Automated Container Terminals: Past, present, and future

AAPA Marine Terminal Management Training Seminar
September 17-21, 2012
Baltimore, Maryland

Andrew Cairns, PE PMP
Regional Port Business Line Leader
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Presentation Overview

- Examples of Implementation Worldwide
- What’s Settled and What’s Uncertain Regarding Automation Concepts
- Challenges for Automation Planning
- Architectural Issues Related to Automation
- Civil Engineering Design Issues for Automation
- Future Concepts

Automation on Marine Container Terminals

- Data capture
  - Gate, Crane, Rail, CY OCR
  - RFID
- *Container lifting equipment without drivers on the machine*
  - *RMGs, Strads*
  - *Largely automated*
  - *Remote drivers as needed (gate and exception)*
- *Horizontal transport*
  - *Automated guided vehicles (lift or standard)*
  - *Automated strads/shuttles*
- Vessel mooring (Vacuum based mooring vs ropes)

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Strengths of Automated Terminals

- Safety
  - Strict separation of trucks and cranes
  - Fewer personnel
- Storage density
  - All containers grounded (not wheeled)
  - Automated cranes allow for easy re-handling
- Low Emissions
  - Electrically powered yard cranes
  - Short travel distance for horizontal transport
- Low operating cost
  - More efficient use of labor
  - Lower maintenance costs
  - Lower energy costs
- Fewer Damaged Containers
  - More accurate handling
- Less Noise
  - Boxes not hitting each other

Tour of Automated Terminals Worldwide

Thamesport, UK

ECT, Rotterdam

ECT, Rotterdam

Altenverder, Hamburg

Altenverder, Hamburg

2nd quay crane
hoist is automated

Nested ASCs that can Pass are Unique to Altenverder

With end loaded CY systems, trucks back up to the landside end of the CY stacks and are served by remote operators

With no need to creep forward, trucks can shut off engines while waiting for service

Console for Remote Yard Crane Operations for Gate Service in Hamburg

Automated Strad Terminal in Brisbane, Australia

“Airlock” Access to Reefer Area in Brisbane

Gate Service in Brisbane is Done Via Remote Control in the Lanes

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APMT Norfolk

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APMT Norfolk Wharf

AMPT Norfolk Landside Operation

DPW Antwerp – Conversion of Strads to Strad+ASC

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DPW Antwerp ASC Interfaces

Gate/ rail Interface (trucks)

Vessel Interface (strads)

Euromax Rotterdam

Euromax Rotterdam

CTB Hamburg

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TTI Algeciras – Opened May 2010

Highlights of the World's ASC Terminals

Location/ start date	Cranes per block	Stack width (boxes)	Waterside transport	Landside transport
Thamesport/1990	2 on same rails	9/7	Trucks drive to side of ASC	Trucks back-in to landside of ASC row
ECT Rotterdam/ 1993	1	6	AGVs to end of ASC	Trucks served via strad interface
CTA Hamburg/ 2002	2 on separate rails	10	AGVs to end of ASC	Trucks back-in to landside of ASC row
APMT Norfolk/ 2007	2 on same rails	8	Manned shuttles at end of ASC	Trucks back-in to landside of ASC row
DPW Antwerp/2007	2 on same rails	10	Manned shuttles at end of ASC	Trucks back-in to landside of ASC row
Euromax Rotterdam/2008	2 on same rails	10	AGVs to end of ASC	Trucks back-in to landside of ASC row
CTB Hamburg/2009	3, on two sets of rails	10	Manned shuttles at end of ASC	Trucks back-in to landside of ASC row
TTI Algeciras/ 2010	2 on same rails	8	Manned shuttles at end of ASC	Trucks back-in to landside of ASC row

What seems to be settled in 2012?

- Street trucks back into the ends of the yard stacks
- All containers under automated cranes, no manual areas for reefers, empties, etc. (all but oversize)
- Work to crane backreach makes automated transport easier
- ASC width from 8-10 containers seems ideal
  - Wider cranes are heavier and more expensive and may not keep up with peak stevedoring requirements
  - Narrower cranes are not space efficient and result in more cranes than needed
- ASC height of 1-over-5 : Taller stacks are hard to manage and may require wider spacing to allow for rope reeving
- No one outside of Hamburg has used pairs of ASCs on different rail gages
- No one outside of Hamburg has used more than two ASCs per row

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What is still being debated in 2012?

- Manual vs automated horizontal transport
- Coupled (AGV), semi coupled (lift-AGV, cassette AGV), or decoupled (shuttles) transport
- Maximum and minimum practical ASC row length
- Feasibility of using 3 ASCs per row for long rows
- Options to increase yard density vs traditional ASCs
- Benefits of multi-pick ASCs and transports
- Parallel vs perpendicular layouts, especially for narrow terminals (TraPac, Pier S) or transhipment terminals.
- Best strategy for rail service, especially on terminals with 33%+ vessel moves via rail.
- Best way to phase from RTG+tractors to automation

Why is Automation so Appealing?
2011 San Pedro ILWU Cost Structure

- Dock crane excluding tractors and yard support ~ $1600/hr
- Seven tractors per crane ~ $800/hr
- Top pick crew ~ $225/hr
- RTG crew ~ $650/hr
- Automation savings:
  - Dock cranes are (probably) more productive
  - Fewer manual transport required with ASCs (shorter distance)
  - Zero transport required with AGVs or Autoshuttle
  - Per-crane yard crane costs of ~ $50/hr (1 driver per 4 ASCs at $200/hr)

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Automation Planning on Non-rectangular Terminals

- What's the shortest and longest practical ASC length?
- Is it feasible to use one, or three, ASCs per row?
- When do you align rows parallel to berth, or parallel to other long terminal border?
- What's the best way to access the railyard?
- Case studies
  - TraPac
  - Pier S
  - WBCT

