An Introduction To the Integrated Automated Container Terminal [IACT]

AAPA Facility Engineering Seminar
Charleston South Carolina
Panel V
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Presented By Jim Hunt, TEC
Current Container Terminal Automation Systems

Are Complex Systems with Many Machines

Can Be Expensive ($2.5-$2.8 MM per ASC)

Do Not Eliminate Congestion At the Berth;

Will Do Not Allow the STS Cranes to Achieve Max Operational Efficiency
Methods

Y Stacks Arranged Perpendicular to the Quay "End-Loaded" –

HHLA - CTA - Altenwerder
APMT - Portsmouth
EuroMax - Rotterdam
ZPMC - Shanghai Prototype

Y Stacks Arranged Horizontally to the Quay "Side-Loaded"

Automated Terminal Systems - the Integrated Automated Container Terminal [IACT]
Typical End-Loaded Perpendicular Design
Typical End-Loaded Concept (Euro-Style)
TWO PHASE STS TRANSFER
TYPICAL TRUCK + RAIL INTERFACE

to check gate / public road
crane
terminal tractor
smaller gantry cranes
chassis
Requires Many Machines

Elements and Interfaces of Handling System

15 quay cranes
- optimum sequence
- QC should not wait

74 AGV
- as few AGV as possible
- AGV should not wait

52 RMG
- high and constant work load
- double cycle

Store
- as small as possible
- truck should not wait too long

Gate

Trailers
- optimize process
- as few trailers as possible

Rail
- with 4 RMG, 6 trains
HHLA - CTA – Altenwerder

15 – Quay Cranes
74 - AVGs
52 – RMG/Stacking Cranes
4 – RMGs at Rail Loading

145 – Total Machines
Requires Complex Operating Systems

Operation System Components

Waterside
- quay crane
  - 1 trolley
- quay crane
  - 2 trolleys
- Feeder bridge
- Floating crane

Transport (quay crane <-> store)
- VC 3/4
- VC 1/1
- AGV
- SAGV 1/0
- SAGV 1/1
- Chassis single-deck double-deck
- Multi-trailer
- Without, (La Spezia) (only import/ export)
- Noell system

Storage
- VC 3/4
- CTRMG
- RMG
- RTG
- OHBC
- HRL

Transport (store <-> domestic loading)
- VC 3/4
- VC 1/1
- AGV
- RMG
- SAGV 1/0
- SAGV 1/1
- Chassis single-deck double-deck
- Multi-trailer
- Without, (La Spezia) (only import/ export)

Loading on to rail
- VC 3/4
- CTRMG
- Transmann
- Direct from store

Loading on to truck
- VC 3/4
- VC 1/1
- RTG
- Reach stacker
- Direct from store
CONGESTION AT THE BERTH

DOES NOT ELIMINATE
The prototype is another design concept.
ZPMC PROTOTYPE REPLACES SHUTTLE CARRIERS WITH RAIL MOUNTED TRANSFER SYSTEM
ZPMC TRANSFER FROM RAIL SHUTTLE TO GROUND SHUTTLE
ZPMC PROTOTYPE

Reduces CO$_2$ by Replacing Diesel Electric Shuttles or AGVs with a Steel Infrastructure + More Cranes, But:

Large Complex Steel Infrastructure = High CAPEX

Attempts to Resolve the Congestion Issue But:

- Adds Machines
- Adds Complexity
- Increases Dynamic + Static Loads on the Quay Structure
Terminal Just Cause More Congestion At the Berth

Response to Larger Ships

Adding More Ship-to-Shore Cranes

Just Adds More Congestion on the Berths

Which In-Turn Adversely Impacts Overall Crane/Terminal Performance
A Better Automation System Would Then

- Allow Each Machine To Operate Independently;
- Provide “Buffer” Areas Between Operations to Allow For Breakdowns In any One Process;
- Allow For Full Automation Of TS to Stacks
- Within Stacks For Storage and Retrieval
- Between Stacks and Rail
The IATC System

- Use of Larger More Robust Equipment - Rail Mounted Gantry Cranes [RMGs] (+200’ Gage, w/ Cantilevered End; total width +300’)
- Simplify Facility Layouts
- adopt a more "Factory-Like" Approach to Processing Containers
- Electric Designs
TYPICAL END-LOADED DESIGNS
IACT COMPONENTS
### Typical System Requirements

