Planning Ahead for Automated Terminals
Presentation to AAPA Facilities Engineering Conference

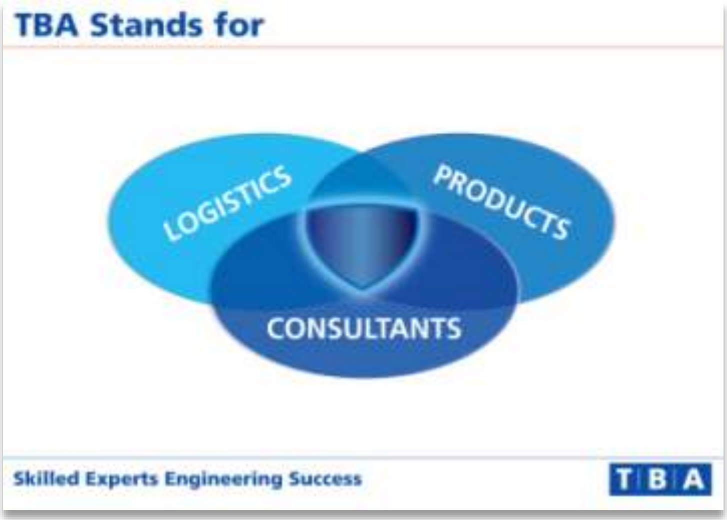
Dan Johnson, P.E. – November 18, 2009

Agenda:

1. Introduction to TBA
2. Critical Background: History and Continuous Change
3. Planning approach used in Portsmouth for APMT (and elsewhere)
4. Example Focus study: Waterside transport

TBA: Focused on Core Competencies

- Headquartered in Delft (Rotterdam)
- **World's largest dedicated simulation firm**
- 75 engineers working full – time
- 8 out of top 10 Global Terminal Operators are customers.
- Active in more than 25 countries
- Completed over 100 terminal projects
- TBA supports port and terminal operators during all stages from concept to realization and thereafter in operations.



TBA applies Proven Decision, Test and Control Tools for Automation

Study:

- Simulate capacity, strategy, CAPEX studies, e.g. vessel deployments: TRAFALQUAR
- Full-terminal **simulation**, peak shift and multi-day (e.g. handling strategy tests): TIMESQUARE

Test, Train, Tune:

- Full system emulation: Simulation plus direct connection to TOS and equipment systems: CONTROLS

Operate:

- Optimization modules for real-time control in conventional and automated container facilities: POSCH
- Automated transport control software (e.g. AGV system operation): TEAMS

TBA Supports the World's Leading Operators

Selected portfolio for support of container terminal conceptual design (2003-2009):

DPW:

- **Antwerp Gateway**
- **London Gateway**
- **Fisherman's Island**
- Jebel Ali CT 2, **CT3 & CT4**
- **Rotterdam World Gateway**
- Southampton extension

HPH:

- ECT barge terminal, Rotterdam
- **Tercat - Barcelona Muelle Prat**
- **Euromax Rotterdam**
- **Thamesport extension**

APMT:

- **Maasvlakte II terminal**
- **Portsmouth, VA**
- Algeciras extension
- Tanjung Pelepas extension

HHLA:

- **Burchardkai extension**
- Tollerort extension

PSA: Voltri Terminal Europe extension

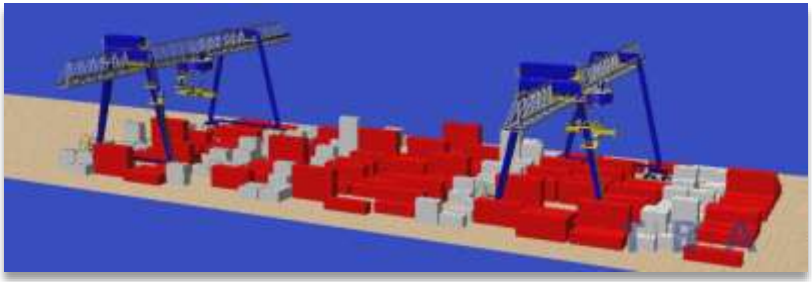
Transnet: Nquga & Durban extensions

Others: (many are secret)

- Northport, Malaysia extension
- Port of Gothenburg extension
- Packer Avenue, Philadelphia

Summary Project Portfolio

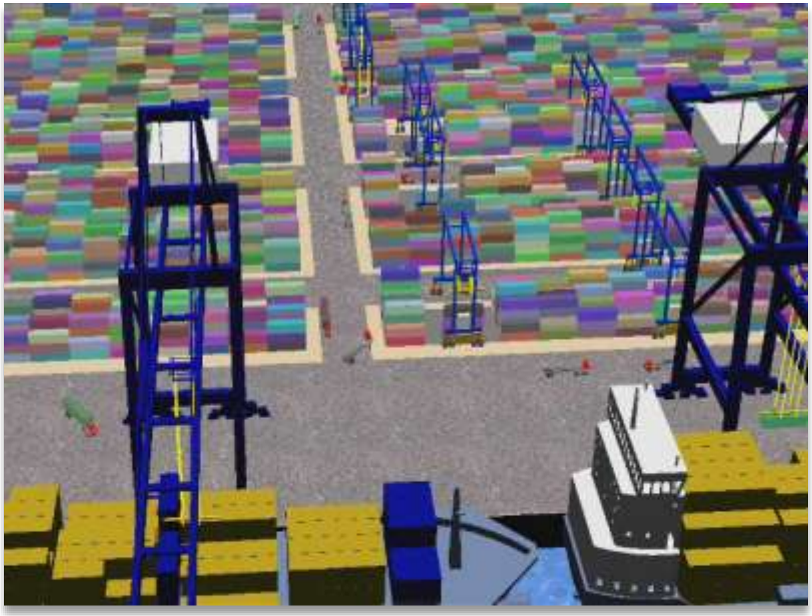
- **Optimization** of existing facilities (layout, TOS, operations):
  - DPWorld Port Botany, West Swanson (2006 - 2008)
  - **HHLA – Container terminal Altenwerder** (2007 – 2008)
  - Durban Container Terminal (2007)
  - DPWorld Caucedo, Chennai, Mumbai (2007 - 2009)
  - **APMT Rotterdam** (2007 – 2008)
  - TSI Vancouver (2008)
  - Ocupa Manzanillo (2008)



- **Performance assessment** of equipment specifications
  - NTB (2004, 2006)
  - **Euromax** (2005)
  - APMT-PTP (2006)

- **TOS Optimization** (CONTROLS):
  - **DPWorld Pusan Newport** (2006)
  - **APMT Portsmouth, Rotterdam**, Algeciras (2006 - 2008)
  - Eurogate Hamburg (2007)
    MSC Home Terminal (2007 – 2009)
  - **DPWorld Antwerp Gateway** (2008 - 2009)
  - Gothenborg Havn (2009)

- Delivery **Automated Equipment Control Systems** (TEAMS)
  - **CTA** (Hamburg, 2002)
  - **Euromax** (Rotterdam, 2008)
  - **Antwerp Gateway** (2007)



