Inland Port and Connectivity Concept

Concept Summary

June 2020
• Arup have been researching the role of automation in extending the port gate in congested port precincts and cities.

- Escalating congestion in port precinct
- Increasing volume of cargo through ports
- Requirement for space for port-centric logistics and activities generating greater revenues and employment
- Shortage of HGV drivers
- Carbon neutral policies require a transformation in operations and a change in infrastructure
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Dry port</td>
<td>A dry port is an inland intermodal terminal directly connected by road or rail to a seaport and operating as a centre for the transhipment of sea cargo to inland destinations. In addition to their role in cargo transhipment, dry ports may also include facilities for storage and consolidation of goods, maintenance for road or rail cargo carriers and customs clearance services. The location of these facilities at a dry port relieves competition for storage and customs space at the seaport itself.</td>
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<tr>
<td>Inland port</td>
<td>The term inland port is used in two different but related ways to mean either a port on an inland waterway or an inland site carrying out some functions of a seaport.</td>
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<tr>
<td>Intermodal</td>
<td>Involving two or more different modes of transport in conveying goods.</td>
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<td>Logistics cluster</td>
<td>Amorphous agglomeration of companies and facilities with logistics-intensive operations with fuzzy borders and no central management.</td>
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<td>Logistics park</td>
<td>Clearly defined ownership and geographic property boundaries.</td>
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<tr>
<td>Port</td>
<td>A town or city with a harbour or access to navigable water where ships load or unload.</td>
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<tr>
<td>Port of entry</td>
<td>A harbour or airport where customs officers are stationed to oversee people and goods entering or leaving a country.</td>
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<tr>
<td>Terminal</td>
<td>The end of a railway or other transport route, or a station at such a point.</td>
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Future Port Operations

- Ports relocated outside city centres with multi-modal connectivity to roads, rail and aviation.
- Automated handling and loading of cargo from central centres.
- Loading and unloading of autonomous cargo ships from both sides.
- Cranes made from lightweight materials to reduce load.
- On-site smart energy micro-grid including solar, wind, wave and tidal power.
- Automated container identification, scanning and tracking.
- Underground freight pipelines for the transportation of containers.
- Tidal and wave power solutions built into breakwaters.
- Adaptive infrastructure to accommodate global warming.
- Predictive maintenance and monitoring of port infrastructure and equipment by drones.
- Alternative shipping routes and new trade dynamics that require new port infrastructure.
- Breakwaters incorporate artificial reef structures designed to support marine ecology.
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Extending Port Gates

The extended port gate concept has been embraced by congested ports across the globe as a method to increase handling capacity at the quay and back-of-quay. Capacity can be provided along the supply chain to accommodate the increased number of road trucks and trains that have to move containers to and from the quay but also to provide more space for added value services.

One solution is to shuttle the imported containers as fast as possible with mass movement systems (rail or other innovative methods) away from the port to an inland intermodal terminal where the usual port functions and value added logistics activities can be performed. The gate of the port is then moved away into the hinterland where road trucks can pick up the containers destined for destinations inland.

The same concept applies for export containers which are dropped at the inland intermodal terminal and then in effect taken into stack for shuttling to the quay when the vessel arrives.

This concept has proved highly effective in alleviating not only congestion in the port precinct, but also locating secondary (peripheral) value adding logistics services such as warehousing and container depots at the extended gate to free up premium property in the port precinct for land use better suited for the primary activities at the port.
Busy ports such as the Port of Rotterdam, Port of Antwerp and the Port of Durban are increasingly suffering from serious congestion of road trucks. Even rail services are struggling to handle the volume of containers.

The Ports of Rotterdam and Amsterdam in the Netherlands, and the Port of Antwerp in Belgium have developed extended port gates using barges on existing waterways and creating a network of inland ports fed by road transport.

This has helped reduce congestion around in the urban areas around the major seaports.
In the UK, Daventry Intermodal Rail Freight Terminal (DIRFT) is a logistics park comprised of warehousing and National / Regional Distribution Centres connected to intermodal rail transfer facilities.

The facility acts as an Inland Port for the major southern Lo-Lo ports at Felixstowe, Southampton and London Gateway (connected by road and rail) as well as feeding major rail freight terminals across the country at:

- Grangemouth (for Edinburgh and eastern central belt)
- Mossend and Coatbridge (for Glasgow and western central belt)
- Teesport (gateway to the North)
- Seaforth / Liverpool (for Liverpool and North West)
- Wentloog (for South Wales and West)
- Thurrock and Barking (for London and South East)

Over 60 rail services operate into and out of DIRFT per week.

**Moving freight by rail rather than road produces 3.4 times less CO2 per tonne-km (70% less carbon emissions)**

*Source: Department for Transport, Delivering a Sustainable Transport System: The Logistics Perspective (December 2008)*
Benefits of implementing a Dry Port / Inland Terminal

Inlands Ports located close to, and serving hinterlands around ports, deliver a number of benefits for both City/Local regions and the Ports themselves.

