Container terminal automation & intelligent cargo handling
Cargotec in brief 2017

Megatrends:

Population growth
GDP growth per capita
Urbanisation
Energy demand
Environmental awareness
Digitalisation

SALES, MEUR: 3,280

SERVICES AND SOFTWARE, % OF SALES:
- KALMAR: 49%
  - Kalmar offers cargo handling equipment and automated terminal solutions, software and services that are used in ports, terminals, distribution centres and various industries.
- HIAB: 33%
  - Hiab is the global market leader in on-road load handling solutions with customers operating in the land transport and delivery industries.
- MACGREGOR: 18%
  - MacGregor provides engineering solutions and services for marine cargo and offshore load handling.

OPERATING PROFIT, MEUR: 226.7

~160 million EUR software sales
McKinsey: EUR 17 billion of waste and efficiency in ocean container supply chain

Planning & Execution: plan and execute all moves across terminal/ increases throughput and lowers cost

Analytics for better operational decision making

Automate & improve truck turn times

Optimise container yard moves, save cost and reduce moves

Optimise vessel load and discharge across cranes

Capture all billable events for accurate and timely billing

Optimise rail load and discharge processes

Optimise vehicle routing and costs

Track vessel operational performance and environmental compliance

Optimise vessel stowage planning

Ensure seaworthy loading of vessels

Source: Cargotec Capital Markets Day 2017
Container terminal automation - current status

- ~1,300 facilities worldwide
- Just over 3% classed as automated
- Seems disappointingly low given the high profile of automation and the potential benefits it offers.
- However, it does suggest a large potential of existing facilities that might be retrofitted with automated equipment.

Proportion of automated container terminals worldwide (by number of terminals)

Source: Drewry Maritime Research
Existing and planned automated container terminals
Potential for retrofit terminal automation

- There are over 100 confirmed greenfield developments currently in the pipeline around the world, although so far only a handful have opted for automation.
- Lower container volumes, greater risks and potentially lower returns from greenfield terminal projects, has led to cautious approach by terminal operators and investors on greenfield projects. With greenfield terminal project pipeline reduced, the opportunity of large automation projects is affected.
- Instead there is greater focus for optimizing existing terminals.
- The natural focus for retrofit automation is the larger terminals, of which there are over 300 not yet employing automation.
- Best potential for brownfield automation can be with larger terminals (above 500K TEU throughput) in high wage economies.
- Low wage locations also show interest due to prestige, reputation and technological learning.
- North Asia (including China) and Europe could offer the most opportunities.

Number of potential retrofit automation terminals (by number of terminals)

Number of container terminals (by terminal size 2016):

- Up to 100k teu: 516
- 100-250k teu: 239
- 250-500k teu: 190
- 500-1,000k teu: 174
- Over 1,000k teu throughput: 193

Source: Drewry Maritime Research
## Fully automated container terminals - existing and planned