Context: Terminal Automation is…

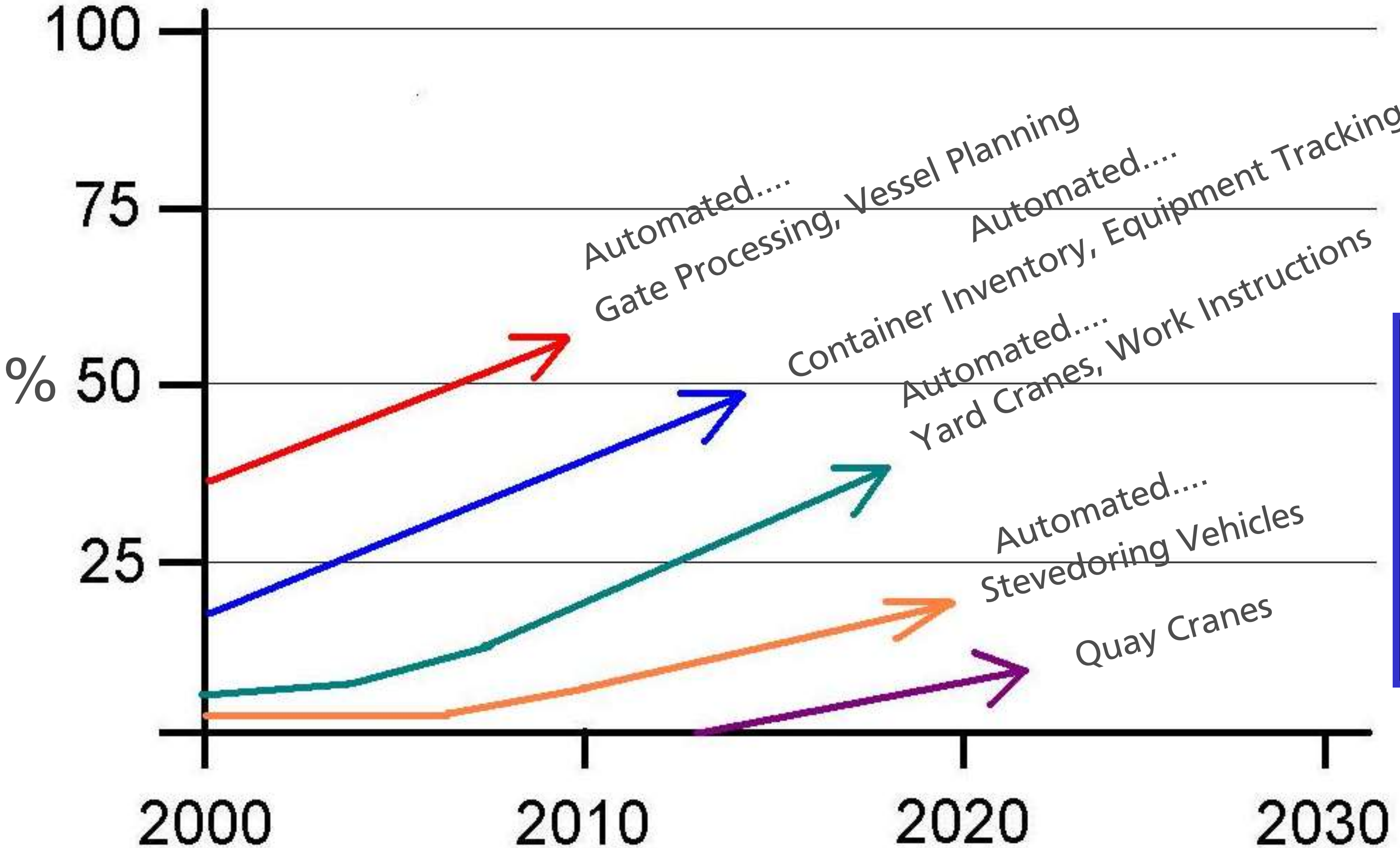
Terminal Automation is…

- Complex
- Expensive
- Time-consuming to implement
- Unique, each time
- Environmentally friendly?
- Leveraged?
- Cost-effective?
- “Inflexible”?

Typical Questions:

- Is it right for my facility? When?
- What mode?
- What are implications for me if a nearby terminal automates?

Growth of Terminal Automation by Type

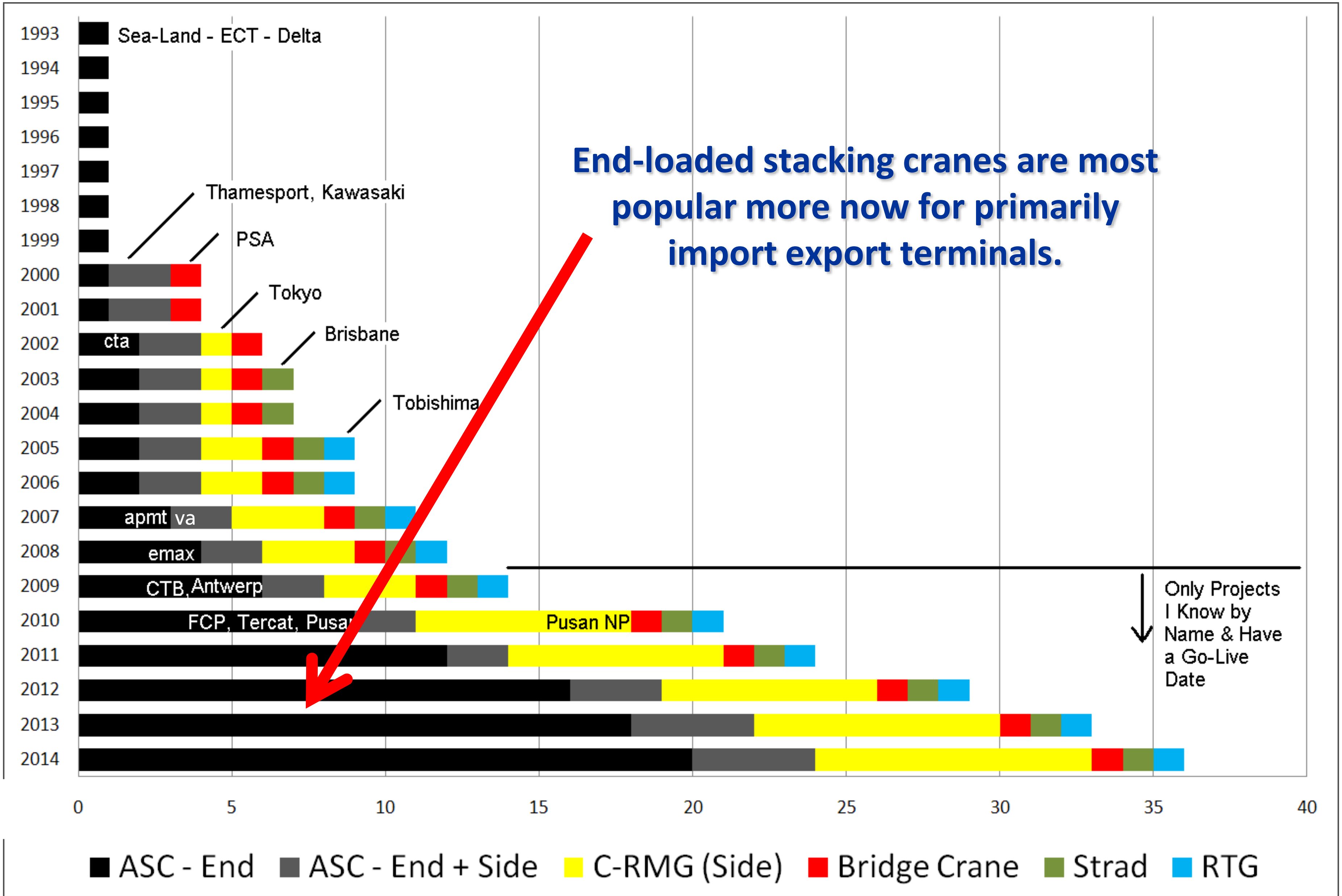


Ea. type typically requires all items above it at same terminal

% Adoption by Large Container Terminals vs. Time

T|B|A

What is the Relative Popularity of Automated Yard Cranes?