Planning and Design Challenges

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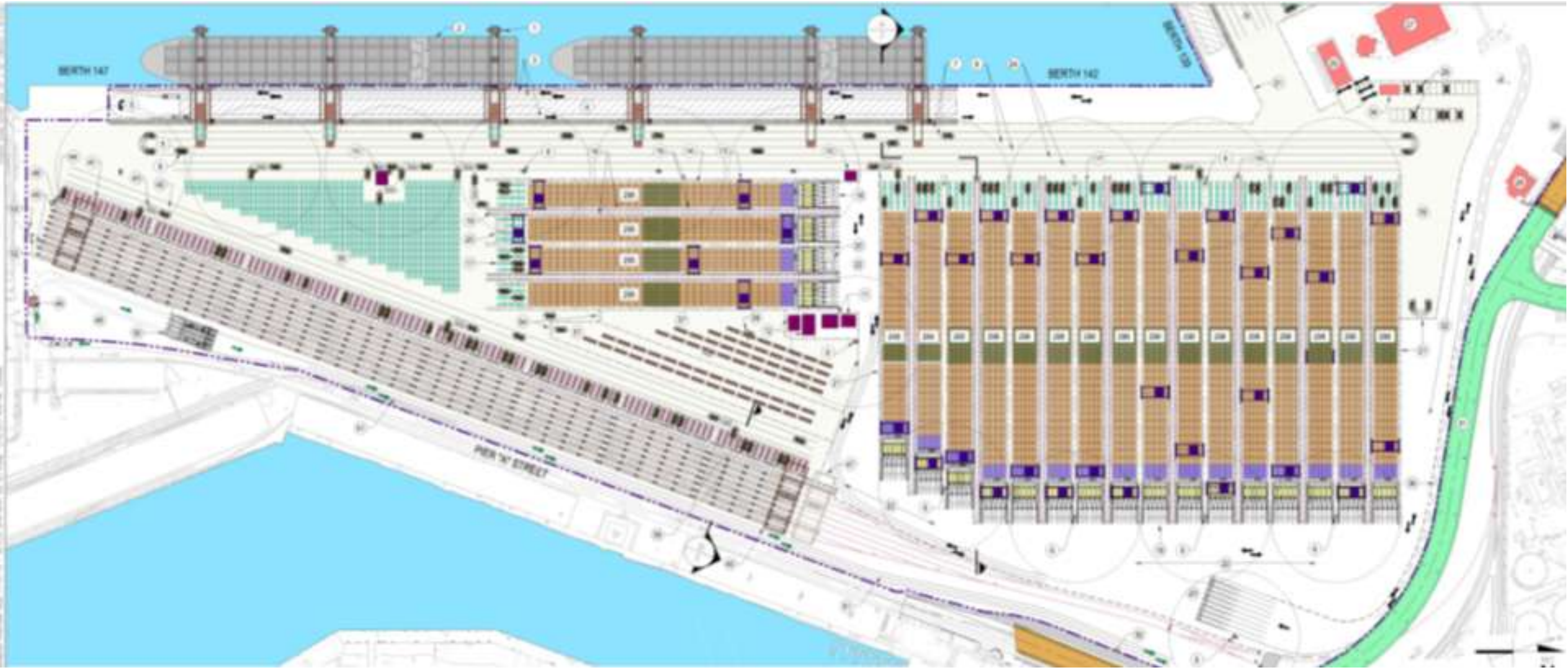
TraPac Base Case Layout



ASCs either parallel or perpendicular to wharf
2 ASCs per row

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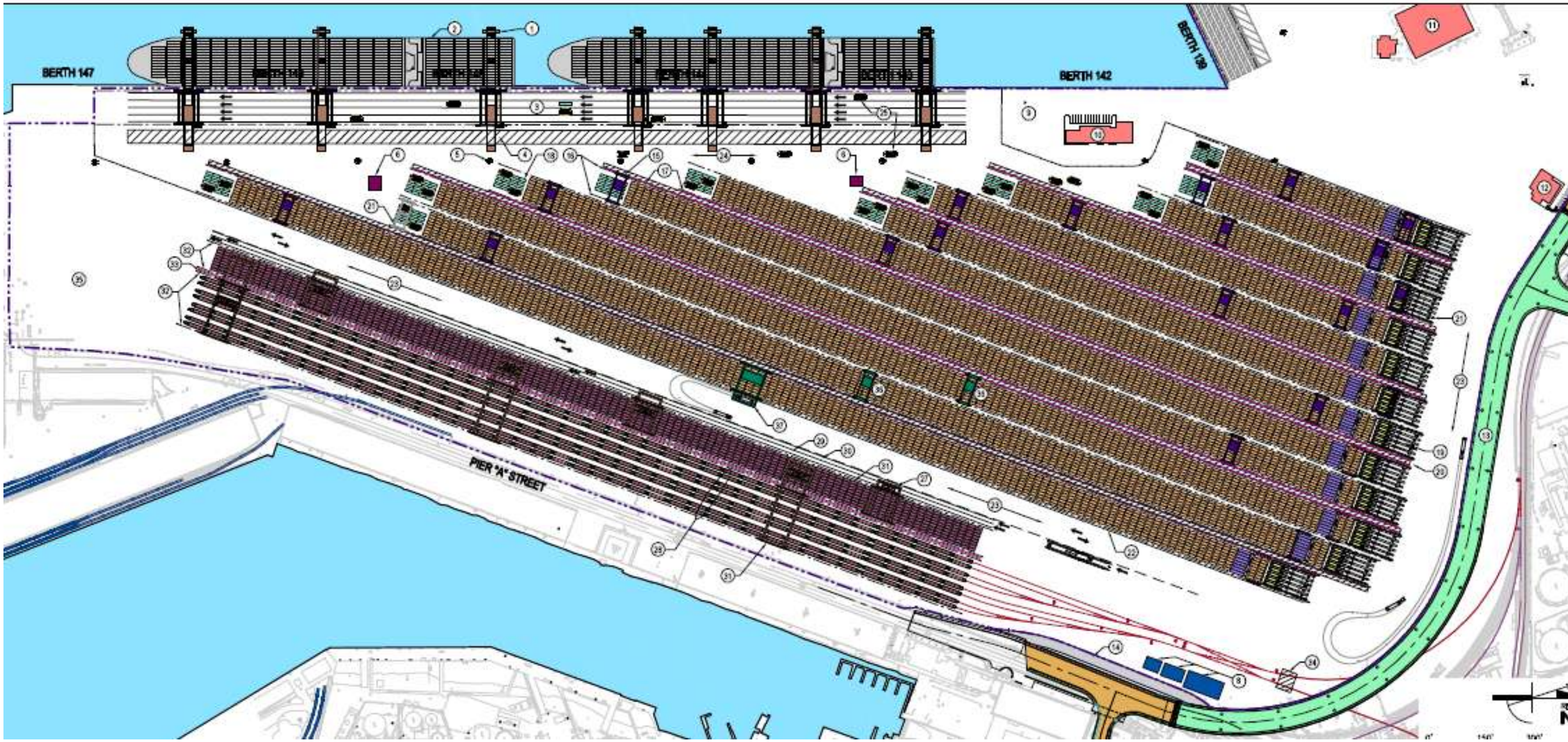
TraPac Option 2 – a more radical approach



