a simple and effective navigation layout in the final scheme. These included:

- Detailed layout of bend, channel buoys, lead lights, and the three-way channel intersection.
- Relocation of the 10km-long crude oil pipeline from the SPBM, which was too shallow to be retained.
- Sequencing of dredging and temporary diversion of the existing navigation.

Main breakwater design

The harbor infrastructure development is constructed seaward of the existing breakwaters into deep water (-18m). The harbor layout is optimized to balance the use of the 15 million m^3 of sand arising from dredging the new two-way approach channel to -20m, with the initial reclamation required for the port access roads, common user areas, and breakwater construction.

Supply of rock armor in large volumes is not an easy task in Sri Lanka, due to the strict environmental controls on quarry operations, and the allocation of suitable haul routes. To mitigate this issue, the two fundamental choices were made for the design of the main breakwater:

- Use of dredged sand in the breakwater core was maximized.
- Use of Core-Loc™ single-layer concrete armor units for the primary armor.

The breakwater structure is designed for a 200-year return period storm (Hs 7.7m, Tp 14s); both for the structural stability of the Core-Loc primary armor, and for the required wave wall crest elevation to control wave overtopping. Hydraulic model testing (2D Flume) confirmed 8.5m^3 Core-Loc units are required for the primary armor, and a +14m crest elevation along the wave wall. The Core-Loc armor extends down to the toe of the main breakwater revetment, and a 4H:3V slope is used to limit the number of Core-Loc rows to 18 in the revetment. Rock armor reinforcement is provided at the toe of the Core-Loc slope on top of the toe scour apron.

Construction – main breakwater revetment

The entire site area was sea, and therefore the first priority was to create sufficient reclamation in order to start Core-Loc production. The overall requirement is some 30,000 units over the four-year construction period, requiring a daily production rate of 62 units and storage area for some 8,000 units.

The required rate of placing Core-Loc is similarly high throughout the construction period. Also visibility during placing is limited, due to the ongoing reclamation works and

UCT terminal improvements within the existing port.


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Courtesy: Google Maps.

An overview of the port expansion.

the sea conditions, which can become unworkable during the SW monsoon period when wave overtopping is hazardous. The contractor has therefore opted to use leading-edge solutions to overcome the associated problems of safety, quality and productivity, irrespective of visibility levels.

In order to comply with the precise requirements imposed by single-layer block techniques, the contractor is using two Posibloc™ systems to place the Core-Loc blocks on the prepared rock armor under-layer.

Summary

The Port of Colombo expansion project is now well under way, and an operator has been appointed for the first terminal (SCT). The market study has proven remarkably accurate and, thanks to the project, the Port of Colombo now appears well placed to take advantage of its strategic location. The project is expected to create 3,870 permanent jobs and trigger far wider economic growth.

ABOUT THE AUTHORS

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Improving business performance while managing challenges

Part 1: How Port Architecture can make a difference

Martin Sharp, Business Development Manager, BMT Hi-Q Sigma Ltd., London, UK

The business context:

Ports and terminals are complex businesses and a key link within the overall logistics supply chain. However, some might argue that they are indeed the weakest and least transparent link in the chain. Examples of these complexities include:

- Operating in different ways, for example Gateways, Transhipment, Free Trade Zones, to name a few
- The structure of ports in terms of land, terminal infrastructure, terminal superstructure, quayside operations, landside operations and the ownership of these, which vary considerably
- The volumes of cargo expected to be handled by a port are ever increasing, and the need for flexibility is creating a new set of challenges
- Ports will soon need to consider the berthing of nuclear-powered vessels, and when this is combined with unrest and terrorism around the world security quickly becomes an added pressure
- Technology – be it automated handling systems, port community systems, planning systems, security systems and so on – and the need to ensure the safety of workers in a dangerous environment
- A growing need to reduce the adverse effects on the environment.

It is clear from this list that running a port is growing in complexity and with no sign of this easing, certainly not in the near future, the question is how do we improve business performance whilst dealing with continuing pressures?

Business planning

Into this complex environment we have to add the customers. Professor Robert Cochrane recently spoke at the FACT 2011 Seminar in London and suggested that "The Terminal Manager's objective is: to satisfy the shareholders by making a profit through providing terminal facilities which attract and serve customers including shipping lines and agents, hauliers, financiers and insurance companies – the most important of which are the shipping lines."

Ports present complex challenges when it comes to improving efficiency while keeping costs down.

Ports exist to move cargo and passengers between sea and land (not forgetting dry ports and transhipment hubs) as quickly as possible; therefore the amount of cargo that customers wish to move through a port is critical to the success of the businesses involved in a port. BMT is frequently asked to provide terminal operators, port owners, financial investors and others with traffic forecasts that provide vital input into business plans looking forward for the next 10 to 30 years. Our multi-faceted approach to port traffic forecasting incorporates a wide variety of variables that directly relate to the port sector, and recognize the importance of relationships between:

- Cargo volumes and developments in both sectors of the economy and industry, as well as with the economies of partner countries.
- Past and future interactions and how these have, or are likely to, shift over time as economic relationships change; whether on a temporary or permanent basis. This is achieved through econometric and other statistical analysis, as well as market research to ascertain structural changes in the industries that import and export.

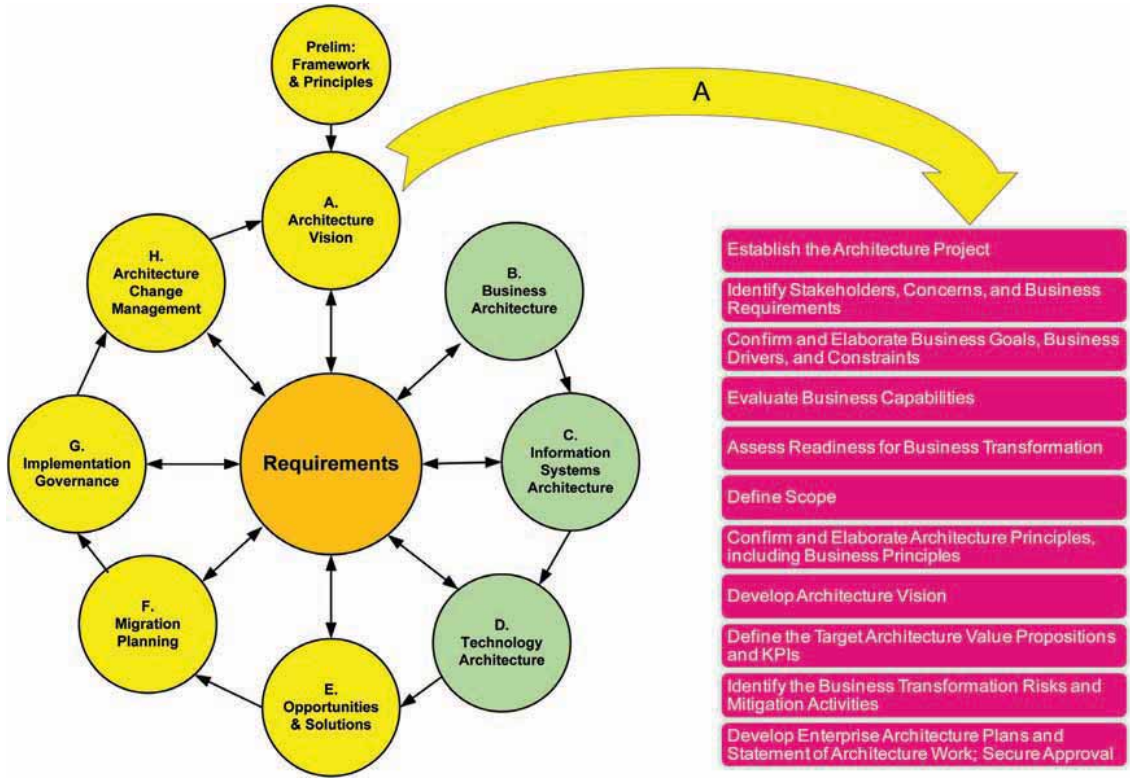
In addition, and most importantly, the impact of changes in the infrastructure, technology and the commercial state of the transport sector are factored in by a process of specialized desk and field research. What everybody is trying to achieve is the highest level of confidence in the volume of goods, passengers and so on through a port, and therefore have a better understanding of the potential for ongoing business in a changing environment. With this ever-changing market, how can we keep on improving the business performance?

Investment in technology

Technology adds another dimension to the problem of improving business performance. At the recent conference on Automation organized by PORTeC in London, speakers acknowledged the importance of automation and its supporting technology, but suggested that there are only minor improvements that are left to be made. The infrastructure for an automated yard requires a high investment and is fixed for its economic life of 20 to 30 years. Some ports have decided that they have gone far enough with automation, and rely upon highly skilled and motivated operators to achieve the efficiencies they require.

Security is another area where significant investments in technology are being planned and implemented. Those ports with deep pockets can install the very latest scanners, set up advanced security centers with hundreds of cameras and detectors, but it is important that it looks at what it actually needs and answer pertinent questions such as how are ports assessing the risks, and what are the financial implications of implementing controls aimed at reducing those risks?

The EU SUPPORT (Security Upgrades for Ports) project, managed by BMT, is developing a financial model to assist in this



Arrow diagram of the Open Group Architectural Framework (TOGAF), upon which Port Architecture is based.

area. What must be avoided is the temptation to solve problems by 'throwing IT' at them without a clear assessment of the cost effectiveness of the proposed systems.

The same applies to Terminal Operating Systems and other IT systems, such as those used for invoicing, planning, payroll and so on. Port Community Systems have been around for many years and are designed to provide the right information to the right people at the right time and therefore reduce costs, but they are a capital outlay and carry an ongoing operational cost – so it is important the right system is chosen.

Being able to integrate with existing and planned systems is vital, as well as fully understanding the benefits of implementing such a system. Technology is critical, but there is an increasing need to ensure the investment delivers the promised benefits from the many vendors of such systems. How do you determine which systems to invest in, and when the system will deliver the promised improved business performance?

Performance

It is appropriate to discuss how we measure performance before answering the question about how to improve performance.

The word on the ports conference circuit in 2011 has been 'Performance' – not just the performance of part of a port, but performance across the whole supply chain. Ports are publishing various Key Performance Indicators (KPIs) as a marketing aid to attract more business. The Container Terminal Quality Indicator standard (CTQI) offers a benchmarking system to adjudicate the efficiency and quality of Global Port Terminal Operators, combining financial, operational and organizational indicators, and the Hamburg Committee of the Global Institute of Logistics decided to distribute the IPR of CTQI recently [1]. Whilst some of the measures are internal and business-related, there are limited measures that can be used to assess the profitability of a port as a whole. The CTQI measures are designed for container terminals, but this isn't the only type of terminal. How do we measure the performance of dry bulk, LNG, general cargo, RoPax or cruise terminals? The fact that a port or terminal is an integral link in the overall chain means that any measures must relate to and take into account the whole end-to-end supply chain.

Problem summary

A port, therefore, is clearly a complex business operating as a key link in an international supply chain. There is increasing pressure to improve profitability, whilst delivering improved services at lower costs in a secure environment with due consideration to sustainability and safety.

It must also be duly noted that nobody would ever consider committing the necessary millions in construction and fitting-out costs without a very detailed design. Therefore, a significant amount of thought and planning goes into the design of the physical aspects of a port such as channel depth, quay length, cargo handling, customs facilities, transport with many expert consultants providing the necessary support. Michael Richter from Moffatt & Nichol recently suggested that the traditional bottom-up development process – Infrastructure, Equipment, Logistics, Operations, and then Business case – must be reversed if we want to improve business performance. He also suggested that we must now design for change and continual improvement.

But, how do you design the business itself?

How do you design the business in such a way that the current and future changes in both volume and type of cargo is taken into account?

How do you design the organizational structure and the processes in order to operate the business and achieve the stated returns on the investments?

How do you ensure you specify the appropriate IT systems to support the business?

The approach we at BMT have termed 'Port Architecture' will enable the Port Operator to design the most effective business, whilst taking into account the complexities outlined above.

'Port Architecture'– what is it?

The first thing to state is that Port Architecture should not be seen as the silver bullet to solving all your issues; it is an aid to

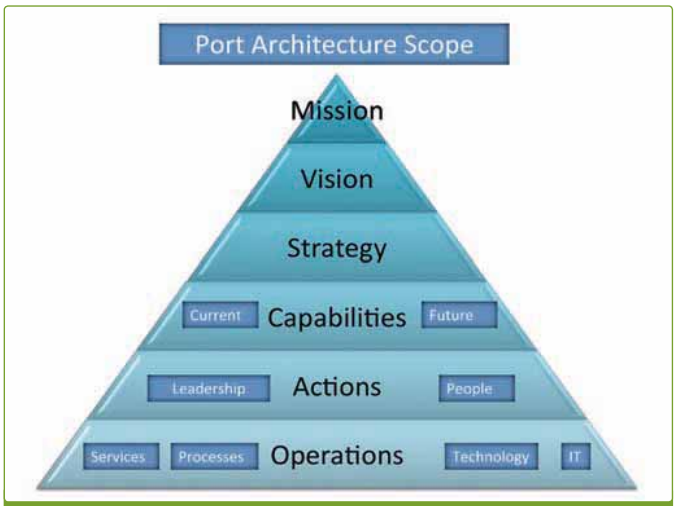


Diagram of the scope of Port Architecture.

help you understand the complex environment and enable you to make better and more informed decisions. It will enable you to have greater confidence in the investment decisions you make both now and in the future, and provide you with the means to continually assess what to do as the market evolves.

Port Architecture is new to ports, but it is based upon many years of experience in other industries including manufacturing; pharmaceuticals, financial services, defense, aerospace, rail and government. Port Architecture is Enterprise Architecture for Ports. It is firmly based upon industry standards, including IEEE Standard 1471-2000, TOGAF (The Open Group Architectural Framework), MoDAF (Ministry of Defense Architectural Framework) and elements of the Zachman Framework.

Port Architecture can be defined as a coherent number of principles, methods, and models that are used in the design and realization of a port's strategic objectives, organizational structure, business processes, information systems and infrastructure. If a port has a Port Architecture it is able to better understand its business, and how the people, processes and technology need to be balanced to deliver the business objectives and satisfy the end customer's demands. With the help of a Port Architecture, a port is able to ask strategic questions to help it determine what changes it should make, and the investments needed to meet the current and projected market requirements. Also, the Port Architecture would enable a port to quickly understand the tactical, in-depth implications of a chosen strategy route, enabling it to take better calculated risks through a fuller understanding of the impact of specific objectives.

Part 2 of this paper will describe how to implement Port Architecture and provide examples of the benefits it brings, and will be published in the next edition of 'Port Technology International'.

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ABOUT THE AUTHOR

Martin Sharp has spent over 20 years working across a broad range of industry sectors delivering business improvements through the implementation of Enterprise Architecture. He is a Naval Architect and Chartered Engineer and combines his marine expertise with that of Enterprise Architecture to deliver this capability in the ports sector. He is proud to be part of the BMT Group of companies and to be regarded as the world's first Port Architect.

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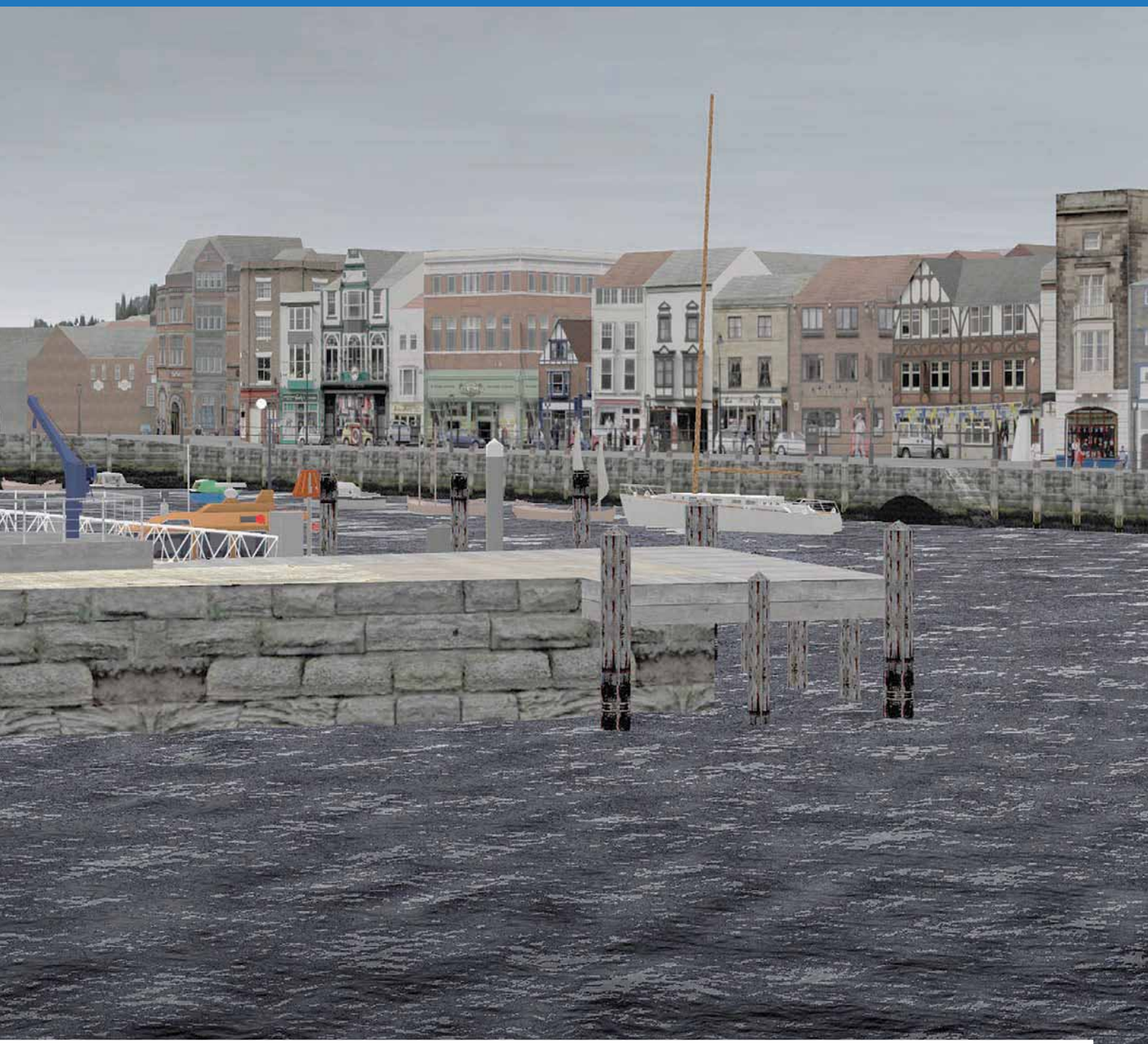

"The software enables every vital detail to be modeled, which means that the exercise carried out on the simulator can take place in incredibly lifelike surroundings."

'Planning tomorrow's navigation today with virtual port development tools', page 40.

Planning tomorrow's navigation today with virtual port development tools

High-fidelity port models for simulator training can be used not only to train pilots, but to safely plan potentially problematic maneuvers

Captain Ian Rodrigues & **Capt. John Lloyd**, AMC, Australia; **Paul Hodgson** & **Chris Thompson**, South Tyneside College, UK; and **Geir Lilje**, Kongsberg Maritime, Norway

On 22nd February 2011, both the *Queen Mary 2* and the *Queen Elizabeth* were due to sail into Sydney Harbor. With two of the world's most famous cruise liners in the same place, the sponsors of the visit seized the media opportunity and thrust the event into the limelight, putting a considerable amount of extra pressure on the pilots who would take part in the operation.

The ships were to come in with a five minute separation. The *Queen Mary 2* was to transit north of Fort Denison, turn around and hold, whilst the *Queen Elizabeth* was also to transit north of Fort Denison and hold. At this point the media coverage was to take place, before the two ships made their way to berth. Such an operation, under even higher levels of scrutiny than normal, required detailed planning, so in the same way that pilots around the world do, the Sydney Harbor pilots used simulation in order to ensure that each and every eventuality was covered.

They flew out to the Australian Maritime College (AMC) in Launceston, Tasmania in order to run the exercise on its extensive simulation facility, which is used to train over 200 students every year. AMC had previously developed a highly detailed area model of Sydney Harbor and could also offer a model of the *Queen Mary 2*. Unfortunately, the faculty had no past requirement to develop a model of the *Queen Elizabeth*, but they were able to offer the pilots a model of *Celebrity Constellation*, which is a virtual clone, and worked just as well for the purposes of the mission planning.

The Australian Maritime College's model of the Queen Mary 2 and Queen Elizabeth cruise ships, which enabled their safe navigation into Sydney Harbor.

So, with the tools in hand, the team of pilots was able to run every aspect of the mission in the safety of the two simulator bridges at AMC. Each bridge acted as its real-life counterpart, enabling the pilots to run and re-run the mission at will. All perceivable risks were simulated, and plans to manage them were drawn up. The simulator offered the realism required to put the pilots in the hot seat as if they were at the helm. All details were considered, even down to simulating the exact tides and related dynamic currents that were predicted for the day.

The realistic-looking Whitby Harbor, as modeled by the Polaris simulator at South Tyneside College.

The ship's bridge simulator at South Tyneside College.

When it came to the live mission, the Sydney Harbor Pilots did a sterling job. On the day, there were no surprises, all went to plan, exactly as it was worked out on the simulator and the city got its flagship media event as two classic ships arrived in port within minutes of each other, without any incident. This, of course, is down to the skills and experience of the pilots and their support team; however, had they not spent hours in AMC's simulator planning for the mission, it could well have been a different story.

Port models

The Sydney Harbor Pilots' use of the ship's bridge simulator at AMC highlights just how far maritime simulation has come over the last few years. Systems such as Kongsberg Maritime's Polaris ship's bridge simulator now offer unprecedented levels of realism and detail that enable pilots the world over to conduct ship feasibility studies in order to train for specific jobs. At the same time, the AMC's simulator facility and hundreds like it all over the world use Polaris as the foundation of extensive maritime crew and pilot training programs. This invariably means the use of detailed port models as exercise areas. Kongsberg Maritime includes the facility within its simulators for users to develop their own models and indeed the skills necessary to do so.

The UK's South Tyneside College also runs an extensive simulator suite based on Kongsberg Maritime's Polaris and, like AMC, has pilots in to use the simulator at least once a month. South Tyneside College has over the years developed skills in database development and ship modeling and has created a large number of port exercise areas for various UK ports including Tees; Tyne, Wear, Blyth, Humber, Firth of Forth, Tay, Orkney; and abroad, TangierMED, Jebel Ali and Tanjung Bara amongst others.

South Tyneside College's port models are used by pilots to train for emergency and 'abnormal' situations on its simulators and some Port Authorities use the area to train more junior pilots. Additionally, port areas are used to trial proposals for new jetties and berths, often in association with the civil engineering company who are contracted to develop and build the structure. Some port areas are used by shipping companies to study ship handling, often together with the ship model South Tyneside College has developed for them. South Tyneside College simulators have also been used for feasibility studies like that carried out by the Sydney pilots at AMC's facility, for missions including towing of aircraft carrier blocks into Rosyth harbor, and testing the Tor Class in the new harbor development at Outer Harbor Immingham.

South Tyneside College develops its port models generally on request of a Port Authority, shipping company or pilotage body with the intention of developing an area that will be then used for training on the simulators. Occasionally the area will only be subsequently used for a development or research study; for example, the modeling of the new Forth road bridge and study of the various navigational light options that the bridge would be fitted with.

To model a port using Kongsberg Maritime's modeling software for Polaris, South Tyneside College starts with a specific list of information from the port, usually from the port survey department. Information would include AutoCAD drawings of port structures; any paper drawings they have, soundings data, tidal data, light lists, photography, and any other data that the development project requires. Further data, such as 3D landform and contour datasets are also used, and STC would normally travel to the port to take detailed GPS-linked video and photography. This is the same methodology followed by AMC and indeed other training institutes globally.

The various data sets and information are imported into 3D drawing applications (Multigen Creator). The landform is generated and the drawings superimposed; this then allows the exact positioning of structures. 3D models are developed of specific structures, such as buildings, cranes, jetties, and so on and these are added to the port model. To provide enhanced realism each building and structure is 'photo-textured'.

Apart from the visual development each port area requires a depth file to enable the echo sounders on each bridge to provide realistic depth profiles; this is generated by importing a specific xyz data file derived from the sounding data held by the port. A radar file is also generated, based upon the 3D landform data, to enable the radar's displays on each bridge to provide realistic radar returns.

Essentially, the software enables every vital detail to be modeled, which means that the exercise carried out on the Polaris simulator can take place in incredibly lifelike surroundings. Modeling a port area is a significant project, with organizations like AMC and South Tyneside College developing their skills over many years. But the combination of powerful Kongsberg Maritime software and a user's expertise ensures that pilots and crew can train in 'real' environments, which is important as the development of port models is integral to high quality training and mission planning. Such realism and fidelity has made the management of risks in pilotage far more effective than has ever before been realized.

Most customers requiring simulation training for crew are rightly interested in ship handling competency so vast, bland seascapes are not the typical simulator exercise area. Ports and harbors are the main playground for student crew or for pilots using simulators. By modeling these areas as realistically as possible, the Polaris simulator enables training institutes to make close-quarters navigation and maneuvers as safe and efficient as possible. And that goes for bringing two of the world's most recognizable cruise ships into perhaps the world's most famous harbor under intense media spotlight, as well as the thousands of pilot sorties happening across the world every day.

ABOUT THE COMPANY AND COLLEGES

Kongsberg Maritime is recognized as a world leading maritime simulator developer. The company has introduced countless innovations into the world of simulation, helping to improve crew and pilot training over the course of decades.

The Australian Maritime College and **STC** are both Kongsberg Maritime simulator users and both have extensive simulator facilities based on the Polaris ship's bridge simulator. Both colleges have well established and extensive skills in port area and ship modeling for the Polaris simulator, and have broad experience in their use for pilot training and mission planning.

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Kongsberg Maritime
Web: www.km.kongsberg.com

VTMIS & AIDS to NAVIGATION

"One group of seafarers has been somewhat forgotten by the ECDIS revolution. Pilots play an essential role in ensuring vessels complete final stages of their voyage without incident."

'Navigation in a digital age: ECDIS training for maritime pilots', page 49.

Safety factors within ports and harbors

How stakeholders can take steps to identify potential risks and mitigate against them

Mark Yong, Associate Director, & **Dr. Richard D Colwill**, Managing Director, BMT Asia Pacific, Hong Kong

While health and safety is driven mainly by legal and moral obligations, there is certainly a commercial element too. The major corporations involved in ports, harbors and shipping are very aware of the commercial fallout that will inevitably follow an accident or incident. In the ever more litigious society that we live in, planning and risk mitigation has taken on a whole new importance.

Contemporary port and harbor operations demonstrate a classic case of risk and reward. In order to reap the commercial benefits, ports are catering for a higher volume of shipping with far more vessel movements than a decade ago. The associated risk is that with increased traffic, often in a restricted environment, there is a far higher chance of a ship-to-ship or a ship-to-infrastructure collision. With economic factors driving the need for port operators to maximize revenues, it is necessary that ports optimize all available water space to the best of their ability. This often leads to delays to inbound vessels if berths are not immediately available. Ships waiting to berth need access to a suitable anchorage away from major transit routes and with protection from rough weather; however, this facility is not always provided, increasing the risk of accident or incident.

Safe vessel traffic

The issue of safe vessel movement often extends beyond the port's jurisdiction but must still be addressed. In areas such as the south-eastern approaches to Hong Kong, which provides the principal access to the Western Shenzhen port clusters and Hong Kong's container terminals, there has been a rapid increase in marine traffic. This has meant a rise in the occurrence of congestion as large numbers of ships try to enter and leave the multiple ports in the vicinity. Recent investment in passage planning 'expert systems' by Hong Kong illustrates one element of the response required to such challenges.

In parallel with the issues associated with vessel movements, external environment factors such as wind, waves and currents need to be taken into consideration. The Sunda Straits, between the Indonesian islands of Sumatra and Java, have a reputation for strong currents and heavy weather. Ships visiting the cluster of petrochemical facilities near Merak need to be ready to deal with these conditions, especially when in close proximity to port infrastructure or other vessels. Experience pilotage and harbor control is key to maintaining safety.

Challenges posed by new super-sized container ships

The new generation of 12,000-18,000 TEU container ships also adds extra complexity to the issues of vessel movement in existing ports. Vessels of this size are set to become the 'work horses' of key international trade routes. While channels can be dredged to accommodate the draft of this new class of vessel, there may be limiting operating windows with regards to wind speed and maneuvering in close proximity to other vessels or port infrastructure.

It has been suggested that more onerous operating procedures should be applied to these vessels because of the impact an accident or incident might have. It's conceivable that a damaged 18,000 TEU container ship could effectively close a port for a number of months if it was disabled in the main channel. Globally, there is only a small amount of marine plant capable of recovering the cargo from such a large vessel, and the same goes for recovering the vessel itself.

As it begins to handle more liquid DG, the Port of Tanjung Pelepas, Malaysia, will need to change operational protocols to ensure the correct separation between container ships and DG carriers.

Dangerous cargo

The risks in the port environment are further multiplied when dangerous cargos are introduced where a potential risk of fire, explosion and pollution must be considered and planned for.