TBA

The Drivers for Terminal Automation are Compelling

- Cost control
- Reduction of labor dependency
- Logistic control – centralized control & optimization
- Reliability and predictability of operations
- Safety
- Reduction of environmental impact (noise, light, emission)
- Reduction of maintenance

The History: Recent Terminals to Go Live

Terminal Simulation HPH - Euromax (2003 → 2009)

Terminal design APMT - Portsmouth (2003 → 2009)

Terminal design DPW - Antwerp (2005 → 2009)

Four Terminals have Yard and Transport Automation

- 4 sites in Operation:

	Automated Yard Crane	Automated Transport
• ECT, Rotterdam	ASC	AGV
• Altenwerder, Hamburg	ASC	AGV
• Patrick, Brisbane	N/A	Automated Strads
• Euromax, Rotterdam	ASC	AGV

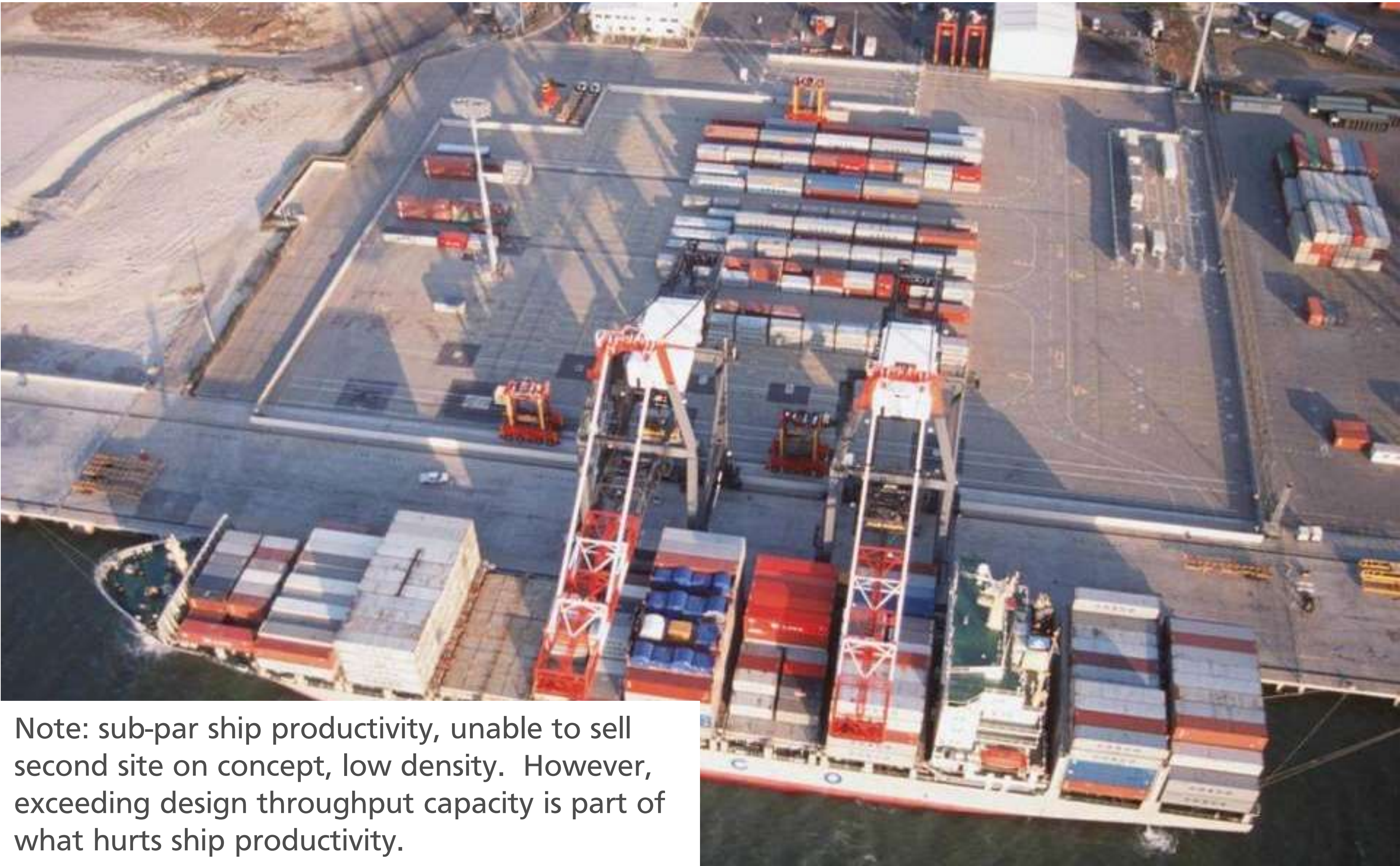
ECT, Rotterdam - 1993
Reduce labor dependencies – labor costs

Notes: Original Automated Terminal, ONE ASC PER RUN, strads used for valet gate service, low ship productivity.

Altenwerder, Hamburg - 2002
Reduce labor dependencies – labor costs

Notes: Successful but sub-par ship productivity. ASC + AGV; 2 asc per run, 1 over 4 ASC; second QC hoist is automated.

Patrick, Brisbane - 2003
Reduce labor dependencies – labor costs



Note: sub-par ship productivity, unable to sell second site on concept, low density. However, exceeding design throughput capacity is part of what hurts ship productivity.