**Benefits for the City / Local Region**

<table>
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<th>Benefit</th>
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<td><strong>Lower emissions</strong> from Port-related transport in the surrounding communities</td>
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<td><strong>Reduced congestion</strong> by removing a number of HGV trips from the local road network; and</td>
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<td><strong>Increased employment</strong> through the facilitation of the Port’s growth ambitions and resulting economic growth.</td>
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<td><strong>Increased development</strong> of sector specific education, research and expertise through partnerships with universities and other educational establishments.</td>
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**Benefits for the Port**

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<td><strong>Creation of increased space</strong> alternative uses within the Port (additional revenue streams);</td>
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<td><strong>Resilience</strong> of the Port’s external transport network including reduced congestion on the road network and improved freight delay value metrics;</td>
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<td><strong>Use of innovative</strong> means of transportation, driving down costs;</td>
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<td><strong>Contribution to a economic growth and increased competitiveness</strong> with cutting edge technology versus competitors (attracts new business); and</td>
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<td><strong>Reduction in emissions</strong> from Port-related transport to help achieve Net Zero requirements (80% reduction in Greenhouse Gases by 2050)</td>
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The UK Department for Transport has forecast future growth in Lo-Lo volumes through UK ports up to 2050.

From 2018 volumes, this equates to the following growth up to 2050:

- Low Growth Scenario +74%
- Central Growth Scenario +114%
- High Growth Scenario +161%

Clearly the implications on existing transport infrastructure, congestion and associated emissions is substantial and additional capacity will be required alongside innovative new methods to lower emissions and ensure that Ports can meet predicated demands.
Automated Guided Vehicles (AGV)

An Automated Guided Vehicle could operate on its own dedicated highway, delivering a constant flow of freight without impeding the current road network around the port. With both low noise and particulate emissions, these solutions could improve air quality for residents of Sefton and allow for around the clock operations for the port.

Background

Automated Guided Vehicles have been utilized in the port industry for decades. Initially petrol powered, expensive, and unreliable, AGVs and wider port automation were rejected for capital delivery projects that boasted greater throughput and capacity. However, as ports have become more constrained by the cities around them, they have sought ways to improve efficiencies. Since then, advances in technology have positioned AGVs as a proven means to conduct Port Automation. Modern AGVs are battery driven and therefore are emission free, reducing harmful particulates from the air within and surrounding ports.

Additionally, IoT sensors are used to improve tracking and tracing of containers, reducing the number of missing containers. The rollout of 5G will only increase the viability of AGVs as networks will be able to support a greater number of increasingly complex vehicles.
Globally, battery AGVs have been the catalyst for wider port automation and are viewed as intrinsic to its development. One such example is the Port of Rotterdam, which has for a long time been at the forefront of global port automation.

**Rotterdam, Netherlands**

Rotterdam received its first battery AGV in 2013 having utilized diesel AGVs since 1993. Rotterdam is engaging with industry to develop AGVs for use on its 14km private highway project, the Container Exchange Route. Since embracing automation, the Europe Central Terminal has seen a reduction in labor costs of up to 25%.

**Tuas, Singapore:**

With land space in the current Port of Singapore heavily constrained. The PSA sought to develop out of the city. The Tuas mega port will continue to drive Singapore’s position as a global leader in maritime logistics. Tuas will be entirely autonomous, with up to 2,000 AGVs delivered over 10 years as it scales up to capacity.

Both Singapore and the Netherlands have been leaders in Port centric logistics solutions and operate as hubs for regional transshipment. Whilst Tuas’ AGVs will not be transferring containers to a hinterland, they will be travelling large distances daily as the Port reaches its 65 million TEU capacity by 2040. Rotterdam’s selection of AGVs for its Central Exchange route highlights that AGVs are a viable option for transferring containers from port to hinterland.
AGV based solution to Inland Port on Urban Boundary
Transport System Technologies – Overhead Systems

**Overhead Container Transfer System**

An Overhead Container Transfer System could be used to transport containers from the Port to the inland container terminal independent of any publicly operated infrastructure. Contrary to its name, these solutions can run underground in a tunnel. As with AGVs, these systems are low emitters of noise and due to this could offer the port the opportunity to move container throughput between the container terminal and the port 24 hours a day. Unlike AGVs, these systems are powered by mains electricity and are not reliant on a battery, and therefore are not exposed to downtime for charging or changing batteries.

**Background**

OCTS have evolved from Overhead Passenger Transfer Systems such as monorails as seen in Dresden, or Ski Gondolas seen across the world. They have been successfully adapted for use in the mining industry to automate and expedite the transportation of ores, gathering the attention of freight transportation market disruptors.

These systems are being adapted to autonomously carry shipping containers from port to hinterland.