ASCs parallel to the IY
Some rows with 3 ASCs

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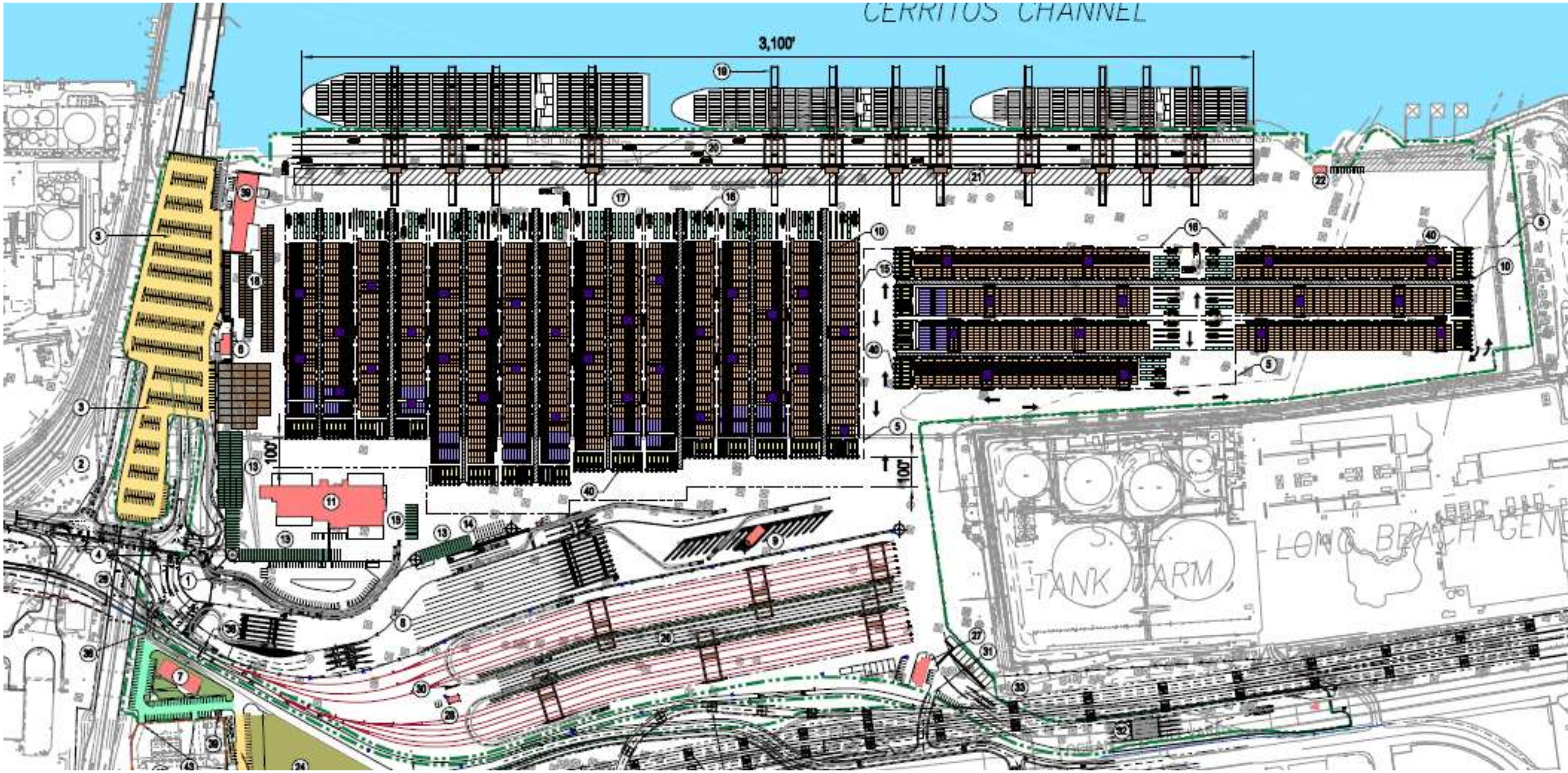
Pier S Option 1 combines parallel and perpendicular ASCs



AGVs to IY?
3 ASCs over 2 Rows?