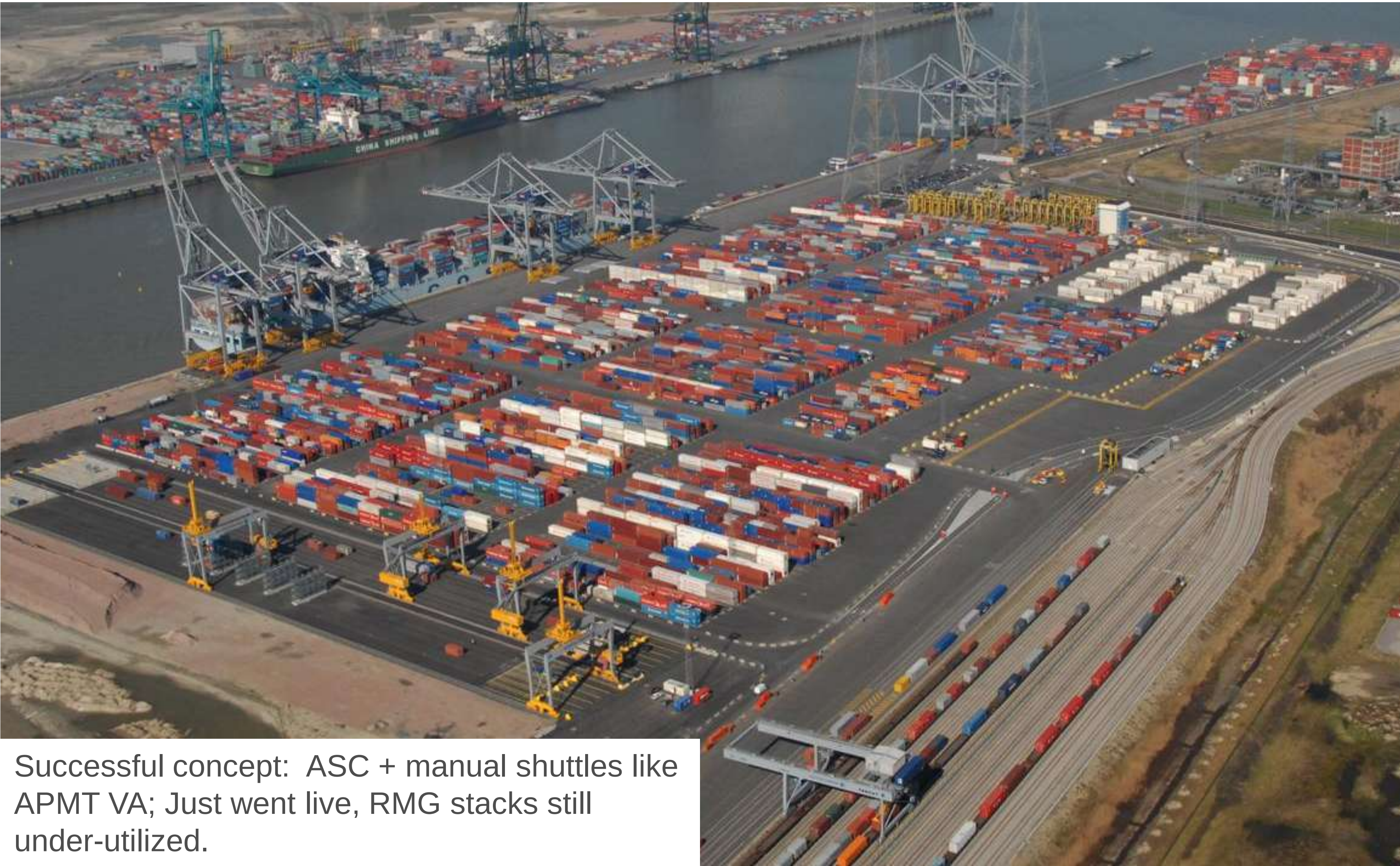
Euromax, Rotterdam - 2008
Reduce labor dependencies – labor costs

Eight Terminals have Yard Crane Automation

- 8 Sites Operating:

	Automated Yard Crane	Manual Transport
• DPW Antwerp	ASC	Strad
• APMT, Virginia	ASC	Strad
• Thamesport, UK	ASC (side & end)	Truck
• Pasir-Panjang, Singapore	Bridge Crane	Truck
• Wan-Hai, Tokyo	C-RMG	Truck
• Evergreen, Kaohsiung	C-RMG	Truck
• DPW – Antwerp	ASC	Strad
• Tobishima, Japan	**RTG**	Truck

DPW Antwerp Gateway - 2004
Densify the operation – transition SC – ASC – Labor costs



Successful concept: ASC + manual shuttles like APMT VA; Just went live, RMG stacks still under-utilized.

APMT Portsmouth, Virginia – 2007
Labor costs

Successful in concept: ASC + manual shuttles RMG stacks still under-utilized, good ship productivity; aggressive financing required a more fully-utilized terminal, APMT now negotiating with VIT to share use. Ship: 40 Moves/hr, ASC gantry speed 300 m/min; 6 QC, 30 ARMG

Thamesport, UK - 2000
Densify the operation – labor cost

fairly successful, side and end loading; Navis SPARCS ship planning

Example: APMT – Portsmouth, Virginia:

Layout and Equipment Selection is just a Small Part of the Work

- Design of terminal
  - Equipment Requirements
  - Layout definition in detail - E.g. reefer facilities, transfer zones
- Design control rules for TOS
  - Automated grounding decisions
  - Automated ASC dispatching rules
  - Control mechanisms and collision control rules for ASCs
- Testing and tuning TOS control rules with Emulation is ongoing

What is Simulation?

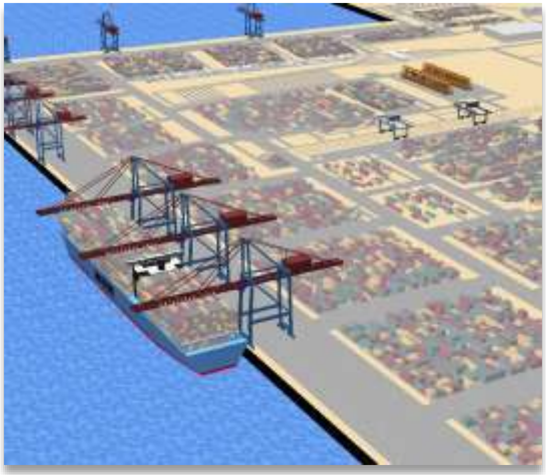
(future) Reality ↔ Simulation model

(future) Reality ↔ Experiments

Simulation model ↔ Validation

Experiments ↔ Validation

Real terminal



Virtual terminal

When to Simulate?