While none of these issues are insurmountable, they do require careful consideration, planning and execution to ensure safe operation in and around the port. In order to ensure that there is a safe system of operation that will benefit all stakeholders, port authorities need to review all current operations under their jurisdiction and, where necessary, recognize plans for future expansion. With this information to hand it is possible to identify the major risks and mitigate accordingly. In general the following guidelines may be followed:

- Both the level of individual risk and societal concerns resulting from the activity must be taken into account when deciding whether a risk is unacceptable, tolerable or broadly acceptable
- The decision-making process should be inherently precautionary
- For every hazard there must be a suitable and sufficient risk assessment
- Suitable controls must be in place to address all significant hazards
- The controls, at a minimum, must achieve the standards of relevant good practice precautions, irrespective of specific risk estimates
- Where there is no relevant best practice (or the best practice is not good enough) the decision as to what control measures are suitable will be informed by risk assessment
- There are some risks that are not tolerable whatever the benefits.

Mitigating risks to vessel traffic posed by new developments

In ports where future developments create significant changes to the fairway structure or traffic mix, it is critical that stakeholders have the means to predict the nature, distribution and magnitude of future risks. One such approach is BMT's Marine Application of 'Massive'. Developed in partnership with Massive Software, BMT has used the software to study marine traffic in busy harbor areas, including sites in Hong Kong, China and Europe.

By running simulations using variation of the following factors it is possible to identify scenarios with raised risk profiles and mitigate accordingly:

- Geometry (draft, width & airdraft) of navigable channels
- Traffic Mix (size, speed, type of vessels & maneuverability)
- Metocean Environment (current, wind & wave)
- Control Regime (Traffic Separation, speed limits, VTS advisory)
- Operational Capability (Mariners familiarity and tolerance to vessel proximity).

One of the scenarios that 'Massive' can be used to assess is the transit of vessels carrying dangerous cargos such as LNG. The particular challenges of ensuring safe LNG carrier access creates a series of new issues within a complex environment that need to be examined by pilots, Vessel Traffic System (VTS) operators, adjacent port stakeholders and harbor authorities who are all crucial to the safe and efficient operation of port systems. Consequently, the ability to clearly and accurately identify and predict the behavior of traffic flows, as well as impacts and delays within the port is a key element in identifying and mitigating risk.

The human element

Realizing that 'ships don't travel around harbors, people travel around harbors in ships' it is key that human decision-making in response to the environment and perceived threats is well represented. Increasing mechanical reliability ensures that human factors are now the most significant elements of risk within these systems, yet these are frequently the most poorly replicated. Training a ship's crew is a vital part of delivering a safe system of work, especially when the issues of vessel size, limited maneuvering space and awkward environmental conditions are combined to increase the risk of accident or incident. Ship maneuvering simulators, such as BMT's 'Rembrandt', can be an invaluable, cost effective way of providing classroom based training that faithfully replicates specific ships and harbors.

Using VTS and Aids to Navigation to reduce risk

Within the port environment, vessel movement needs to be monitored and controlled with up-to-date vessel traffic systems (VTS) and other navigation systems. While traditionally port authorities have provided the drive to ensure that suitable VTS is in place, they are not necessarily best placed to fulfill this function due to lack of funds or other more political factors. It is now often the role of local or central government to provide the investment, especially when a successful port can have such a positive effect regionally or even nationally. However, there is still a need for checks and balances to ensure that adequate investment is secured to deploy suitable navigation and control systems in line with the volume of traffic.

Safe port planning

By proactively managing risk in the planning stages, a port developer can add value to the facility in the longer term. While it might appear easier designing a port complex from scratch, a rigorous planning process must be completed to ensure that the facility will be fit for purpose and safe to operate. However, it is not always possible to consider all eventualities at the planning stage and some pragmatic action by the port authority is often required.

The Port of Tanjung Pelepas in West Malaysia opened in 1999 and has had nearly 12 years successful operation as a container terminal. However, in coming years, liquid DG storage facilities will open adjacent to the container terminal creating a whole new set of risks for the authorities to address. Operational protocols will need to change to ensure the correct separation between container ships and DG carriers. Additional tugs will need to be made available to assist berthing; contingency anchoring points will have to be established and a whole range of additional contingency measures developed to address the different risk factors involved.

Conclusion

Port authorities and developers need to be very careful to identify and mitigate as many current and future risks as practicable. It is a complex task that requires expert knowledge and experience in order to be confident that all known bases are covered. The commercial, legal and moral drivers are onerous when considered in isolation; however when dealt with by subject matter experts can be both illuminating and rewarding.

ABOUT THE COMPANY

BMT is an established multi-disciplinary consultancy operating on a global basis and serving clients in the Energy & Environment; Transport & Infrastructure and Defense sectors. The company operates through a series of subsidiary companies each focused on particular markets, technologies or geographical areas.

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How will your port ride the wave of the demographic tsunami?

Christene Best, Vice-President – Sales & Marketing, Klein Systems Group Ltd., Burnaby, Canada

We've all heard it's coming – that epochal sea change in demographics that will see the Baby Boomer cohort retire over the next 20 years, to be replaced by the Busters, Gen-Xers, Echoes and ultimately, Millennials. It is commonly held that the Baby Boom started in 1946 (although some demographers say 1947), so the first Boomers will hit age 65 this year. In some countries, Boomers make up over one-third of the work force.

Why should you care? If your port already has a state-of-the-art port management information system (MIS) based on current technology that supports effective knowledge transfer, efficient workflows and easy access to information, then you can skip this article. If not, read on.

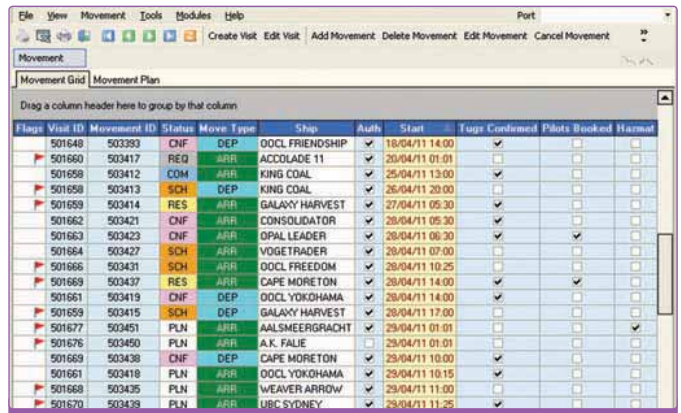
Maritime traffic organizations and ports have legacy information systems that rely on the expertise of a limited number of long-tenured workers. For them, the challenge is to get all that key information out of the graying heads of key people. Expertise regarding business processes, business rules, customers, partners and organizational knowledge needs to be shared, not just with the next generation of maritime workers but also across the organization. This facilitates rapid, fact-based decision-making. Implementing current technology, such as the Klein Systems Group Ltd. (KSG) KleinPort system, allows ports to reduce key person risk for the organization.

Recent economic realities mean that some Boomers are delaying retirement, but without doubt, organizations will face significant changes in their workforces as the Boomers ease out. As a result, you will have very old workers side by side with very young ones. Since the younger generational cohorts are smaller than the Baby Boom was, get ready to compete for talent. Google 'labour shortages in next 10 years' and see how many academics and government agencies are predicting a shortfall in the numbers of qualified workers in practically any industry you can name. Depending on your source, there could be 10-17 million unfilled positions in the US alone over the next 10 years. Europe will face similar challenges, particularly in finding skilled replacement workers.

Qualified talent from the tech savvy Gen-X and Echo cohorts is more likely to be attracted to organizations where they get to use the latest commercial technology, as opposed to older legacy systems.

Many retiring Boomers are keen to leave their own legacy. When ports adopt KleinPort, KSG's consultants, who have deep industry knowledge of the maritime community, work with them to document their existing processes. KSG's experts then help the port and its various stakeholders to deploy the system that supports their desired business processes. There are a lot of stakeholders whose requirements must be considered in implementing a new system. KleinPort can accommodate the needs of harbor masters, traffic operators, billing managers, property managers, terminal operators, pilots, shipping lines, agents, IT managers and other partners. Their requirements are seamlessly woven into a system that enables easier training and knowledge transfer from tenured employees to new ones.

The challenge for a new employee coming on board is to learn to distinguish what information is essential to the safe and efficient operation of the port, from the myriad data that is available. Think about all the activity within a port that is triggered by a vessel call. Every port has its own rules, procedures and practices for dealing with a long list of considerations, such as tidal windows, pilot exemptions, hot work, permits, ship defects, billing and cargo to name a few.



Screenshot from the KleinPort PMIS.

KleinPort automates operational details and enables management by exception by providing timely alerts for items impacting operational completion and the execution of scheduled events. All relevant information is automatically collected and displayed in a logical fashion based on efficient workflows. This simplifies the task of bringing new employees up to speed on how the port operates.

In addition to ramping up on the operational side, there is a critical revenue component to understand as well. Consider the harbour dues, pilotage fees, wharfage, dockage and other service fees that result from a vessel visit. These charges can originate from diverse operational and sometimes geographic areas. Port operators need to collect, sort, check, adjust and review information from the various stakeholders that make up the port's community. Not only is there a daunting amount of information that needs to be collected and analyzed, but it comes through diverse channels like fax, telephone, snail mail and email. KleinPort automates the capture of all billable events, ensuring that no revenue opportunities are missed.

As your port plans for the inevitable transitions that accompany demographic change, explore how upgrading your port MIS can reduce risk, increase knowledge transfer and reduce the learning curve for new employees.

ABOUT THE COMPANY

Christene Best, Vice-President, Sales & Marketing for Klein Systems Group Ltd. is a Boomer. She has over 20 years of experience in sales, marketing and customer service in the technology field with expertise in enterprise software & services, quality and business process improvement. She is based in Vancouver, Canada.

Klein Systems Group Ltd. (KSG or Klein) is an international provider of software solutions that has been meeting the diverse and changing needs of maritime ports, vessel traffic and coastal surveillance organizations, tug operators and Maritime Community Systems for over 28 years. Klein specializes in the automation of maritime business operations processes. Our solutions have been deployed in 40 ports around the world.

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Navigation in a digital age: ECDIS training for maritime pilots

As ECDIS mandation looms, ECDIS training for port pilots is becoming increasingly important

Mike Pearsall, Business Development Manager, ECDIS Ltd., Fareham, UK

Marine navigation is currently experiencing its greatest reform since the introduction of radio communications and the development of radar – some argue even as big as the transition from sail to steam. The change is affecting everyone from deck officers to chart agents, fleet superintendents to inspecting officers and crewing managers to pilots.

In case you've been living underground for the last few years, I'm talking about the mandatory introduction of ECDIS to the world's fleets. Electronic Chart Display and Information Systems, to give them their full name, are a specialized form of Geographic Information System (GIS) built to meet strict performance standards laid down by the IMO, the latest version of which, MSC.232 (82), was adopted in December 2006.

Common misconceptions about ECDIS

What is unique about ECDIS is that, together with correctly installed official electronic charts (ENCs, or RNCs in RCDS mode) and appropriate training, it satisfies the legal carriage requirements for charts, as laid down in SOLAS Chapter V. It is important to note that ECDIS is all too frequently confused with its lesser cousin ECS (simply, Electronic Chart Systems), which although subject to an ISO database standard (laid down in ISO 19379), does not meet the SOLAS carriage requirements and therefore cannot replace paper charts. Furthermore, readers should be aware that contrary to popular misinformation, ECDIS is in no way reliant upon a GNSS (GPS) input; it can continue to be effectively monitored in Dead Reckoning (DR) mode, with traditional visual, radar and sometimes other (manufacturer dependent) fixing methods.

As it stands, many ships say they have an ECDIS fitted, but the reality is less than 5% of the world's fleet have installed a type-approved system that satisfies all of the regulations associated with the rolling installation program mandated by the IMO in June 2009. Furthermore, when the Manila amendments to STCW come into force on 1st January 2012, every deck officer who keeps a bridge watch is now required to have completed formal ECDIS training, both in generic principles and, in many cases (flag state dependent), the specific operation of each system he will use.

Mike Pearsall (author) training John Clandillon-Baker, Editor of *The Pilot*.

Courses underway in ECDIS Ltd's e-Navigation Centre.

Aside from the expense and differences in flag-state regulations, the hardware and training requirements for shipping companies and their crews are actually quite clear-cut and simple; install a system and train your crews on that system.

Specialist ECDIS training for pilots

In contrast, one group of seafaring individuals has been somewhat forgotten by this technological revolution. Pilots play an essential role in the shipping industry, by ensuring vessels complete the inherently dangerous initial and final stages of their voyage without incident. Their ability to do this, of course, relies on intricate local knowledge of an area, but almost certainly requires reference to a nautical chart, if not just to explain the situation and plan to a ship's master. Given that ECDIS is now becoming that very chart, a pilot needs to understand it and differences they will witness.

In its role of fusing navigational information in a single display, an ECDIS screen can provide an up-to-the-second indication of the movement – and predicted movement – of the vessel. This can be of considerable reassurance to both the pilot and master, as tight turns are negotiated and the final stages of berthing or unberthing are completed.

More crucially, another benefit of ECDIS is the ability to tailor the display to the navigational task at hand whether that be ocean passage by day or anchoring by night. The mariner can specify the draught of his vessel and the system will automatically delineate between safe and unsafe water with a so-called 'safety contour'. He can also choose what features to display on his chart, whether that be object names, light sectors or shallow water pattern, for example. When correctly configured, the system will also alert the mariner of pending dangers – a particularly useful safety feature, if correctly employed.

The author training a group of delegates from the Port of London Authority pilots.

The implication of this is that no two ECDIS are likely to be configured identically, so if a pilot arrives onboard with no knowledge or understanding of what to expect from a system, how can he impart his knowledge to the bridge team? How can he ask, for example, for soundings to be displayed, if he is not aware that this option is configurable? How can he alert Port State Control to deficiencies in a ship's navigational fit if he is does not understand the legal aspects of ECDIS installation and employment?

Recently, there has been some debate as to how pilots should be trained in ECDIS but gradually it seems that the need to take ECDIS seriously is gaining momentum. The United Kingdom Maritime and Coastguard Agency states that to revalidate a Certificate of Competency (CoC), they "accept time spent as pilot as suitable", but in light of the new STCW amendments, certificate holders must have completed [generic] ECDIS training. Those individuals who have failed to do so will have their CoC endorsed "Not for use on ECDIS-equipped ships" upon re-validation. At present there is no requirement to complete equipment-specific ECDIS training due to the plethora of systems available.

Summary

In summary, for those pilots who require a valid CoC to work within their authority, they will need to have completed an IMO 1.27 ECDIS course in order to revalidate after 31st December 2011, when the STCW amendments come into force. However, training is beneficial even for those that don't require a valid CoC to work as a pilot, as Don Cockrill, Chairman of the UKMPA points out, "clearly from a professional perspective [ECDIS training] is desirable and there may be post-incident legal implications for a pilot that has not undertaken any appropriate ECDIS training."

To date, ECDIS Ltd., global providers of flag-state approved ECDIS training, based in Southampton, UK, has trained pilots from Nigeria, Kuwait and the United Kingdom, and during the course of writing this article, the author has personally delivered an IMO 1.27 generic ECDIS course to two groups of pilots from the Port of London Authority (PLA). Within the UK, the PLA has taken the lead in training their pilots in this new technology, and to assist the process, ECDIS Ltd. have developed additional bespoke modules for their course. These extra modules include familiarization with a range of different manufacturers' systems, as well as an exercise that highlights an incorrectly and dangerously configured system that, to an untrained eye, might appear to be without fault.

John Clandillon-Baker FNI, PLA pilot and editor of *The Pilot*, the magazine of the United Kingdom Maritime Pilots' Association (UKMPA), stated that he and his colleagues both "needed and wanted to undertake ECDIS training to better understand the new technology". Realizing that "without paper, ECDIS is a fundamental feature of ship's safety", John said they were keen to "be able to utilize certain basic functions" and to ascertain faults with a system setup.

Kevin Vallance of Europilots, summed up in his report to Trinity House following the inaugural ECDIS Revolution conference, held last November. He said, "It appears to me that the challenge for pilots is that in embracing fully the benefits to safety of navigation that ECDIS can give us, we must also be wary of any problems – whether foreseen or unforeseen – that can occur."

PPUs

PPUs (Pilot Portable Units) have been developed to assist pilots with their specific needs in the course of their duties and are now into their fourth generation. Here, Peter Thornton, also of ECDIS Ltd., provides his summary:

- PPUs do not need to be an ECDIS as they are used purely as a personal navigation aid.
- PPUs are becoming more widely used; countries like Canada have been using them for over 10 years now.
- Many PPU systems are ECS that have been developed by manufacturers with assistance from pilots in order to incorporate appropriate tools and displays for their geographic requirements, such as:
  - Fraser River – Riverbed constantly changing, real-time water level information.
  - Columbia River – Significant AIS requirement for calculation of meeting points.
  - Halifax – Precise air drafts incorporated with tidal heights and GPS sensors for bridge clearances.
- PPUs can be tailored to local requirements such as wireless and webcam technology.
- PPUs provide many benefits, allowing pilots to create accurate navigation plans to use in conjunction with ship's plans.
- PPUs provide another GPS source to use for a cross-check of ships' systems, although associated errors are still applicable.
- Pilot Plugs are sensor feeds only and do not allow control of the ship from PPUs. The responsibility, therefore, remains with the ship to navigate and assess risks contained within the navigation plan/track control etc.

There are no standards or legislation for PPUs and there is no desire for such 'legislation' – one of the benefits of PPUs being that they can be personalized and tailored to specific pilotage requirements. There are, however, guidance notes, such as those provided by the IMPA.

- IMPA advice is "not to go anywhere that you would not go without them".
- However, it is recognized that the benefits are significant and PPUs should enhance navigation.
- Pilot Ports provide sensor information only and not control of ship systems.

See IMO SN/Circular 227 Section 3.2 and Guidelines on the design and use of PPUs, prepared by IMPA with technical input from CIRM, for more details.

ABOUT THE AUTHOR

Mike Pearsall is a former seaman officer in the British Royal Navy, with first-hand experience of transitioning from paper to full 'digital' navigation. He now works as Business Development Manager for ECDIS Ltd., where he is also on the team of highly-qualified instructors, delivering the world's best ECDIS training and unbiased ECDIS consultancy.

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CONTAINER HANDLING

"When the acceleration/deceleration effects on the operator no longer need to be considered, the trolley can be designed for higher speeds and shorter ramp times. This decreases cycle times and increases productivity."

'Remotely controlled quay cranes: safer and more productive', page 62.

Safe solutions for lifting project cargoes

Gottwald's new Vertical Lift Assistant & Tandem Lift Assistant modules increases accuracy and safety when lifting heavy and outsize project cargoes

Gottwald, Düsseldorf, Germany

A noticeable development in our modern world is that, while electronic devices are becoming smaller and more portable, many goods being shipped around the globe are increasing in size. Globalization and industrialization are driving the need for heavy cargo, and this includes the components used in renewable and sustainable energy developments, such as wind turbines. Wind turbine components provide an excellent example due to their considerable mass. The machinery housings, called nacelles, are one example, while the rotor blades are extremely bulky and awkward to manipulate. With the development of wind farms around the world moving up a gear, turbine design is creating even larger units.

Consequently, moving heavy or oversized loads is becoming an increasingly important new business opportunity for terminal operators, but it poses new challenges at the same time. With lifts increasing not only in weight but also in their overall dimensions, it is not only the demand for more powerful cranes that is growing. There is a growing need for alternative methods of lifting. In view of the problems often posed by awkward shapes, such as the extremely long tower and rotor blade sections, it has become commonplace to handle these items by tandem lifting with two cranes.

Cranes ideally suited for heavy lifts

For a long time now terminal operators around the globe have been using Gottwald Mobile Harbor Cranes both for single heavy lifts, and as an effective solution for tandem lift applications, including railway wagons, boats, marble blocks, generators, gas and, of course, wind turbines. The Port of Aalborg Ltd., Denmark, for example, uses a G HMK 7608 B Mobile Harbor Crane with a lifting capacity of 140 tonnes for moving project cargoes such as components for wind turbines weighing up to 140 tonnes. The Port of Carrara, Italy, relies on two G HMK 8710 Mobile Harbour Cranes, with a capacity of 200 tonnes each, that can be used in tandem to handle loads of up to 400 tonnes. C. Steinweg (Süd-West Terminal) GmbH & Co. KG, Hamburg, Germany uses two Model 7, G HMK 7608 Mobile Harbor Cranes with a lifting capacity of 150 tonnes each, capable of tandem lift operations up to 300 tonnes.

Safe performance

Moving heavy goods is always a challenge, irrespective of whether it is a single or a tandem lift. Safety and lifting accuracy are the most important aspects, and are essential in avoiding the danger of injury to workers and damage to the load and cranes. Rotor blades, to quote a good example, are often transported unpacked because of their size, which makes them prone to damage.

Gottwald has not only a long track record with cranes used in heavy lift applications, including tandem lifts, but also a successful one. To date, these tandem lifts have been manually operated, which confirms the suitability of these machines for this demanding

The Gottwald Tandem Lift Assistant enables safe lifts of heavy or outsized project cargoes with the full capacity of both cranes.

operation. But the company has always been proactive in implementing crane features that enable and secure accurate, safe loading. The Visumatic® Crane Management System is standard equipment on Gottwald Mobile Harbor Cranes and provides many control features that further increase operating safety and crane availability. These features are either available as standard on the crane, or as optional modules that can be installed independently according to individual needs. The load guidance system, available with a range of options, ensures even safer and easier operation with such features as anti-sway, semiautomatic point-to-point handling, load linear motion and hoisting height limiting.

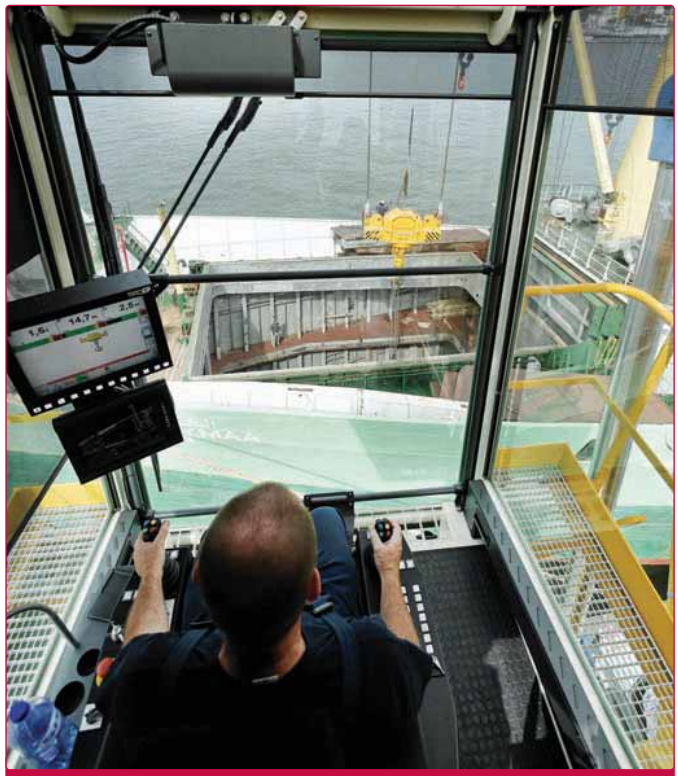
In addition to these there is a radio remote control which is of particular advantage when doing a conventional, manually operated tandem lift where each of the cranes has its own operator. The remote control facilitates communication between the two crane drivers, as both can stand side-by-side and operate the cranes at ground level to control synchronous operation.

Gottwald's new assistants: Vertical Lift Assistant & Tandem Lift Assistant

The Vertical Lift Assistant and the Tandem Lift Assistant were recently launched by Gottwald, and are two new modules and additions to the Visumatic® Crane Management System. The development of the new modules represents a further advance in handling accuracy and, consequently, the safety of the cargo, crane drivers and the cranes. The Vertical Lift Assistant is designed to monitor the angles of the ropes and ensure the ropes remain vertical. It is available as a stand-alone system for single lifts and is also part of the Tandem Lift Assistant.

Vertical Lift Assistant – stand-alone system for single lifts

As a stand-alone system, the Vertical Lift Assistant is a crucial aid for single heavy lifts with Gottwald Mobile Harbor Cranes. For a Mobile Harbor Crane driver, sitting in the tower cab high above the work site, it is difficult to assess whether the boom tip is positioned exactly above the load. Even if he has an excellent view of the working area and load, his view of the hook and load is not from vertically above them. The images supplied by the camera mounted on the boom head to the tower cab monitor are of great help, but might not be sufficient when it comes to project cargo, such as a heavy marble block or a wind turbine component, where absolute accuracy is mandatory.



The Gottwald Vertical Lift Assistant ensures that no load sway can occur even when the crane driver does not have a clear view.

In these applications, the crane driver, to a great extent, has to rely on his visual skills and the instructions from the banksman on the ground when positioning the boom. Even for the most experienced crane driver this is not an easy task and slight deviations in handling accuracy are possible. If the boom tip is not exactly above the load, i.e. the wire rope is not absolutely vertical, the load will sway when it leaves the ground. This load sway may

Background: Regulations and recommendations for tandem lift operations

The level of risk associated with tandem lifting (or 'multiple lifting') is generally regarded as greater compared to single lifts, due to a number of reasons, including human factors. The most important aspects are to synchronize the movements of both cranes, and to prevent lateral forces acting on the crane boom, additional or side loads, unequal load sharing or overturning moments. Lifting at unequal speeds, for example, might result in an unequal distribution of the load on the two involved cranes, which might, in extreme cases, result in an overload on one of them. If the two cranes involved in tandem lifting are controlled by two crane drivers, the human factor comes into play. However, even if the operators do not make any mistakes, it would be virtually impossible to synchronize the operation perfectly, and this might result in a degree of unequal load sharing.

There are various standards and regulations from different countries that address the complexity of tandem lifts and provide crane operating companies with rules for such operations.

The ISO standard 12480-1 gives advice for the crane operating company for safe use of cranes under different circumstances (Cranes – Safe use – Part 1: General/Paragraph 11.4: Multiple Lifting). The main points of this standard are: lateral forces on the crane boom have to be avoided, if possible with appropriate instrumentation and crane movements have to be synchronous.

In addition, ISO 12480-1 allows cranes to use up to 100% of their safe working, provided all the relevant factors can be monitored. If the factors cannot be evaluated, a down-rating of 25% or more will be applied. These ISO recommendations are translated into local regulations and, while in some countries the lifting capacity can generally be used to the full, it is often not permitted to exploit the full lifting capacity for conventional, manually-operated tandem lifts.

Examples of standards and regulations addressing tandem lifts:

- ISO standard 12480-1 (Cranes – Safe use – Part 1: General/Paragraph 11.4: Multiple lifting.
- BS 7121-1:2006: British Standard Code of Practice for Safe Use of Cranes (Part 1: General).
- BS 7121-3:2000: British Standard Code of Practice for Safe Use of Cranes (Part 3: Mobile Cranes).
- Safety and Health in Ports. ILO Code of Practice; Geneva, International Labor Office, 2005.
- Accident Prevention Regulation for Cranes ("Unfallverhütungsvorschrift Krane") BGV D6 issued by the German Institutions for Statutory Accident Insurance and Prevention.

Vertical Lift Assistant

The Vertical Lift Assistant, designed to monitor and ensure a vertical rope position, consists of two rope inclination sensors which are fitted to the boom tip. The redundant system – one sensor would be sufficient – offers double safety. The rope inclination sensors are guided by spring-loaded rollers on the rope and are suspended from the boom tip steel construction to measure the relative positions of the boom tip and hook. The system senses rope angle deviations in two directions. The relative position of the load is displayed on the operator's screen.

result in collisions with other goods. Wind turbine rotor blades, to name only one example, are often not crated and are stored directly next to each other.

This is where the Vertical Lift Assistant comes in. By means of rope inclination sensors fitted to the boom tip, the controller automatically ensures that the boom tip is positioned exactly above the hook and load (i.e. no inclination in the rope), to prevent unwanted lateral movement after the load is lifted off the ground.

Rope inclination sensors fitted to the boom tip automatically guarantee the hook is positioned exactly vertically over the load.

The Visumatic® crane management system enables the crane driver to monitor the Vertical Lift Assistant visually.

In compliance with ISO 12480-1	Gottwald Tandem Lift Assistant
• Lateral forces on the crane boom have to be avoided (if possible with appropriate instrumentation)	✓
• Crane movements have to be synchronous	✓
• If all relevant factors can be monitored, the cranescan be used up to their safe working load (i.e. 100%)	✓

The principle incorporated in the Vertical Lift Assistant is also a considerable aid to handling tandem lifts, which led Gottwald to develop the Tandem Lift Assistant, which includes the Vertical Lift Assistant.

Tandem Lift Assistant

Designed to perform computer assisted, synchronous tandem lifts, with one crane driver controlling both cranes, the new Tandem Lift Assistant addresses risk factors that could be experienced in moves involving multiple cranes, such as lateral forces, overturning moments, deviations in crane speed and the like.

The new Tandem Lift Assistant eliminates the need for de-rating the maximum crane capacity, which is recommended or even prescribed by regulations in view of the complexity of multiple crane lifts. In accordance with the ISO 12480-1 regulations for multiple lifting, the new Tandem Lift Assistant allows two Gottwald Mobile Harbor Cranes to be operated in tandem up to their full working loads. If the maximum capacity of each crane is 200 tonnes, for example, it is not only technically possible but also in compliance with regulations to lift a load weighing up to 400 tonnes.