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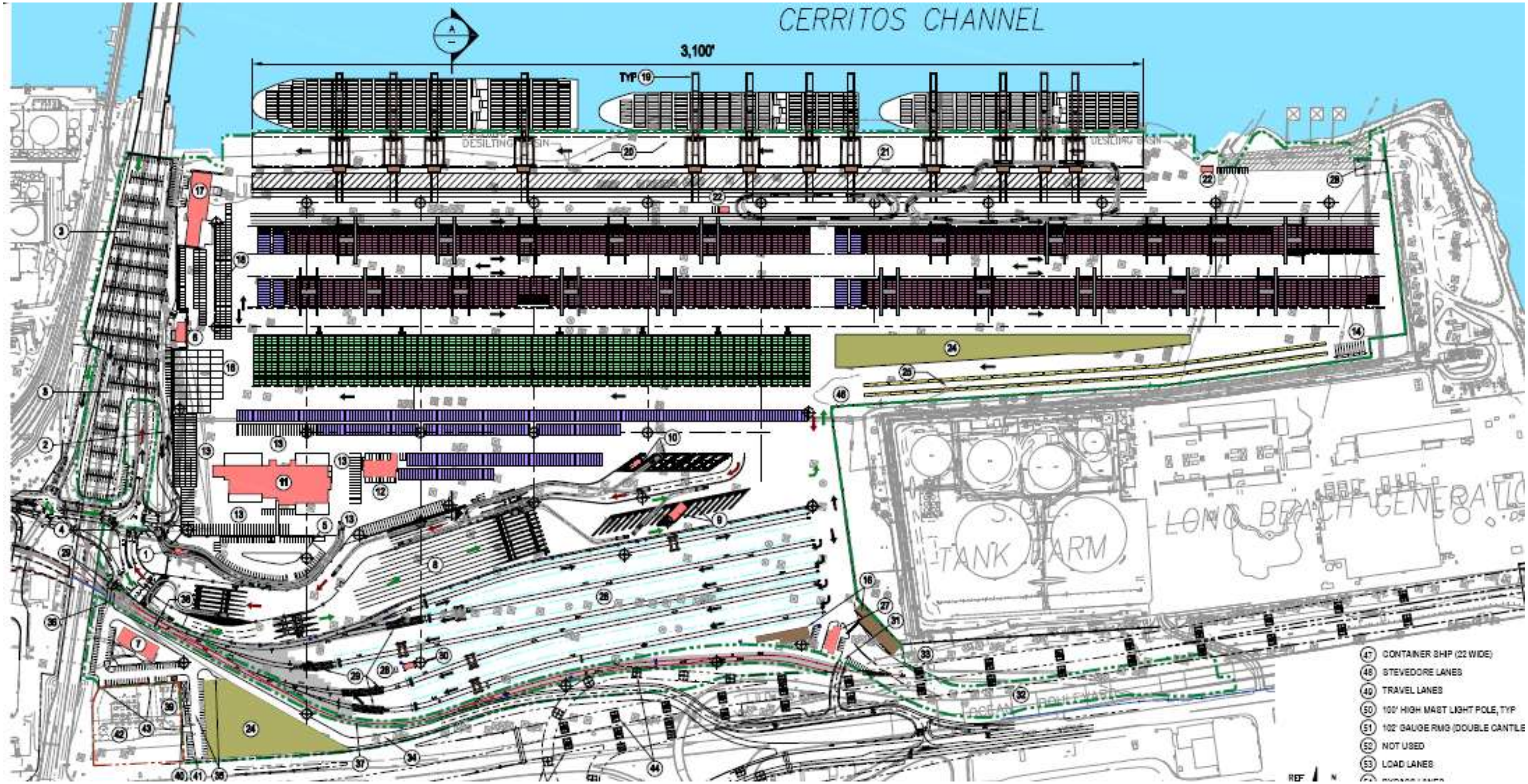
Pier S Option 2 uses side loaded RMGs in the Shallow but Broad Terminal CY