<table>
<thead>
<tr>
<th>Euro</th>
<th>IACT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STS CRANE</strong></td>
<td><strong>STS CRANE</strong></td>
</tr>
<tr>
<td>Dual Hoist Tandem Pick</td>
<td>Standard Design Automated over land</td>
</tr>
<tr>
<td><strong>TRANSFER TO STACK</strong></td>
<td><strong>TRANSFER TO STACK</strong></td>
</tr>
<tr>
<td>Semi Automated AGVs Transfer Strads</td>
<td>Indexed Conveyor Fully Automated</td>
</tr>
<tr>
<td><strong>Stack Operations</strong></td>
<td><strong>Stack Operations</strong></td>
</tr>
<tr>
<td>Small RMGs Perpendicular Operator In the Loop</td>
<td>Large RMGs Fully Automated Industrial Design</td>
</tr>
<tr>
<td><strong>Truck + Rail Transfers</strong></td>
<td><strong>Truck + Rail Transfers</strong></td>
</tr>
<tr>
<td>Manual</td>
<td>Semi-Automated</td>
</tr>
<tr>
<td><strong>Operating System</strong></td>
<td><strong>Operating System</strong></td>
</tr>
<tr>
<td>Expert</td>
<td>Computational Intelligence Real-Time Process Control</td>
</tr>
<tr>
<td><strong>Complexity</strong></td>
<td><strong>Complexity</strong></td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Euro</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Berths</td>
<td>4</td>
</tr>
<tr>
<td>STS Cranes</td>
<td>12</td>
</tr>
<tr>
<td>CY Blocks</td>
<td>26</td>
</tr>
<tr>
<td>RMGs</td>
<td>54</td>
</tr>
<tr>
<td>VVs/Shuttle Strads</td>
<td>&gt;125</td>
</tr>
<tr>
<td>Truck Handlers</td>
<td>30</td>
</tr>
</tbody>
</table>
Comparison of Automated Systems At Proposed NYK Terminal At Port of Tacoma
TYPICAL SIDE-LOADED RMG DESIGN
PROBLEMS WITH
CONVENTIONAL SIDE-LOADED
RMG DESIGNS

...to Take Advantage of RMG Capabilities
Main Beam Spans too Limited
Stack Heights too Low
...operated as if the RMGs Were Large RTGs
...rely on Chassis Hustlers to Move Containers Between Stacks + STS Cranes
<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>IACT</th>
<th>End Loaded RMG</th>
<th>Side Loaded RMG</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMGs</td>
<td>27</td>
<td>50</td>
<td>46</td>
</tr>
<tr>
<td>Hostler Combos</td>
<td>0</td>
<td>76</td>
<td>84</td>
</tr>
<tr>
<td>Side Picks</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Truck L/UI</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conveyors</td>
<td>23</td>
<td></td>
<td></td>
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</table>
## EQUIPMENT COSTS COMPARED

**ALL COSTS IN $MM**

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>IACT</th>
<th>Cost</th>
<th>End Loaded RMG</th>
<th>Cost</th>
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<tbody>
<tr>
<td>RMGs</td>
<td>27 @ 4.5M</td>
<td>121.5</td>
<td>50 @ 3.5M</td>
<td>175.0</td>
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<tr>
<td>Hostler Combos</td>
<td>0 @125,000</td>
<td>0</td>
<td>76 @125,000</td>
<td>9.5</td>
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<tr>
<td>Side Picks</td>
<td>2 @ 500K</td>
<td>1.0</td>
<td>4@500K</td>
<td>2.0</td>
</tr>
<tr>
<td>Truck L/UI</td>
<td>12 @ 1.0M</td>
<td>12.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conveyors</td>
<td>23 @ 1.0M</td>
<td>23.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane Rail + Foundations</td>
<td></td>
<td></td>
<td>+6,200 lf (Over IACT)</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td>157.5</td>
<td></td>
<td>191.5</td>
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</tbody>
</table>
Conclusion

The Equipment Required For the IACT is Available and Proven; similar Systems Are Operational In Heavy Industry.

THE IACT System Can Reduce Equipment Costs and Complexity while Increasing Throughput capacity (TEUs/AC./YR.).

It's All About The Operating System
Additional Detail Available from Automated Terminal Systems Inc.  
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