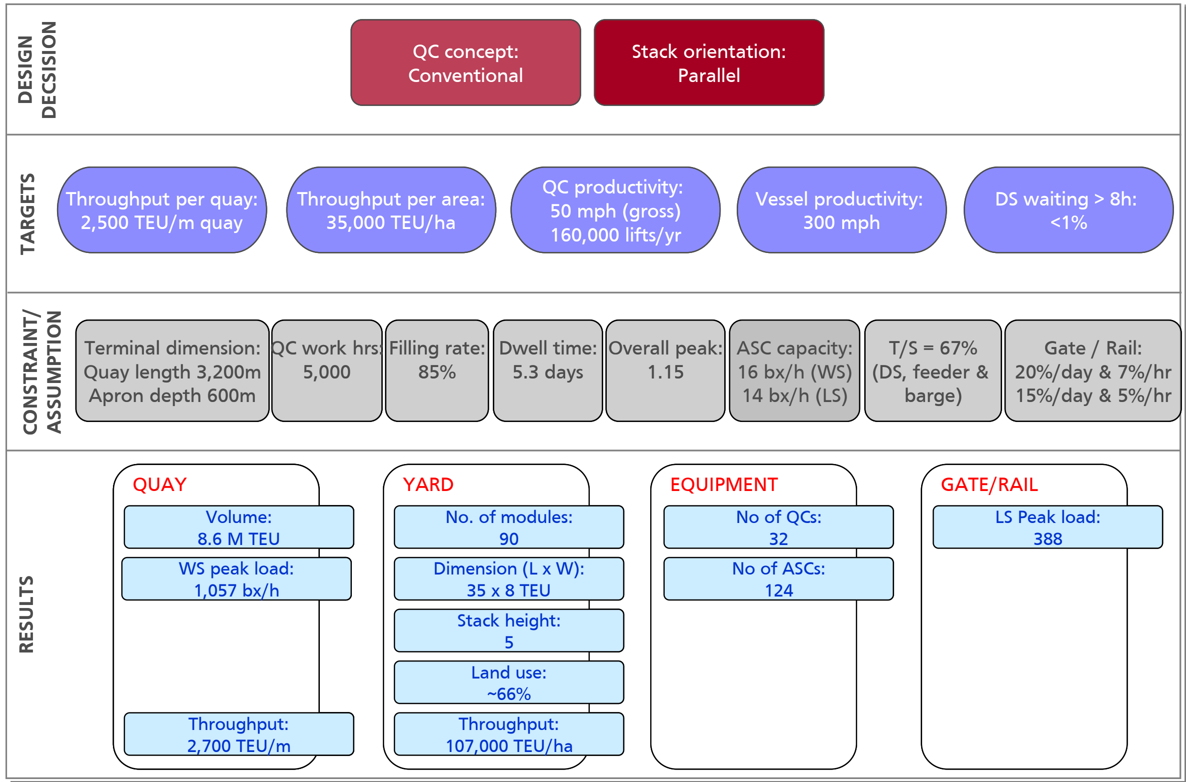
- New approaches, equipment, operating logic, site size, etc..
- Obtain non-intuitive results: E.g. Is a buffer required for Automated shuttle
- Board members need convincing argument to spend $$$
- Accurate ROI, OPEX, CAPEX calculations
- Accurate engine hours/emissions estimates
- Decide on waterside transport

Typical project approach:

The steps in designing a terminal meeting the targets

- **Definition of operational scenarios** ←
- Conceptual layouts Capacity calculation
- Assessment of alternatives under dynamic conditions (simulation)
- Sensitivity analysis (simulation)
- Design of transition trajectory
- Cost analysis (OPEX & CAPEX)

Definition of operational scenarios



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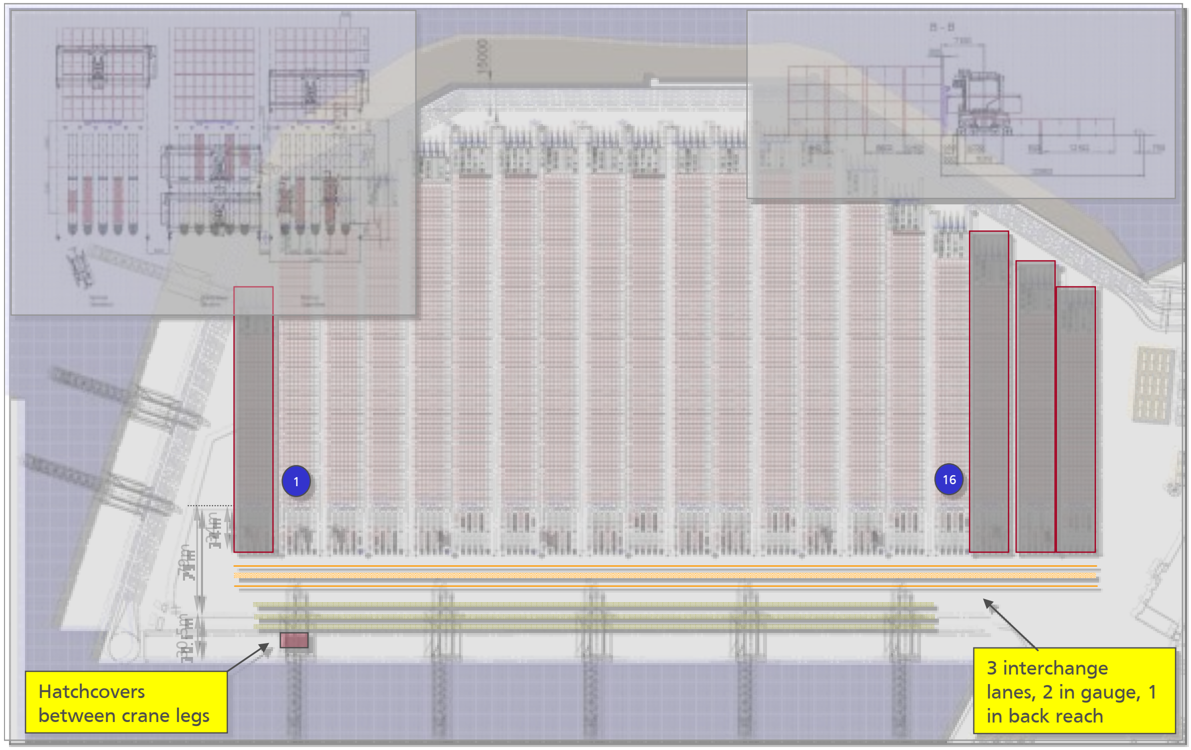
Conceptual layouts Capacity calculation



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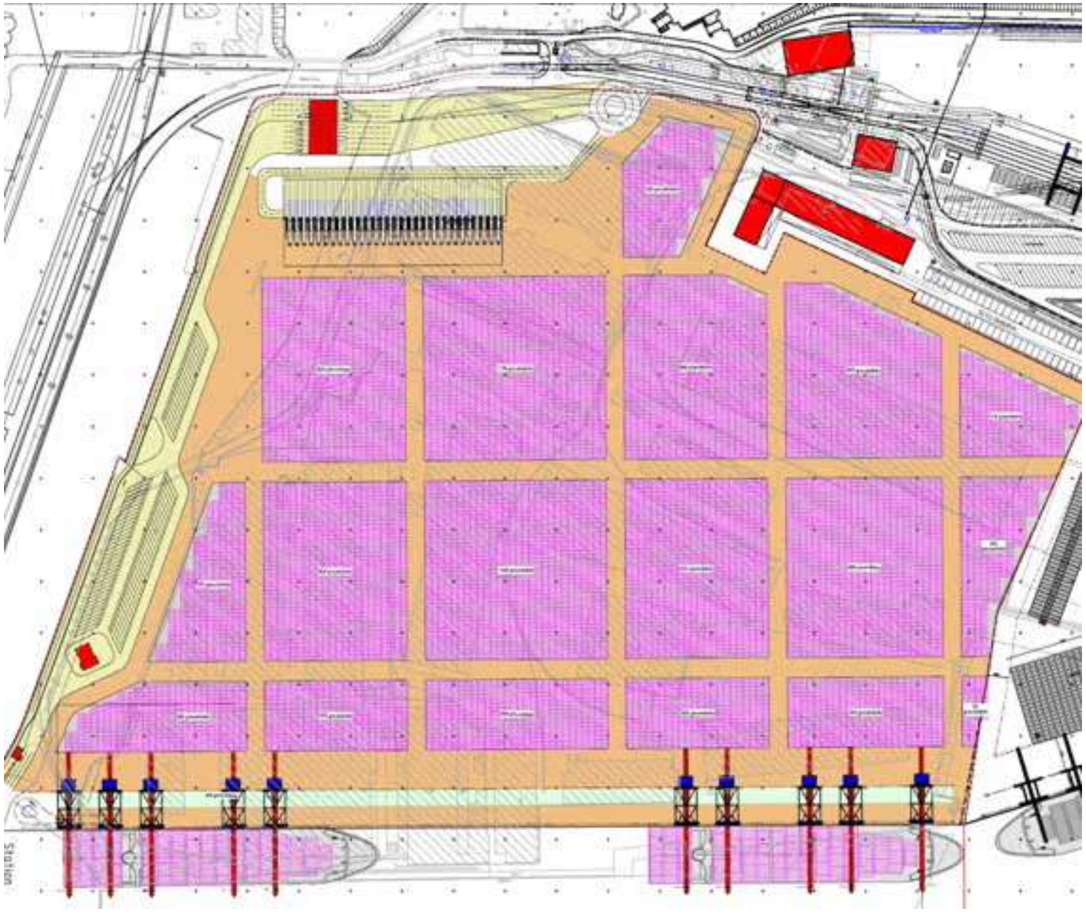
Assessment of alternatives under dynamic conditions (simulation)