Basic principle

The three central aspects of the new Tandem Lift Assistant are:

1) The two cranes used for a tandem lift are controlled synchronously by only one crane driver. This can be done either from one of the crane cabs or, more conveniently, by radio-remote control at ground level.
2) Synchronous crane operation is achieved via state-of-the-art hardware and software provided by Gottwald and installed on both cranes. This includes the Tandem Lift Assistant software, safety PLCs, a wireless LAN system with a safe radio link between both PLCs plus the sophisticated Vertical Lift Assistant – the heart and most important hardware element of the Tandem Lift Assistant. The two cranes are operated in a master-slave combination, where one crane (the master) has unidirectional control over the other (slave).
3) In contrast to the conventional working principle of a slewing crane, the crane driver carries out the movement commands relative to the load using Cartesian coordinates. The crane control system automatically converts these commands into slewing and luffing movements of the two cranes. In accordance with official regulations, such as the British Standard Code of Practice for the Safe Use of Cranes, which prescribes the strict use of only one motion at any one time, the vertical and horizontal movements, which usually overlap in duty cycle operation, are decoupled. Simultaneous movements are only possible in one plane, either vertical or horizontal.

How the Tandem Lift Assistant is used

To combine the forces of two cranes with the help of the Tandem Lift Assistant, the two cranes, equipped with the necessary hardware and software, first have to be synchronized with each other, i.e. they need to know their relative distances from each other.

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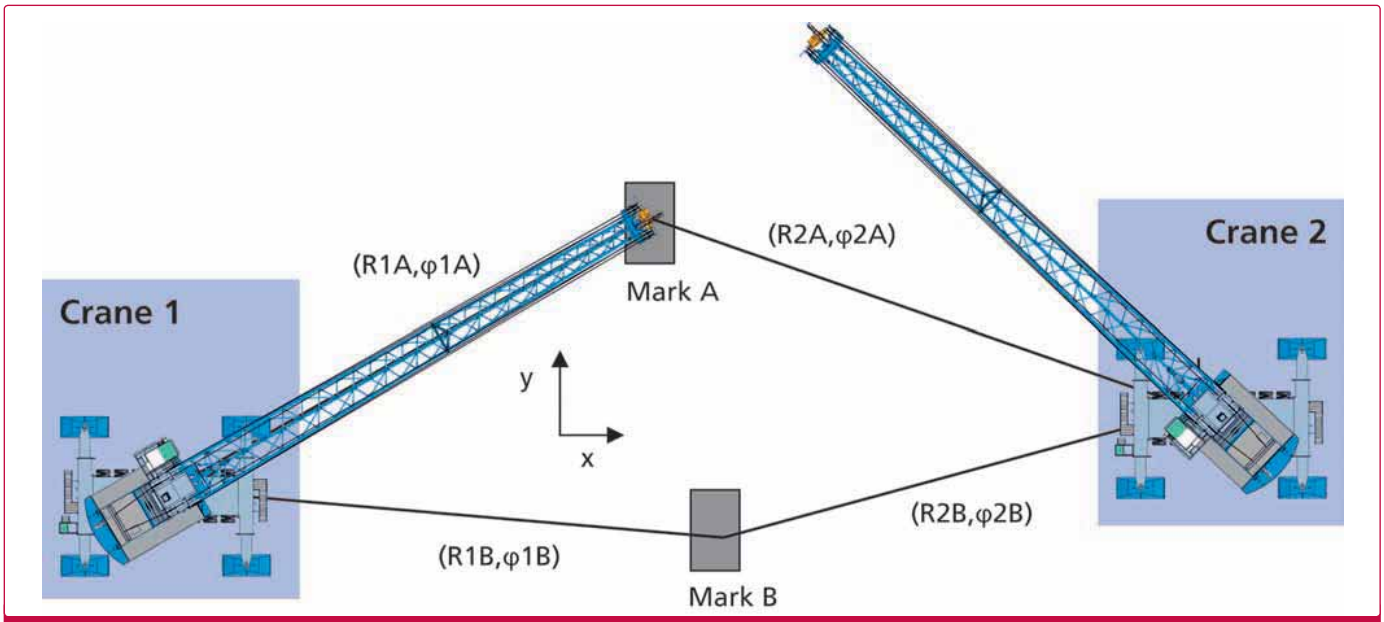


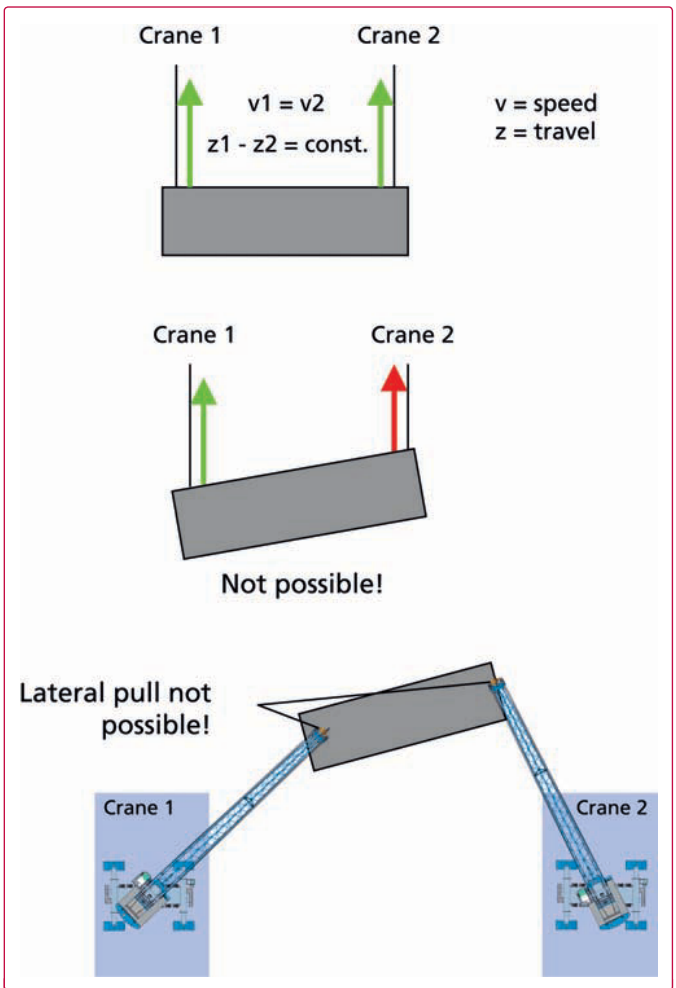
Synchronisation of both cranes is effected by a simple referencing procedure.

System preparations – synchronizing both systems

To synchronize the two cranes, two user-defined marks, i.e. coordinate reference points, on the quay surface have to be approached by each crane manually, one after the other. The positions are stored in the cranes' relative coordinate systems (radius and slew angle). The relative position of each crane's centerlines is then calculated in the x and y-directions. This Cartesian reference is valid until one of the cranes' chassis travels.

This standard manual referencing procedure is very simple but there may be terminal operators that would prefer the referencing procedure to be automated. This is why Gottwald has also developed an advanced automatic referencing system. This allows for automatic distance measuring by radar, and automatic angle measuring.

Now that the two cranes have been synchronized, they can start working together. This involves two steps, the rigging mode and tandem lift operation.

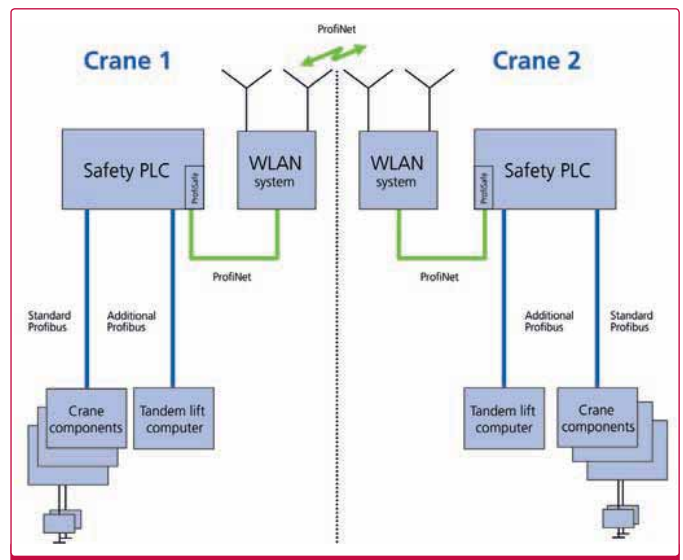


Perfectly synchronous operation of the two cranes ensures the load is balanced and avoids lateral pull on the crane booms.

Rigging mode

In the rigging mode, each crane is still operated individually and the controls of the other crane are blocked automatically.

First of all, the crane driver moves the first crane hook to the right position for attaching the load (by slewing, luffing, hoisting). The crane driver then changes to the second crane and also moves its hook to the right position. The load is then attached and the crane driver applies tension to the hoist ropes without lifting the load off the ground.



The sophisticated safety control layout ensures secure tandem lifts at all times.

Now the Vertical Lift Assistant with the inclination sensor comes into play. As in single lifting, it monitors the rope inclination. If rope inclination is detected, the boom position is corrected automatically, so that the boom tip is located exactly above the hook. As a result, no unwanted lateral movement can occur when the load is lifted clear of the ground.

Tandem lift operation

The scene is now set for the tandem lift. As already mentioned, both cranes are operated from one control point only. The crane driver can either sit in one of the crane cabs or use a radio remote control and operate at ground level. The load, radius and hook height of both cranes are visible at a glance on the operator's control screen. Based on the master-slave principle, the hoisting and lowering actions of both cranes are effected synchronously with only one controller. In the same way, motion in the horizontal plane (based on Cartesian coordinates) and rotation of the load are synchronized.

This master-slave system guarantees synchronous operation. Nevertheless, Gottwald has implemented additional functions as a fail-safe system. A minor difference in the basic crane configuration (for example, with regard to hoisting speed) might cause a deviation, which is where Gottwald's monitoring and safety mechanisms help to take corrective action as early as possible. The PLCs of both cranes monitor any differences in hook height and hoist speeds between the two cranes. In the event of a deviation, corrective action is performed automatically. If, for whatever reason, the deviation cannot be corrected, the hoists are switched off automatically. In the case of deviations in the slewing and luffing speeds, this is detected by the Tandem Lift Assistant and, if automatic correction is not possible, the drives are switched off automatically so that no lateral pull can occur.

Safety developed by Gottwald

The complete system, including hardware and software – that is, the tandem lift computer, crane components such as the rope inclination sensors, safety PLC and wireless LAN system – has been designed by Gottwald in compliance with safety category 3, according to European standard EN 954-1 'Safety of machinery – Safety-related parts of control systems' (to be replaced by EN ISO 13849-1 in 2012).

This industrial standard ensures a safe and stable radio network and wireless LAN system, amongst other things. In terms of integrity, it is comparable to a cable connection, which can also be supplied as an alternative if, in a certain application, local regulations require a fixed cable connection between the cranes.

More than just safety

Additional safety features include emergency stop functions, which are transmitted redundantly between both cranes. As soon as an emergency stop button is hit, both cranes stop. Also the main crane switch function is transmitted redundantly and when one main crane switch is turned off, both cranes are switched off. Furthermore, in case one drive is switched off due to a fault on the crane, the relevant drive of the other crane is also switched off. If, for whatever reason, the radio link is interrupted, crane operation is automatically stopped.

New modules for Gottwalds Visumatic® crane management system

Both the new Vertical Lift Assistant as a stand-alone system and the Tandem Lift Assistant (including the Vertical Lift Assistant) are new modules for Gottwald's Visumatic® crane management system, the visualization and control system which optimizes crane performance and enables Harbor Cranes to develop their full handling potential. All the functions required for operation, maintenance and production statistics management are arranged in a simple, accessible form.

The Gottwald Visumatic® features:

- A graphical user interface for crane operation
- A visualization system for all key crane functions
- A facility for recording and evaluating handling rates
- A maintenance system which displays the count-down in operating hours to the next maintenance interval
- A diagnostics system with detailed diagnostics messages.

Further modules of the Visumatic® include:

- A radio remote control for all crane functions
- Teleservice
- A slewing angle limiting function
- A pre-settable lifting height function
- **The new Vertical Lift Assistant as a stand-alone system**
- **The new Tandem Lift Assistant (including the Vertical Lift Assistant)**

Special options for bulk handling:

- Load-sensing mode
- Full use of the truck loading capacity when the crane loads trucks directly
- Point-to-point handling mode
- Hopper control from within the tower cab.

More than just safety – Gottwald Tandem Lift Assistant

Safety features:

- Monitoring of rope inclination in two directions
- Redundant rope inclination sensor
- Comparison of hoist speeds
- Comparison of hook height difference
- Decoupled vertical and horizontal movements
- Lifting from the ground without lateral movement
- Use of safe control systems (Safety PLC)

Further safety features:

- Operation is stopped when radio link is interrupted
- Emergency stop functions are transmitted redundantly between both cranes → both cranes will stop when an emergency stop button is hit
- Crane main switch function is transmitted redundantly between both cranes → both cranes will be switched off when crane main switch is switched off
- In case one drive is switched off due to a fault on one crane, the relevant drive of the other crane is also switched off

ABOUT THE COMPANY

Gottwald Port Technology GmbH, based in Düsseldorf, Germany and a subsidiary of Demag Cranes AG, is a manufacturer of harbor cranes and terminal automation technology. With a total of over 1,300 mobile harbor cranes sold, the company is world market leader in this product sector. In the field of terminal automation, Gottwald Port Technology offers system solutions that incorporate both the company's own software and hardware. Gottwald Port Technology supplies customers in around 100 countries.

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Remotely controlled quay cranes: safer and more productive

Remote control technology for STS cranes is now ready for large-scale deployment

Clara Holmgren, Product Manager, ABB Crane Systems, Sweden

Introduction

The world's first remotely operated ship-to-shore crane is now in commercial operation. The crane is operated from a remote control station, similar to a control station for automatic stacking cranes (ASC). The control station is located in a control room in the terminal office area. The remote operation system has been developed in close cooperation between ABB Crane Systems and Manzanillo International Terminal (MIT) in Panama.

The first phase: fixed cabin

The crane is equipped with a fixed cabin mounted on the crane leg. Aided by cameras, the operator can control the crane from a familiar environment; the fixed cabin is a replica of the trolley-mounted operator's cabin with additional monitors for camera images.

After having delivered more than 300 remotely operated stacking cranes and with a suite of automation features for the STS cranes, it was a natural step for ABB to test automatic STS operation supported by camera images.

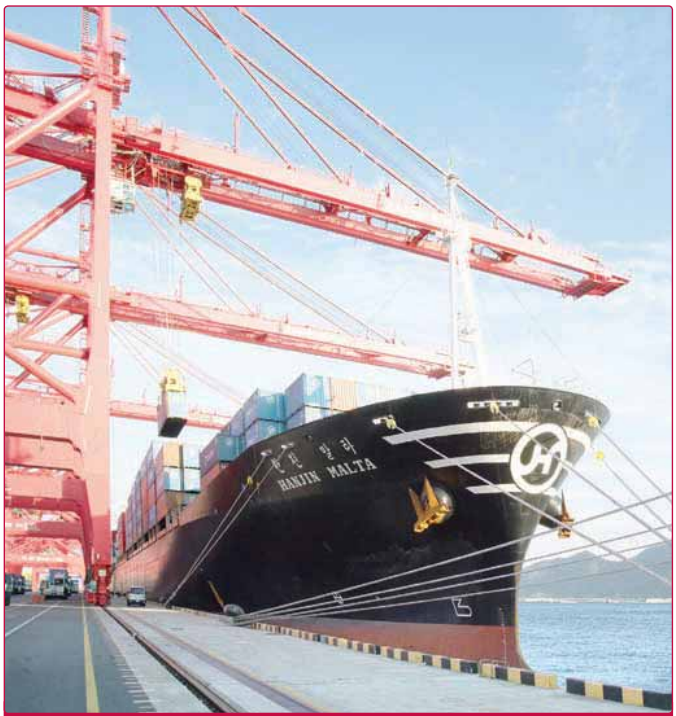
With a more upright operating position and by avoiding the acceleration/deceleration forces from the trolley, the operator gains a better working environment. Frequently occurring back problems can be eliminated and costs of sick leave are greatly reduced. This opens the way for future cranes with faster trolleys and shorter acceleration/deceleration times.

During the test period, ABB worked closely with the MIT team to evaluate and improve functionality. Engineers and operators were involved throughout the entire development and testing process to guarantee the best possible solution for operation. The goal was to prove that operation from a fixed cabin could be as productive as operation from a movable cabin. That goal was well achieved.

The second phase: remote control

After successful implementation of the fixed cabin, the next phase was to implement operation from a remote control station (RCS), similar to the one used for ASCs. Remote control was

Remotely operating quay cranes from a desk rather than a crane cabin means improved ergonomic working conditions for operators, with stress on the back and neck reduced to a minimum.



The world's first remotely operated ship-to-shore crane is now in commercial operation.

a logical step, given that ABB is the world leader in stacking crane automation, and also has an extensive range of automation solutions for quay cranes. The remotely operated quay crane is an excellent example of how one market segment can benefit from progress made in another segment.

The strategy has been to combine proven technology with cutting-edge camera technology to minimize risks and guarantee successful implementation. Being at the forefront of technology means working closely with suppliers; each new application poses demands never before encountered.

RCS

The remote control station is an operator's desk of the same type used for automated stacking cranes. The desk is fitted with joysticks and buttons for remote control of the crane, and monitors for camera images and information for the operator. The operator can communicate with people on the ground via radio, for example, getting updates on the load list.

The video system includes cameras for load tracking, control and area supervision. While remote operation means some limits to depth perception, the cameras can provide views and angles not seen from the traditional operator's cabin. These views are very helpful during fine-positioning of the spreader and improve safety for people onboard the ship.

Ergonomics

When operating from the trolley mounted cabin on the crane, the operator is leaning forward, looking downwards between his feet. With the fast accelerations and decelerations of the trolley, this position can be very hard on the back and neck. By using cameras the operator can sit in an upright position. The height of the desk and chair can be adjusted to vary the working posture. Stress on the back and neck is consequently reduced to a minimum, resulting in healthier operators.

When the acceleration/deceleration effects on the operator no longer need to be considered, the trolley can be designed for higher speeds and shorter ramp times. Tuning of the automatic sway and position control can also be more aggressive. This decreases cycle times and increases productivity.

Quay crane automation

The crane is fitted with a number of automation systems to facilitate remote operation. The main part of the crane cycle is performed fully automatically by the crane control system, with the operator only supervising the crane movements. A work order, initiated by the operator or generated directly by the terminal operating system (TOS), is sent to the crane and after acceptance by the operator, movement begins. With automation, the operator can focus on the final critical parts of the cycle.

If the crane is fitted with a lashing platform or a vehicle alignment system, landside operations can be fully automatic. With the implementation of automation systems for lashing and vehicle-guiding comes control of both the crane and people in the vicinity, meaning a safer environment for all people involved in the operation.

Production and planning

Comparisons between manual and automatic operation show that berth productivity increases with automation since the difference in operation will be evened out. Measured over a shift, all operators will benefit from automation and the production becomes more predictable. With the operators moved to a controlled office environment, they can work side-by-side with other operators, which improves their social situation and enables direct communication with the operations department. Since any crane can be controlled from any desk, short breaks can be taken without interrupting production.

The remote control stations can easily be adapted for control of multiple crane types. A pool of operators can handle both quay cranes and stacking cranes, thus enabling improved and flexible staff planning and more efficient use of resources.

If new cranes are delivered without an operator's cabin, the weight on the trolley is greatly reduced. This means that the trolley motor and drives can be scaled down, while still maintaining the same performance as a crane with a trolley mounted cabin. Apart from the lower initial investments, the smaller motors have lower energy consumption.

For ABB, unmanned operation has been one important step in a series of development projects targeting quay crane productivity, energy efficiency and operator ergonomics. There is an ever-growing interest in remotely operated quay cranes, and ABB is confident that this technology is now ready for large-scale deployment.

ABOUT THE COMPANY

ABB is a leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. The ABB Group of companies operates in more than 100 countries and employs about 117,000 people.

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New 'State of the Industry' forum brings leading equipment companies together

Leading port equipment and technology suppliers will gather at TOC Europe to discuss emerging trends and advances in terminal automation

Rachael White, Secretary General, Port Equipment Manufacturers Association, London, UK

Founded in late 2004, the mission of the Port Equipment Manufacturers Association (PEMA) is to provide a forum and public voice for the global port equipment and technology sectors. The Association has seen strong growth in the last few years and now has more than 45 member companies, including crane, equipment and component manufacturers, systems and software providers, consultants and other experts.

From its inception, a core part of PEMA's mandate has been to advance knowledge and best practice in the design and application of equipment and technology, which play such a critical role in meeting today's demands for productive, efficient, safe and sustainable ports. The pace of change and innovation within our industry continues to accelerate, and exciting new technologies are being introduced at terminals around the globe as a result of continued R&D efforts by the commercial sector.

PEMA is therefore very pleased to host a new 'State of the Industry' forum at this year's TOC Europe event in Antwerp, where representatives from member companies and their clients will discuss current developments in business process and terminal automation technology and what to expect in the near future.

Taking place on the afternoon of June 7th, the forum dispenses with traditional presentations in favor of a live interview and debate format, where a series of panels will be quizzed on five key themes: crane automation; horizontal transport; data capture and telemetrics; software applications; and complex IT integration. We hope this new format will lead to active debate and some lively discussion, and allow many points of view to be aired in a short space of time.

The adoption of automated stacking cranes (ASCs) in container yards continues to gather speed, with a significant number of new projects now in planning worldwide. A selection of key equipment manufacturers and automation system providers will discuss what's driving yard automation growth, where the technology is headed and debate prospects for quayside crane automation.

Compared with the yard, automation of horizontal quay-yard transport has yet to reach the same level of adoption, but as global trade returns to pre-recession levels and vessel size continues to increase, the speed and efficiency of vessel-stack transfers will be increasingly critical to overall terminal performance. A second forum session brings together three experts to focus on horizontal transport options, with debate on the comparative outlook for AGVs, shuttle carriers, cassettes and other innovative approaches against traditional truck-chassis systems.

Real-time data capture and telemetrics are hot topics in the supply chain at the moment, with more and more business looking to implement new systems that make the supply chain more visible. The ports and terminal markets are no exception. Advances in data collection technology are now allowing operators to eliminate manual data entry and automate core business processes, while the fast-emerging field of telemetrics is giving new insight into the real performance of terminal equipment and other key assets.

A third panel of experts talks about what new technologies are coming and how data capture technologies like OCR and RFID are already changing the face of traditional and automated terminals. With software bringing it all together, a fourth segment will address new applications including simulation, emulation and asset management systems.

To wrap up the afternoon, PEMA members will be joined by customers to discuss the theme of Complex IT Project Integration. What does it really take from both the supplier and client side to ensure successful integration of multiple systems both during project start-up and for its duration? Joining this panel will be Oscar Pernia Fernandez, Processes, Systems and Innovation Team Leader at Total Terminal International Algeciras, the first automated terminal in southern Europe; and David Serral, IT Manager for Grup TCB, responsible for the operator's new greenfield terminal in Buenaventura, Colombia.

Development and implementation of innovative technologies are an integral part of modern terminal design and operations, offering multiple benefits including better productivity, lower costs, reduced energy consumption and emissions, and greater safety. It is an exciting time for the equipment and technology industries serving this dynamic global market. PEMA looks forward to contributing to industry knowledge with this new forum at TOC Europe, as well as to participating in other debates taking place during the show on Safety and Energy & Environmental Conservancy.

ABOUT THE AUTHOR AND ORGANISATIONS

Rachael White is Secretary General of the Port Equipment Manufacturers Association. She has spent the last 24 years charting trends in global maritime container logistics and transport as a researcher, journal editor, conference producer and marketing consultant. As well as her role at PEMA, Rachael also serves as Editorial Director for TOC Events Worldwide.

Founded in late 2004, **PEMA**'s mission is to provide a forum and public voice for the global port equipment and technology sectors. The Association has seen strong growth in the last few years and now has more than 45 member companies, including crane, equipment and component manufacturers, systems and software providers, consultants and other experts.

Running from 7-9 June at the Antwerp Expo, Belgium, the **TOC Europe** conference and exhibition is the trusted global forum for government, cargo owners, logistics providers, liner shipping, ports and terminals, inland transport, finance and other key stakeholder groups to meet, debate and shape the future of global container transport.

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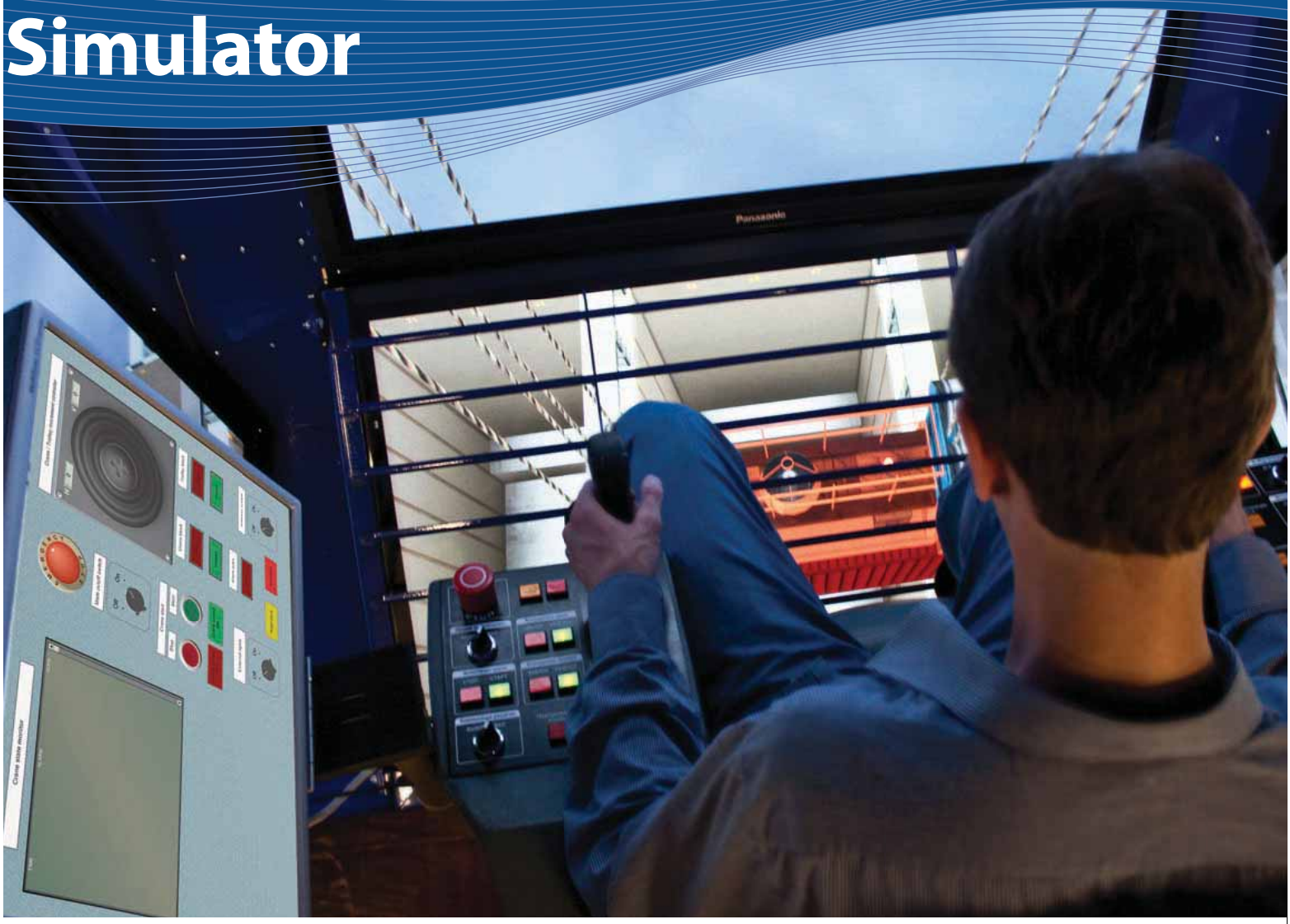
Transas Crane Simulator



Safe and cost efficient training in crane operations

- Safe handling of various cargo types
- Securing cargo and coastal objects against damage
- Practicing in optimal trajectory and effective techniques for cargo transfer
- Minimizing crane load and number of control actions

Available crane models:

- Ship-to-Shore Gantry Crane (Konecranes)
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- Portal Crane ("Stork")
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TRANSAS
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Simulators as a safe and cost-effective solution for crane operator training

What you should know before selecting a simulator to train your crew

Mikhail Mikhailov, Head of Technological Simulators Development Department, Transas Technologies, St. Petersburg, Russia

Why simulation-based training?