Whilst not a new concept, the overhead container transfer system commercial market is relatively new and with a limited number of concepts competing for feasibility studies globally. Two main providers are EagleRail and FuTran.
Case studies

As outlined in the introduction of this technology, the OCTS comes from a less well developed path than that of an AGV system. However, there are key advantages to this technology that investors, entrepreneurs, and industry are realising; especially for moving high volumes of freight over medium to long range distances. The two companies identified have approached this style of system from two different perspectives and therefore both have a set of positives and negatives to be explored.

Futran
Developed in South Africa, FuTran has sought to disrupt the mining industry’s reliance on truck transportation. Fully autonomous and electricity powered, a two way FuTran system can move over 250 million tonnes of ore in a year, removing diesel trucks from the road network and lowering operating costs for mine owners. Beyond this initial application of bulk transport, MiloTek, FuTran’s owning company, seeks to apply the technology to container transportation, mass transit in Urban centres and even in manufacturing. FuTran is deploying its OreVeyor solution at Mpumalanga and intends to work with the mine to consolidate its access into one tunnel with a multi-application FuTran system for the transport of equipment, ore, and people.

EagleRail
Solely focussed on container freight transportation, EagleRail recognises the global issue of congestion around ports in cities and port precincts and markets itself as a competitor to short to mid distance diesel drayage. Like FuTran, EagleRail operates on an elevated trackway and can be deployed above or underground, dependent on local constraints, such as housing, or protected areas etc. EagleRail’s focus on container transport has seen it engage in dialogue with over 17 port authorities and, including the signing of a memorandum of understanding with the Port of Chittagong, Bangladesh, to connect its new and older terminals and intermodal connections. EagleRail seeks to connect Port to Hinterland multi-modal hubs without burdening the local road network of containerised freight.
Overhead based solution to Inland Port on Urban Boundary via dedicated route or shared road corridor
There are of course other solutions that could move unitised cargo in significant volumes.

Mole solutions produces subsurface transport systems for containers but also much smaller consignments such as pallets which could be transported directly to customers from the Port.

These systems would require a more substantial network of tunnels but could be focussed around logistics clusters around the periphery of urban areas.

There is also the opportunity to reach adjacent urban areas and markets by taking advantage of shared transport corridors. These could be new transport corridors created through the development of High Speed Rail or existing corridors where the transport system runs underneath or alongside.
Inland Port Sites

The inland intermodal terminal concept has been developed to integrate various individual components in adding logistics value at a facility that acts as an intermediary in the supply chain. This concept works on a "hub-and-spoke" principle, where containers are received from various origins by unit or block trains to the central hub, and distributed to the destinations.

Peripheral services at an inland intermodal terminal can include the following:

- Container repair and refurbishment;
- Container cleaning and maintenance;
- Empty container storage;
- In-bond warehousing;
- Specialised warehousing (e.g. refrigerated, high security, liquid/bulk handling and storage);
- General warehousing for less-than-container loads (LCLs);
- Cartage, delivery and pickup;
- Groupage (consolidation of loads);
- Shipping line container parks; and
- Specialised services such as export packing.
## Inland Port Sites

Selecting the right site or sites is key but generally the following should be taken into account:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>1 Land availability</td>
<td>The availability of the proposed site to be developed, taking into account current site ownership and any developments currently taking place on the site.</td>
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<tr>
<td>2 Strategic Road Network access</td>
<td>The proximity of the site to the Strategic Road Network (SRN) for ease of access and to minimise HGVs on local roads.</td>
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<tr>
<td>3 Rail access</td>
<td>The proximity of the site to existing rail infrastructure, taking into account routes to the WCML and relevant gauge clearance (W10 or W12) for containers by rail.</td>
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<td>4 Site Size</td>
<td>Is the site of sufficient size to be able to handle future demand (over 1 million TEUs p.a.), including associated supporting functions such as office space, warehousing, value added services etc.</td>
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<tr>
<td>5 Distance from Port</td>
<td>The distance from the Port to the proposed site. Sites located closer are ranked best with those furthest away ranked worst.</td>
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<tr>
<td>6 Topography (flat land)</td>
<td>Is there sufficient flat land on the site to allow it to be developed cost effectively.</td>
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<tr>
<td>7 Environmental suitability</td>
<td>Are there any environmental issues related to the site? Is it located within the Green Belt for example.</td>
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<tr>
<td>8 Technology Fit</td>
<td>Can the site be accessed by one technology solution i.e. all AGV or all overhead?</td>
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<tr>
<td>9 Potential Route Cost</td>
<td>A high level estimation of the cost to develop the route to the site i.e. High cost includes longer distances and significant sub-surface sections; Low cost includes shorter routes and most of the route at grade.</td>
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<tr>
<td>10 Surrounding land uses</td>
<td>Takes account of land uses around the proposed site. Residential scores low, whereas existing industrial / logistics functions score higher.</td>
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