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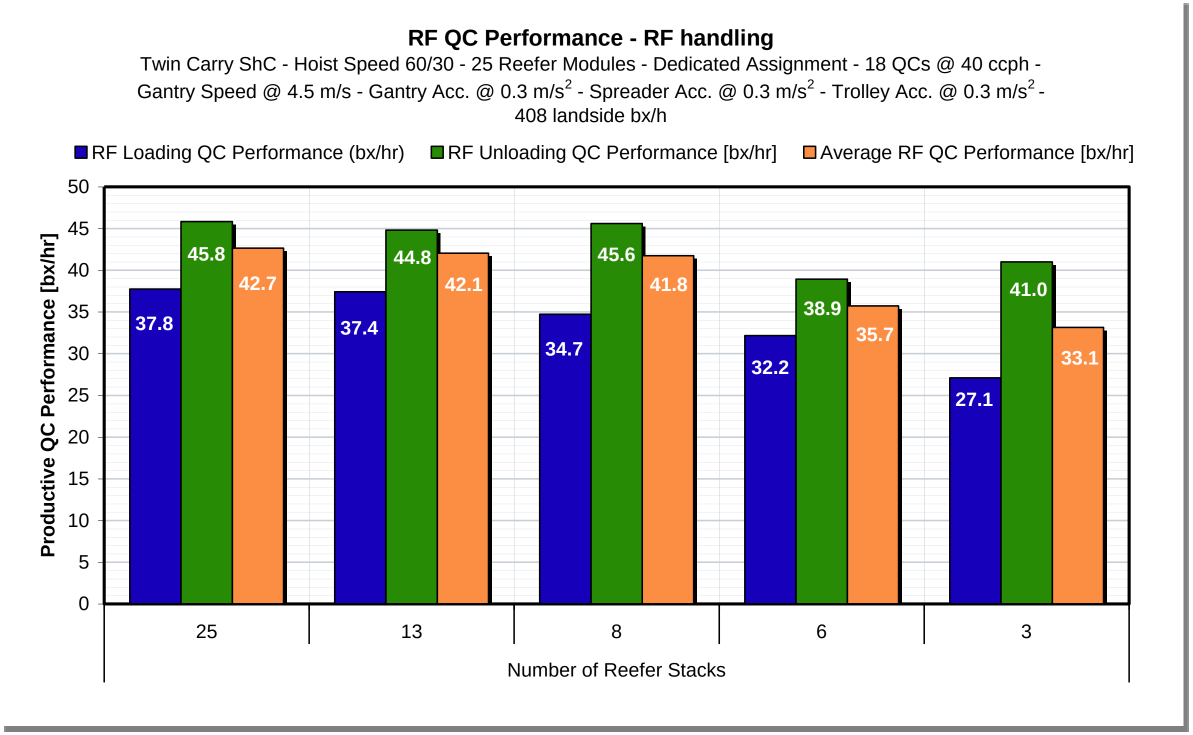
Sensitivity analysis (simulation)



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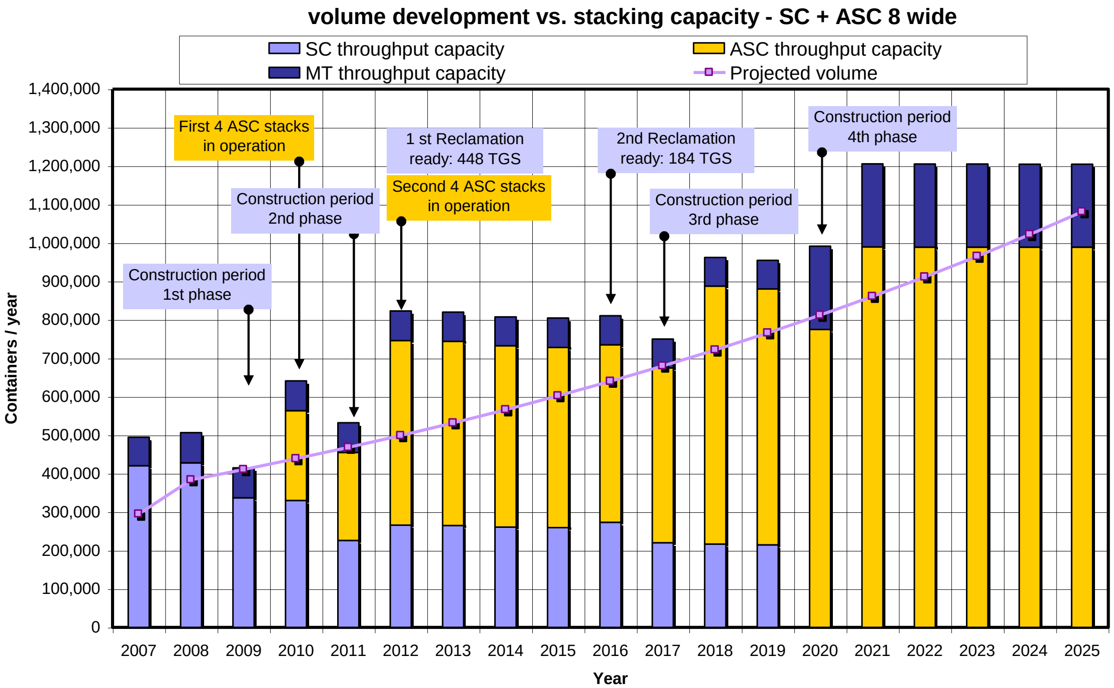
Design of transition trajectory



Typical project approach:
The steps in designing a terminal meeting the targets

Definition of operational scenarios

Conceptual layouts
Capacity calculation

Assessment of alternatives under dynamic conditions (simulation)

Sensitivity analysis (simulation)

Design of transition trajectory

Cost analysis (OPEX & CAPEX)