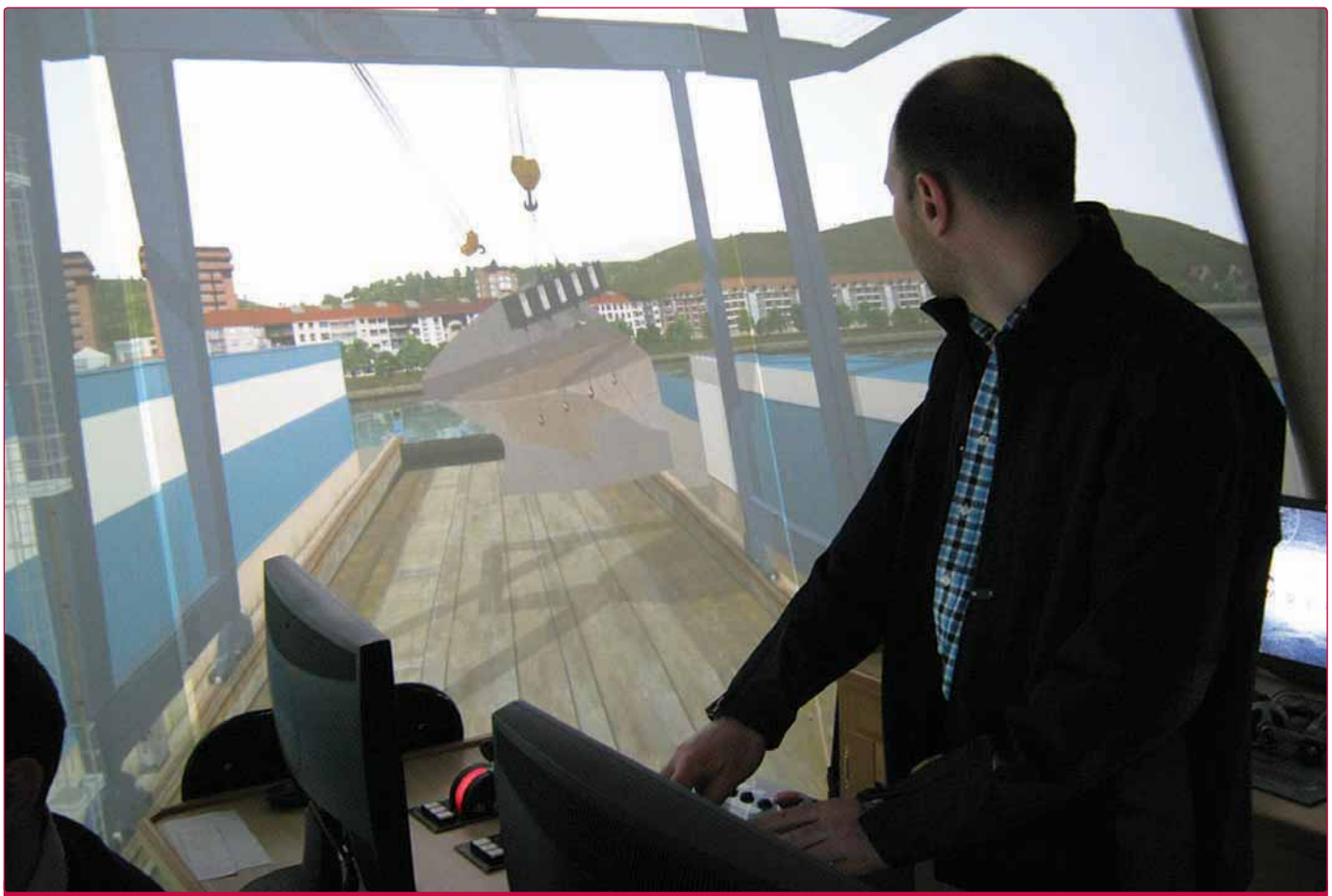
Many of those who read this article are well aware of the expense involved in training crane operators: you literally pay for each mistake of every trainee, be it damage of equipment or cargo during operations. But it's not only about mistakes; weather also imposes restrictions on training.

This considered, the benefits of simulation-based training are convincing enough. First of all, the trainee obtains realistic experience in a controlled and safe environment. This reduces the duration of work placement training and, furthermore, overall training time. A simulator is the only means with which to practice emergency operations and troubleshooting without exposing trainees to risk, and not damaging equipment and the environment. In addition, there is no need to disrupt operations for training; there are no additional expenses for transportation of trainees to a training site (especially in case of offshore operations), and training doesn't depend on weather conditions. A simulator can reproduce any weather conditions, even the most adverse.

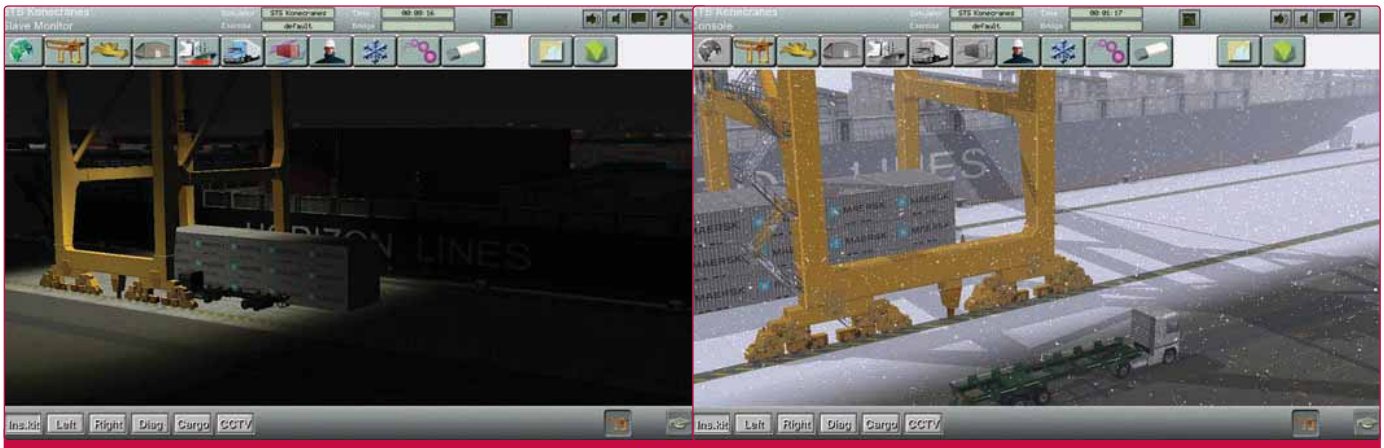
Training goals should define simulator configuration

When it comes to deciding which configuration is needed, it is important to remember that it is the training goal that defines the configuration. Transas, for instance, offers variety of configuration options. A standalone PC-based configuration is sufficient for familiarization purposes and self-education, while more advanced training will require a PC-based crane cabin mock-up or network class that provides joint training under instructor supervision. The most realistic training is achieved with the help of a full mission simulator. It can use rear projection-based 3D visualization, and 3-5-channel 3D visualization on plasma screens. Furthermore, training realism can also be enhanced by implementing a motion platform.

Very often budget can be a restricting factor. However, most often it is possible to find a solution. As an example, one of Transas' customers, Balenciaga shipyard, required the simulator to be economically effective and run on the same premises and hardware



The crane simulator at Balenciaga Shipyard is installed on the same platform as the shiphandling simulator.



The simulator can be used to model different weather conditions and time of day.

Can you say which picture is real and which is simulated?

equipment currently used for the existing Ship Bridge Navigational simulator. The task was completed sucessfully. The crane simulator was added to the existing Transas navigational and maneuvering simulator NTPro, which has been used for new building projects. Combining two simulators provides a cost-effective solution (both use the same visualization and HW), and enables the utmost level of realism for the development of new vessel projects.

Mathematic modeling: key factors

To provide realistic training, crane models should be based on the real physical characteristics of the equipment. Simulation should imply all dynamic and kinematical features of devices, mechanisms and cargo. Possible physical interaction should also be taken into account (impacts, blows, blocking, shaking, friction, etc.) to include them in simulation of real load handling operations.

Motion simulation should be based on preset dynamic mathematical models. Dimensions, speed, structure, balance and amplitude should be adjustable. Besides the basic characteristics of equipment design and its reaction to control signals, crane movements are affected by cargo mass and the center of gravity; resistance during heavy cargo hoisting; cargo dynamics in response to jerky movements; the impact of other objects and collision with objects, including friction; and the dynamics of motion parts of a crane.

Visual system

The visual system greatly contributes to training realism. It should enable realistic reproduction of the environment including crane, cargo and weather. The system allows different environmental conditions to be modeled simultaneously, such as:

- Visibility (fog, mist, rain, snow)
- Time of day (dawn, day, dusk, night)
- Illumination (shadows; switching on/off crane illumination; illumination system failure)
- Friction (adjustment of friction of load and surface/spreader; ice modeling, automatic change of friction when raining), and
- Wind (influence on crane; hauling device and load, selection of wind direction, wind force, fluctuation amplitude, windless regions).

Operator workplace

The operator's workplace should be designed to provide control over operation of the crane model operation during scenario runtime. The software consists of panels that realistically replicate the control system panels of a real crane. The simulated controls can be operated by using a mouse, a track ball or a touch screen. The operator commands are then transferred to the simulator model so that it starts acting accordingly.

The instructor needs a perfect training tool

The instructor is a key figure in the training process. There should be competent people behind every system, but the system itself is an important factor for success. We worked closely with experienced crane operators to develop a tool that meets training requirements in the best possible way.

The instructor's workplace software should be designed to select and set training conditions (simulator exercises) for the crane operator's workplace, assigning the exercise to the simulator operator workplace, controlling the simulated scenario process, and guiding operator's actions during his task. The software is also used for the simulator scenario debriefing.

At Transas we use the following approach: the instructor workplace software is a two-window application, running on a single PC connected to two monitors. The main window layout is

designed as a character-mode display, i.e. a kind of table with text data and numerical values. The instructor's main window includes control buttons: the 'Data Monitor' panel is used for visualizing crane status and its parameter values. The 'Actual Alarm' panel provides current system status; the 'Event Log' panel is designed for recording and viewing events; and with the 'Scenario' panel it is possible to view the content of current exercise. The Slave Monitor window provides full information on each trainee's workplace, and allows crane parameters to be controlled and new tasks created. It helps to define training scenario objects' properties on the exercise area vector chart layers. It can also assign a scenario to the operator workplace, set environmental conditions for an exercise, and preview a scenario on a 3D runtime visualization screen.

Evaluation and assessment

One of the important stages of education is the evaluation and assessment process. At Transas we developed an E-Tutor, which increases the efficiency of using a simulator because it allows the instructor's work to be automatized. The tool reduces the time taken for control of a complicated scenario and performing of manual operations during an exercise. It also demonstrates the progress and preliminary results of several trainees simultaneously during exercises, and provides the possibility of using the simulator in self-training mode with automated instructor help.

This tool provides unique features such as embedded electronic registry (trainee and log database); a trainee performance monitor, for easy monitoring of overall status of multiple sessions, and 'zooming-in details' when necessary; and an embedded questionnaire system with the capability to integrate Computer-Based Training (i.e. multimedia files).

To complete the list of important factors for a good crane simulator, it is necessary to mention lifetime support from manufacturer, a variety of simulated crane models to match your existing needs, integration capabilities and expansion of the training system with minimum investment. Overall, all this contributes to cost savings and crew retention.

ABOUT THE AUTHOR AND COMPANY

Mikhail Mikhailov is Head of Technolgical Simulators Developent Department, Transas Technologies. He graduated from North-West Polytechnical Institute (St. Petersburg, Russia) with MS in automation and telemechanics. He continued postgraduate study at State Marine Technical University of St. Petersburg (MTU), specializing in Math. modeling, numerical computing and program complexes. In addition, Mr. Mikhailov studied human resources management at International Management Institute St. Petersburg (IMISP).

Mr. Mikhailov has vast experience in development of marine simulators (concept creation, work with technical documentation, math models and interface development) and object-oriented modeling in Model Vision Studium (MVS) environment and C++. Mikhail is member of IMarEST (The Institute of Marine Engineering, Science & Technology).

Transas (TRANsportSAfety Systems) is a world-leading developer and supplier of a wide range of software, integrated solutions and hardware technologies for the marine industry, including both onboard and shore-based applications. Transas offers technologically advanced solutions for Maritime security services, shipping companies and ship operators, Naval and Coast Guard organizations, training and educational centers, port and harbor administrations, governmental, municipal and local authorities and administrations, environmental services and institutions, as well as OEM partners.

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LIEBHERR
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ALP and ALS: the automatic lashing platform and system

The missing link in the automation chain, closing the gap in automated terminal operation

KALP GmbH, Böel, Germany

Today leading terminal operators aim to achieve a fully automated container handling process. Modern automated or partially automated terminals attain better levels of safety at work by replacing stevedores who work under suspended loads on the heavily trafficked lanes of the horizontal transport. The decision for automation is the next step towards simultaneously improving planning and security, and reducing human resources.

Secure planning

Stevedores still work under dangerous conditions in order to remove and fix twistlocks manually while loading and discharging containers. Only a fully automated process can provide optimum efficiency and safety in container handling. The weak spot in this process can be seen between STS cranes and the horizontal transport. An automatic lashing platform closes this gap. KALP GmbH has developed a fast and reliable system that can fix and remove twistlocks, and furthermore stores the various types of twistlock currently available in internal stacks in a fully automatic process.

Development objectives

KALP GmbH has been seeking to break new ground with the development of an automatic lashing platform (ALP) since 2006, which can be considered a key technology in automated container handling. The integral aim of this system is to remove stevedores from hazardous work areas, in order to meet the extreme requirements of container handling and increase efficiency.

Safety

During container handling, stevedores mainly work in the blind spot of crane and straddle carrier drivers, since they have to step between and under suspended containers to access the twistlocks. The ALP is designed to eliminate the high risk of human injuries, especially with respect to multi-box lifting, making the entire process safe.

The missing link in the automation chain

The automatic lashing platform (ALP) is available in three different versions:

- **ALP ECOTEC**
  An independent hydraulic system with integrated energy recovery.
- **ALP ENERGY**
  An electrically driven system.
- **ALP BASIC**
  A system without energy recovery.

Implementing the ALP as a standalone unit on the ground at container terminals ensures reliable automatic twistlock handling, and thus enables smooth operation of horizontal transport. The ALP stores twistlocks in integrated magazines during the discharge operation, and removes twistlocks during load operation.

The ALP is able to handle 20', 40', 45' containers; also in twin, tandem, and twin-tandem operation. The system is a key technology in multi-box lifting, and is especially efficient in tandem operation.

Clearing the lanes is one of the main requirements to organize terminal operation in a safe and efficient way. The ALP can be moved wherever it is required, preferably by straddle carrier.

ALP The Automatic Lashing Platform

A Key Technology In Terminal Automation

Times are a changing - we've got the concept.

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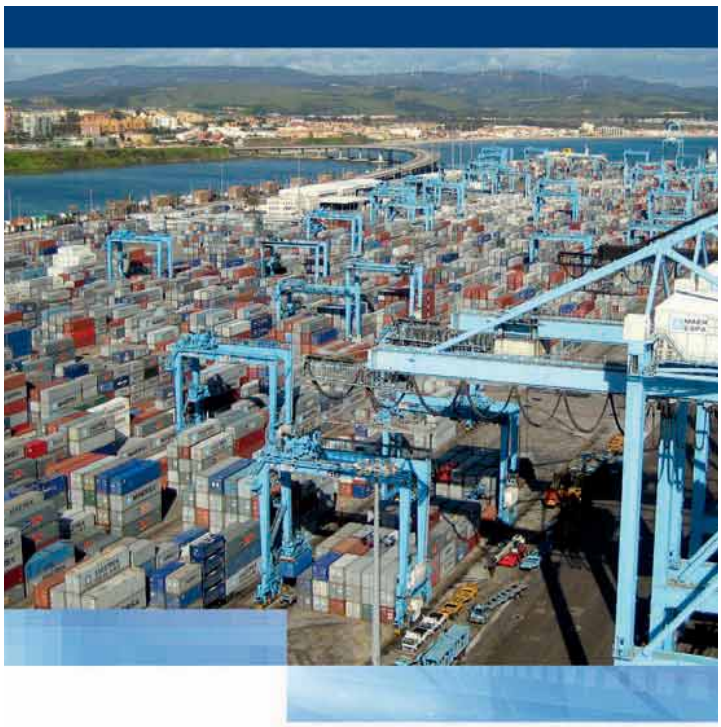

- **ALP System (ALS)**

  A system designed to be installed and operated directly on STS cranes in pre-installed lashing platforms with the same twistlock technology features as the ALP. The ALS is integrated in a significantly small frame, and can be operated electrically or electro-hydraulically according to customer requirements.

Existing co-operations

KALP GmbH cooperates with leading crane manufacturers on creating proper interfaces between crane control and ALP, and possible data transfers to TOS systems. Design and construction of the static crane platform is also done with other companies. All assembly of the ALP is done by renowned German manufacturers. The steel construction of the frame is produced in Slovakia, whereas the entire mechanical engineering assemblies are made on site on KALP premises in Hamburg, northern Germany.

Available options

The ALP and ALS are equipped according to the specific and individual demands of customers. As an option, the KALP GmbH for example offers weight measurements for containers, OCR or radiation detection. All data acquired is sent to the recipient wirelessly.

Manufacturing

Since April 2010, the ALP prototype has been tested at the Container Terminal Bremerhaven, Germany, to assess its durability and suitability for daily use. The results show that the ALP achieves up to 35 moves per hour even under the toughest weather conditions, and can easily keep pace with the speed of STS cranes. In December 2010, the ALP successfully passed a 24-hour test.

The 0-series has been produced by the KALP GmbH since January 2011.

ABOUT THE COMPANY

Achieving the progress of efficient, sustainable terminals and improvements to modern twistlock handling will require creative and innovative technology to cope with new challenges. As a manufacturer of an automation technology, **KALP GmbH** offers solutions for automatic twistlock handling bridging the gap between STS cranes and horizontal transport systems.

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Rebuilding a container crane for Madagascar Port

Refurbishment is an attractive and less costly alternative for replacing port equipment

Ralf Teichmann GmbH, Essen, Germany

A typical 'like-new' solution

In 2009, Ralf Teichmann GmbH from Essen, in close coordination with the Distripool Schiphol Holding BV, a consortium of Dutch forwarding agents, completely redesigned, rebuilt and supplied a used container gantry crane to the Madagascar Port in Amsterdam.

In this project, Ralf Teichmann GmbH could again successfully put into practice their corporate philosophy as a full range supplier of cranes in mint condition. The crane had originally been used by Deutsche Bahn AG (German Rail) and was dismantled by their staff, reconstructed in Essen, and finally erected at its new location at the Madagascar Port in Amsterdam. All logistical services, including the simultaneous deployment of six large truck-mounted cranes, were likewise coordinated from Essen.

Redesign of the steel construction

Since the crane had formerly been used at an inland terminal with no water connection, extensive work had to be done to adapt it to the new location. After intensive discussions with the customer on site and in Essen, the crane was completely reconstructed. The span was reduced from 25 meters to 22.5 meters. To enable the efficient unloading of container ships, the cantilevers had to be extended on the water side to a length of 18 meters, and on the land side to 12.5 meters. Since the cantilevers facing the water side are exposed to harsher conditions, the decision was made to not only reinforce the support columns, but also to provide for anchoring of the pylons to increase stiffness. After completing the necessary calculation and design work, Ralf Teichmann GmbH implemented the project at their own production facilities.

By optimizing the hoisting gear and installing a new rope drum, the crane was adapted to the required lifting height to be able to lift one container over four, and was likewise prepared for the lowering depth underground below the rail surface.

The Distripool Schiphol Holding BV was interested in enabling efficient container handling without any time delays. Consequently, the distance between the columns was extended to allow containers of up to 40 feet to be transported without the time consuming overhead of turning them around between the columns. This dramatically increased the handling capacity which, in turn, can mean a significant competitive advantage for a tri-modal terminal with storage as well as direct ship truck transhipment between vessels.

The technical specifications of the crane remained largely unchanged. This applies to both the lifting capacity of 42 metric tons at the ropes and the operating speeds (hoisting full load/partial load: 10m/min and 18m/min; trolley travelling 45m/min; crane travelling 75m/min).

Original container crane.

Container crane after reconstruction.

Reconstruction of the electrical system

Besides the steel construction, the complete electrical equipment of the crane was also renewed – starting with the main power supply, which was converted from 400 V to 10kV, down to the high voltage cable drum and the high voltage transformer.

In order to be prepared for future expansions of the terminal, the cable drum was designed so that a crane runway of about 300 meters (its current length is 200 meters) can also be used later without any issues. After completely gutting the existing electrical switching cabinet, the electrical installation was reassembled on mounting panels.

The crane was equipped with a new controller based on frequency converters, including SPS S7 and Profi bus. To secure emergency operations, the control system was designed to be fully redundant. Even in terms of hardware and software, the crane is now equipped with state-of-the-art technology. A powerful computer was installed for the warehouse management system. In addition, the crane includes a crane management system to identify all crane coordinates such as the hoisting gear, trolley, crane bridge, and so on. The current position of every single container can thus be localized in real time.

In order to meet the rigorous safety requirements in modern container terminals, Ralf Teichmann GmbH installed a system for personal safety and obstacle monitoring, which stops the crane as soon as any obstructing individuals or objects are detected on the crane runway.

To calculate the cargo-handling operations as quickly as possible, the weighing technology for the containers was optimized so that the measurement takes place during the lifting procedure, with wireless transmission of data. Consequently, no separate weighing is needed, which again optimizes the handling capacity. A further feature of the new crane installation is the integrated power measurement system, which allows the operator to measure, track and account for the energy consumption of the crane on a per container basis.

"A special challenge in this crane construction was the so called 'cocoa containers'," explains Urban Lehmkühler, Technical Manager of Ralf Teichmann GmbH. "These types of containers have an electrical hydraulics system to open the bottom of the container and allow the dust free loading of dry bulk materials like cocoa. We therefore had to develop a system that could supply power to the containers."

An appropriate prototype was developed: When connecting the containers with the twist locks of the spreader, the crane operator has the option of connecting the power supply at the same time by simply pushing a button. The containers are then opened by the operator on the ship by radio control and subsequently closed. After having returned the container to the storage area, the crane operator disconnects the power supply.

Conclusion

"With this successful project, we have once again impressively demonstrated our capabilities as a full service provider of 'like-new' cranes from a single source," states Ralf Teichmann, Managing Director of Ralf Teichmann GmbH. "Our customer received a state-of-the-art crane within a very short time frame, and at only 60% of the costs they would have incurred for a new steel construction. This results in decisive competitive advantages."

Besides the crane itself, the scope of delivery for the group of Dutch forwarding agents also included the rails for the crane runway with special track supports and end stops, as well as a telescopic spreader for 20–40 foot containers in the form of a rotary spreader with gravity point adjustment. Furthermore, the crane was fully repainted in the color desired by the customer, while taking the specific climatic requirements of a seaport terminal into account.

ABOUT THE COMPANY

TEICHMANN Cranes was founded in 1988 by Mr. Ralf Teichmann and is today, with about 200 employees, Europe's leading supplier of used, overhauled or rebuilt cranes. After having taken over BRUNNHUBER in 2009 both new and used cranes are offered to customers from all over the world.

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Modern container security devices for modern cargo

The Intelligent Container R&D Center (ICC), Busan, Korea

Since its inception under the auspices of the Korean Government in 2007, the Intelligent Container R&D Center (ICC) is now pursuing cutting-edge research on conveyance security devices for ever-safer transport of container freight.

The ICC's major product developments to date include the ConTracer (container security device), the *i*-CON (intelligent container), and the *i*-Seal (electronic sealing device). The ICC is sharing its role with a consortium of leading universities and companies in the region to commercialize these products successfully.

ConTracer: the modern conveyance security device

Produced in response to the safety and security regulations of the U.S. SAFE Port Act of 2006, the ConTracer device attaches quickly and simply inside the cargo container and provides real-time monitoring of the container's location and status. It is currently undergoing domestic and international trials to improve its performance and increase its commercialization.

ConTracer: the ConTracer's mounting location. Conveyance security device (inset).

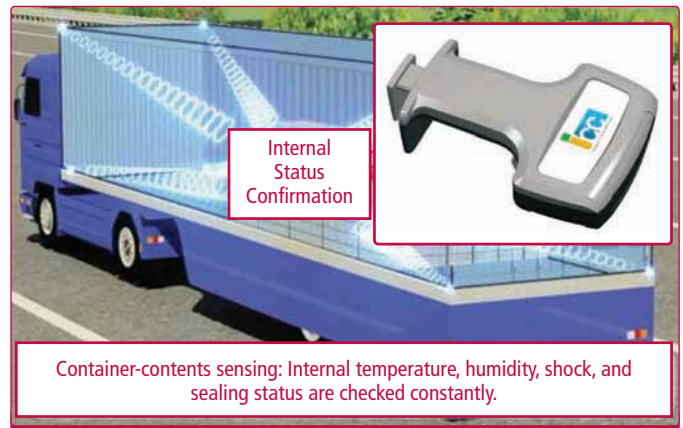
With a ConTracer installed, real-time tracking of a container's complete status becomes possible. The ConTracer monitors temperature, humidity, shock levels, and internal status of cargoes. It can also detect illegal container opening through its e-Seal function and send a real-time warning through its 2.45GHz and 433MHz wireless system – all powered by a rechargeable battery.

TABLE 1: ConTracer SPECIFICATIONS

Item	Specification
Size	210mm × 64mm × 54mm
Sensors	Temperature, humidity, shock, sealing status
Communication	2.45GHz, 433MHz
Application Protocol	CSD based
Battery	3.7V, 9,600mAh 12 months (communicates 300 times)

i-CON: the modern intelligent container

By integrating u-IT intelligent technology into existing cargo containers, all aspects of freight status can be monitored and confirmed in real-time, facilitating rapid clearance of port security and faster cargo transportation.



i-CON: Intelligent container.

Once mounted inside a container, *i*-CON's main features are its ability to report illegal access (e-seal), temperature/humidity/shock/sealing status information, and real-time position tracking through Global Positioning System (GPS). With its communications array, *i*-CON sends constant information to the monitoring center, allowing shippers to determine the ideal transportation environment, and can even transmit emergency information through the same network.

TABLE 2: *i*-CON SPECIFICATION

Item	Specification
Size	210mm × 100mm × 54mm
Sensors	Temperature, humidity, shock, sealing status
Communication	UMTS/HSDPA/GSM/GPRS/EDGE 2.45GHz CSD, 2.45GHz Ad-hoc, Wi-Fi
Location Tracking	GPS
Application Protocol	CSD-based
Battery	3.7V, 12,000mAh 2 months (communicates every 30 minutes)

i-Seal: the modern e-Seal method

Developed with the participation of the INNOMD Corporation, the *i*-Seal is affixed to the outside of the cargo container and uses a mobile network (WCDMA) to provide real-time tracking of the location and sealing status of the cargo. This product was delivered to the Korean Customs Service at the end of 2010 for use in the real-life 'Bonded Goods Transportation Monitoring' project. With customs problems like smuggling and hijacking on the rise, the *i*-Seal will be an increasingly employed solution to ensure safe cargo transportation.

i-Seal: the *i*-Seal mounting location. e-Sealing device (inset).

Like the ConTracer and *i*-CON products introduced earlier, *i*-Seal products can be used to improve the transportation of heavy cargo, hazardous and toxic materials, and industrial wastes, facilitating real-time management of the cargo flow and frequent confirmation of bonded-cargo status. The shippers and receivers who utilize these advances can expect great satisfaction and significantly improved logistics.

TABLE 3: *i*-Seal SPECIFICATION

Item	Specification
Size	412mm × 74mm × 100mm
Sensors	Sealing Status
Communication	WCDMA
Location Tracking	GPS
External Interface	Standard 20 Pin TTA
Battery	3.7V, 9,600mAh 12 days (communicates every 5 minutes)

For example, when high-value cargoes are exported to the U.S., the conveyance security devices described here can provide real-time location and status monitoring for peace of mind. Once in the U.S., the devices will allow cargoes to clear customs quickly as they adhere to the SAFE Port Act's security provisions, significantly reducing the time and costs associated with traditional cargo inspections.

Specifically, when exporting goods to the United States from 2014 onwards, the lack of an electronic CSD will subject cargoes to three to five days of additional inspections and extra costs of approximately US$500.

ABOUT THE ORGANISATION

Intelligent Container R&D Center (ICC) in Dong-A University is a member of the Regional R&D Cluster Project teams which is newly supported by the Ministry of Knowledge Economy (MKE) and Busan Metropolitan City in Korea for the 2007-2013 period. ICC is focusing on research, development and commercialization of intelligent container system that monitors the cargo status inside the containers on a real-time basis, in order to prevent accidents in advance, and also give a prior notice in case of risk perception.

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Prysmian takes over Draka

The recently announced take-over by Italian-based Prysmian of the Dutch cable manufacturer Draka Holding N.V. changed the dynamics of the cable industry, as the new group has herewith overtaken the French company Nexans and is now the world's largest player in the industry.

Describing the take-over as "a compelling industrial and strategic rationale", Prysmian said it had brought together highly complementary know-how and a geographic footprint and product portfolio, on which to build a strong platform for future organic growth and industry consolidation.

The new group is a perfect fit geographically, with a global presence in more than 50 countries with over 90 factories and net sales of € 5.8 billion (US$8.4 billion), based on 2009 aggregate figures. Geographically Draka is strong in northern Europe, while Prysmian is strong in southern Europe and increasing its coverage in fast growing emerging markets.

Prysmian – market

Based on port projects, 'collapse' of the equipment market over recent years, which could be seen in the massive drop in orders (e.g. ZPMC's order book), had a knock-on effect throughout the cable sector as well, according to Thomas Kittel, Product Manager for crane cables at Prysmian in Germany. "Orders are returning but slowly and terminals seem to be more focused on refurbishment," he says.

Prysmian – new development

For the past 18 months Prysmian has been promoting its Protolon IQ 'intelligent' cable, used as a reeling umbilical cord for all sorts of other cranes types in the container and materials handling industries. The cable contains sensors that 'feel' real-time stress measurements as well as sudden mechanical impacts along its entire length, 'communicating' its condition back to the operator.

"Our customers have given us positive feedback saying that it is the way forward, especially for automated stacking cranes (ASC, RMG). We completed our first installation at the end of 2010, following which we received another order and have others in the pipeline," explained Kittel. Claiming that "good development takes time", he said the company is developing other new cables, which are expected to be launched later this year.

ABOUT THE COMPANY

Prysmian is one of the world's leading players in high-tech energy and telecom cables and systems, with a strong position in high value-added market segments. It develops, designs, produces, supplies and installs a wide range of products and services in the two sectors covered by its two divisions: 1) Energy Cables & Systems for underground and submarine power transmission and distribution, both for industrial applications and for residential and commercial buildings; 2) Telecom Cables & Systems for video, data and voice transmission.