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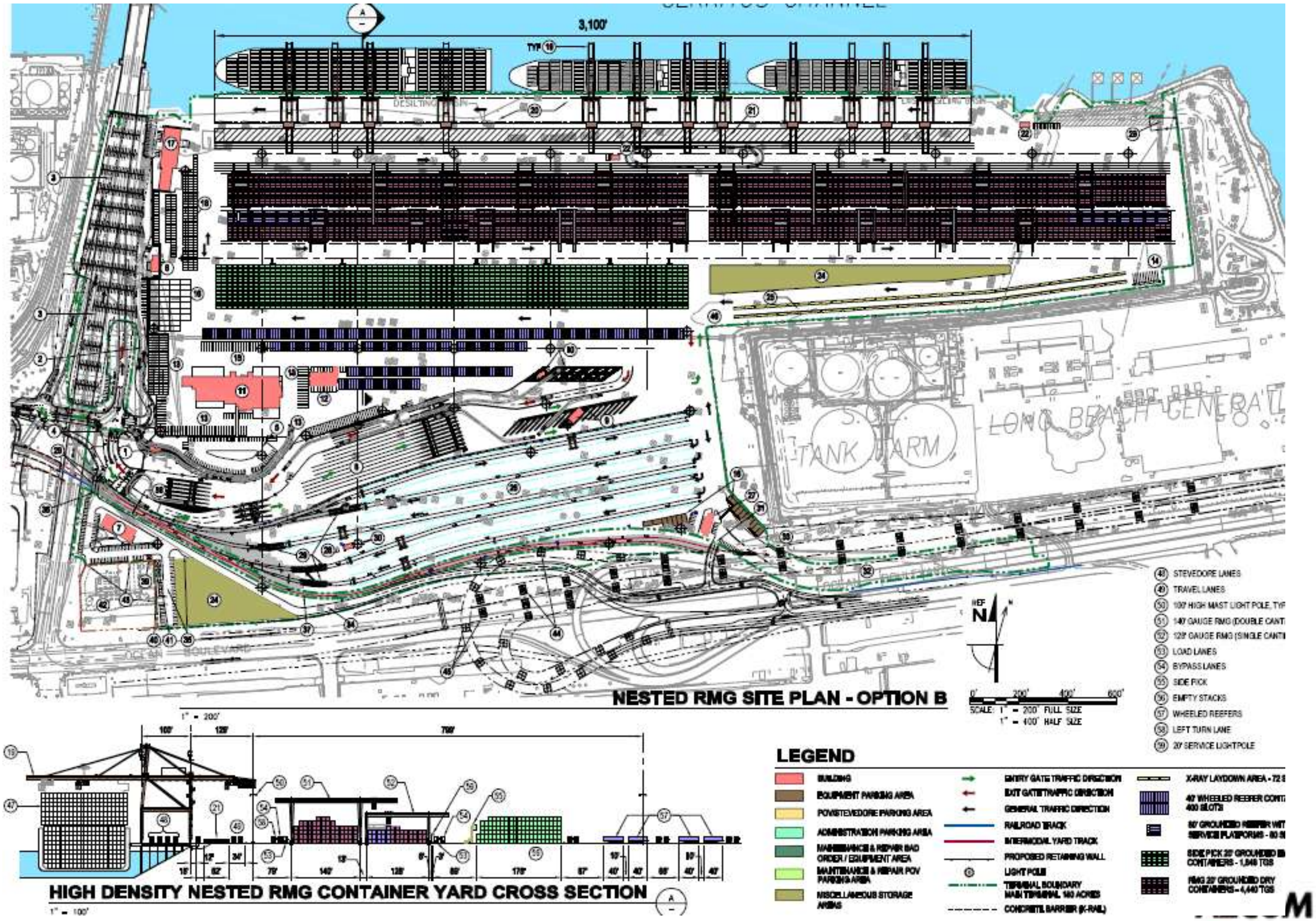
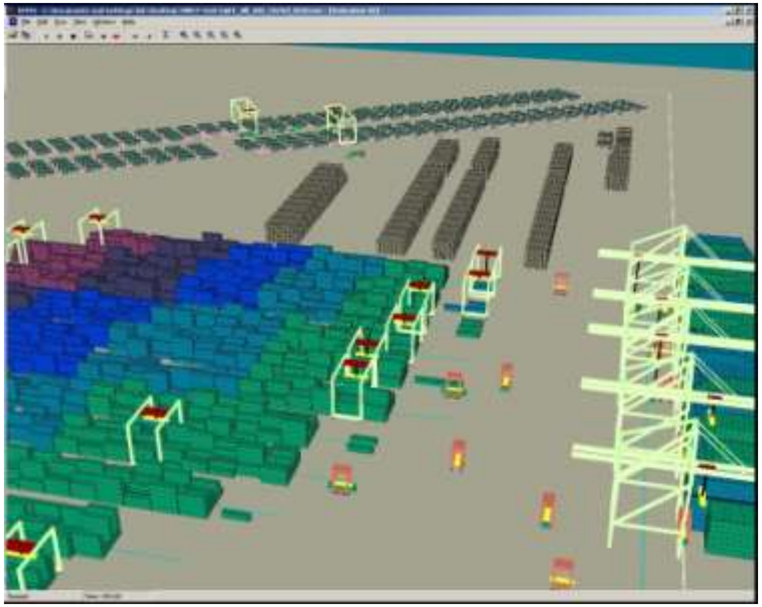
Pier S Option 3 Nests the RMGs for more Storage

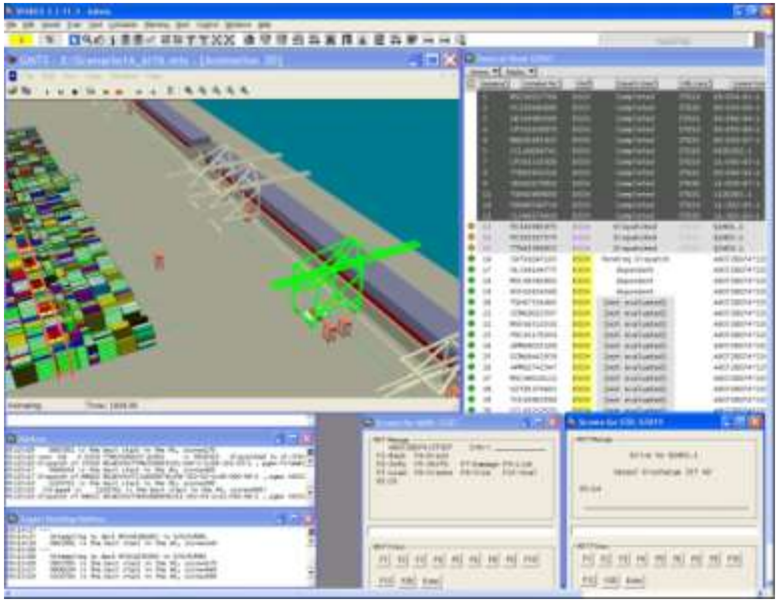


One Option at WBCT

- ASCs with manual tractors
- Similar to Thamesport/NYCT concept
- Can be easily converted to end loaded optoins

Simulation and Emulation to Support Planning





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Terminal fleets will see a transition from hustlers and bombcarts to shuttle carriers or AGVs

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Automation and Architectural Issues

- Buildings should be flexible enough to service near term and long term equipment fleets
- Existing maintenance buildings may need to be modified
- New maintenance buildings may be configured to accept final equipment while accommodating interim equipment

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Civil Design Challenges with Automated Terminals

- Pavement
  - Asphalt vs. gravel
  - Rutting
  - Drainage
- Rails on Gravel vs Beams
- Settlement
- Electrical utilities

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Electricity Related Planning Issues

- Optimum sizing of infrastructure
  - Oversized substations cost more to build
  - Oversized substations draw more power at idle
- Larger numbers of cranes will lower the mean draw per crane due to asynchronous activity (some are generating power while some are drawing power)
- Can TOS be tuned to run cranes with lower power during off-peak activity (esp gate moves)?
- Can TOS be tuned to time overhead moves when power is cheapest (usually at night)?
- Do operators and Ports care about high-detail power and emissions data reports?