<table>
<thead>
<tr>
<th>Country</th>
<th>Port</th>
<th>Terminal</th>
<th>Operator/owner</th>
<th>Yard stack system</th>
<th>Horizontal transport system</th>
<th>Fully or semi-automated?</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Brisbane</td>
<td>Fishermans Island Berths 8-10</td>
<td>Patrick Ports</td>
<td>AutoStrad</td>
<td>AutoStrad</td>
<td>Fully</td>
<td>Operational</td>
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<tr>
<td>Australia</td>
<td>Sydney (Port Botany)</td>
<td>Brotherson Dock North, Port Botany</td>
<td>Patrick Ports</td>
<td>AutoStrad</td>
<td>AutoStrad</td>
<td>Fully</td>
<td>Operational</td>
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<tr>
<td>Australia</td>
<td>Melbourne</td>
<td>Victoria International Container Terminal Limited (VICTL)</td>
<td>ICTSI</td>
<td>ASC</td>
<td>Automated SC</td>
<td>Fully</td>
<td>Operational</td>
</tr>
<tr>
<td>China</td>
<td>Xiamen</td>
<td>Xiamen Ocean Gate Container Terminal (XOCT) *</td>
<td>Cosco Pacific</td>
<td>ARMG</td>
<td>AGV</td>
<td>Fully</td>
<td>Automation of existing terminal (Phase 1 operational, Phases 2 and 3 under development)</td>
</tr>
<tr>
<td>China</td>
<td>Shanghai</td>
<td>Yangshan Phase 4</td>
<td>SIPG</td>
<td>ARMG</td>
<td>AGV</td>
<td>Fully</td>
<td>Trial vessels handled end 2017</td>
</tr>
<tr>
<td>China</td>
<td>Qingdao</td>
<td>Qingdao New Qianwan Container Terminal (QQCTN)</td>
<td>Qingdao Port International</td>
<td>ARMG</td>
<td>AGV</td>
<td>Fully</td>
<td>Operational</td>
</tr>
<tr>
<td>Germany</td>
<td>Hamburg</td>
<td>Altenwerder Container Terminal (CTA)</td>
<td>HHLA</td>
<td>ASC</td>
<td>AGV</td>
<td>Fully</td>
<td>Operational</td>
</tr>
<tr>
<td>Japan</td>
<td>Nagoya</td>
<td>Tobishima Pier South Side Container Terminal</td>
<td>Nagoya Port Terminal Corporation (Tobishima Container Berth Company)</td>
<td>ARTG</td>
<td>AGV</td>
<td>Fully</td>
<td>Operational</td>
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<tr>
<td>Netherlands</td>
<td>Rotterdam</td>
<td>Delta Dedicated East &amp; West Terminals (ECT)</td>
<td>Hutchison Ports</td>
<td>ARMG</td>
<td>AGV</td>
<td>Fully</td>
<td>Operational</td>
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<td>Netherlands</td>
<td>Rotterdam</td>
<td>Euromax Terminal - (Maasvlakte)</td>
<td>Hutchison Ports</td>
<td>ARMG</td>
<td>AGV</td>
<td>Fully</td>
<td>Operational</td>
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<td>Netherlands</td>
<td>Rotterdam</td>
<td>Rotterdam World Gateway Terminal</td>
<td>DP World</td>
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<td>AGV</td>
<td>Fully</td>
<td>Operational</td>
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<td>Rotterdam</td>
<td>APM Terminals Maassvlakte II</td>
<td>APM Terminals</td>
<td>ARMG</td>
<td>AGV</td>
<td>Fully</td>
<td>Operational</td>
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<tr>
<td>Singapore</td>
<td>Singapore</td>
<td>Tuas</td>
<td>PSA</td>
<td>Not confirmed</td>
<td>Not confirmed</td>
<td>Fully?</td>
<td>Planned</td>
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<tr>
<td>USA</td>
<td>Los Angeles</td>
<td>TraPac Terminal</td>
<td>MOL</td>
<td>ASC</td>
<td>AutoStrad</td>
<td>Fully</td>
<td>Operational</td>
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<tr>
<td>USA</td>
<td>Long Beach</td>
<td>Long Beach Container Terminal (Middle Harbor Redevelopment Project)</td>
<td>OOCL</td>
<td>ASC</td>
<td>AGV</td>
<td>Fully</td>
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<td>China</td>
<td>Tianjin</td>
<td>Dongjiang</td>
<td>Tianjin Port Company</td>
<td>Not confirmed</td>
<td>Not confirmed</td>
<td>Not confirmed</td>
<td>Under development</td>
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<tr>
<td>India</td>
<td>Vizhinjam</td>
<td>Adani Terminal</td>
<td>Adani</td>
<td>Not confirmed</td>
<td>Not confirmed</td>
<td>Not confirmed</td>
<td>Under development</td>
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<tr>
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<td>Dublin</td>
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<td>Not confirmed</td>
<td>Semi</td>
<td>Planned automation of existing terminal</td>
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<tr>
<td>Italy</td>
<td>Vado</td>
<td>Vado Ligure</td>
<td>APM Terminals</td>
<td>ARMG</td>
<td>IMV</td>
<td>Semi</td>
<td>Due to be operational in 2018</td>
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<tr>
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<td>Tanger Med</td>
<td>Tanger Med 2</td>
<td>APM Terminals</td>
<td>ARMG</td>
<td>Not confirmed</td>
<td>Not confirmed</td>
<td>Under development, due to open 2019</td>
</tr>
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<td>New Zealand</td>
<td>Auckland</td>
<td>Fergusson Container Terminal</td>
<td>Ports of Auckland</td>
<td>AutoStrad</td>
<td>SC</td>
<td>Semi</td>
<td>Automation of existing terminal, due for completion 2019</td>
</tr>
<tr>
<td>UAE</td>
<td>Jebel Ali (Dubai)</td>
<td>Terminal 4</td>
<td>DP World</td>
<td>ARTG</td>
<td>IMV</td>
<td>Semi</td>
<td>Due to be operational in 2018</td>
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<tr>
<td>USA</td>
<td>Norfolk</td>
<td>Norfolk International Terminal</td>
<td>Virginia International Terminals</td>
<td>ASC</td>
<td>SC</td>
<td>Semi</td>
<td>Under development (partial automation of existing terminal)</td>
</tr>
</tbody>
</table>

+31 already operational semi-automated terminals
in Australia, Belgium, Germany, Indonesia, Japan, Mexico, Panama, Singapore, South Korea, Spain, Taiwan, UAE, UK, USA

Source: Drewry Maritime Research
World first fully automated container terminal
- Victoria International Container Terminal (VICT), Melbourne

- A public-private partnership (PPP) for a 26-year concession between ICTSI / VICT and the Port of Melbourne Corp. was signed in May 2014.
- The 35-hectare terminal has an annual capacity of one million plus TEU. VICT has a straight berth of 660 meters, which can accommodate two large vessels with capacities of up to 8,000-12,500 TEUs at once.
- ‘OneTerminal’ automation solution, built using Kalmar’s technology and Navis’ software.
  - 11 Kalmar AutoShuttles
  - 20 Kalmar Automated Stacking Cranes
  - Kalmar Automated Truck Handling
  - Fully integrated Kalmar TLS with Navis N4 TOS
  - System integration services
- VICT also secured a crane spreader specialist Bromma after an automated lashing platform (ALP) was implemented with quay cranes (QC) from ZPMC.
- ICTSI’s total capital investment around US$ 450.

Optimising end-to-end value chain

Source: Cargotec Capital Markets Day 2017
Intelligent cargo handling solutions

Source: Cargotec Capital Markets Day 2017
Optimisation of vessel cargo system performance

- Maximising vessel’s cargo carrying capacity in relation to deadweight tonnage.
- Ship and its container stowage design starting from defining the cargo profile.
- Input data includes program control settings such as number of average operable days per year, crane properties, vessel data, route data including ports of call, leg distances and freight rates, port data, and other information such as fuel costs. Analysis is specific to a vessel, but benefits of scale can be reached if the whole fleet is analysed.
- Efficient cargo handling system design
  - optimises vessel earnings over lifetime, instead of just looking at the initial order price at shipyard.
  - minimises emissions for each carried commodity, thus reducing their carbon footprint.

Smart cargo handling developments ongoing e.g.:
- CargoBoost for container ships
- Multipurpose vessel breakbulk stowage planning tool
- Cloud based port efficiency tool for RoRo cargo

Source: MacGregor News 166