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New: Port Equipment spare parts from TVH

For over 40 years, TVH has had the reputation of being a company with a passion for forklift trucks, aerial platforms and industrial in-plant vehicles. For more than 17,000 customers in over 160 countries, TVH looks for and aims to offer the best solution.

In a further effort to increase its service and supply to customers, TVH now also includes 'Port Equipment' spare parts in its product range. Covering all brands of terminal tractors, spreaders, reach stackers and empty container handlers with spare parts supply in the market. By using the existing know-how and facilities of the group of companies, TVH gets another step closer to becoming the 'one-stop shop' supplier for all its customers.

TVH's service is built on three principles:

- A broad range of parts in stock
- Delivery within 24 or 48 hours
- Making it easy for customers to buy parts.

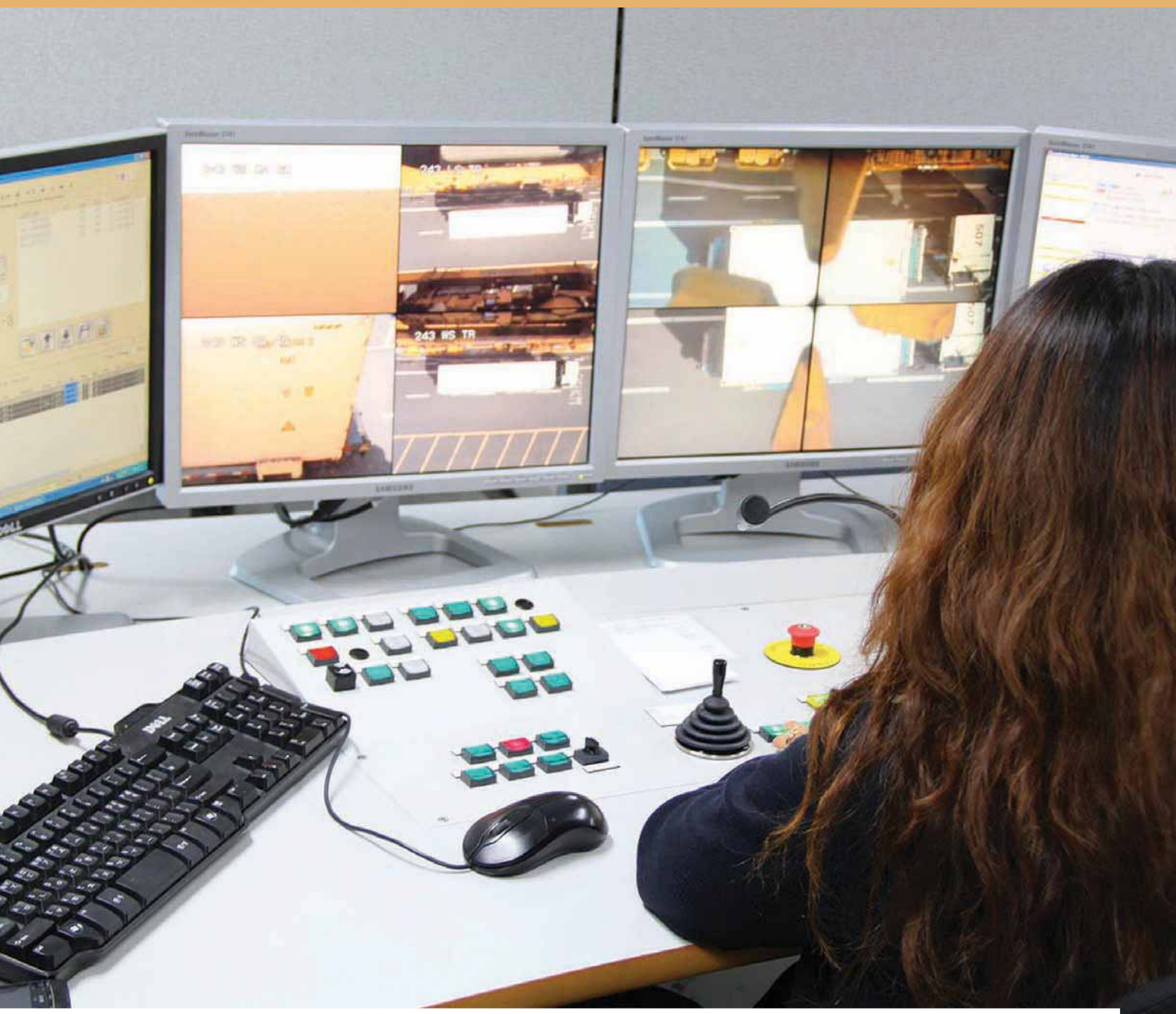
Through an elaborate e-commerce system, customers can consult TVH's stock 24/7. The in-house sales teams are always available to advise customers from all over the world in 33 languages.

ENQUIRIES

Mr Diederik Lenssens/Ms Benedikte Demunck
Tel: + 32 56 43 42 11 E-mail: ports@tvh.com

TVH now includes port equipment for a wide variety of brands in its product range.

TERMINAL LOGISTICS



"Using twin and tandem-lift STS cranes can double moves per hour at the vessel, but can also build up new bottlenecks in other areas of the terminal. Therefore, TOSs are becoming more and more complex, and calculate moves beforehand for the best result."

'How to avoid checkmate', page 82.

How to avoid checkmate

Virtual terminals support terminal operators in getting the most out of their TOS

Prof. Dr.-Ing. Holger Schuett, ISL Applications GmbH, Bremerhaven, Germany

Requirements are escalating

Like in a chess match, terminal operators have to react to the moves of shipping lines and terminal equipment suppliers again and again. On the one hand, the next generation of container vessels – carrying some 18,000 TEU – is expected to arrive soon. On the other hand, new technologies are available that increase productivity at some point on the terminal. Using twin and tandem lift STS cranes can double moves per hour at the vessel, but can also build up new bottlenecks in other areas of the terminal. Therefore, current Terminal Operating Systems (TOS) are becoming more and more complex, and have to calculate some moves beforehand to receive the best result.

Nowadays huge terminals, especially Greenfield ones, are planned and optimized using simulation technology (see box) to guarantee optimal operation. But small and medium-sized terminals are much more affected by the changes described, as not only might they lose business to their competitors, but it's also rather a question of whether they thereby reach capacity and/or productivity limits. To avoid the checkmate, these terminals have to use new technologies like the virtual terminals described in this paper.

Simulation and emulation of container terminal operation

Container terminals may be supported by means of simulation and emulation during all phases of terminal planning, developing, start-up and operation.

Simulation ("The copy of a dynamic process in the form of a model, to get knowledge that can be applied to the real system") combines the information flow as well as the material flow within one model. It is used in the planning phase for defining the best layout, comparing various types of operation, and evaluates the quantity of equipment needed.

Emulation ("A model that accepts the same inputs and produces the same outputs as a given system" IEEE 610.3-1989) provides a virtual terminal that is connected to the Terminal Operating System (TOS) and behaves like the physical terminal. It may be used for testing as well as fine-tuning the TOS, training the control staff and replaying previous problematic situations.

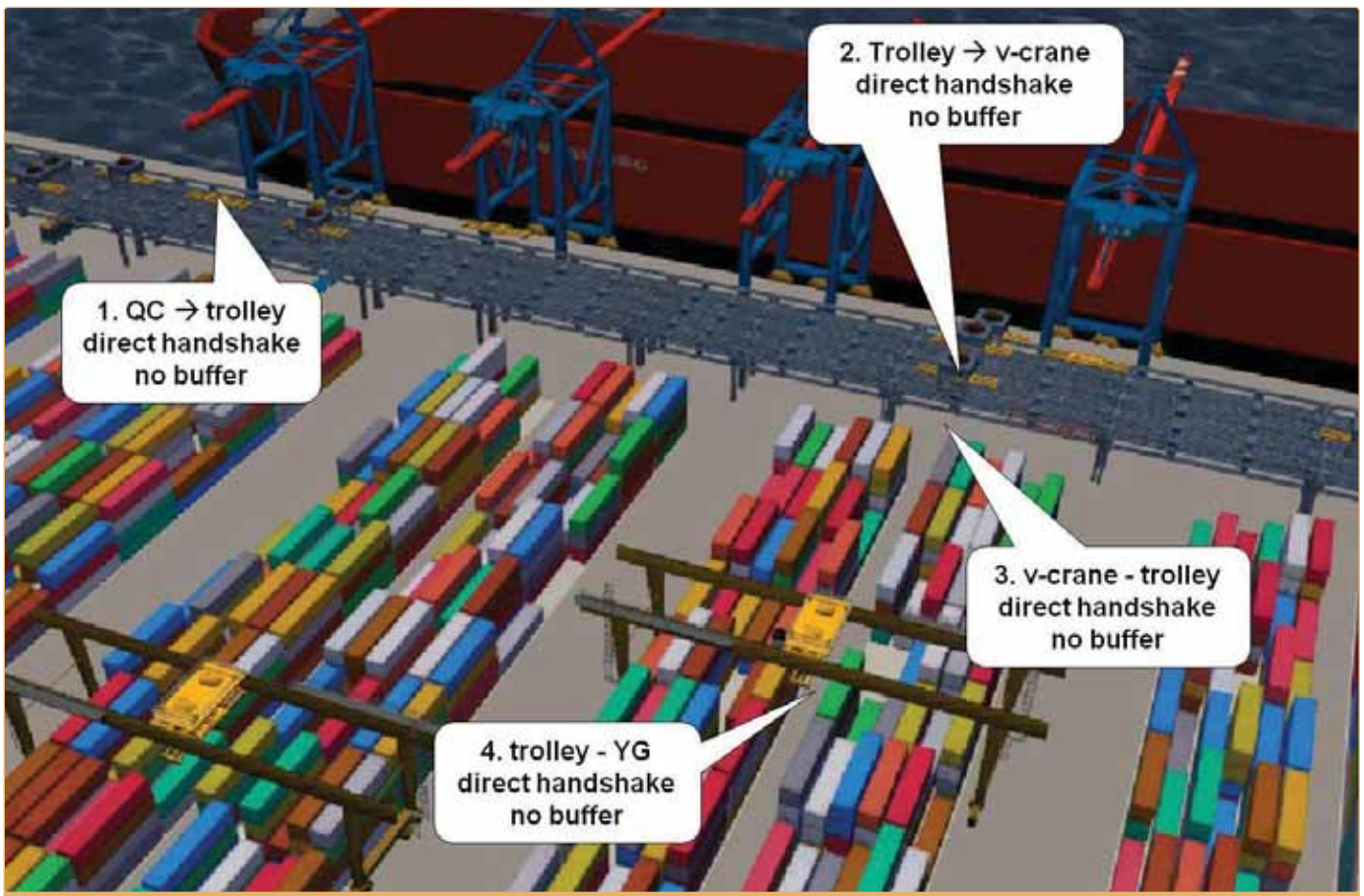


Figure 1. Some years ago, ZPMC developed the simple principle of horizontal transport technology.

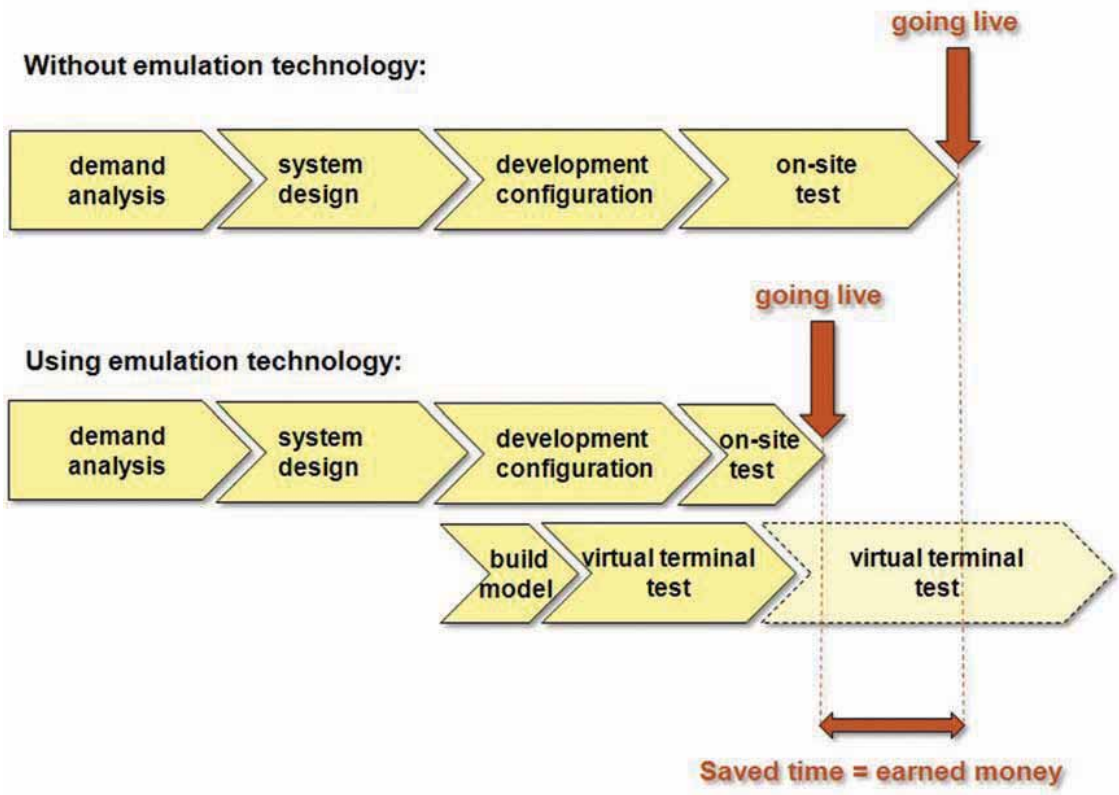


Figure 2. Where time is saved testing technology virtually before it goes live, money is saved too.

New strategies are demanded

To increase a terminal's productivity, often new technological approaches are used. In this way some years ago ZPMC, the Chinese market-leading supplier of STS cranes, developed a new horizontal transport technology. The straightforward basic idea of this concept is to divide the whole transport between the STS crane and the yard into small pieces. Each part of transport is done on only one axis:

- First transport is parallel to the quay, via platform using a supported carriageway
- Second transport is vertical from the rail to the ground by a moving crane
- Third transport is perpendicular to the quay using another platform on the ground.

All handshakes between the STS and the platform, the platform and the moving crane, the moving crane and the ground platform, as well as the ground platform to the yard stacking crane are to be handled directly without any buffer. Thus the equipment control of this technology has to ensure that all devices needed for the handshake have to be at the same place at the same time. This task seems not to be a problem for transport of a single container, but looking at a productivity of some 200 moves/h at a vessel shows the extreme complexity of this control task.

The same holds for the automation of container terminal operation. As the manned device at the terminal is equipped with highly sophisticated local intelligence (the brain of the driver), the automated one is not. Each decision about bypassing traffic congestions on the terminal and exception handling may be done by the driver directly. However, the central control of automated technology has to regard all possibilities, and has to

Figure 3. The layout defined in the TOS – such as Navis' SPARCS – is automatically converted into a virtual terminal.

Figure 4. A lot of training is required for operators to become Grandmasters of solving problems using virtual terminal software.

think for all single pieces of the equipment (e.g. some 70 AGV at the Container Terminal Altenwerder). The difference between artificial and human intelligence may be seen by the fact that chess computers are only just yet at the same level as the human Grandmasters after many years, and a lot of software developers trying to defeat them.

Virtual terminals

The basic idea of emulation technology (see box) that may support terminal operators is the provision of virtual terminals. These react to the TOS's commands as the physical ones do. A complete model including seaside operation, horizontal transport, stacking yard, gate operation and all equipment used at the terminal is built into the computer. The TOS, which is connected to the virtual terminal, does not know whether it controls the virtual or the physical one.

In this way, the TOS may be tested without disturbing the real operation. Neither operating costs nor wear of the equipment will occur during the test. Furthermore, environmental impacts such as noise and pollutant emissions will be avoided. Running these tests with the TOS guarantees the correct functionality, as well as it may be used to fine-tune the parameters controlling the strategies. The tests may be repeated as many times as needed (e.g. with different parameter settings) under exactly the same conditions – while the real-life weather conditions and workers' behavior will change for each test. Thus the changes in the results of these laboratory tests can be traced to the parameter changes.

Using the virtual terminal in the start-up phase of new terminals, or during the reorganization of existing terminals, will lead to less time needed for tests with the physical environment and thus will result in earlier start of operation, as shown in Figure 2.

(Semi-)automatic modeling

The tests with virtual terminals are only as good as the modeling of the terminal. Thus building a model has to be done in a very detailed manner and will take some amount of effort. Therefore easy to use modeling tools have to be designed. One module within this toolbox may be a graphical editor that allows the user to draw the layout of terminals. With the use of "copy and paste" as well as a package of predefined objects (e.g. a stacking block with various parameters describing the structure), the layout may be defined within a few hours.

To ensure compatibility with the physical terminal, the terminal description within the TOS, and the virtual terminal layout, an automatic converter has been developed. The yard block description from the TOS is used to define the blocks in the virtual terminal. The labeling and the numeration of the stacks, as well as their rows, slots and levels may be taken directly from the TOS. The same holds for the equipment in use and their technical data (as far as it is available in the TOS). This semi-automatic method will speed up building virtual terminals, and thus may smooth the way for small and medium-sized terminals using this technology in an economic way.

Do it yourself

Another important method of using a virtual terminal for optimizing operations is to enable the terminal operator himself to update it according to changes in the layout, the equipment (quantity as well as technical data), and so on. This may be done in the same manner as terminal operators are already familiar with from their TOS configuration.

The TOS typically is developed by the TOS suppliers such as NAVIS, TotalSoftBank, CyberLogitec, Jade, RBS, Tideworks, and

others. They deliver the entire software solution (as a standard product), and customize it regarding the individual demands of the terminal. They train the control staff of the terminal to use the software, as well as to configure it to upcoming new demands. Typically, terminal staff are in the position to do all changes needed in the day-to-day operation. From time to time, it may be a good idea to invite a TOS expert to have a look at the system and to check whether it is working in an optimal way. If there are huge reorganizations at a terminal, often these specialists are called to help the control staff to start up the reconfiguration and then leave after a short time.

Today, this is also possible with simulation and emulation technology. The terminal operator purchases the virtual terminal software (only few operators develop their own systems). The supplier will build the first model, including the TOS interface. The layout modeling may be done within the first training session, as well as the definition of the equipment. At the end of the installation and training the control staff will be able to use the virtual terminal for testing purposes. Furthermore, they will be able to change layout parameters, and modify the number and technical data of equipment. Scenarios may be defined by logging actual shift data and may be enhanced by the user. Very experienced users may also define brand new terminals as far as they are controlled by the same TOS. For special challenges, the terminal operator may ask the supplier for support during the start-up phase of new projects.

Thus the usage of the virtual terminal software may be compared with varieties of chess: beginners will start without time limits, at some level they will start to play blitz chess, and Grandmasters play simultaneous chess.

Become a Grandmaster

To become such a Grandmaster, a lot of training is required. The virtual terminal allows the control staff to train in controlling their terminal using their TOS, using historical data from bygone shifts. Problematic situations at the terminal may be replayed and the staff may learn how to solve the situation better next time.

Learning from shipping lines that use vessel simulators to train their shipmasters, terminal operators may use the virtual terminal as a training centre. Predefined scenarios (for example, captured from previous operations) are to be controlled by the trainees. As mentioned before, the environment is the same for each match as well as for each participant. Thus the trainee is able to recognize the changes in the output directly as a result of his own input variation, which is the best way of learning, from a psychological point of view. Championships may even be organized to find the best control expert of the training session.

Conclusion

Virtual terminals enable terminal operators to optimize the parameter settings of their TOS, as well as training their control staff to find the best moves to the demands of day-to-day operation. As IT technology has improved, small and medium-sized terminals are in the position to use virtual terminals in an economical way, and thus survive in competition and win the match.

ABOUT THE AUTHOR AND COMPANY

Prof. Dr.-Ing. Holger Schuett has been working in the field of container terminal optimization for more than 20 years. He is CEO of ISL Applications GmbH and since 2003 has been Head of the Competence Center of Optimization and Simulation within the Institute of Shipping Economics and Logistics (ISL). Furthermore he took up a professorship at the University of Applied Science in Bremerhaven in 2010. Before Holger worked as a project manager at HHLA/ Hamburg, his most famous project had been the simulation based consultancy of the new fully automated container terminal Hamburg Altenwerder.

ISL Applications GmbH has been founded in September 2010. It will market and customise ISL's simulation and emulation products and will offer training, consultancy services and maintenance to the clients. ISL has more than twenty years experience in the market of supporting container terminals with means of simulation and emulation. The product family CHESSCON (formerly known as SCUSY, CAPS, ViTO) is used worldwide in all five continents by terminal operators as well as planning organizations.

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Flexible TOS software for any budget and a wide range of applications

Esoware B.V., Barendrecht, The Netherlands

For small and newly established terminals confronted with huge investments, finding a TOS geared to their requirements and, in particular, their budget is a struggle. Based in Rotterdam, Copas B.V. designs its software and TOS products with the needs of smaller terminals in mind. Esoware B.V. distributes Copas' software for terminals from its office in Rotterdam, managed by Mr. Frans Jol, who has extensive experience in the terminal business.

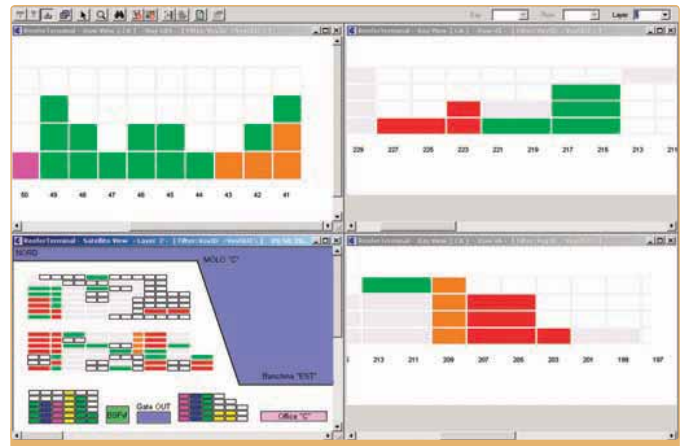
Copas is headed by former senior management of Europe's biggest container terminal, with over 40 years experience in port and terminal operations, supported by 16 dedicated analysts and software developers. They understand the need of any terminal, small or large, to be able to use a comprehensive set of functions, from graphical planning systems to advanced EDI-systems. To date, the affordable Copas TOS software has been successfully installed on more than 14 'wet' and 'dry' terminals throughout Europe and the UK, and modules have also been installed in Holland and Sharjah, UAE.

Esoware B.V.'s integrated container control system for terminals is STEP2, which was developed using modern tools, like Java, and uses SQL-compatible database situations such as MS SQL-server, Oracle or Open Source Databases as a database tool, which ensures safe and reliable storage of valuable data. Using a VPN-connection, Esoware staff can assist customers with the necessary system management or support tasks. Management reports can be made using a standard report generator.

The YARD Planning & Viewer software, a module of the STEP2 container control system, has also been developed using advanced Java techniques. YARD communicates with the STEP2 database to obtain container data in real-time. YARD shows the current status of the container yard, and all containers therein. Certain containers – from a certain vessel or for a certain destination, etc. – can be identified, and their exact location pinpointed in the yard. YARD automatically determines the optimal location in which to place newly arrived containers, and can then communicate this planned location to the reachstacker driver via the RFnet module (see below).

Other modules of the STEP2 system include:

- **GATEwizard** assists the gate clerk with entry and retrieval of data from the database for truck arrival and departure; container pick-up and delivery, customs release, operator release, etc.
- **RFnet** maintains a communication channel to each active Radio Data Terminal in the yard, whether in terminal buildings, equipment or handheld ancillary computers used by checkers.
- **EDI-STEP** uses safe and secure communication channels to automatically send and receive EDI-messages. These messages are automatically converted from their internal format to the agreed format, and vice-versa.
- **E-Terminal** is an Internet-based interface for the terminal's customers, which can generate real-time container status; tracking release orders, order entry, vessel calls, feeder/train planning and various other reports.



A screen-shot from EYard, STEP2's graphical yard planning and monitoring module.

- **TIS Terminal Invoicing System** automatically stores all data on container moves, stocking days, contracts, and all other relevant data on the database, and also generates draft invoices. At any time, the invoicing clerk can start invoicing the process for a certain customer or vessel etc.
- **PLANMASTER** is a professional vessel planning tool in use by many terminals and shipping lines all over the world. PLANMASTER interfaces with STEP2 and YARD. Data entry can be kept to an absolute minimum using EDI messages and the data from STEP2 and YARD.
- **VSS Visual Security System** covers all new European laws and ISPS rules. It offers a closed security system within ports by using key cards for all people entering the port area. Video cameras can also be added to the system, which can then be connected via E-Terminal.

STEP2 also has a specialized module tracking the movements of RoRo cargo (RoRo-trailers), which can also be used for planning, full administration and invoicing on the terminal via EDI and other communication methods. As well as Copas, Esoware also represents Refrigerated Transport Electronics (RTE), a US-based company that has developed software for monitoring reefer temperatures aboard vessels, but also for container, barge or rail terminals. Features include supervision of reefers' actual condition, pre-trip maintenance, downloads of trip reports, set point charges, power management, bay/yard view, and a container arrival and departure log.

Based in Rotterdam and Hong Kong, ARL-shipping.com Limited has also teamed up with Esoware to sell each other's products around the world. ARL provides innovative and configurable e-Services to the global transport community. ARL's specialist TOS applications for the port industry include berth planner software, resource demand managers, RTG deployer/dispatcher, yard clash predictor, lashing planner and quay crane visualizer.

ABOUT THE COMPANY

Based in The Netherlands, **Esoware B.V.** was formed in 2009 when the company took over the Italian-based Esoware Srl., which was founded in 1994. Esoware B.V. is the marketing and sales company responsible for the distribution of dedicated software for container terminals, inland and rail terminals around the world, as well as specialized software for vessel planning, ship agents and forwarding companies.

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"Coal railed to the Port of Beira cannot be loaded into Panamax or Capesize vessels. Therefore, offshore transshipment is the only viable solution to take advantage of economies of scale in the sea transportation part of the logistics chain."

'The transhipment solution: overcoming constraints in port logistics in developing countries', page 92.

The transhipment solution: overcoming constraints in port logistics in developing countries

Coeclerici transhippers are supporting Mozambique coal exports where conventional port facilities are insufficient

Capt. Giordano Scotto d'Aniello, Head of Commercial Department, Coeclerici Logistics, Milan, Italy

In January this year Coeclerici Logistics successfully launched *Bulk Zambesi*, a 55,000 DWT transhipper vessel of last generation. The vessel, which is the first of two units, will start operations in Beira, Mozambique in July 2011. The second transhipper named *Bulk Limpopo* will be operative in the first half of 2012.

Background

In December 2009 Coeclerici Logistics, the logistic division of Coeclerici Group, specializing in international offshore logistics for raw materials, acquired the biggest offshore coal transhipment project ever awarded, which foresees the handling of about 11 million metric tons of coal per year during a 20-year contract. The cargo involved is 80% coking coal and 20% steam coal. Coeclerici's project was selected among offers made by leading offshore logistic operators that participated to the international tender for the Moatize coal project in Mozambique issued by Vale, the Brazilian company world leader in metal and mining production.

Mozambique mining

Mozambique is seen as one of the new and fast growing countries with the mining industry, and is expected to grow at a rate of 9.2% during 2010-2012. The major coal demand is expected to come from Asia, China, Europe and India. Mozambique is well positioned for exports to these countries and its coal is seen competitive with that originating from Australia, South Africa, Indonesia and Colombia.

The 55,000 DWT *Bulk Zambesi* transhipment vessel, the first of two such vessels to be deployed at Beira port, Mozambique.

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Moatize coal project

The Moatize Coal Project involves the development of a concession area in Moatize, located in the Tete Province of Mozambique, approximately 600 kilometers from the Port of Beira. The overall investment expected to be of about US$1.2 billion, accounting for 12% of Mozambique's GDP in 2008. Tete Province has an estimated 2.4 billion tons of coal reserves.

The coal that will be railed to the Port of Beira can not be loaded into big Panamax or Capesize vessels due to limitations in the Port and draft restrictions in the approaching channel. Therefore, offshore transshipment is the only solution that can be implemented to take advantage of economies of scale in the sea transportation part of the logistics chain. The project, which envisages the employment of two tailor-made transshipment units, will thus help to overcome these infrastructural limitations.

Both transshipment units, fully designed and built by Coeclerici Logistics, will be loaded at berth in Beira and will transport their coal cargo to a suitable deep-water anchorage off the coast, where there are no draught constraints and where the coal will be transferred into ocean-going vessels (OGV) up to 180,000 DWT by means of a sophisticated loading system installed onboard.

Bulk Zambesi and *Bulk Limpopo* are each duly equipped with heavy duty cranes, grabs, a belt conveyor system capable to transship at 4,000 tons/hour, and state-of-the-art gears allowing a throughput of around 12 million tons of coal per year. The two vessels will fly the Italian flag, will be classed with RINA, and will be in compliance with the latest international code resolutions for ships' safety and security, protection of crew and of the environment.