Future Concepts to Contemplate

- Direct yard crane / dock crane handoffs
- Rail based transport (ZPMC etc.)
- Nested cantilever RMGs
- New Container Handling Technologies

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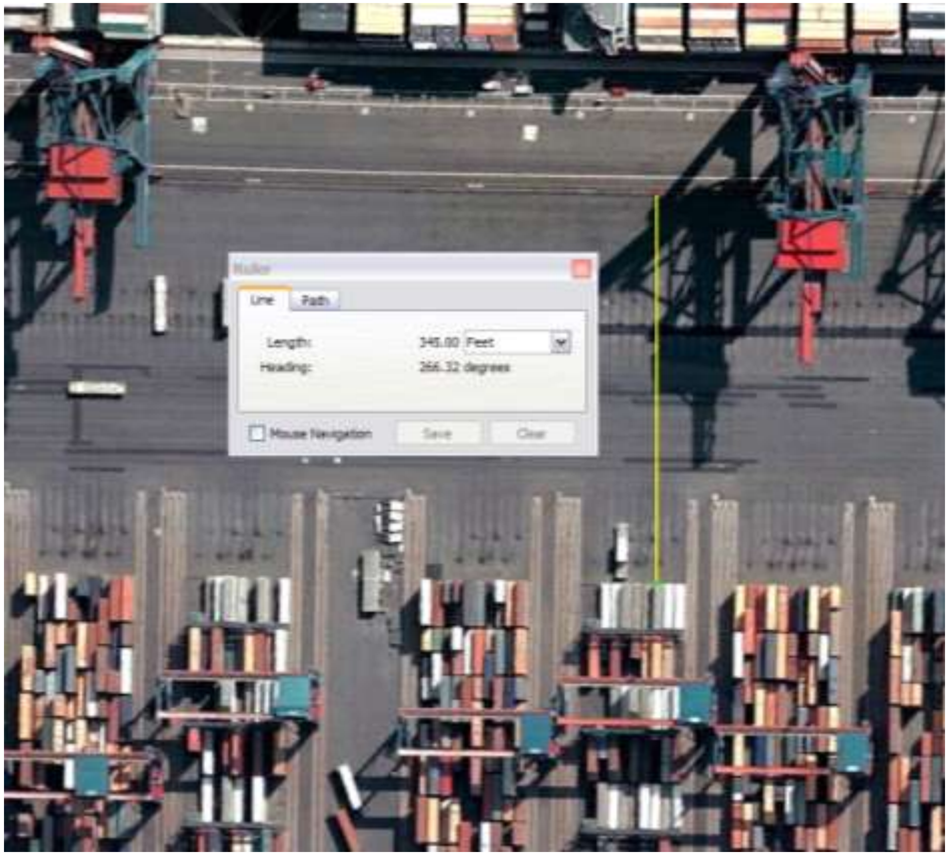
ASC Terminals Require a Large Maneuvering Area Waterside of the ASC Blocks



CTA Hamburg = 345’

APMT Virginia = 330’

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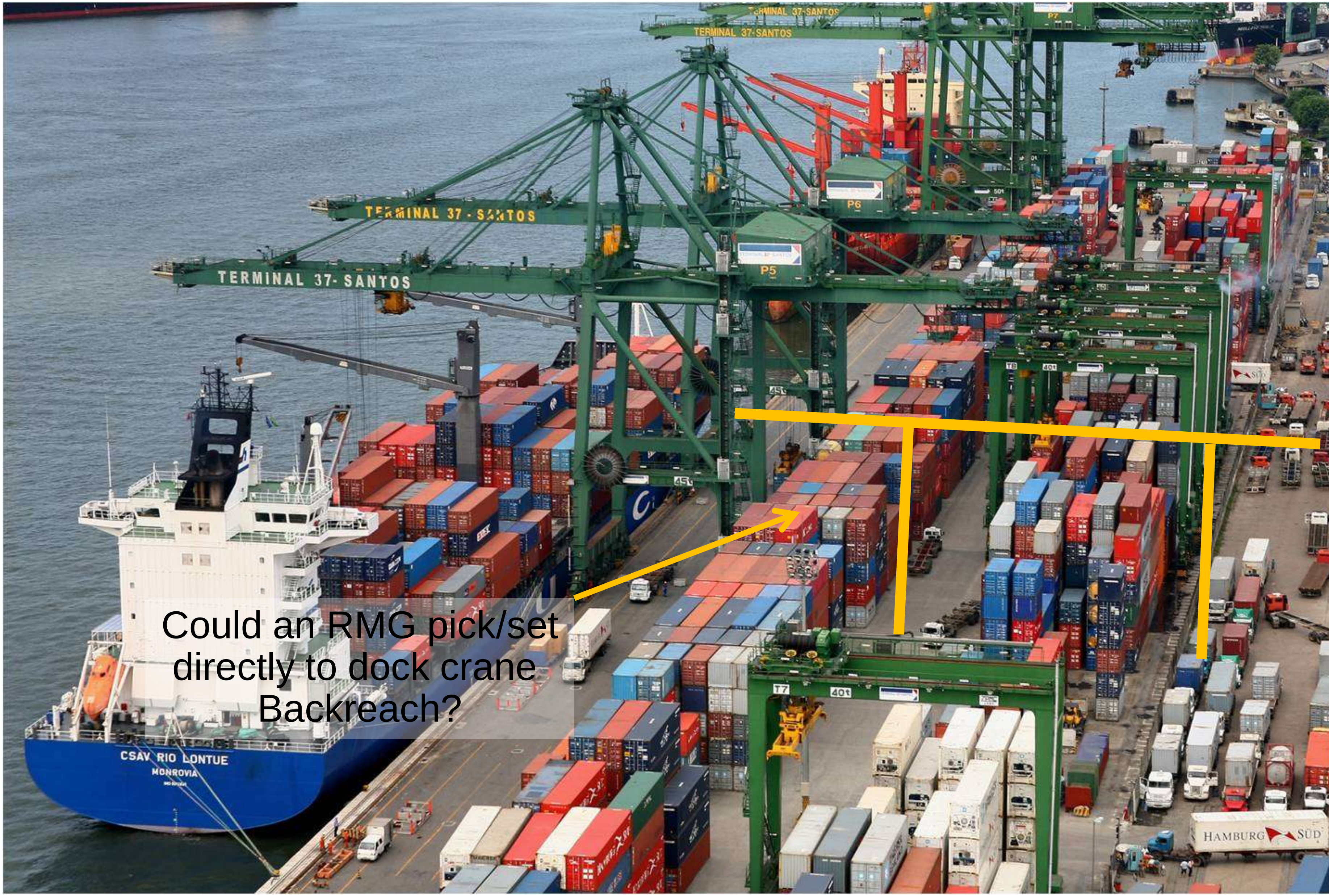
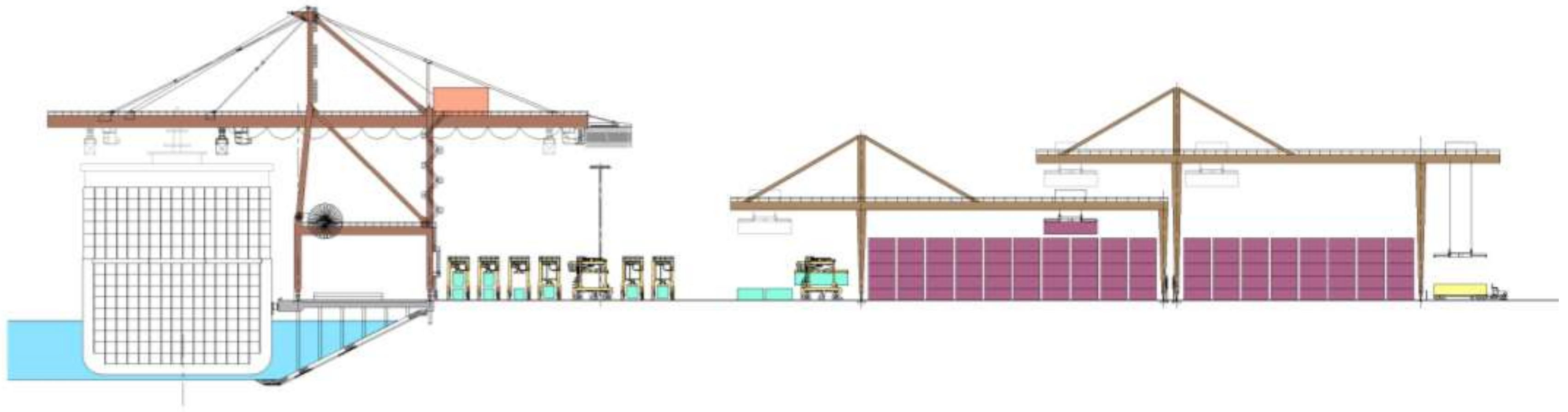
A Space Efficient Terminal!



