Container terminal automation
Experiences & lessons learnt

State of the Art October 2015
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1. Types of automation
   - Process Automation
   - Automated Decision-making
   - Robotization

2. The business case for automation

3. The latest automated terminals reviewed
   - APMT MV2
   - RWG
   - LBCT

4. Optimizing container terminal automation:
   - Selection of horizontal transportation system
     - Lift AGV vs. AGV vs. Automated Shuttle Carrier
   - Selection of yard stacking system
     - ARMG vs. CRMG vs. ARTG

5. Experiences & lessons learnt
Automation today
Automation globally

- Abu Dhabi
- Algeciras
- Antwerp
- Barcelona
- Brisbane
- Dubai
- Hamburg (2)
- Kaohsiung
- Lazaro
- London (2)
- LA / LB (2)
- Nagoya
- New York
- Pusan (4)
- Rotterdam (4)
- Sydney
- Tokyo
- Norfolk
- Semarang
- Surabaya
Types of automation

DEVELOPMENT OF TYPES OF AUTOMATION

- Automated tracking & tracking, PDS
- Automated decision making
- Automated yard cranes
- Automated horizontal transport
- Automated quay cranes
- Automated gate

% OF TERMINALS WORLDWIDE ADOPTING TECHNOLOGY

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Return on investment “Auto technology”

CAPEX vs. OPEX savings

- Quay crane automation
- Automated twistlock handling
- Yard Crane PDS
- Automated landside truck operation
- Crane OCR
- Automated horizontal transportation
- Automated yard cranes
- Gate automation

Data for 1M TEU terminal

Automation: Experiences & Lessons learnt / (c) TBA
Process Automation & Automated decision making
1. Truck appointment, including container number

2. LPR + OCR

3. OCR read + known appointments \(\rightarrow\) >99.9% quality

4. X-ray / radiation scan

5. Pedestal for driver ID + ticket

6. Routing advise

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Process automation

- Location of Prime Mover
- Location of RTG
- Container weight
- Location of road truck
- Location of container
- TOS
Automated stow planning of vessels, based on optimizing the rehandles, and well as the flow to the QC.
Automated container decking (position assignment) based on algorithms & parameters
Building a *business case* for automated terminals
Building blocks for automation business case

SAFETY

ENVIRONMENT

OPERATIONS

FINANCIALS
Financial business case

- Reduced labour deployment
- Less unproductive time
- Less wear & tear
- Between -40 and -60% ops labour
- Between -10 and -20% time for shift changes and breaks
- Between -10 and -25% less M&R costs due to damages and abuse
- Between -20 and -50% lower training costs

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Example: CAPEX increase versus OPEX reduction
High labour cost level (75 USD / h)

CAPEX and OPEX - 1M TEU

- Reference manning level: 0.60 - 0.70 man hour / container
- Reference manning level: 0.20 - 0.30 man hour / container
Example: OPEX
High labour cost level (75 USD / h)

OPEX per container

- Labour / container
- Energy / container
- Maintenance / container
- Capital / container

- RS+TT: $73.3
- SC: $44.3
- SC (Auto): $18.5
- RTG / TT: $67.9
- C-RMG / TT: $41.9
- ASC / SHC: $25.8
- ASC / L-AGV: $16.3

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Example: CAPEX increase versus OPEX reduction
Medium labour cost level (40 USD / h)
Operational business case

Tracking & tracing

No loss of containers
Saving: TBD

Information availability

Increase service level to customer: TBD

Control

Continuity

Consistency

5 - 10% increase in productivity

10 – 20% increase in vessel operating time

Less slack time in berth schedules → more capacity (10% or more)
Environmental business case

- **5 - 15% less energy consumption**
- **-25% reduction in sound levels**
- **Performance dependent behaviour**
- **Less noise (no diesel engines)**
- **Electrical equipment (no emissions)**
- **Less noise (smooth operation)**
- **100% cut in local emissions**
- **-25% - 75% reduction lux levels**
- **Less lighting**
Safety business case

- Predictable equipment behaviour
- Systems rather than humans in control
- Programmed safety features
- Extra measures in hazardous areas

- Double safety systems
  - Reduction of risks
- Double safety systems
  - Reduction of risks

- 99% reduction of errors
- 99% reduction of errors
- 70 - 80% reduction of # people exposed

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## Summary of building blocks for automation case

<table>
<thead>
<tr>
<th>Performance dependent behaviour</th>
<th>Systems rather than humans in control</th>
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<td>No people on the ground</td>
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The latest terminals reviewed

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State-of-the-art in terminal automation: APMT Rotterdam (2014)

Rail terminal

- Cantilever modules
- Block of 10 modules
- Barge stack and barge quay
RWG terminal Rotterdam Maasvlakte 2

AGV Performance Test
RWG terminal Rotterdam Maasvlakte 2

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Terminal Layout - Final Phase

- Planned yearly capacity: 3.3Mio TEU
- Waterside Productivity: 500 boxes/hour
- Quay wall length: 1,300m
- Modal split: Approx. 35% rail
- Final Phase: 14 STS, 37 ASC Modules, 72 B-AGV

LCBT will service the shipping lines:
- OOCL (mother company) and
- Grand Alliance partners and
- Third party vessels
Long Beach Container Terminal (Port of Long Beach) (Planned 2016)
AGV System for LBCT

Fully Automated Zero Emission Container Handling at Long Beach Container Terminal based on Terex Gottwald Automated Guided Vehicles
Battery Exchange Station – Exchange Positions

Battery Exchange Position 1

Battery Exchange Position 2
Battery Exchange Station – Charger and Power Distribution

Chargers in Rack Gangway

Power Distribution behind Rack
Experiences & lessons learnt
There is no single best automated terminal solution for any location.

The optimal solution is the one that:

- Satisfies throughput objectives (quay, yard, gate)
- Satisfies handling performance objectives
- Provides the most cost-efficient mode based on cost / move
- Provides acceptable characteristics in terms of environment and safety
Concluding remarks

- Automated terminals are (very) successful from cost-efficiency point of view
- Automation is the future, but is also all around us already
- Humans determine the success of automation
- If you fail to plan, better plan to fail → use tools like simulation & emulation to ensure the quality of the design
- Integrated planning is key for an automation project
- When planned properly, automated terminals can deliver the highest performance levels, and highest cost-efficiency
Thank you

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