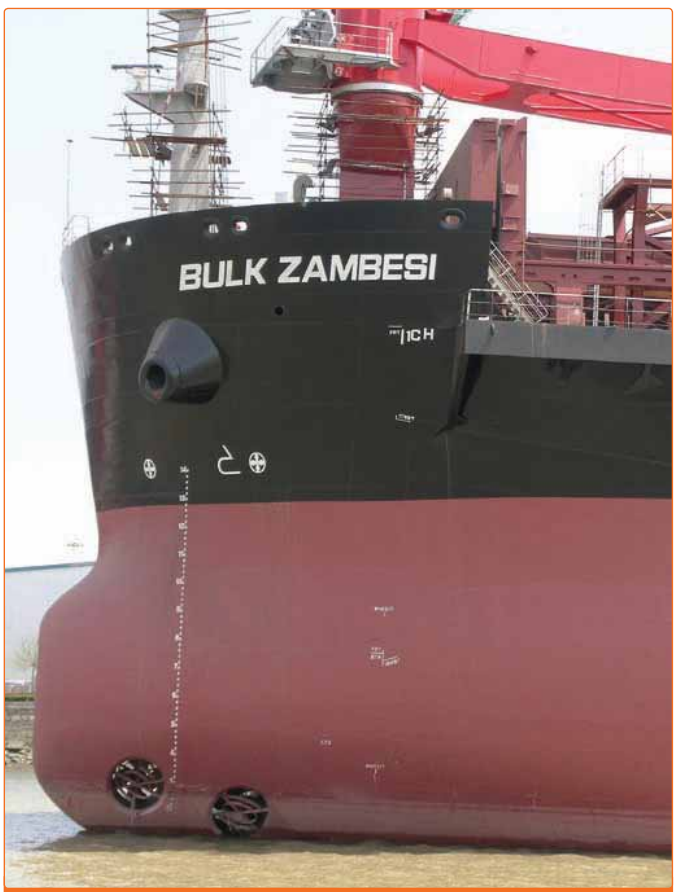
Transhipper operation cycle

• Loading at berth

The coal mined in Tete Province will be railed up to Beira port using the Sena line, which was finished being upgraded a few months ago. Coeclerici transhippers will be loaded at berth no. 8 by means of shore facilities. The loading operation will be completed on the basis of available tide and each OGV's schedule.

The average tidal depth is about 11.3 meters (being spring tide plus 6.7 meters), which will permit the transhippers to load about 44,000 metric tons of coal.

It will be possible to load different grades of cargo, which will be segregated in the five holds existing onboard.



The *Bulk Zambesi* has two sets of bow thrusters, each with an output of 700kW.

• Sailing to the transshipment area

The transhippers will navigate through the Macuti channel, which has a depth of 8 meters on Chart Datum and is about 135 meters wide, to reach the OGV, which will be anchored in the transshipment deep-water area located about 25 nautical miles from the loading berth. The transhippers are equipped with special flap-rudder and heavy power double bow-thrusters to facilitate the navigation along the hairpin-bends of the Macuti channel.

• Loading the OGV

Bulk Zambesi and *Bulk Limpopo* – equipped with a pitch-propeller, flap-rudder and double bow-thrusters for smooth maneuvers – will approach and will moor alongside the OGV. The two units, fitted with suitable Yokohama fenders, will safely start transshipment operations. The five cranes onboard (one for each hold) will start to grab the cargo and will discharge it into the five hoppers.

The hoppers are equipped with anti-spillage plates, and the grabs used are spillage-free to avoid coal pollution at sea. A pay-loader is also available into the holds to gather the cargo and maximize the loading operation.

A system of fully covered conveyor belts, which run under the hoppers, will transport the cargo to a gantry traveler conveyor. This conveyor will finally put the cargo into a 37-meter long loading boom for loading coal into OGV holds.

The loading boom will be able to rotate and incline, and will be equipped with a 9-meter swiveling chute, which can smoothly deliver the cargo into any part of the OGV holds while avoiding 'empty spaces'.

Both transhippers are able to guarantee great stability even with adverse weather conditions. A 'tank test' simulation has been duly carried out during the design phase at USP University of Sao Paolo, resulting in a high percentage of operational days.

TABLE 1: BULK ZAMBESI TECHNICAL SPECIFICATION

Criteria	Value
LOA	190m
Breadth	32.26m
Depth	18m
Draught (scantling)	12.80m
DWT	Approx. 54,400
Speed	Approx. 14Kn
Main Engine	kW 9480

- **Propeller**: One four-blade pitch-propeller
- **Rudder**: One rudder composed of a single main blade, plus additional flap permitting high manoeuvrability while turning.
- **Bow thruster**: Two sets of bow thrusters, each with an output of 700kW.

Cargo handling system

The handling system has a peak loading rate of 5,500 tons/hour, guaranteeing an average loading rate in excess of 3,000 tons/hour in all conditions.

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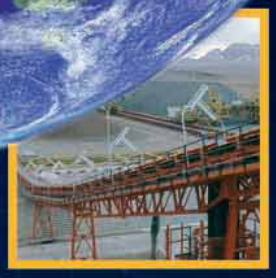

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Cranes

Five electro-hydraulic heavy duty high performance four-rope grab cranes, designed for high speed continuous operation in open sea, with a lifting capacity of 40 tons and an outreach of 26 meters, with the following characteristics:

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- Operation of all three motions simultaneously with maximum load
- Automatic power output regulator for all motions
- Wide rope field
- Low center of gravity
- Designed with focus on low maintenance and life-cycle costs
- Comfortable driver's cabin with all-round vision and ergonomically designed layout.

Hoppers

Five hoppers positioned starboard side with upper opening of about 10 meters by 6 meters, with inner lining made by Hardox 400, each equipped with two electrical vibrators and fitted with anti-spillage plates operated by hydraulic pistons.

Conveyors

- One belt feeder (one for each hopper)
- One longitudinal conveyor of approximately 162 meters on starboard side
- One astern cross conveyor of approximately 30 meters
- One tripper conveyor of approximately 161 meters on port side
- One travelling gantry on port side with a travelling length of approximately 79 meters, designed to accommodate the boom conveyor
- One boom loading conveyor of 37 meters length and 18 meters air-draft, with a maximum elevation of -10°+ 18° and a maximum slewing of about 100° at 15° luffing. The loading boom is also equipped with a 9-meter rotating chute to gently handle cargo in each part of the OGV holds.

Environmental impact

Both transshipment units have been designed to meet the most stringent environmental protection standards set by all major international certification bodies: IMO, MARPOL, IOPP, and ISPP. The loading system has been tested to reduce pollution and spillage of coal in the sea, mainly thanks to devices such as:

- Hoppers with anti-spillage plates
- Covered conveyor belts
- Anti-spillage grabs.

Hence, we can classify *Bulk Zambesi* and *Bulk Limpopo* as 'environmentally friendly transhippers'.

The rudder of the *Bulk Zambesi* is fitted with additional flap, making the vessel highly manoeuvrable.

Coeclerici Group

The agreement with Vale Group is another example of Coeclerici Group's ability to develop solutions that can overcome port logistics constraints in developing countries, based on Coeclerici's know-how and expertise gained over more than a century of professional experience in the shipping industry. In addition, owing to its 20-year duration, this project is perfectly in line with recently implemented policies that aim to ensure stable profitability for the Group through agreements with first-class international operators.

Projects where tailor-made solutions developed by Coeclerici Logistics are employed include:

- Lake Maracaibo, Venezuela where *Bulkwayuù* handles over 6 million tons of coal on behalf of Carbones del Guasare, the main exporter in the country
- Goa, India where *Bulk Prosperity* is employed in offshore logistic operations on behalf of Fomento Group
- Tanjung Bara, Indonesia where *Bulk Pioneer* serves Kaltim Prima Coal handling 5 million tons of coal every year;
- Piombino, Italy where *Bulk Irony* serves Lucchini, and
- *Bulk Kremi I*, through the recent joint venture with Transship Ltd (the major transshiper operator in the area) is now employed in the Black Sea.

ABOUT THE COMPANY

Coeclerici Logistics, the logistics division of Coeclerici Group, is today a leading company in land-sea transport of raw materials, with transshipment, port logistics, and short-sea shipping operations.

Founded in Genoa in 1895, Coeclerici Group, with a turnover of about € 500 million and 800 employees, is a leading international operator for the supply of integrated and innovative services for the power, iron and steel industries.

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Maximum capacity, minimum fuss

Limestone and FGD gypsum transport at a coal-fired power station in England

Arthur Loibl GmbH, Straubing, Germany

Transportation of limestone

At the Rugeley coal-fired power station in Staffordshire, England, the two existing coal-fired boilers 6 and 7 of 500 MW each were equipped with a flue gas cleaning plant. Plant and materials engineering firm Arthur Loibl GmbH supplied and installed the materials handling equipment for receiving limestone and the transportation of Flue Gas Desulfurization (FGD) gypsum. The required limestone, with a grain size of 20mm, is delivered by wagons and discharged into a hopper in an enclosed unloading station.

For dust suppression and dust removal in the unloading area a de-dusting plant with a de-dusting air volume of approx. 60,000 Nm^3/h is applied, with feeding of the cleaned dust to the adjacent materials handling equipment by means of screw conveyor. A supply of compressed air is provided by means of screw compressors.

The reinforced concrete hopper is covered with an open grid of 110mm spacing, and lined with wear rubber plates 27+3mm to minimize wear.

Underneath the hopper in the basement area, discharging is made via two unbalanced vibratory conveyors, each with a width of 1,500mm, which in turn feed a vibratory cross-conveyor. The total discharge capacity is 600 tons/h = approx. 480m^3/h max.

Sorting and refining conveyed material

For removing metallic parts an electric overbelt magnet is installed above the discharge of the vibratory cross-conveyor onto the adjacent troughing belt conveyor, which discharges the ferrous parts into a container.

In order to measure mass flow the conveyor belt, which has a belt width of 1,000mm and a conveying capacity of 600 tons/h, is equipped with weighing scale. On the discharge side, a hammer sampling station is integrated into the hood for quality inspection of the delivered limestone.

Limestone is discharged on to a sidewall belt conveyor, which has a belt width of 1,400mm and a center distance of approx. 34,000mm, for the following transfer to a customer-supplied pipe conveyor.

Cleaning scrapers were applied underneath the horizontal sections of the sidewall belt conveyor. These scrapers collect the spillage and return it into the conveyed flow.

After the customer-supplied pipe conveyor, the two limestone silos are fed via a reversible troughing belt conveyor with a belt width of 1,000mm, center distance of approx. 19,000mm and a conveying capacity of 600 tons/h.

The enclosed, curve-negotiable Sicon® conveyor transports gypsum from the dewatering station to the silo at a capacity of 25.0 tons/h.

The arm that discharges gypsum from the silo is driven by two 22kW motors and has a capacity of 280 tons/h.

Transportation of FGD gypsum

Inside the dewatering station the FGD gypsum is transported via a reversible belt conveyor, belt width 650mm, for both the main and auxiliary routes. Outside of the dewatering station, an enclosed, curve-negotiable Sicon® conveyor (S100/650 x 80,000mm) transports the FGD gypsum to the gypsum silo, with a conveying capacity of 25.0 tons/h.

The Sicon® conveyor begins on a platform +11.50m outside the dewatering building and runs around a limestone silo, ascending at about 17° and 12°, with concave and convex curves as well as two horizontal deflections. For this purpose the conveyor belt frame is designed as a self-supporting structure and is fastened to the limestone silo.

On the FGD gypsum silo at +33.0m the FGD gypsum is discharged into the gypsum silo, which was not part of Loibl's scope of supply.

From the gypsum silo, the FGD gypsum moves through a customer-supplied pipe conveyor to the FGD gypsum loading silo (with a volume of 150m³), for which engineering was also provided by Arthur Loibl GmbH.

The gypsum loading silo stands on weighing cells and the gypsum is discharged by a heavy, rotating discharge arm with a capacity of 280 tons/h. The discharge arm, with a diameter of 5,500mm, is frequency-controlled and driven by two 22kW motors. The discharged FGD gypsum drops on to the adjacent moving conveyor belt, width 1,000 mm, center distance 16,000 mm, and is discharged on to a telescopic loader. The loader in the pipe segment design and dust cap fills up containers, which are placed on wagons. The loading process can be controlled on site via an operating panel.

In August 2009 the equipment was preliminarily handed over to the customer and has been running trouble-free to the client's satisfaction since that time.

ABOUT THE COMPANY

Arthur Loibl GmbH is a family-owned enterprise with tradition. Mr. Arthur Loibl, a professional engineer, founded the company in 1960 at its current site of Straubing, Germany. He led the firm until 1992, when his son took over. The company still remains under private ownership and is one of the most successful and best known mid-size companies in the materials handling technology branch for bulk material.

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New developments in offshore dry bulk handling

Offshore transshipment facilities are becoming increasingly important in overcoming the bottleneck caused as vessel size outstrips port expansion

Sanjeev Mathur, Country Manager, Bedeschi & BLL, Dubai

Since the beginning of the last century Bedeschi has been involved in handling various kinds of dry bulk material for a variety of industries such as cement, brick, clinker, coal, bauxite, iron ore, among others.

Based on the company's 100-year know-how in the handling of several different and difficult bulk materials, several years ago Bedeschi realized the vast potential of the growing offshore transshipment market and started developing cargo handling systems for offshore applications too. Bedeschi is now among the market leaders in this sector too.

Offshore transshipment: an overview

Offshore transshipment essentially means transfer of dry bulk cargo, such as coal or iron ore, from large vessels into smaller vessels or vice-versa. The growth in vessels' size has rapidly increased since the Second World War, but port development has not been able to keep pace with it. Vessels' sizes have increased because of economy of scale, i.e. the larger the vessel size, the lower the per-ton transportation cost. Port development, unfortunately, has lagged behind, mainly because of a high gestation period and high development cost. The only way to overcome this bottleneck is offshore transshipment. Many kinds of transshipment devices have been devised and deployed in various parts of the world, mainly for coal and iron ore handling.

A classical transshipper essentially comprises of two main components: the cranes, and the cargo handling and delivery systems. Their application varies from the usage of the system, i.e. if the system is intended to carry out offshore loading of cargo from barges into ocean-going vessels (OGVs), or discharging the cargo from OGVs into barges.

For a loading system, the cranes need not have a very big outreach because they have to pick up cargo from barges, which are relatively smaller in size and berthed alongside. The cargo handling system instead should be equipped with a shiploader, with sufficient air draft and outreach to deliver cargo into the holds of large OGVs. The reverse is applicable for discharging systems where the cranes, which are supposed to pickup cargo from large OGVs, have large air draft and outreach; and the cargo handling system has a smaller barge loader sufficient to deliver cargo into barges, instead of a shiploader.

Bedeschi has implemented various systems that are now in successful operation in different parts of the world. Let us now examine a few systems as case study to emphasize the application.

Princesse Chloe

Princesse Chloe is equipped with two heavy duty offshore four-rope Liebherr cranes, of 30 tons capacity each. They have been fitted with Peiner Smag grabs of 20.5m^3 capacity. The cranes are strategically placed adjacent to the hoppers so as to minimize the slewing movement, thereby increasing the cycle time and efficiency.

The *Princesse Chloe* floating bulk terminal operates in East Kalimantan, Indonesia and has a loading rate of 40,000 tons per day.

Detail of trimming chute.

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Extended telescopic boom.

The cargo handling system supplied by Bedeschi consists of two duly designed hoppers and an array of conveyor systems, leading to a telescopic/shuttle shiploader. The hoppers are of 50m^3 volume, with a top opening sufficient to accommodate the large grabs in use. The trunk-pyramidal shaped hoppers have asymmetrical walls to ensure smooth flow of coal through the hoppers into the transfer chute. The hoppers are fitted with vibrators to ensure free flow of sticky coal, in order to maintain the required flow rate. The top of the hoppers are fitted with mesh grill to eliminate any oversize or undesirable material, which may potentially damage or block the conveyor system. The water sprinkler system is installed on top of the hoppers to suppress the coal dust during grab delivery.

Coal from each of the hoppers is extracted by means of individual variable speed belt feeders. These frequency controlled feeders extract coal from the hoppers and transfer it to the longitudinal conveyor. The belt width of the feeders is kept high and the speed is low to ensure uniform extraction of coal from the hoppers. Another conveyor then transports the coal longitudinally through the length of the Floating Terminal through to the transfer point – a transverse conveyor, which will help in crossing over the entire beam of the terminal, and will lead to the final conveyor leading to the shiploader. The inclinations of all the conveyors have been designed in accordance to the grade of coal to be handled, in order to achieve smooth flow of cargo and avoid back-flow. Special care has been taken in the design of the transfer points to ensure no blockage occurs and the material flows smoothly. All the conveyors are enclosed to avoid airborne pollution.

The shiploader is of shuttle/telescopic boom type. The shiploader has 19m air draft, which makes the *Princesse Chloe* capable of loading large vessels up to cape size. The ship-loader is capable of swiveling by means of geared slewing rings, and luffing by means of hydraulic mechanisms. The cargo handling equipment constructed and supplied by Bedeschi is manufactured with the highest classification for heavy duty work for open-sea conditions. The equipment has been designed for a heel and trim of 5° and 3° respectively.

The cargo transfer takes places when the Floating Terminal is safely moored alongside the OGV, with barges transporting the coal from the mine head alongside. The cranes transfer the coal from the barges into the hoppers. The coal then gets transported though the conveyor system and the delivery ship-loader to the OGV's holds at an average guaranteed daily rate of 40,000 tons. The swiveling capability of the ship-loader ensures serving multiple holds of the OGVs without the need of shifting the *Princesse Chloe* alongside. The luffing mechanism of the shiploader is used to cater to the difference in the OGV's air draft from ballast to fully laden condition. Thanks to the buffer storage of about 11,000 tons, the coal transfer operation continues even in times of barges unavailability or while mooring/unmooring.

This system is owned by PT Mitra Swire CTM and operating in East Kalimantan, Indonesia and carries out loading at 40,000 tons per day, and has an annual capacity in excess of 9 million tons. Thanks to the implementation of this system, the user PT Berau Coal has experienced a quantum increase in their export capacity and competiveness.

Mara

Sometimes there is a requirement for large buffer storage, especially when the barging distance is large or cargo sourcing is varied. This was exactly the situation faced by Scorpio Logistics when they decided to implement a system with large floating storage and a high loading rate. For this purpose it was decided to convert the panamax size vessel *Mara* into a transshipper to be used for coal loading operations in Kalimantan, Indonesia.

The floating terminal *Mara* has storage of around 70,000 tons and is equipped with four cranes: two with extension arms and two without. The Bedeschi-supplied cargo handling system comprises of two large hoppers, each serving two cranes. The specially designed hoppers are capable of receiving coal from two cranes simultaneously. Basically they are two hoppers each of 50m^3 combined into one. The hoppers are equipped with variable-speed belt extractors leading to longitudinal conveyors systems moving in opposite directions. The two conveyors converge on to a hopper to transfer the coal on to a transverse conveyor, which transports the coal across the beam of the transshipper on to the port side.

On the port side, two large shiploaders are installed, capable of swiveling and luffing. They have also been fitted with retractable

Mara vessel starboard side.

Mara vessel port side.

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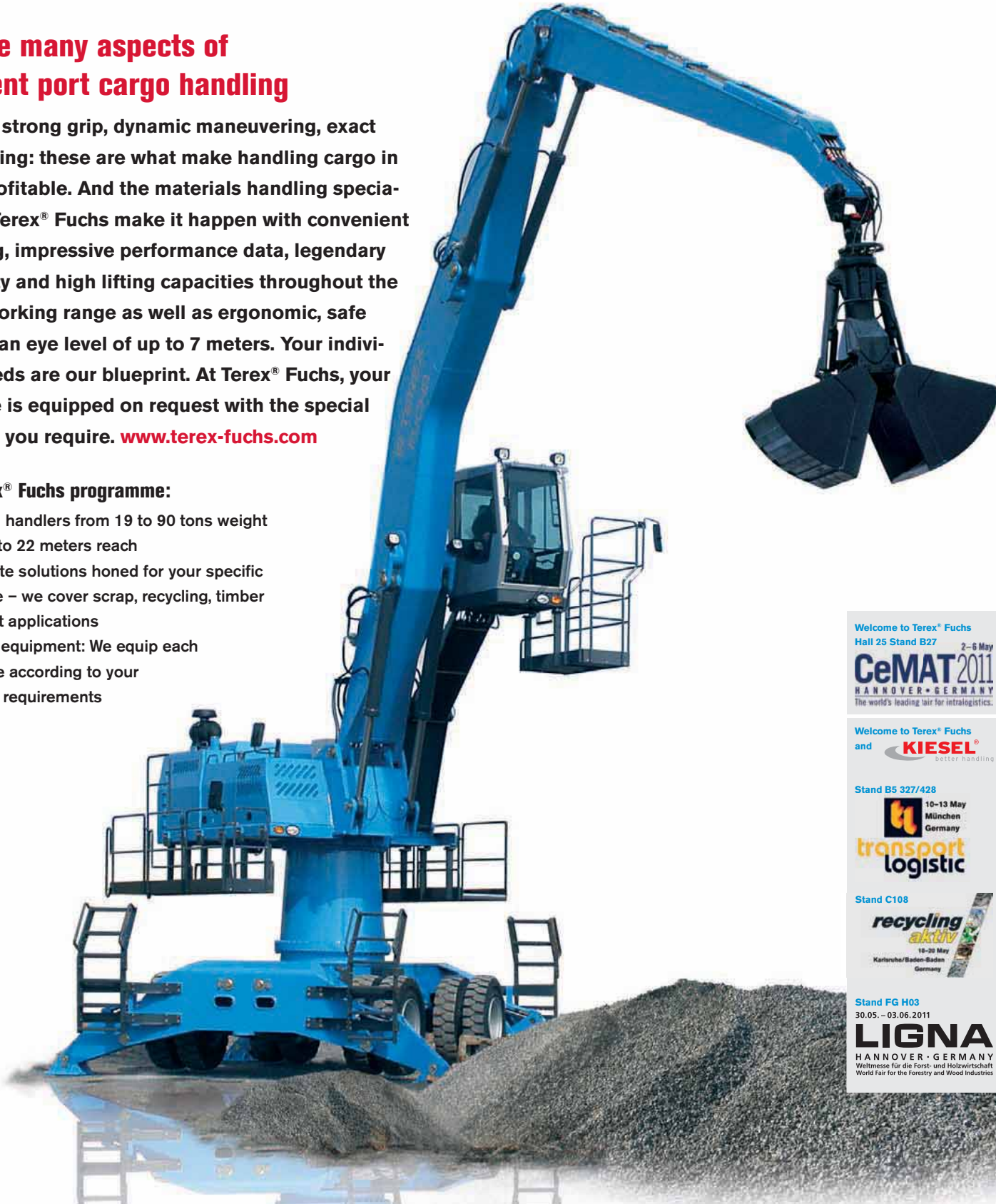

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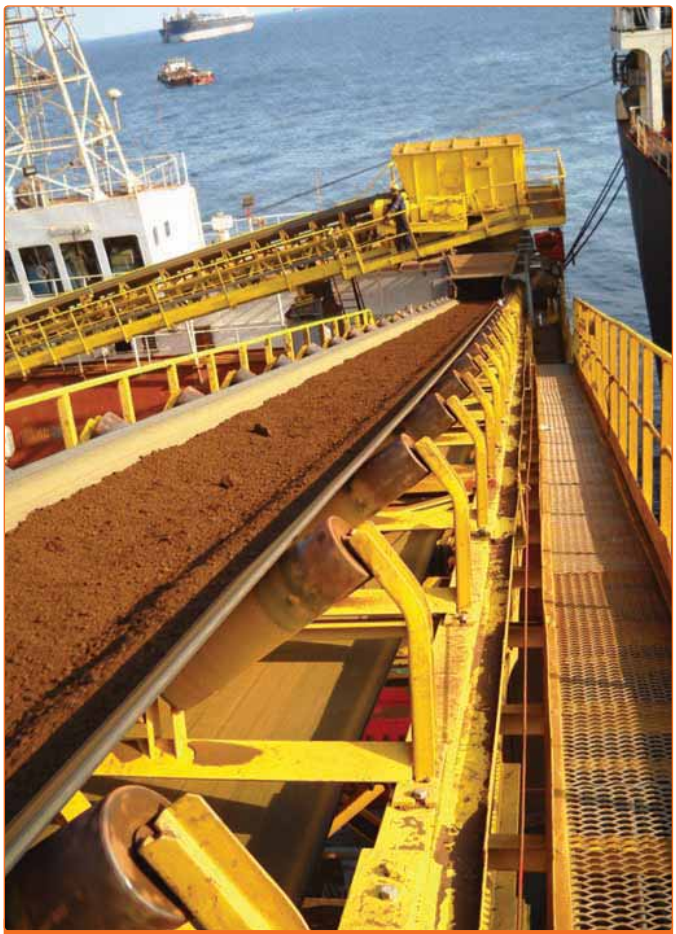

Iron ore handling.

delivery booms to enable delivery of coal into all the parts of the OGV's holds. The system is capable of loading coal at a rate of over 60,000 tons per day. The advantage of having a large floating storage is that the loading operations can carry on even when there are no barges alongside.

The system is operating in Kalimantan, with loading rates exceeding 60,000 tons per day. It is also capable of blending two grades of coal and delivers a homogeneous grade. The annual capacity of the system is in excess of 15 million tons and has helped the user Glencore increase their competiveness manyfold.

Shatixa

The case of *Shatixa* is unique in that a system originally designed for unloading was converted into a loading system by Bedeschi. The system had been in operation in Goa, India and was being used to load iron ore from barges into OGVs at a daily rate of about 18,000 tons.

Timblo selected Bedeschi to supply the new cargo handling system, because Bedeschi has its own production facility to manufacture the critical items in-house rather than outsourcing them. The cargo handling system, which is designed for a handling rate of 2,000 tons per hour, consists of two large hoppers mounted under the cranes; variable-speed belt feeders to extract iron ore from the hoppers, longitudinal and transverse conveyor systems, and a slewable, retractable delivery boom to

Extended boom and shuttle reversible conveyor.

deliver the iron ore into the holds of the OGVs. The shiploader has a unique shuttle system, which facilitates uniform distribution of iron ore into the holds of the OGV. The slewing range of the shiploader reduces the necessity of warping of the terminal alongside the OGV. The shiploader's outreach and air draft ensures that it is capable of loading cape size vessels with ease.

Shatixa, which previously used to load at a daily rate of 18,000 tons per day (in fair and calm weather), and now loads at 40,000 tons per day. With the improved bow it is less sensitive to weather conditions, and is easily navigable. This not only increases the speed but also decreases the fuel consumption substantially. The conversion of the *Shatixa* was carried out at the Dubai dry docks, and the system is now successfully operating in Goa with greater efficiency, greater stability and a higher loading rate.

Vale latest news

Bedeschi is presently implementing the biggest transshipper in the world, in another prestigious project for *Vale*.

To take advantage of the economy of scale, i.e. larger the size of the vessel, the lower the unit freight of cargo, *Vale* has ordered vessels up to 400,000 tons deadweight capacity, to be known as Valemax, to transport iron ore from Brazil to the Far East. Today these huge vessels cannot be accommodated in most ports; hence a transshipment device is needed that can transfer iron ore from the Valemax vessels into more manageable cape size vessels. The transshipper being implemented for this is a vessel of 300,000 tons capacity. The transshipper will be fitted with five cranes and each one will feed a separate 50m^3 hopper located adjacent to them. A cargo handling system comprising of extractors, longitudinal and cross-conveyors will lead the iron ore to a mobile shiploader capable of delivering cargo at 5,000 tons per hour, which make its daily rate in excess of 100,000 tons per day. The system is presently under implementation and is expected to commence operations towards the third quarter this year.

With capacities like this, clients have to rely on companies that not only have the experience but also the ingenuity to come up with designs to suit the exact requirement of the clients. Bedeschi has a full design team, who can translate any innovative ideas into workable design. The manufacture of the critical equipment is done by Bedeschi in its own manufacturing facilities.

ABOUT THE COMPANY

Bedeschi S.p.A. has been a family-owned business since it was founded in 1908. The company is the leading supplier of machinery and services to bulk material handling and minerals industries, and focuses on handling difficult materials from sticky coal or clay to dry and wearing, iron ore and minerals.

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Long reach, low fuel: the continuous improvement of floating grab cranes

NKM Noell Special Cranes, Hoofddorp, The Netherlands

Efficiency is the key for harbor cranes in modern times. Faster, greater capacity, longer reaches, heaver loads, fuel efficiency, low emissions and many other aspects determine the applicability of the harbor crane of the future.

These factors formed the basis for the design of the Lemniscate-type crane, developed for high efficiency bulk handling. The continuous development of materials and technology offers the opportunity for continuous improvement.

In 2005 NKM Noell reentered the harbor crane market with the innovative new design of the traditional Lemniscate-type crane. The basis of the NKM Floating Grab Crane design is a study of the types of operating cranes. The top five findings are that reach, capacity, cost, environment and reliability are most important for the operator.

Technology & innovation

Handling 2,000 tons per hour is no exception for the floating grab crane. Not the grab's size but the efficiency of the crane is the key. This efficiency is created by balancing the complete system for optimal speeds, which can be based on the actual load, work cycle and travel path of the grab.

Due to design constraints, the older Lemniscate-type cranes are limited to a flight of 43 meters. With the use of advanced materials and construction techniques, we have successfully crossed this boundary. Our latest design now offers a flight of 47 meters, and further increase is anticipated in the future.

Our approach to capacity is the sum of speed, travel efficiency and sheer grab size. By utilizing the power to increase speed at minimum load, optimal crane efficiency leads to maximum performance. Like the rest of the crane, the operator cabin is designed in conjunction with the user; as a result the operator seat has an unobstructed view in three dimensions, reaching 270 degrees horizontal and 135 degrees vertical. This allows the operator's work position to be ergonomically optimized, and also makes the crane safer.