Cantilever RMGs vs ASCs



- More slots per acre
- More flexible crane assignment
- More buffer slots
- Less RMG rail reqiured

- More expensive cranes
- Limited terminal depth with two rows
- Complex TOS required

ZPMC Automation Module

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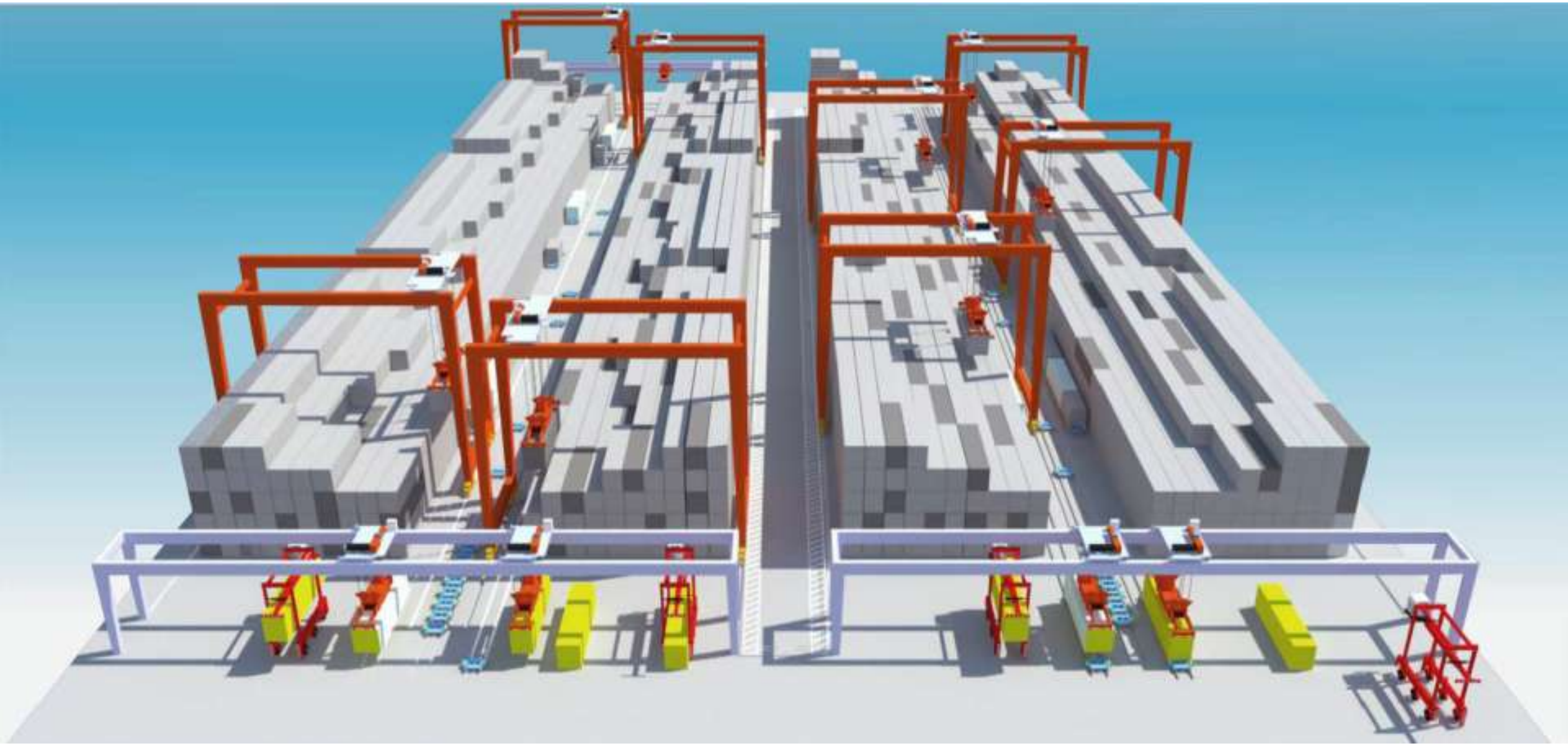
Paceco SegCart Concept