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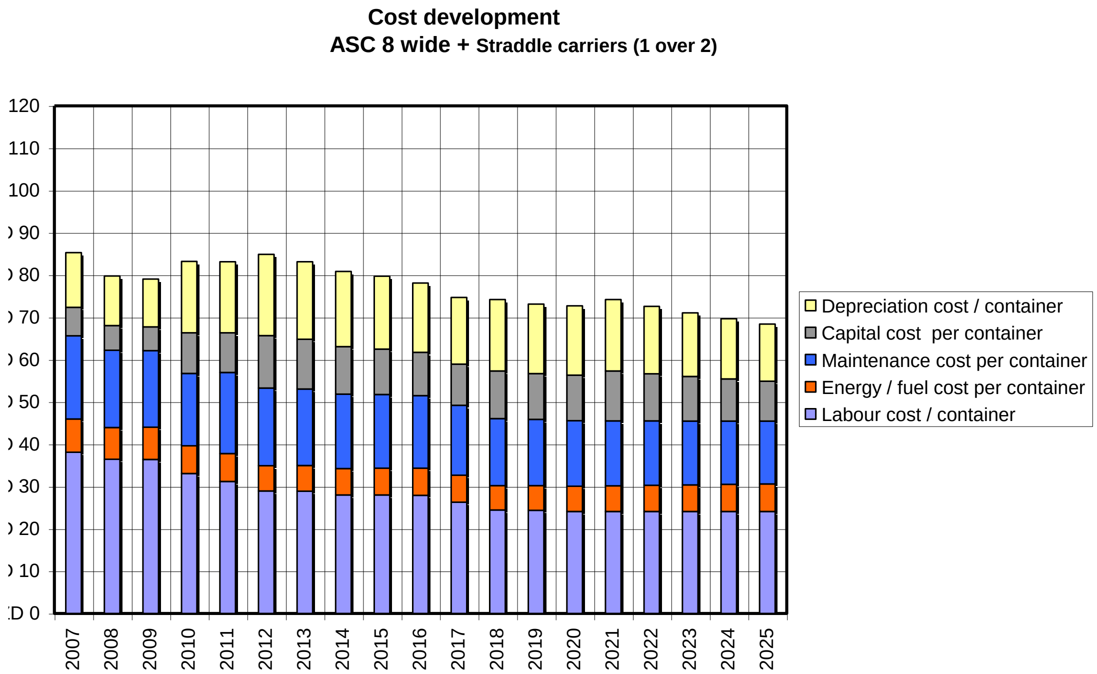


Interesting Test Case: Automated Waterside Transport Options

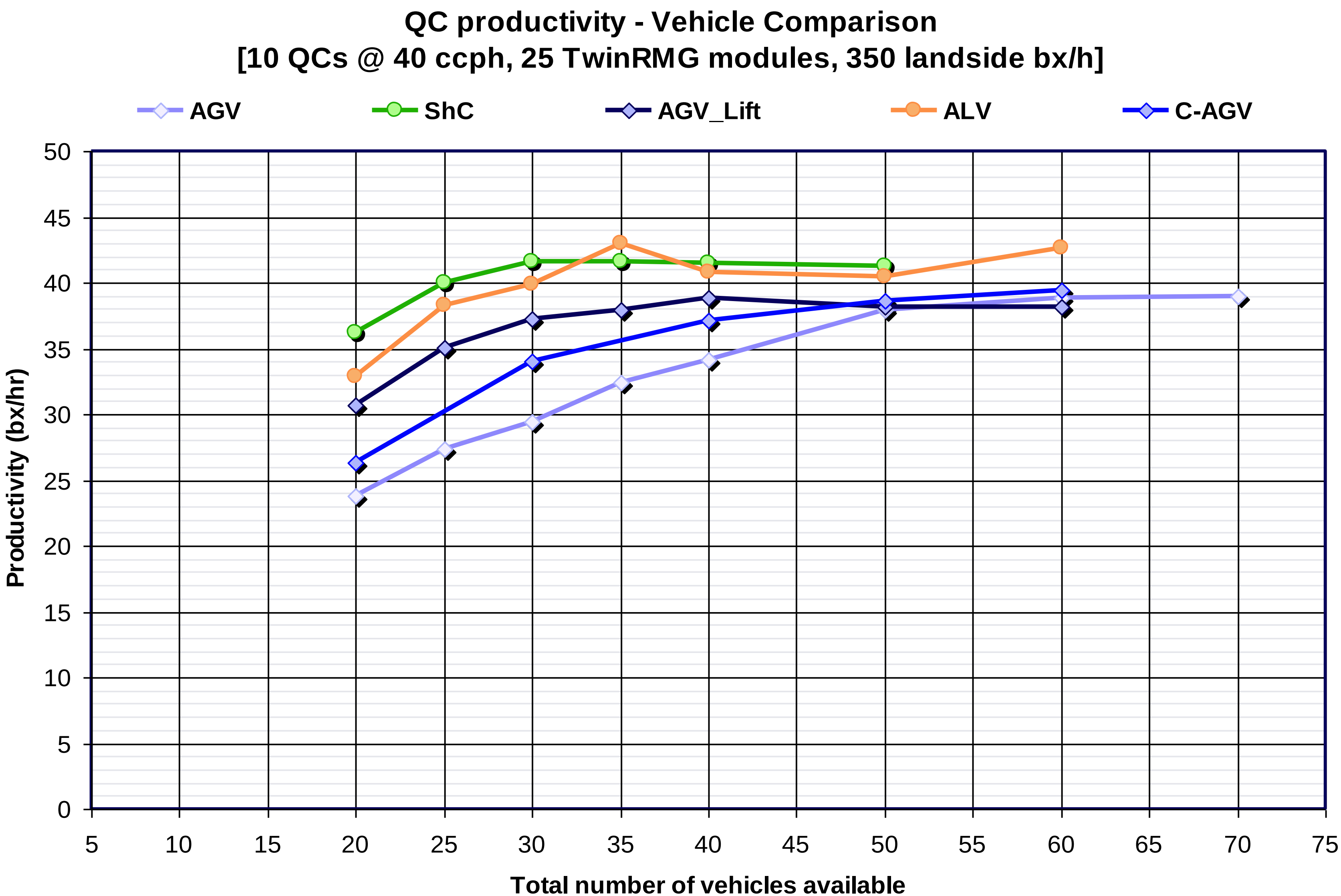
Shuttle Carrier
(ShC)

Cassette AGV
(C-AGV)

