Container Terminal Planning & Operations

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Latest Trends – This and That

• Marine terminal lighting technology
  – Light emitting plasma and other new technology

• Ships and cranes
  – 8-high on deck and its implications

• New terminals in old boundaries
  – Automating the original terminals
Terminal Lighting Technology

• Virtually all terminal lighting is done with high-pressure sodium (HPS) fixtures mounted on high-mast light towers
  • These are typically “1000 W” fixtures
  • Poles range from 80’ to 150’ in height
  • Pole spacing is usually on the order of 3.0 to 3.5 times the pole height, typically 250’ to 400’
  • Poles have rosettes of 8 to 12 fixtures per pole
  • Maintenance is done by longshore mechanics
  • Each pole and foundation costs ~$300,000
Regulatory and Safety Environment

• Lighting of the working areas of marine terminals is governed by 29 CFR 1917.123 (OSHA/NMSA)

• This requires:
  – 5 foot-candles “minimum average” in marine terminal working areas
  – 1 fc minimum

• Engineers limit Maximum / Average to 3:1 or less

• The regulation is silent as to how this is to be measured or established

• Traditionally, this has been done with lighting models prepared by the light fixture vendors
Limitations of HPS

- **High power consumption**
  - 1280 w x $0.146/kWh = ~$818/fixture/year (California)

- **Short replacement cycle**
  - 10,000 hours to ballast and fixture replacement (2 yr)

- **High light pollution**
  - Fixture design relies on glowing housing to spread the light, which causes substantial sky glow

- **Poor light quality**
  - Light is in the pink-yellow part of the spectrum, not optimized for human night vision
Outer Harbor Marine Terminal, Oakland

175 gross acres of marine terminal
107 high-mast light poles, 8 to 12 luminaires each
1,000 luminaires total
About 1 MW in total power consumption by lights
Massive light pollution from this and other facilities
Light Emitting Plasma
LEP Test Installation at OHMT
LEPs vs. HPS at OHMT
At Luminaire Height
LEP Numeric Results vs. OSHA Requirements

• OSHA Minimum Average:
  \( \geq 5 \text{ fc required, 5.1 achieved} \)

• OSHA Minimum:
  \( \geq 1 \text{ fc required, 1.3 achieved} \)

• Uniformity:
  \( \leq 3:1 \text{ required, 2.1 achieved} \)

• With new LEP lamps, **OSHA requirements are met**

• Color is substantially improved
Summary

- LEP effectiveness established
- Payback for new: 1.5 years
- Payback for replacement: 3.2 years
- Substantially improved visibility
- Substantially improved uniformity, spread
- Substantially reduced light pollution
- Substantially improved control
- Substantially reduced maintenance
- Energy consumption reduced >50%
- All on the current light pole system
Alternatives to LEP and HPS

**Light-Emitting Diode**
- Each emitter is small, 100s of emitters per fixture
- Very pointable
- Very sensitive to heat, so large heat sinks required
- Result is a heavy head, about 95 lbs, to achieve current lumens/fixture
- Capital cost the same as LEP
- Energy savings a bit more than LEP

**Metal Halide**
- Each emitter is large, and can produce a lot of light
- Mirrors can direct as needed
- Not a lot of energy savings
- Not a lot of capital savings
- A good option if you are stuck with very long pole spacing and need more light
Ships and Cranes

• Shipping lines have long predicted ships of 20 to 24 container stacks across on deck
  – Beam up to 200 ft or 61 m

• No one really predicted that ships would get a lot taller, up to 8-high on deck
The New Monsters
A Bit of Perspective
Dock Gantry Cranes – Target Envelope
Outer Harbor Crane Array
Outer Harbor X434/X435, Mean Tide, 3° list
Potential Crane Modifications

• To be fully capable:
  – Raise X438/X439 by 34’, extend by 24’
  – Raise X434/X435 by 32’, extend by 17’

• Issues:
  – Mechanical capabilities - ropes, drums, drives
  – Productivity - drives, motors, speeds, duty cycles
  – Frame structural strength - boom, frame seismic
  – Wharf structural strength - rail girders
  – Wharf tie-downs and stowage pins
  – Power supply and demand – terminal and wharf
  – Cranes may need to be shuffled
Choices

- There are only three possible responses to bigger ships
  - 1. Do nothing
     - Keep going with what you have
     - Forego new freight and revenue from big ships
  - 2. Modify existing cranes, if possible
     - Raise and extend
     - $1.0M to $2.0M per crane, 30 to 60 days of downtime
  - 3. Build new cranes
     - $11.0M to $12.5M per crane, depending on location
New Terminals in Old Boundaries

• We are being asked to consider the application of new automation technologies in old terminals
• Automation likes nice, rectangular shapes
• Most automation to date has been deployed on new sites, which can be made rectangular
• Existing sites are what they are – changing shapes is difficult
• We must work with what we have, and adapt technologies to suit
Greenfield Rectangles are:

- Flexible
- Efficient
- Productive
- Capacious
- Easy to lay out
- Easy to design
- Easy to build
- Lack pesky constraints
- ...and exceedingly rare
Not Everything is a Greenfield Rectangle
A Case in Point: West Basin Container Terminal

existing Wharves

New Wharves

Refinery

River

South Yard

Rail Yard

Bridge

North Yard
Challenges

• No rectangles, anywhere
• Port is rebuilding the wharves to ease navigation and increase crane gauge from 50’ to 100’
• Uncertain future access to refinery area
• Split terminal

• And a desire to convert this to a high-performance automated facility for very large container ships
Imposing Rectangular Thinking

- Assume Kinder Morgan Site
- Extremely Long ASC Blocks
- No Way to Get There from Here
Perpendicular to Berth 122?
Perpendicular to KM Boundary?
Parallel to Both Berths?
Rebalanced with KM?
What’s a Planner to **Do**?

• There is no obvious “best” solution that perfectly balances:
  – Capacity
  – Productivity
  – Efficiency
  – Phaseability
  – Flexibility to use or not use Kinder Morgan
  – Accessibility from North Yard to rail yard

• Something unorthodox is required...
An Unorthodox Solution

- Zipper Grid
- CRMG Rail Yard
- AGVs
- 8w 5h ASCs
- Manual Trucks
- Phased Capacity
Zipper Grid

- Zipper Grid concept allows yard/truck interface in a very compact space
- Overhead bridge crane, very similar to an ASC trolley, shuffles boxes across the wall: 1 OHBC per six pairs of slots
But will it work?

- Detailed simulation analysis
  - Equipment counts, Productivity
  - Inter-yard transfer performance
  - Congestion relief
  - Resource allocation paradigms

- Detailed phased financial model
  - Equipment
  - Manning
  - Management Labor
  - Capital and Operating Costs, Revenue Phasing

- ...Yes!
Current Layout, 2.2M TEUs
Rail Yard, Berth 126 Yard, to 2.6M TEUs
Dredge, Fill, Berth 122, to 2.9M TEUs
Future Expansion into KM
Future Buildout, 3.3M TEUs
From Past to Future through Present

- Many “Terminals of the Future” will be built atop “Terminals of the Present”
- We must adapt to big ships using big, fast, efficient cranes backed by dense, fast, efficient yards
- We will use our existing terminal resources
- We will reconfigure yards while operating
- We will run “two terminals in one”
- We will have parallel resources (TOS, etc.)
- We will flex manned and automated models
- We will cope with construction