Container Terminal Robotization

Next Challenge: Brown-field?!
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About TBA
Company Profile
Headquartered in Delft, The Netherlands, founded in 1996, with subsidiaries in Germany and Romania, TBA is the largest simulation consultant worldwide.

We have a highly skilled workforce of 135 engineers, consultants and software developers.

9 out of top 10 Global Terminal Operators are customers (HPH, PSA, APMT, DPWorld, TIL, Cosco, Hanjin, HHLA, Eurogate).

Active in more than 75 countries across the globe.

Completed over 800 terminal projects with varied scope; from planning review to complete master planning.

TBA supports terminal operators during all stages from concept to realization and thereafter in operations.

TBA is specialized in ensuring that the planning is realized and targeted performance levels are achieved.
About TBA – Scope of Services / Products

✓ I SERVICES
  – **Consultancy** to container terminals with our *simulation* and *emulation* tools

✓ I PRODUCTS
  – **Software** for control of automated / robotized equipment at container terminals

<table>
<thead>
<tr>
<th>TBA</th>
<th>What</th>
<th>Stage</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation</td>
<td>Virtual terminal plus virtual TOS</td>
<td>Conceptual terminal design</td>
<td>Create a design that works and performs</td>
</tr>
<tr>
<td>Emulation</td>
<td>Virtual terminal plus real TOS</td>
<td>Terminal construction / implementation</td>
<td>Make sure TOS works and performs</td>
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<tr>
<td>Software</td>
<td>Equipment control software for real equipment</td>
<td>During operation</td>
<td>Run the operation efficiently</td>
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Recent Automation Projects

Automated equipment
- Quay cranes (semi): QC / STS
- Yard cranes: ASC
- Transport: AGV / L-AGV
- Rail cranes (semi): RC

APMT MV2 (Rotterdam – The Netherlands) / End-2014
Long Beach Container Terminal (California – USA) / Mid-2016
Rotterdam World Gateway (Rotterdam – The Netherlands) / Mid-2016
TBA's History with Container Terminal Automation Projects

- Abu Dhabi
- Antwerp
- Auckland
- Barcelona
- Bremerhaven
- Brisbane
- Dubai
- Freemantle
- Hamburg
- Lazarro
- London
- Long Beach
- Melbourne
- New York
- Pusan
- Rotterdam
- Southampton
- Sydney
- Vancouver
Trends in Automation
Illustrated in a Port Context
1. Truck appointment, including container number

2. LPR + OCR

3. OCR read + known appointments ➔ >99.9% quality

4. X-ray / radiation scan

5. Pedestal for driver ID + ticket

6. Routing advise
Vehicle Dispatching
Automated Decision Making

Automated vehicle dispatching (using Prime Route)
Automated container decking (position assignment) based on algorithms & parameters
Container Terminal in Rotterdam – The Netherlands
Robotization
Case Study: Maasvlakte 2
Ambitions > Results
Ambitions

☑️ | Handling the largest ships

☑️ | In the shortest possible time

☑️ | Minimized safety risks

☑️ | Minimized environmental impact
The Result / 2

- Fully automated truck handling
- Automated battery swap
- Optical Character Recognition on rail

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The Result / 3

Automated routing

Collision avoidance

Automated interchange & handshake

Automated error diagnosis

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### The Result / 4

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<tr>
<th></th>
<th>BC201</th>
<th>QC101</th>
<th>QC102</th>
<th>QC103</th>
<th>QC104</th>
<th>Average</th>
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<td>51</td>
<td>45</td>
<td>39</td>
<td>65</td>
<td>46.2</td>
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<tr>
<td>moves this hour</td>
<td>16</td>
<td>35</td>
<td>27</td>
<td>22</td>
<td>23</td>
<td>24.6</td>
</tr>
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![Diagram of container terminal with robotization options](image-url)
Lessons Learnt

- Requirements need to be crystal clear
- Use simulation to ensure that the system can deliver future demands
- Automated terminals are still run by humans
- Regular operation = disturbed operation
- Simulation = Emulation = Live operation
- Automation = integration → multiple vendors
Next Challenge
Brown-field
What’s Next?

- Combined work of human workers and robots
- Intelligent everything: from refrigerator to road
- Autonomous vehicles
- Self-learning devices → new behaviour
What’s Next in a Container Terminal Context?

- Sufficient capacity => shift of focus from green- to brownfield developments

- Main driver for automations – cost-efficiency on the longer run – remains

- BUT, how to apply automation in brown-field terminals …

- … in space-constrained, manned ops without performance loss?
Example: Auto Strad

In operation

- Automated Straddle Carriers in Australia
- Not brown-field but starting from a greenfield operation
Example: Auto Strad plus ARMGs
In progress

✔ | Automated Straddle Carriers in LA / Long Beach in combination with Automated Rail Mounted Gantries
✔ | New land in addition to existing terminal provides for a lot of flexibility in transition mode
Example: Auto Strad plus Manned Strad
Planned

- Auto Straddle Carriers (planned for operations) in New Zealand to serve yard / landside operations and doing a hand-over to manned Strads that serve the waterside operation
- Transition is supported by some new land in addition to existing terminal
Example: Auto RTG plus manned terminal trucks
In progress

- Automated Rubber Tyred Gantries (RTGs) in Indonesia in combination with manned terminal trucks
- Transition is supported by some new land in addition to existing terminal
Some Functional / Technical Considerations

- Apply automation in terminal equipment other than (L-)AGV to cover the broader range of existing handling systems.

- Design clever transition from manned to automated operation overcoming space constraints and supporting performance levels throughout transition.

- Define new measures to establish safe man-machine interaction in every area where men meet machines.