Not only does the unobstructed view of the operator increase safety, but also the ergonomic placement of the controls and camera systems, allowing the operator to check the machine room, pedestal and other places. Access to the cabin is routed outside the areas with moving machines, such as the gearboxes and hoists. For safety purposes, the cabin can be accessed either by a divided ladder or with an elevator.

Green solutions

Port technology has more and more demand for environmentally friendly technological installations. Not only must the fuel consumption and the emissions be considered, but the entire life-cycle must be taken into account if a Green Passport is to be issued.

In the Lemniscate-type design, environmental concerns are very important for the efficiency of the crane, and are used to optimize the movement and speed. To improve fuel economy, NKM Noell included technology for storing excess energy while braking, which is used to reduce the total power consumption of the crane in operation. This technology reduces the peak load and leads to a substantial reduction in emission of soot particles and noxious gas emissions.

The NKM Noell Lemniscate-type crane is able to handle up to 2,000 tons an hour.

For safety, access to the crane cabin is diverted away from the crane's moving parts, by ladder or elevator.

The choice of the construction materials and material suppliers is part of the environmental policy of our organization. We are concentrating on durable solutions the have a positive influence on the environment and help us improve our green balance.

NKM Noell Lemniscate-type cranes are built for a working life of over 25 years. This has a positive influence on the life-cycle analysis of the crane and reduces the total cost of operating the crane. The usage of innovative materials and improved design and lower power requirements has reduced the noise level of the crane by several decibels.

Life cycle cost & maintenance

Besides the initial investment, the NKM Noell Lemniscate-type crane is a very economical crane concept. The expected life-span of the crane can be well over 30 years; the construction is so rigid that, if properly maintained, major maintenance jobs can be 10 to 15 years apart. Given the development of port technology, the systems can be upgraded to expand the economic life to the length of the technical life of the installation. To reduce the maintenance cost, the NKM Noell crane is designed for maintenance, good accessibility to the wear parts, the use of durable components and the conformity to industrial standards.

Service division

The service group of NKM Noell Special Cranes, based in the Netherlands, is now focused on the maintenance and modernization of harbor cranes. As a manufacturer the company has a dedicated engineering group with a broad range of knowledge and experience. This specialism is utilized when performing retrofits, refurbishment and full upgrades of existing cranes. The services provided vary from feasibility studies, regular maintenance work, supervision, erection and commissioning, to turnkey project realization.

In conclusion, as result of an appropriate and optimized new design, the Lemniscate-type crane manufactured by NKM Noell will improve loading and unloading operations, which will open new opportunities to access new bulk industries. Together with the new service activities, NKM Noell Special Cranes can fulfill the increasing demands of customers worldwide.

ABOUT THE COMPANY

NKM Noell Special Cranes is part of the French Réel group, which comprises a network of dedicated crane and related equipment manufacturers and maintenance companies around across four continents – from Malaysia, to Venezuela, Russia, Qatar and The Netherlands. Each company in the group has its own specialties in very different sectors, such as the offshore, aluminum, waste incineration and nuclear industries. The group's development strategy aims to meet market trends, and offers a full range of services – from the drawing board, to commissioning and maintenance. As part of the Réel group, NKM Special Cranes has access to a wide knowledge base for design, construction and maintenance, and a worldwide support network.

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Air cannons hammer preheater build-up at Ash Grove Nebraska cement plant

Andy Marti, Martin Engineering, Neponset, IL, USA

Efficient material flow is a critical element of dry-process cement manufacturing, and accumulation or blockages can take a big bite out of a plant's profitability. Hang-ups in storage systems and accumulations in process vessels can choke material flow, while bottlenecks create costly reductions in equipment and process performance. Poor material flow raises maintenance expenses and drags profits down. If they become severe, flow problems can bring production to a complete stop. Although many plants still use manual techniques to remove build-up, the cost of labor and periodic shutdowns has led some producers to investigate more effective methods for dealing with this inevitable maintenance.

Ash Grove Cement is the largest American-owned cement manufacturer and the sixth-largest in the nation. The company's network includes nine cement plants, two deep-water import terminals and a major quarry operation in Blubber Bay, British Columbia, as well as subsidiaries consisting of ready-mix companies, aggregate suppliers, packaged materials companies and a paving firm. In all, Ash Grove has a total annual capacity of nearly 9 million short tons of cement, including a wide range of specialty products for difficult service environments. The company has a reputation stretching back to 1882 for running some of the most efficient and best maintained plants in the country.

The facility in Louisville, Nebraska has an annual output of about 1 million ST per year of Portland and blended cement. Located on the south bank of the Platte River between Omaha and Lincoln, the plant was originally opened in 1929 with an annual capacity of 240,000 ST per year, and the operation has been expanded and updated continuously throughout its life.

Among the issues the plant has confronted is material buildup in the precalciner, which interfered with operating efficiency by impeding the flow through the preheater and into the kiln. The staff used the common technique of water lancing to remove blockages, particularly from the preheater tower's riser duct. Twice daily maintenance personnel opened access doors into the tower and removed the accumulation with a high-pressure spray. The work was time-consuming, and the water blasting had a tendency to cause lumps of material to fall into the kiln feed, interfering with production.

An air-powered solution

In order to prevent the resulting loss of efficiency and clinker quality, a group led by process engineer Mark Junkins investigated possible solutions. They met with material handling experts from Martin Engineering, and together the group designed a system that uses high-performance air cannons to control material build-up and enhance the flow.

The system is based on 25 Big Blaster® XHV Air Cannons, which fire a powerful discharge of compressed air in a prescribed pattern to remove material that becomes adhered to the vessel walls. Introduced by Martin Engineering in 1974, the technology has since developed a proven track record around the world for relieving bottlenecks caused by material buildup in high-capacity storage and process vessels.

Martin Engineering technicians installed the air cannons during a scheduled maintenance outage, starting where the accumulation appeared most severe: below the riser orifice, where the duct is reduced in size to increase velocity. The unique cannon design requires no high-temperature discharge pipes or special mounting plates, and discharge nozzles are embedded directly in the refractory lining of the preheater tower.

A network of 25 air cannons was installed to remove material that becomes adhered to vessel walls.

The air cannons were installed starting where the accumulation appeared most severe: below the riser orifice, as the duct reduces in size to increase velocity.

Valve performance and timing

All of the air cannons in the main production line network are equipped with the Martin Engineering XHV Valve, designed specifically to deliver premium performance and long service life in preheater towers, clinker coolers and other high-temperature applications. The negative pressure-firing valve was developed to provide reliable operation and long service life in challenging applications.

The XHV valve is constructed with a rugged, short-stroke piston that features a high-temperature polymer seal for dependability and low maintenance requirements. The advanced design delivers high output force and excellent sealing to reduce air loss, as well as rapid discharge and filling. All XHV valves are guaranteed for 200,000 firings, and a removable piston seat simplifies service.

Available in 2-, 4- and 6-inch models and ten different tank sizes, the XHV Valve Assembly features an aluminum piston with a high-temperature polymer face. Because of the short piston stroke (just 5/8" or 16mm), the design minimizes wear on the piston and cylinder. A return spring snaps the piston quickly back into firing position and prevents dust entry.

The company also offers a retrofit kit that allows a simple performance upgrade of air cannons from virtually any manufacturer. A simple, bolt-on attachment allows the XHV Assembly to be installed on existing Martin Engineering internal- and external-valve air cannons, as well as onto competitive models.

The cannons discharge in a timed sequence that moves in an upward spiral around the tower firing about 20 seconds apart, with the entire cycle taking just over eight minutes to complete. Control room operators can alter the schedule to accommodate a range of kiln pressures and operating conditions, extending the sequence to as much as 45 minutes.

A crew from Martin Services installed the entire system, including cannons, air lines and controls, as well as the company's Thermo Safety Shields™ on each unit. Operating like trap doors, the sliding shields bolt in between the air cannon valve and mounting flange, helping to protect workers from exposure to severe heat, gases and high-temperature materials.

Based on its success with the initial air cannon system, Ash Grove started planning a similar system for the plant's second production line. For that operation, engineers designed a network of 15 additional Big Blaster Air Cannons, equipped with Martin® Tornado Exhaust Valves. Described as the latest advancement in air cannon valve design, the patent-pending Tornado valve fires in response to a positive air pressure surge delivered by a solenoid valve, which can be located as far as 200 feet away.

This positive action improves air cannon safety, since the discharge sequence requires a positive signal. Unlike negative pressure-firing designs, a cannon equipped with the Tornado valve will not discharge accidentally in response to a pressure

All of the air cannons in the main production line network are equipped with a negative pressure-firing valve design.

drop, so an air supply failure or broken line won't trigger its firing. In addition, this positive-acting valve amplifies the discharge force, delivering up to 20% greater force than a standard XHV-equipped air cannon of the same size.

Available in 2-, 4- or 6-inch models, the positive action of the valve also delivers faster discharge, amplifying output force by as much as 20% over the standard Big Blaster XHV Air Cannon. In addition, the improved air path of the Tornado fills the reservoir three to four times faster than most standard designs.

Martin Services once again supplied turnkey installation, but by the time Ash Grove could cool the production line and perform routine service to the refractory lining, the technicians had just a few days to complete the air cannon system. In order to accommodate the abbreviated maintenance window, crews worked a round-the-clock schedule, finishing their work just in time for the plant's scheduled return to production.

Cannons, air lines and controls, as well as Martin Engineering's Thermo Safety Shields™ were installed on each unit.

Results

With the new air cannon network in place, the Louisville plant has been able to significantly reduce the need for water blasting. Material now flows more efficiently, and maintenance personnel have drastically reduced the man-hours that were spent on manual removal.

"We still hydro-lance occasionally, because of changes in raw material or fuel," Junkins explained. "But we don't have the issues we had before. We can see that the air cannon system has paid for itself, by allowing us to maintain production rates without many of the interruptions and issues that water blasting created."

The Ash Grove Cement Company has established a longstanding tradition of service, reliability and quality that stretches back more than 125 years. A pioneer of the lime and cement industries, the company was incorporated in Missouri in 1882 as the Ash Grove White Lime Association.

ABOUT THE COMPANY

Martin Engineering supplies conveyor products around the world in a wide variety of bulk material applications, including cement/clinker, rock/aggregate, coal, biomass, feed pellets, grain and other materials. Founded in 1944, Martin Engineering is the world leader in making bulk materials handling cleaner, safer and more productive. The company is headquartered in Neponset, IL, with global reach from operations in Brazil, China, France, Germany, Indonesia, Mexico, South Africa, Turkey, India and the UK.

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"The HF radar uses a frequency modulated continuous wave mode for range resolution, hence the transmitter and the receiver are operated simultaneously. This mode allows a blind range in front of the radar to be avoided."

'Monitoring ship traffic using oceanographic WERA high-frequency radar', page 114.

Monitoring ship traffic using oceanographic WERA high-frequency radar

Anna Dzvonkovskaya & **Hermann Rohling**, Institute of Telecommunications, Hamburg University of Technology, Hamburg, Germany

High frequency radar

High frequency (HF) radar, which is based on surface electromagnetic wave propagation, provides a unique capability to detect targets far beyond the conventional microwave radar coverage. HF radars use the frequency band of 3-30 MHz to provide a large coverage that could extend to 200NM in range. This large range of values is of great interest, and appears as a consequence of the United Nations Convention on the Law of the Sea, which established 200NM as the Exclusive Economic Zone (EEZ).

Regular maritime surveillance of activity within a nation's EEZ is a key question in protecting national security. HF radar systems recently became an operational tool in coastal monitoring worldwide for many applications including ship detection, tracking, and guidance; as well as search and rescue, distribution of pollutants, fishery and research in oceanography.

WERA (WEllen RAdar) HF radar system

The WERA (WEllen RAdar) HF radar system was developed at the University of Hamburg, Germany in 1996. WERA allows a wide range of working frequencies, spatial resolution, and antenna configurations in order to operate as a low-power oceanographic radar, providing simultaneous wide-area measurements of sea surface currents, waves and wind parameters. The WERA system transmits signal using an average low power of 30 Watts, but can achieve a detection range of 110NM, which is far beyond conventional microwave radar coverage of up to 30NM.

The HF radar uses a frequency modulated continuous wave mode for range resolution, hence the transmitter and the receiver are operated simultaneously. This mode allows a blind range in front of the radar to be avoided, simplifying the radar range resolution modification, and reducing the impact of radio interference. The azimuth angle covered by WERA is ±60° perpendicular to the linear array of antenna receivers, which consists of 16 antenna elements located linearly along the coast as shown in Figure 1.

Selecting the appropriate radar frequency and bandwidth

The attenuation of the electromagnetic wave traveling along the sea surface depends on the radar frequency, and on the conductivity (salinity) of the water. These factors determine how large the observable area is. However, the radar frequency is selected taking into account the use of the radio spectrum by other communication services. The values for the highest possible range resolution of the radar system are limited by the available chirp signal bandwidth (the width of the gaps in the radio spectrum).

To find the optimum radar operating frequency and bandwidth, frequency scans are started regularly. For example, the operating frequency band of the WERA system is 8 MHz with a typical bandwidth of 100 kHz; it gives a 1.5-km range resolution cell. Every hour the operating frequency is selected adaptively according to the scan of an HF spectrum load. Depending on the radar operating frequency, the total HF radar coverage area occupies from 10,000 to 80,000km^2 of sea surface.

Figure 1. A linear array of WERA HF radar receiver antennae.

Useful implementations of a WERA system

WERA is based on a modular design that can be easily adopted to the requirements of an actual application. Most of the signal processing steps are implemented in software and thus the system can be adapted to different needs in a simple way – for example, simultaneous oceanographic research, ship traffic monitoring, tsunami warning, and so on.

The dominant contribution for HF radar echoes is due to scattering from the sea surface. Since sea waves are moving targets, they cause Doppler frequency shifts while moving towards and away from the radar site. That is why this radar system is a tool for synoptic online mapping of sea surface current fields and spatial distribution of the wave directional spectrum simultaneously.

Using the WERA system to monitor ship traffic

This paper describes a new approach to utilize oceanographic low-power HF radar in order to monitor ship traffic over long distances. For ship detection and tracking procedures the sea clutter can be considered to be an unwanted, self-generated interference. This interference level can ultimately limit the detection capability of the radar system. To evaluate the quality of radar detection, a data set of GPS-acquired ship locations, provided by the Automatic Identification System (AIS), was recorded for the same period of time.

Due to external noise, radio frequency interference and different kinds of clutter, special techniques of ship detection using the WERA system have to be applied. In the case of

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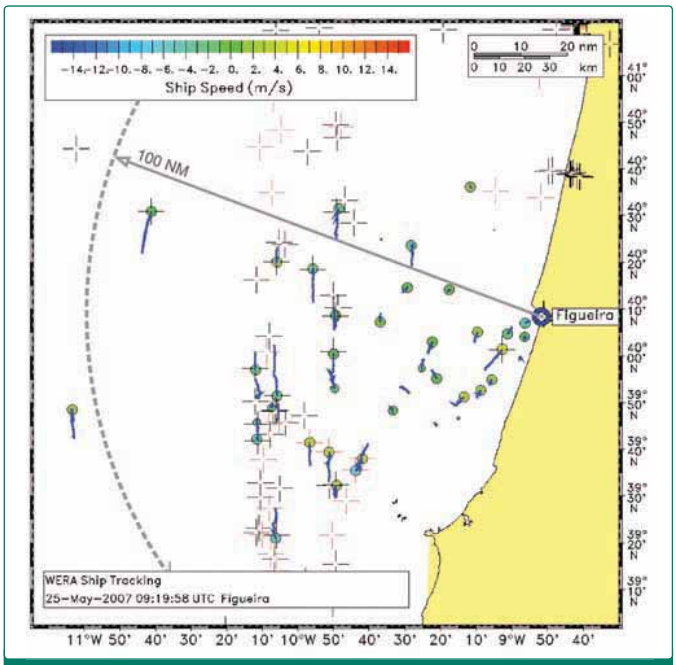

Figure 2. Detection and tracking results of the WERA radar system (circles) and AIS records (crosses).

ship monitoring, the main interference contribution for the WERA system is due to the sea surface echo signals. In a range-Doppler frequency map the sea surface reflections are observed permanently, and limit the target detection performance. The technical challenge is to detect targets in this strong interference environment and to control the false alarm probability.

A set of processed HF radar data in range, Doppler frequency (i.e. radial velocity), and azimuth angle is collected for each snapshot in time. The detection algorithm was applied to the range-Doppler frequency power spectrum map for each azimuth beam direction. The range-Doppler map statistics may vary from snapshot to snapshot, therefore we have to detect ships against a background signal, which has an unknown distribution of echo signal amplitudes.

Detection of a target echo signal can be expressed with statistical hypotheses testing. Constant false alarm rate (CFAR) methods usually formulate a test statistic for each radar cell of interest and compare it to some power threshold. The CFAR threshold calculation is usually based on the Neyman-Pearson criterion, with a fixed probability of false alarm and a maximum probability of target detection. A detection decision must be processed for each range-Doppler cell individually. The detection scheme is based on the conventional curvilinear regression analysis and CFAR detection technique.

The measured range, azimuth, and radial velocity form a plot for each detected ship during a measurement scan. These plots enter the tracking filter, which includes three main steps for a single iteration: measurement, prediction, and update. After each update step, a test to delete false targets is made.

Signal processing techniques for ship detection

The proposed signal processing techniques for detection and tracking of ships have been tested using the data measured by the WERA HF radar system located in Portugal. The WERA system has been in continuous operation for several months.

The data shown in this paper have been acquired during a period when ship locations have been reported by their AIS. The detection scheme has been delivering plots to the tracking algorithm every 33 seconds to form a tracking history of each ship detected by the radar. The results of the tracking procedure are shown in Figure 2. Here the detections and tracks of real moving ships can be observed. The single colorful bullets in the figure show the ship locations observed at the tracker output, where the color indicates the ship radial velocity measured by the HF radar. The blue tails behind each ship show recorded tracks for the last 30 minutes of ship movement. The black crosses correspond to the AIS data, indicating the ship movement in the observed radar coverage. There are also some cases when the radar detected ships that were not equipped with AIS. These are probably smaller ships, for example, fishing boats.

The AIS ship information is very useful to understand the limitation of the low-power HF radar for ship traffic monitoring. To verify the detection and tracking results obtained by the radar, ship locations reported by AIS have been recorded for a 12-hour period. In total, 131 ships of different sizes, which were equipped with the AIS, have been observed in the radar coverage.

The AIS information about the ship position, speed, heading and type (recorded as a MMSI code) was superimposed on the measured radar range-Doppler frequency spectra. Using the measured radar spectra, the signal-to-noise ratio of these ships was derived to study the detectability performance of the radar. The AIS speeds were recalculated to the radial components observed by the radar using the additional information about ship heading and course. The deviation between AIS and radar detected locations was below 1.5km (one range resolution cell) for 87% of these comparisons.

Conclusion and recommendations

Beyond any doubt there is a space left for future research activities. Preliminarily, it can be said that using an average transmittance power of 30W, in case of the ship broadside view towards the radar, the maximum HF radar detection range for very large and large cargo vessels can be up to 110NM, for the medium-sized vessels up to 85NM, for the small-sized vessels up to 75NM, and for the vessels of very small size up to 65NM. The ship detection and tracking results based on the radar data processing show a good performance of the oceanographic HF radar system to monitor ship traffic.

ABOUT THE AUTHORS

Dr. Anna Dzvonkovskaya currently works at the Institute of Telecommunications, Hamburg University of Technology. She holds diplomas in applied mathematics and a Ph.D. degree from Moscow, and is also a fellow of the German Academic Exchange Service (DAAD). Dr. Dzvonkovskaya has also worked as a research scientist at the remote sensing group at the University of Hamburg, conducting research on high frequency (HF) radar applications for oceanography and ship traffic monitoring.

Prof. Dr. Hermann Rohling is the Vice President of the Hamburg University of Technology, Germany. He is the Head of the Institute of Telecommunications where he has developed an international reputation for mobile communications and automotive radar systems. Prof. Rohling's research interests include signal theory, digital radar signal processing, and wideband mobile communications based on multicarrier transmission techniques (OFDM). Prof. Rohling is the President of the German Institute of Navigation (DGON), a member of Informationstechnische Gesellschaft (ITG), and a Fellow of IEEE. Every year he organizes the International Radar Symposium.

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New megapixel system to empower IP surveillance at Malta Freeport

Genius Vision Digital (GVD), Hückelhoven, Germany

Malta Freeport

Malta Freeport, located in the heart of the Mediterranean is ranked among the top European ports and is the third largest transshipment and logistics centre in the region.

Enforced by law under ISPS Code, the IP Surveillance System is required to consistently support governments evaluating risks, and offset changes in threat and vulnerability for ships and port facilities, which includes certain equipment, monitoring and controlling access, and monitoring the activities of people and cargo.

In order to meet these requirements, there are more than 60pcs of IP cameras implemented and controlled from the central management room to provide 24/7 monitoring via a fiber backbone network.

The challenge

After the 9/11 attacks in New York City, global society was alerted to and threatened by terrorism, including Europe. In order to prevent any security breaches while monitoring a large and wide area of seaport, the Malta Freeport area needed the most powerful and scalable system to manage busy shipping and transit traffic, security of goods, and the safety of people.

In addition, the capability to look for details in live videos was crucial, and this can only be achieved using megapixel system. For these reasons, an IP-based surveillance system is the exact solution for this.

The durable IP surveillance system

GVD cooperates with world-leading IP camera vendors and the system provider Alberta to provide the best performance of megapixel surveillance. Monitoring using the GVD NVR M600 series, server class rack mount, the real-time video can be seamlessly sent to the control center with just one click, in combination with the alarm pop-up feature, so that any critical scene will not be missed. GVD provides not only the hardware but also the software, making their systems cost effective and convenient.

Advanced streaming technology

Under GVD Time Sector Engine's intelligent search and flexible video streaming capability optimizes both bandwidth and storage, which allows resolutions from 4 CIF to 2 megapixels for fixed and PTZ cameras to be used. This not only delivers live, recorded and playback video, but also highly demanded remote access anytime from anywhere.

Surveillance staff can easily construct a real-time CCTV wall using the GVD E100/E200 series.

The CMA CGM *Christophe Colomb* berths at Malta Freeport.

Smarter CCTV wall

From the GVD E100/E200 series, surveillance staff can construct a real-time CCTV wall easily and monitor for 24 hours a day, seven days a week. The high resolution allows for better viewing; the high frame rate is ideal for later investigation; and the capability of decoding large amounts of data makes the systems perfect for long-term operation.

ABOUT THE COMPANY

Genius Vision Digital (GVD) is a company based in Taipei with cutting-edge technologies. GVD brings the next generation of IP surveillance systems for the upcoming 'Full High Definition' age by providing robust video storage and management systems for the mission critical applications in banking, hospital, retailing, government, and gaming etc. With the established subsidiary GVD Europe in 2010, GVD is able to offer excellent support to the European market in sales, marketing and technical matters.

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Tightening the loop

Recommended methods of perimeter security for seaports

Magal S³, Yehud, Israel

Need for port security

The terror attacks of September 11 raised global awareness about terrorism and its impact on the world economy. The potential to ship weapons, chemical material and 'dirty bombs' into unsuspecting harbors has become a major threat to the global community. Governments around they have realized that the terror organizations – in their attempt to disrupt globalization and modernization – regard trade, open seas and ports as high-value targets. However, due to the complexity of today's trade processes and practices, countries have to come to realize that securing the entry point alone is insufficient; the entire supply chain must be secured – beginning with seaports – as they often represent the weakest point in the chain. In addition, ports face an added level of threat with the continued rise of criminal activity. In light of these risks, combined with the inherent difficulties in securing such facilities, the challenge of port security has become evident.

Inherent vulnerabilities

Mainly due to its topography, ports represent a major challenge in border security. An additional complexity is the large number of interconnected facilities and their operations including bridges, dams, dock infrastructure, hazardous material depots, pipelines, and many other critical assets that may be an enemy target. Furthermore, there is a high volume of foreign vessel, truck and rail traffic to and from these sensitive seaside areas, with significant numbers of passengers passing through on a daily basis.

Terrorism

A decade after 9/11 and amid political instability in many regions, worldwide security measures are being stretched to the limit, with terrorists becoming far more sophisticated in their attempts to penetrate foreign borders. From bombs in sneakers to explosives sewn to animals, terrorists continue to take advantage of any security gap that will allow them to infiltrate and wreak havoc on the global community.

The security vulnerabilities of seaports and maritime operations have not escaped the attention of terrorist groups. The Al-Qaida chief operator – Abd al Rahim al Nashiri – developed a strategy to attack western shipping targets when he was captured in 2002. Furthermore, the possibility of smuggling a 'dirty bomb' via a seaport in order to contaminate a Western city with radioactive material is a real fear. In fact, over the years there have been a number of attempted and successful terror attacks against seaports and maritime operations, as shown in Table 1.

Criminal activity

Organized crime is well-established in many ports. Criminal activity, from smuggling to petty theft, continues undeterred due to the absence of collective supervision and governance. An additional obstacle is the pressure to accelerate the handling of cargo and reduce costs, leading to the omission of various precautions and inevitably compromising port security. These challenges illustrate the critical importance of implementing the appropriate local safety measures in the context of securing global maritime transport.

ISPS code

To address the issue of seaport safety on a global scale, the International Maritime Organiz ation (IMO) – at the behest of the United States – instituted the International Ship and Port Security (ISPS) Code in December 2002. The code is a comprehensive set of measures and requirements aimed at enhancing the security of ships and port facilities around the globe. The ISPS code offers a series of guidelines to governments, port authorities and shipping companies in order to meet these requirements.

The code was quickly adopted by the international convention for the Safety of Life at Sea (SOLAS) as countries and governments realized that secure ports directly benefit their economies.

Need for smart, integrated security

Comprehensive security is comprised of three key elements: technology, human resources and processes. These three components must be tightly integrated through the Concept of Operation (ConOps), allowing for effective and efficient port operation without compromising security.

The core technology of perimeter protection for seaports includes smart fences, access control for all gates and an integrated command and control system. Verification and surveillance cameras are also an important element of the full solution. Ideally, the perimeter should have more than one layer of protection, with additional layers deployed in particularly sensitive areas.

As explained below, the combination of basic fences with simple or smart cameras does not yield an adequate level of security. Moreover, ineffective perimeter protection can create many false alarms, which, in addition to being both time consuming and costly to verify, causes personnel to lose vigilance.

Basic fences only

While physical barriers may deter and delay intruders, they are essentially simple fences without detection capabilities. Due to the

TABLE 1: RECENT MARITIME TERROR ATTACKS

Date	Location	Nature of Attack	Terrorist Group
July 2009	Egypt	Attempted attack against the Suez canal and the adjacent oil pipeline	Egyptian cell of Al-Qaida
March 2005	Indonesia	Discovery of training terrorist operatives in sea-borne guerrilla tactics, including gaining unauthorized access to ships and port facilities in order to plant explosives	Islamic extremist group, Jemaah Islamiya
February 2004	Philippines	Attack on a passenger ferry that killed over 100 people	Abu Sayyaf group
October 2002	Yemen	Attack on French oil tanker Limburg off the harbor of Ash Shahir	Yemenite cell of Al-Qaida
October 2000	Yemen	Attack on the US destroyer USS Cole	Al-Qaida

large area and long perimeters of ports, intruders can easily cut or climb the fence and enter the site without being noticed.

Basic fences and simple cameras

A combined solution of basic fences covered by simple cameras is also inadequate, as it is not feasible to manually monitor the large number of cameras necessary in such a solution. In fact, studies have shown that security personnel tasked with monitoring only nine cameras lose alertness in less than ten minutes.

Basic fences and smart cameras

Although smart cameras can automatically analyze irregular events, a combination of a simple fence with smart cameras will not provide adequate security due to a number of inherent imitations:

- In order to provide complete perimeter intrusion detection, a camera would be required every 60-90 meters, increasing costs significantly.
- Smart cameras with high quality outdoor video motion detection (VMD) – which are capable of performing under extreme changes in lighting and weather conditions – make the solution even more expensive.
- CCTV cameras are limited in poor visibility conditions and thermal cameras, while more robust, are nevertheless inadequate in heavy fog conditions.
- Sophisticated long-range surveillance cameras (IR, CCD, fixed or scanning) may have coverage gaps and suffer from the inherent visibility limitations mentioned above; therefore they are unable to support the required 99% probability of intruder detection.

Perimeter intrusion detection systems (PIDS)

Magal S³'s intrusion detection systems are durable, robust and designed to perform under any seaside condition including salt fog, corrosive materials, water, wind, extreme temperatures, electromagnetic interference, and vibrations induced by ground traffic.

Several categories of outdoor site protection technologies are available to address a broad range of strategic threats and can be tailored to fit any budget.

- **Taut wire** – A hybrid system of sensors woven into a barbed wire fence. This fence offers guaranteed performance in all-weather conditions. It has demonstrated a high probability of detection (POD) and an almost zero false alarm rate (FAR). It is therefore ideal for high security where deterrence and delay must be achieved on top of uncompromised intrusion detection.
- **MagBar** – A robust grid designed to plug critical holes in perimeter security systems by custom-fitting a specific opening, such as canals, pipes, open tunnels or drains. The grid is fortified with either electro-mechanical or electro-optical sensors threaded within the steel. Any attempt to tamper with the structure will trigger an alarm.
- **Fence-mounted sensors** – These sensors are ideal add-ons to existing fences as an affordable solution. A second security measure, such as CCTV, can be integrated as a further verification layer.

Outdoor perimeter fence-mounted sensors installed at Eilat Port, Israel.

