Design of Port Services with Dramatically Increased Throughput

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Presentation Overview

• Existing port services and anticipated challenges

• Traditional methods to improve capacity

• Decoupling port service from the land-sea interface
  • Double sided loading/unloading
  • Mobility
  • Throughput

• Concluding remarks
  • Potential benefits
  • Why floating? Why mobile?
Existing Port Services

- Ships are loaded/unloaded at a berth
  - The interface between land and sea
- Cranes conduct one-sided loading/unloading operations

[1] Incheon harbor and Pusan harbor aerial images courtesy of Google Earth
Container Shipment Market Demands
Dramatic Increase in Port Productivity

- Global container shipment volume continues to (and is expected to) increase
  - About 9% annually since 1990
  - 10-11% in last few years

- Container shipment industry responds: Mega-container ships
  - Allows for economies of scale
  - Requires new capabilities at hub-ports
    - Physical capacity (such as depth, etc.)
    - Productivity
    - Stronger need for trans-shipment capability

Mega–Container Ship: Increasing Dimensions

**Implication to Port**
- Quay wall: >400m*
- Water depth: >16m*
- Yard Capacity >225,000m² **
- Gate capability, Terminal operation system, Traffic

**Crane Capability**
- Outreach of crane: >60m
- Height of crane: >50m
- Crane workload: higher # of cranes, higher # of lifts

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[1] [www.globalsecurity.org](http://www.globalsecurity.org),* Numbers are estimated based on 9000TEU ships; ** 김형태, 컨테이너 선의 대형화에 따른 항만의 물리적인 대응전략, 해양한국, 2000
Traditional Methods to Increase Port Service Capacity

- Build more berths
  - Requires existing land, or
  - Create new land (can be difficult)
  - Example: PSA (Singapore) consists of 44 berths and is constructing 13 more by 2009
- Increase depth of existing berths
- Increase existing productivity
  - Faster cranes
  - Lift multiple containers (tandem lift)
- There is a limit to capacity increase

**Fundamental Issue:** Port service capacity is tightly coupled with the land-sea interface!

A Key Step to Reduce Dependence Upon Land-Sea Interface

- Load/unload with fast cranes (tandem lift where possible)
- Load/unload from both sides of the ship

Features: Double-sided, automation, ship-to-ship

Substantial increase in capacity
- Capacity increase > 150% at the land-sea interface (berth)
Next Step to Minimize Dependence Upon the Land-Sea Interface

- **Goal:** Decouple load/unload from the land-sea interface
  - Want fastest load/unload possible at the land-sea interface
  - Fastest known technology is RORO (roll-on, roll-off)
  - Container ships don’t have RORO capability

- **Constraint:** Ship structure cannot be substantially changed!

- **Question:** How can we satisfy this constraint and still decouple the load/unload from the land-sea interface?
Decouple (un)loading from land-sea interface

**Mobile Floating Port (MFP)**

- Create a system with ultra-fast ($\mu$) cargo handling interface with land port

Interface to work with existing ship constraints (i.e. conventional crane)

New design for land port - MFP cargo handling interface with ultra-high loading speed
Mobile Floating Port System Can Dramatically Improve Berth Productivity

Ref. Case

Improve crane productivity

Alt. 1

Double-sided loading/unloading

Alt. 2

Mobile Floating Port

T1 ~ \( \frac{1}{2} \) T0

T2 << T1
Embodiment of Mobile Floating Port Concept

[1] Created by KAIST iCAD Lab (Prof. Soonhung Han, Dept. of Ocean System Engineering)
New Port Service Concepts Using MFP

- Can maximize the use of land-based port
- Mobile Floating Harbor is a “mobile” service assets
- Land-side interface can be standardized so that it can serve wide range of ship sizes
So, Why Mobile Floating Port?

- We need a floating port because …
  - Insufficient depth to handle mega-container ships
  - Limited port construction site
  - Reclamation has challenges

- Furthermore, we need it to be *mobile* because …
  - Decouples load/unload from the land-sea interface
  - Can dramatically improve port productivity
  - Allows agile and flexible port service design