http://www.youtube.com/watch?feature=player_detailpage&v=ty-PuF6VlCM

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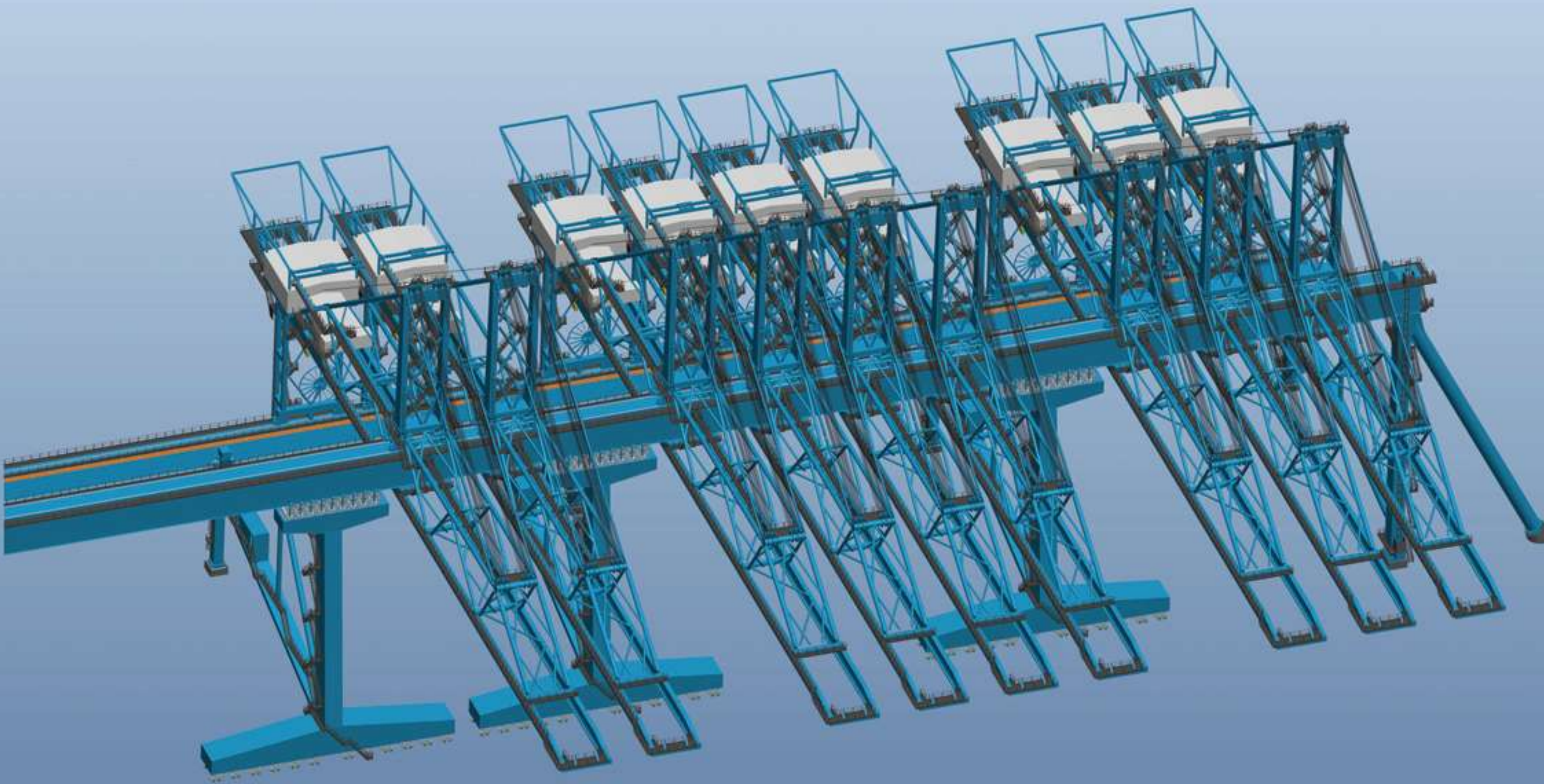
APMT FastNet



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Conclusions

- Fundamentals of terminal automation have been well proven
  - Driverless RMGs can handle containers easily
  - Automated transport vehicles can achieve fair, if not great, productivity
  - Off the shelf software and sensors can coordinate terminal activity
- Terminal automation is relatively new, with many challenges and areas of improvement still to come
  - Decoupled ASC operations
  - Automated rail transfer
  - Non-rectangular terminals
  - Conversion from existing operations
- Careful planning, analysis, and expert integration assistance is important for project success

Speaker Contact Information

- Andrew Cairns, PE PMP
  AECOM
  20 Exchange Place
  New York, NY 10005
  Phone: 510-844-0549
  Email: andrew.cairns@aecom
  Web: www.aecom.com

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