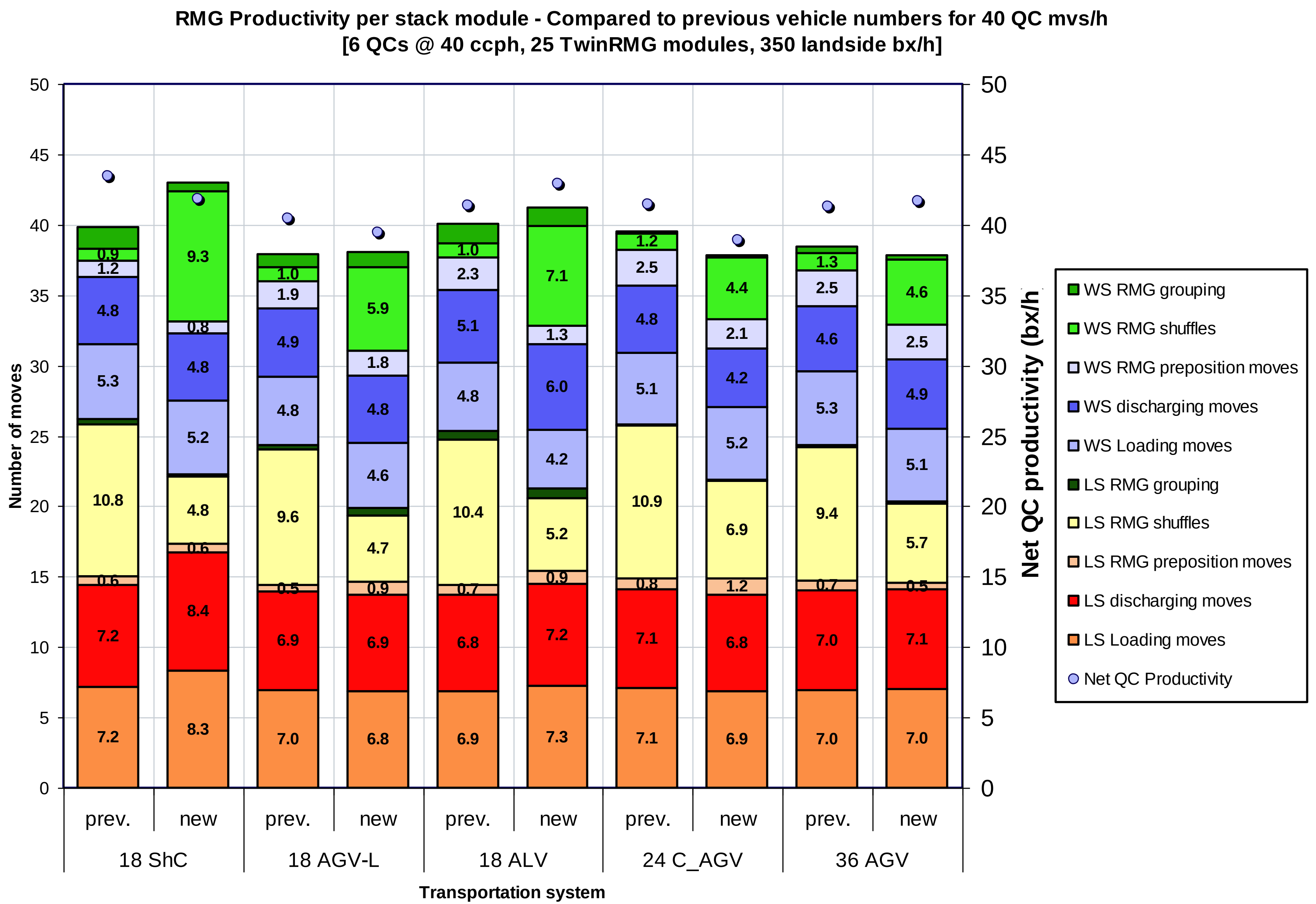
Automated
Shuttle
(ALV)

Lift AGV
(AGV_L)

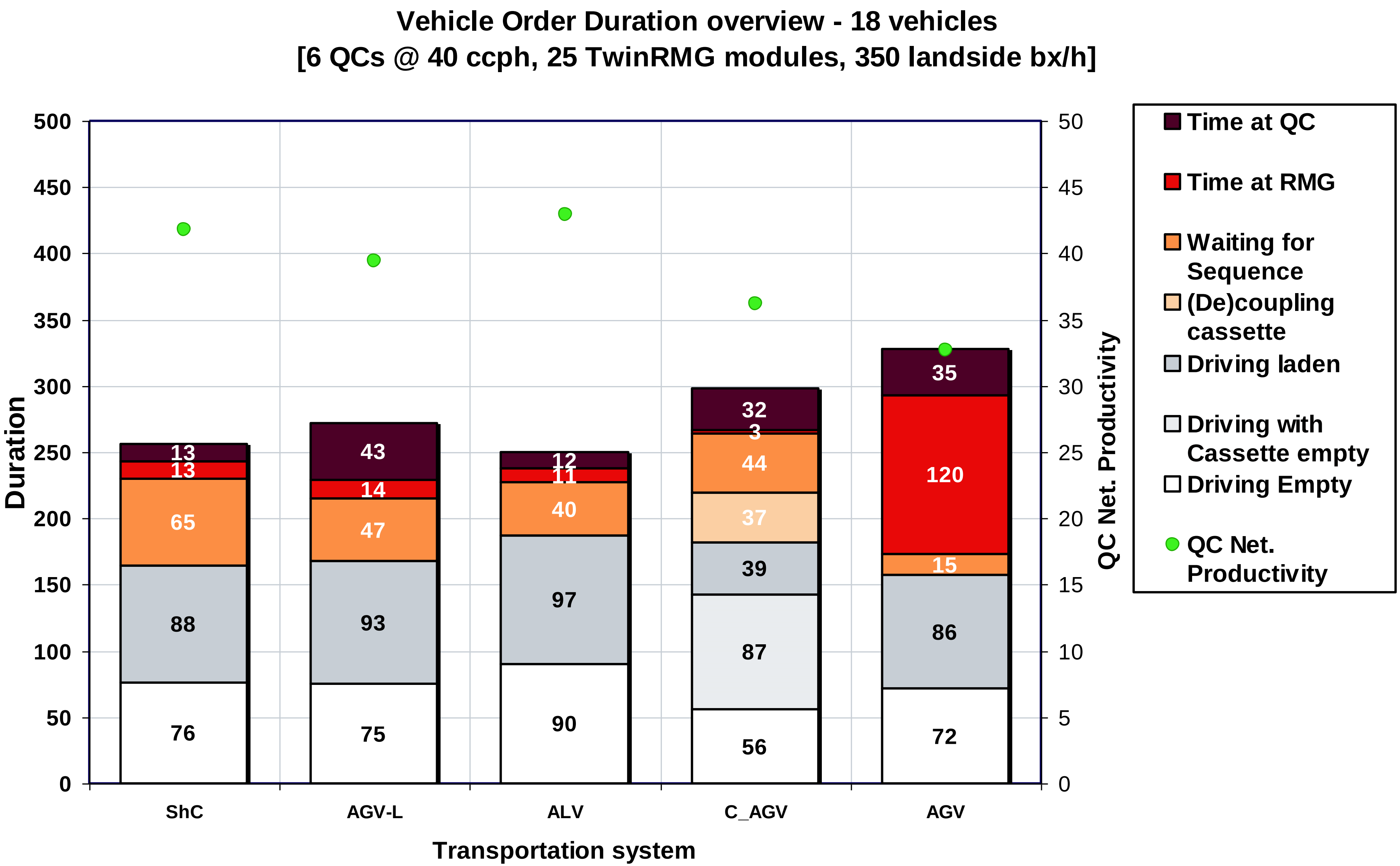
Results: net QC productivity (Average operation)



Results: RMG productivity comparison



Results: vehicle status comparison



Questions?

For Further Questions:

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