- **Buried cable sensors** – A virtual fence implemented by a smart cable, buried less than one foot underground. The cable creates an invisible electromagnetic field, capable of detecting any intruder entering the narrow virtual corridor. The buried cable sensor is an ideal solution for places where a fence cannot be installed for aesthetic or environmental reasons, such as concrete platforms where movement must be restricted during non-active parts of the day. Although 'ranging' (the ability to detect an intruder's exact presence) is not essential with actual fences because the structure itself can delay a trespasser long enough for apprehension; in the case of virtual fences that do not cause a delay, 'ranging' is critical to effectively intercept intrusions.
- **Decorative fence** – Innocent-looking ornamental fences equipped with internal sensors that will detect climbing, bending or cutting. This fence is ideal for protecting the façade of ports – particularly in passenger or administrative areas.
- **Radar** – Ground protection radars are ideal for a port's open and clear areas, where early warning can significantly reduce the first responders' reaction time.
- **Microwave (μW)** – Another type of virtual fence that creates an invisible electromagnetic beam. This is ideal for virtual gates, where the 'gate' must be open for traffic during the daytime but must be shut down at off-times, such as nights or weekends. It is also well suited for temporary construction when the 'gate' must be easily installed and removed.

ABOUT THE COMPANY

Magal S³ is a leading international solution provider in security, safety and site management. The company serves a wide range of vertical markets which includes but is not limited to: airports, seaports, railway stations, borders, correctional institutions, municipalities, nuclear and utility facilities. Magal S³ has developed a unique set of solutions and products optimized for perimeter, outdoor and general security applications. The turnkey solutions are typically integrated and managed by a single, sophisticated modular command and control system.

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LIQUID, CHEMICAL & GAS HANDLING

"Widespread use of LNG as an alternative source of energy and as an alternative ship fuel requires construction of special infrastructure, such as LNG import terminals and port infrastructure for distribution of LNG to ships."

'LNG supply in the Baltic Sea region', page 121.

LNG supply in the Baltic Sea region

New opportunities are arising for Baltic ports as demand for LNG in the region grows

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LNG as an energy source for economies around the Baltic Sea

World energy use is constantly increasing, and countries around the Baltic Sea are no exception. The energy issue is closely linked with major environmental issues such as climate change, acidification and over-fertilization. Today, the world is dependent on oil as an energy source. It contains many harmful components and replacing it would benefit the environment. Oil is rich in carbon, which means high carbon dioxide (CO_2) emissions when combusted. Natural gas is also a fossil fuel, but is a better source of energy in terms of CO_2 emissions and environmental effects.

The main natural gas producers includes countries such as Russia; the United States, Canada, United Kingdom, The Netherlands, Iran, Norway, Algeria, Indonesia, and Saudi Arabia. Because of the difficulty of transporting natural gas over long distances, natural gas has been generally imported by close regional neighbors of gas producers.

Energy security is a very important issue in current international relations. There is an increasing dependency of the energy-consuming countries on the energy-producing countries. The situation of Europe and especially Baltic Sea Region is an example. There are no large natural gas supplies in Eastern Europe, so Russia is a dominant supplier of gas to Baltic countries such as Estonia, Finland, Latvia and Lithuania and Poland. This part of the Baltic region is still an energy island, because of energy isolation and dependence on a single source. Therefore, in an emergency situation, these countries do not have any alternative solution to assure continuous supplies of natural gas. That's why diversification of energy sources of these Baltic countries becomes a priority for the entire Baltic Sea region, as well as the whole European Union.

Transporting natural gas through pipelines is an obvious choice for importing natural gas from nearby producers. However, in order not to be dependent on nearby gas producers (or those located further away), building long-distance pipelines across oceans or mountains is very expensive and introduces various challenges. A technology which is changing distance limitations and is cheaper at long-distance is liquefaction. Cooling down natural gas to -162°C turns it into a liquid (LNG). This process reduces the volume of natural gas significantly. As a cryogenic liquid, it takes up about 1/600 of the volume of uncompressed gas. As a result, natural gas in its liquid form is an easier product to store and to transport. Hence, LNG provides an excellent way to diversify Baltic counties' energy sources away from Russia. However, LNG import terminals must be constructed.

LNG is also considered as an alternative source of energy by another two Baltic countries, Sweden and Denmark. In Sweden, natural gas is used to cover only 2% of the total energy input. Some of the most densely populated areas are covered by the pipeline network, but there is still a great area of the country left, including larger cities such as Stockholm, Uppsala and Linköping as well as some industrial areas [1]. The absence of natural gas causes that these regions have to rely on fuel oil, coke or coal. If these sources of energy were replaced by natural gas, great environmental benefits could be achieved. Natural gas could be delivered to these regions as LNG if special LNG import terminals were constructed. In turn, Denmark is expected to rely on pipeline gas from offshore North Sea fields in the medium-term. Existing pipelines and existing contracts will give this county a sufficient supply in the near future. However, in the long-term, LNG is considered as an alternative source of energy.

LNG as an alternative fuel for ships in the Baltic Sea

Pollution in the Baltic Sea is very high and is constantly getting worse. The shipping industry is one of the several contributors to local pollution, especially in terms of nitrogen oxides (NO_x), sulfur oxides (SO_x) and particle emissions. For example, Baltic Sea shipping in 2008 emitted about 135,000 tonnes of SO_x, 393,000 tonnes of NO_x and 18.9 million tonnes of CO_2. This is the same amount of NO_x and twice the amount of SO_x as the total land-based emissions from Sweden and Denmark combined [2].

There are several steps undertaken to save the ecosystem in Baltic Sea area; one of these is emission reduction requirements for shipping industry. The Baltic Sea and the North Sea are IMO Emission Control Area (ECA) seas. In order to reduce SO_x emissions in ECA, the IMO requires reduction of fuel sulfur content. As of 1 July 2010 the fuel sulfur contents must be below 1%. In turn, from 1 January 2015 fuel sulfur content must be below 0.1%. However, according to directive 2005/33/EC, valid from 1 January 2010, ships at berth in all ports of the European Community shall not use marine fuels with a sulfur content exceeding 0.1% by mass.

The IMO specifies also existing and future NO_x emission limits for marine engines. The IMO NO_x emission standards are commonly referred to Tier I, Tier II and Tier III standards. The Tier I standard applies to diesel engines installed on ships constructed on or after 1 January 2000. Currently the Tier II standard is enforced, and has been in effect since January 2011. It means that NO_x emissions of the engines must be approximately 20% lower than the previous IMO Tier 1 standard. However, vessels with a keel-laid date on or after 1 January 2016 that travel in NO_x ECA will require IMO Tier III certified engines. It means that another 75% NO_x reduction will be required for these ships.

TABLE 1: SO_x LIMITS IN FUEL IN ECA

Date	Sulphur limit in fuel in ECA (%)
2000	1.5 %
1 July 2010	1.0 %
2015	0.1 %

Source: MARPOL 73/78, Annex VI Regulations for the Prevention of Air Pollution from Ships.

TABLE 2: NO_x EMISSION LIMITS

Tier	Date	NO_x limit (g/kWh) n < 130 rpm	130 rpm ≤ n < 2,000 rpm	n ≥ 2,000 rpm
Tier I	2000	17.0	$45 * n^{-0.2}$	9.8
Tier II	2011	14.4	$44 * n^{-0.23}$	7.7
Tier III*	2016	3.4	$9 * n^{-0.2}$	1.96

* in ECA
Source: MARPOL 73/78, Annex VI, *Regulations for the Prevention of Air Pollution from Ships.*

New regulations on emissions of SO_x and (NO_x) within the Baltic Sea and the North Sea have recently increased the interest in and demand for alternative fuels. LNG as an alternative fuel is currently the most popular option. Using LNG instead of oil considerably lowers the emissions of SO_x and NO_x.

Natural gas is the cleanest form of fossil fuel. Natural gas consists of methane with minor concentrations of heavier hydrocarbons such as ethane and propane. When ships are fuelled with LNG, no additional abatement measures are required in order to meet the ECA requirements. The burning process of natural gas is clean. LNG contains virtually no sulfur; hence SO_x emissions from natural gas engines are reduced by close to 100%. The particle emission is also reduced by close to 100%. Moreover, burning LNG produces 85% to 90% less NO_x than conventional fuel, and greenhouse gas emissions are reduced by 15 to 20% [3]. There is currently much research being made on ships propelled by LNG. For example, replacing a conventional passenger ferry in Norway to a LNG-powered vessel would be equivalent to taking 160,000 cars out of traffic as far as NO_x emissions are concerned [4].

LNG has been used as marine fuel since 2001. Norway has pioneered the use of LNG-powered ships. Currently, about 20 LNG-fuelled ships are being operated in Norwegian waters, ranging from coast guard boats and supply vessels to ferries.

Many manufacturers are offering LNG-fuelled engines already. Gas engines currently available on the market can be divided in two main categories: dual fuel engines (e.g. Wärtsilä, Man), and lean-burn gas engines (e.g. Rolls-Royce, Mitsubishi). These engines have varying characteristics and levels of efficiency. The dual fuel engine runs on both LNG and conventional fuel. It is flexible solution when the availability of LNG fuel is uncertain (e.g. lack of LNG bunkering stations). The lean-burn mono-fuel engine gives a simpler installation onboard, and is a more suitable solution for ships operating in regions with a developed grid of LNG bunkering stations.

MARINTEK carried out the studies which indicate that additional costs for a gas-fuelled ship will be of 10 to 15% of the total cost of a conventional ship. This additional cost is connected mainly with large LNG tanks and the fuel piping system. It can be estimated that for a typical RoRo ship of 5,600 DWT, the additional costs will be about €3.2 million [5].

There are major challenges to the widespread implementation of LNG as a ship's fuel. One of the main challenges is the large space is required onboard for LNG tanks, and this contributes to the loss of cargo space. For example, LNG requires about 1.8 times more volume than marine diesel oil (MDO) with equal energy content. If we add the tank insulation, the needed volume is about 2.3 times higher [6]. For new-build ships it is quite simple to find space for the larger fuel tanks, while this may be much more difficult – or even impossible – to find it on ships already in operation. That's why there is very little probability that existing ships will be using LNG instead of conventional fuel. It is more likely that LNG as marine fuel will be used by new-build ships.

Moreover, it has to be noticed that in order not to lose much cargo space, the operational range must be reduced, due to bunker capacity of the vessel. Therefore, LNG is a fuel alternative basically for vessels that can be re-fueled quite often. Hence, this fuel alternative is not suitable for large vessels engaged in deep-sea shipping. LNG as ship's fuel is most convenient for short-sea shipping and such ships as RoRo and ferries. That's why more investment in LNG-powered ships is expected in this sector.

Apart from LNG, there are two other alternatives to meet the future ECA requirements: switching to low sulfur fuel (MGO, MDO) or installing exhaust gas scrubbers. However, of these three options, LNG has the best environmental impact. NO_x, SO_x, particles and CO_2 emissions from natural gas engines are the lowest. What is more, LNG is economically the best solution. According to DNV estimation, switching to LNG power could potentially save 12% on total vessel operational costs over a 10-year period compared to HFO with scrubber, and 35% on total vessel operational costs compared to MGO. In turn, over a 20-year period a switch to LNG power could potentially save 22% on total vessel operational costs compared to HFO with scrubber, and 45% on total vessel operational costs compared to MGO [7].

LNG infrastructure in ports

Construction of the LNG import terminals

A number of LNG terminals are planned or considered to be constructed in Baltic Sea region in the near future. Plans assume constructions of large import terminals, as well as smaller terminals for local LNG distribution. The localization of planned LNG terminals is shown in Figure 1. However it must be mentioned that some of these terminals are only proposed terminals. Their construction depends on many factors and it is not certain if they will be established.

Around the Baltic Sea region, three LNG terminals are already under development – a large-scale LNG terminal in Świnoujście (Poland); a small-scale LNG terminal in Nynäshamn (Sweden), and a small-scale LNG terminal in Gothenburg (Sweden). In Finland there are plans to construct two small-scale LNG import terminals: in Poorvo in the vicinity of new liquefaction plant, and in Turku/Naantali. A large-scale import terminal is planned in Inkoo.

Other Baltic countries such as Lithuania, Latvia and Estonia are considering the construction of large-scale LNG terminals in order to diversify of energy sources and reduce energy dependence on Russia. Each of these three countries plans to build their own LNG terminal. However, three large-scale LNG terminals in the near vicinity will be certainly too many. That's why it is very likely that only one large-scale LNG terminal will be established for these three countries.

LNG terminal in Świnoujście, Poland

The sea part of the terminal is designed as an external port situated next to the eastern breakwater. The terminal will receive vessels of about 70,000 DWT, transporting approximately 145,000m^3 of liquefied gas. The land part of the terminal will occupy about 38 ha. However, twice as much land is available. According to the plans, the annual handling capacity of the terminal will vary from 2.5 to 7.5 billion cubic meters of gas following the demand of the market [8].

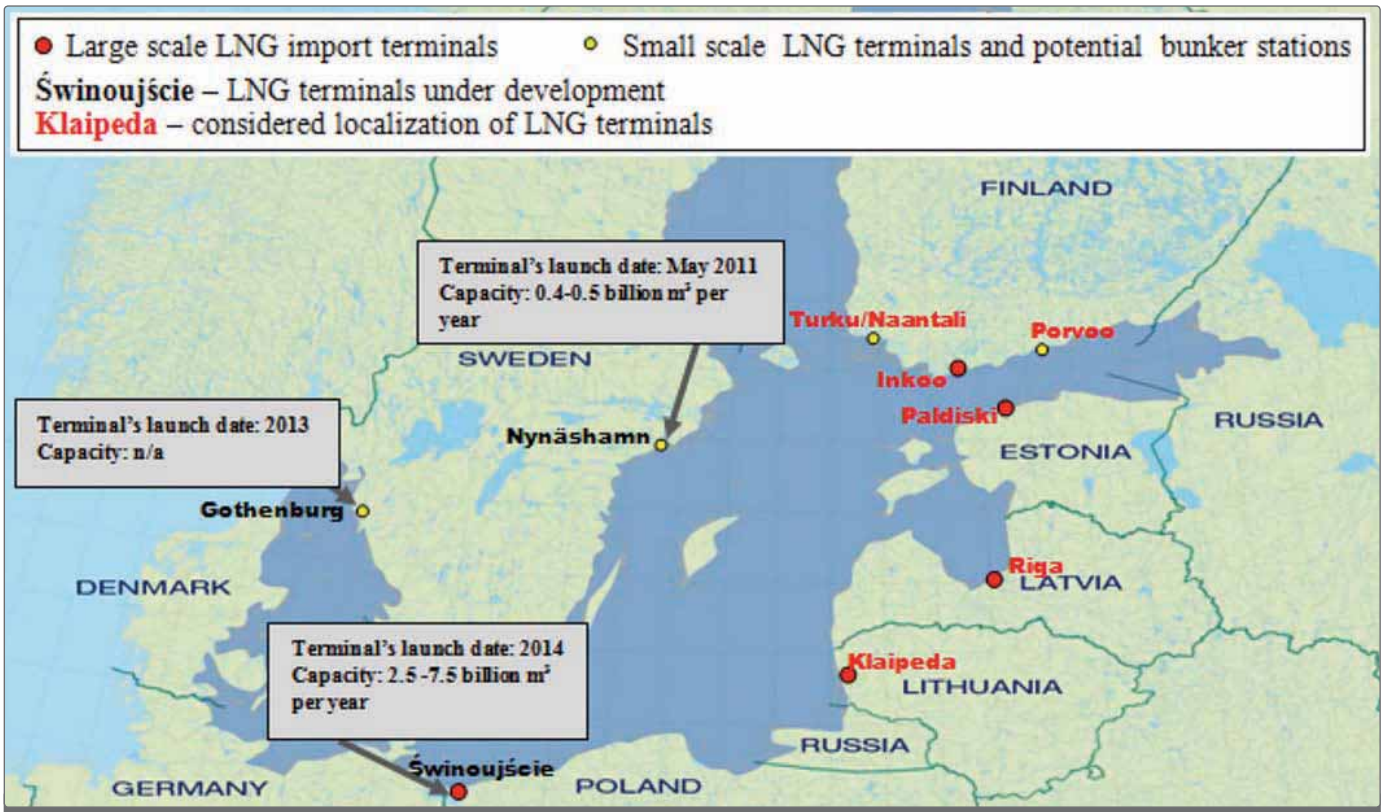

Figure 1. Proposed LNG import terminals in the Baltic Sea Region.

There are three investors carrying out the works: Polskie LNG Ltd is responsible for the construction of the LNG terminal. Szczecin Maritime Office is responsible for breakwater construction and dredging works (navigation routes and rotation points). The Port of Szczecin and Świnoujscie Authority are responsible for the construction of the port jetty, with some dredging works around the jetty.

The whole project is financed by the state or state-owned companies. The cost of the construction of LNG terminal is estimated at 2.9 billion PLN [9]. The cost of the breakwater construction and dredging works are estimated at 814 million PLN. The cost of constructing the port jetty is estimated at 167 million PLN [10]. The LNG terminal is expected begin operation in 2014.

LNG terminal in Klaipeda, Lithuania

In July 2010, the Government of the Republic of Lithuania adopted a decision to construct a LNG terminal in Klaipeda. The public company Klaipedos Nafta was chosen as the main terminal building tool. The terminal is expected to be constructed at the Klaipedos Nafta oil product terminal at the port. The proposed capacity for the LNG terminal is 2 billion cubic meters a year. The terminal may cost about €200-300 million. It is believed that terminal could be put into operation in late 2014 [11]. It is not clear where the LNG shipments will be sourced from.


Courtesy: http://www.eswinoujscie.pl/
Figure 2. Visualization of LNG terminal in Świnoujście.

LNG terminal in Riga, Latvia

According to the Free Port of Riga Development Program, there are plans to construct LNG terminal in the Port of Riga. The LNG terminal could be located on the north-east bank of the River Daugava, near to the river's mouth. The area of the LNG terminal is expected to be 34 ha. The proposed capacity for the LNG terminal is 1,500,000 tonnes of LNG per year (about 2 billion cubic meters). The LNG terminal will comprise of the following elements: a tanker berth with unloading equipment, an LNG storage facility, a re-gasification process plant, and infrastructure connecting the terminal to the pipeline transmission network [12]. The construction of an LNG terminal in Riga may cost around €710 million [13].

LNG terminal near the town of Paldiski, Estonia

There are plans to construct an LNG terminal near the town of Paldiski. The estimated cost of investment is about €350 million. The terminal's operator will be Balti Gaas. It is planned that two tanks with a capacity of 160,000 cubic meters each will be constructed. When completed, the terminal will employ about 60 people [14].

LNG terminal in Nynäshamn, Sweden

Construction of LNG terminal in Nynäshamn began in autumn 2008. The terminal is scheduled to be ready for operation in May 2011, and is owned by AGA Gas AB. The cost of the terminal and tank was 275 million SEK [15]. NCC Construction was responsible for construction of the infrastructure required for the new terminal. The LNG tank itself was design and built by Cryo AB (Gothenburg, Sweden), part of Linde's engineering division.

The terminal has a capacity of 300,000 to 400,000 tonnes per year. Natural gas for the terminal will be sourced from a liquefaction plant in Stavanger, Norway and from Central Europe.

Courtesy: Port of Klaipeda.

Figure 3. Visualization of LNG terminal in Klaipeda.

The height of the tank is 36.6 meters, diameter 37.5 meters, and the volume 20,000 cubic meters. The harbor for the terminal will receive tankers up to 160 meters in length, 9 meters in depth and with a capacity of 50,000 cubic meters.

LNG terminal in Gothenburg, Sweden

The proposed LNG terminal in Gothenburg will be a small-scale terminal. It will hold up to 10,000 cubic meters of LNG. This terminal will be established especially for bunkering purposes. According to the planned schedule, the terminal will be put into operation by year 2013. The overall project was initiated by Göteborg Energi together with the Port of Gothenburg, with Gasnor joining later. In early 2010, Göteborg Energi and Gasnor formed a new company, LNG GOT, which will manage the operations of the terminal [17].

Port infrastructure for distribution of LNG to ships

To offer LNG as a fuel to ships in the Baltic Sea region, infrastructure for LNG distribution must be established. This infrastructure should consist of small-scale LNG terminals

Courtesy: Linde Group.

Figure 4. LNG terminal in Nynäshamn.

Courtesy: Gasnor.

Figure 5. Bunkering of the vessel form tanker truck.

designed especially for bunkering purposes. They could be supplied by a small-scale LNG shuttle vessel (e.g. 20,000m^3) from a local LNG import terminal, which would serve as a hub to such bunker stations.

The choice of location for a LNG bunkering terminal depend both upon where potential users of LNG are and where there are areas available. LNG is considered as a alternative fuel mainly for ships operating in liner service (such as RoRo ships, ferries and feeder container vessels). Hence, LNG terminals for bunkering purposes should be constructed in locations where there are the most dense liner services.

Planned LNG terminals in the Baltic Sea region could be considered as part of a future supply infrastructure for LNG fuel. The proposed terminals in Estonia, Latvia, Lithuania and Poland could be potential hubs for LNG fuel because they will be capable of receiving full-size LNG vessels. The proposed terminals in Sweden could be potential bunker stations.

Currently, 13 LNG terminals are available for fuelling ships in Norway and the number of such terminals in Norway is growing. Depending on circumstances in the bunkering terminal and the quantities of LNG to be supplied, two types of bunkering are currently being used for LNG propelled vessels in Norway:

1. Bunkering from fixed filling lines.
2. Bunkering from a tanker truck.

Fuel transfer directly from fixed onshore tanks is the most relevant option if ships can usually be bunkered at one location, and there is available space to install LNG tanks. In this case, LNG is transferred from the storage tanks to the ship via an insulated pipeline. The second solution assumes that the vessel is being bunkered at berth directly from tanker truck (see Figure 5). Moreover, the development of a ship-to-ship LNG bunkering solution can also be considered.

Conclusion

The chances are that LNG may play an important role in the Baltic Sea Region in the near future. It is a significant alternative to energy sources currently being used in the region, and to bunker fuels currently used by ships operating in the Baltic Sea. The majority of Baltic counties are still energy islands because of energy isolation and dependence on a single source. Hence, the diversification of energy sources of Baltic countries is a top priority for the Baltic Sea Region.

LNG seems to be an important factor for the security of the Baltic Sea region's future energy supply. Moreover, LNG as a ship fuel is the supreme solution in compliance with the upcoming ECA requirements concerning limits of sulfur and nitrogen contents in the fuel used by ships operating in the Baltic Sea. However, widespread use of LNG as an alternative source of energy and as an alternative ship fuel requires construction of special infrastructure, such as LNG import terminals and port infrastructure for distribution of LNG to ships

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Increasing efficiency, accuracy, and safety at bulk liquid storage facilities

A new fully scalable tank gauging system from Emerson

Rosemount Tank Gauging, Emerson Process Management, Gothenburg, Sweden

Emerson Process Management's new Raptor tank gauging system makes it easy to install the devices needed today and add or replace units in the future. This flexibility protects users' investments so that refineries and tank farms can easily become and stay efficient. Additional benefits include lower installation costs, high accuracy, and built-in safety features.

The Raptor system consists of a complete range of tank gauging instrumentation including high performance, non-contact radar level gauges; temperature and pressure transmitters, plus water interface sensors and inventory management software. Tank hubs are used to communicate with the measuring instruments and control room via standard communication protocols. The design is based on open technology and is fully scalable with functionality and scope that can be adapted to any application and performance class.

The system includes new safety technologies to help protect plant assets, personnel, and the environment. One example is the unique two-in-one functionality – with two independent radar gauges in one single enclosure – providing SIL 3 safety for overfill prevention.

Raptor gauges have drip-off antennas for undisturbed performance in tanks with condensing vapors.

The two-in-one functionality means better overfill prevention and enables SIL 3 safety.

The Raptor system includes the ultra precise 5900S Radar Level Gauge.

There are also a number of other dual redundant configurations available to suit individual tank safety requirements.

Raptor reduces installation costs substantially. Raptor's unique, bus-powered two-wire Tankbus communication is based on self-configuring FOUNDATION™ fieldbus technology, allowing easy start-up and integration of all system units. The tank units are intrinsically safe, which means no expensive cable conduits are required. Communication to the control room can be made using Modbus over most existing cabling, or using other fieldbus standards.

Further installation cost savings can be realized with Emerson's Smart Wireless functionality, which eliminates the need for long-distance signal wiring. This is especially valuable when no suitable ground cabling is available and it is necessary to cross roads, or when ground conditions make cabling expensive. Wireless communication can also be used as a redundant and independent communication path beside the traditional wired communication.

There are many tank farms with gauging based on older technology, even in fairly recent installations, leading to maintenance problems and low performance. Raptor can emulate gauges from other manufacturers. This means the customer can add Raptor units to their existing system using the same cabling and control room infrastructure.

Raptor is built around a new line of Rosemount® 0.5mm (0.02in.) precision radar level gauges, and ultra stable temperature transmitters with three- or four-wire multiple spot sensors. The result is the highest available precision in net volume calculations for custody transfer and inventory management. Having access to reliable and accurate tank content information in real-time is key to high plant efficiency, as the operators can handle even more tanks, fill the tanks higher and better utilize the storage capacity.

Emerson's Rosemount Tank Gauging is the world market leader in systems for high-precision tank gauging used at refineries and bulk liquid storage plants. The systems are applied on all types of storage tanks, both fixed roof and floating roof tanks. The radar gauges use the drip-off antenna concept, proven in 100,000+ installations world-wide. They can be used in virtually any liquid ranging from light products such as liquefied petroleum gas, liquefied natural gas, and gasoline, to heavier products such as crude oils and asphalt.

ABOUT THE COMPANY

Emerson Process Management, an Emerson business, is a leader in helping businesses automate their production, processing and distribution in the chemical, oil and gas, refining, tank storage, power, water and wastewater treatment, food and beverage, pharmaceutical and other industries. A business unit of Emerson, **Rosemount Tank Gauging** is the largest manufacturer of high-precision tank gauging with radar level gauges, temperature and pressure instrumentation. Rosemount's best-in-class technology and expertise play a key role in Emerson's combining of superior products and technology with industry-specific engineering, consulting, project management and maintenance services.

ENQUIRIES

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"We are well aware that time is money"

The Port of Felixstowe is preparing for the vessels and cargo of the future, says **David Gledhill**, Chief Executive Officer, Hutchison Ports (UK) Limited

"The Port of Felixstowe is the UK's largest container port and the only one in the UK equipped to handle the next generation of container vessels. In addition to container traffic, Felixstowe also handles a significant quantity of RoRo traffic with Northern Europe.

"The UK economy is dependent upon imports and a very wide range of products are imported through Felixstowe. One of the advantages of Felixstowe for importers and exporters is that they can connect with just about every overseas market through the port.

"Berths 8&9 are the first phase of a project to refurbish and redevelop facilities in the southern part of the port. Ultimately, the project will provide an additional 1,285 metres of quay. Berths 8&9 provide the first 730 metres of quay dredged, initially, to 16 metres alongside but we have designed and built the terminal to allow this to be increased to 18 metres as and when required.

"The other factor behind the development of Berths 8&9 has been the drive by the world's major shipping lines to secure economies of scale. Every week we are seeing new vessels of 12,000 TEU, 14,000 TEU and soon 18,000 TEU. We are wholly committed to providing our customers with the facilities they require and there is a clear requirement for terminal capacity for the largest ships. Berths 8&9 provide that capacity.

"From a customer perspective, it is also important that these facilities can be accessed with minimum deviation from the main shipping routes. We are well aware that time is money, and that schedule reliability is crucial, and these new facilities will help our customers provide the efficient and reliable service that shippers rightly demand.

"The construction phase of Berths 8&9 is all but complete. We have handled the first trial vessels and are now ramping up the testing phase to ensure that all the systems and equipment are functioning as designed and, importantly, will continue to operate as designed when under full load. Comprehensive commercial operations will commence later in 2011.

"The new facility is equipped with the largest cranes of their type in the world. They have an outreach capable of handling ships with containers stowed 24-wide on deck, which is larger than anything currently on order.

"Larger cranes present a range of challenges for the crane drivers and to help them in their tasks, and to ensure we achieve maximum operational performance, the cranes are equipped with a number of driver aids. These include a Trailer Positioning System, which recognises the trailer under the crane and aids the truck operator to correctly position the container by means of ground level indication, an Automatic Skew Control, which corrects any skew movement of the spreader caused by wind, vessel cell guides or load imbalance, and a Semi-automatic Positioning System which allows the crane operator to pre-select a ship discharge or loading operation from which the system will automatically calculate and position the crane to the target position with an optimised path and with anti-sway control.

"At the Port of Felixstowe we were very pleased to be able to report a 10% reduction in our carbon footprint since 2008. We are determined to build upon this success and these efforts will be helped by the Rubber-Tyred Gantry cranes (RTGs) we have specified for Berths 8&9. These Eco-RTGs will allow a reduction in fuel use, and therefore emissions, of 40-50% per machine.

"It is important that we provide the facilities that help others reduce carbon across the whole supply chain. The largest ships that can use Berths 8&9 have a significantly lower carbon footprint per unit than smaller vessels, and the investments we are continuing to make in rail facilities within the port and beyond, mean that we put more containers onto more trains to more destinations than any other UK port.

"The scale of operation at Felixstowe not only ensures that we are able to offer shippers a much wider range of rail and coastal feeder services than the alternatives, it also means that these services are better utilised. A full train is environmentally much more sustainable than a half-empty one. This all produces a virtuous circle in which we offer better choice and lower emissions to the users of our port."

To read the interview in full, visit www.porttechnology.org/davidgledhill

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