

Session 9

Port Management & Operations

Part 2: Maintenance Management and Equipment Procurement and Selections



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Part 2: Maintenance Management and Equipment procurement and selections

Speaker: Mr. Teo Woon Hun

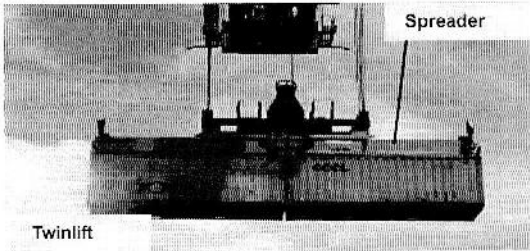
Outline

- Overview of the types of Container Handling Equipment (CHEs)
- Equipment Maintenance System : Concepts and Implementations
- Procurement selection and evaluation of new equipment.
- New improvements in Container Handling Equipment.
- Towards Automation and Environmental friendly solutions.

Terminal Equipment

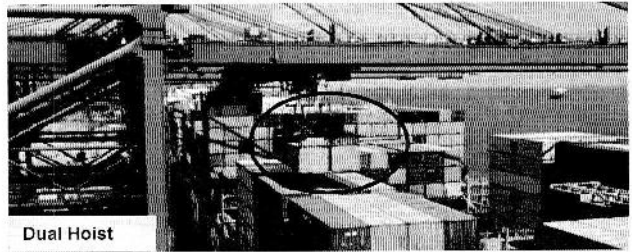


Quay Crane (QC)



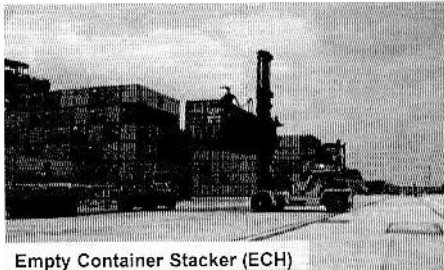
Spreader

Twinlift



Dual Hoist

Terminal Equipment / Yard Cranes



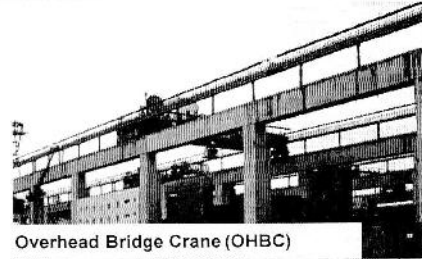
Empty Container Stacker (ECH)



Rail Mounted Gantry (RMG)

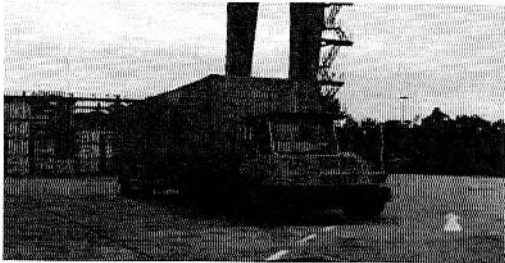


Rubber Tyre Gantry (RTG)



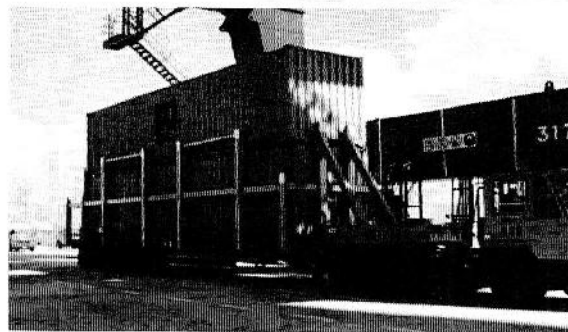
Overhead Bridge Crane (OHBC)

Terminal Equipment / PMs & Chassis

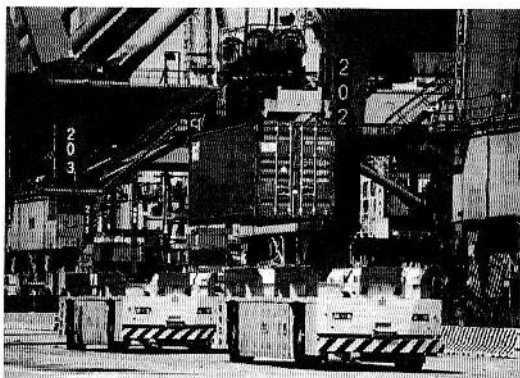


Prime Mover (PM) + Single Stack Trailer (SST)

Double Stack Trailers (DST)

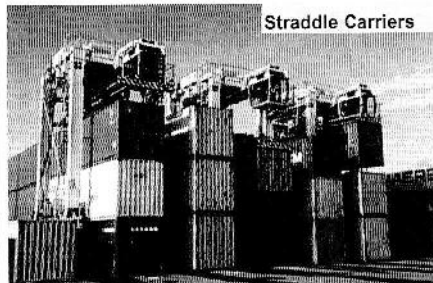


Automated-Guided-Vehicles (AGV)



<https://youtu.be/5Np3tLNlxxk>

Other equipment not deployed in PSA Singapore

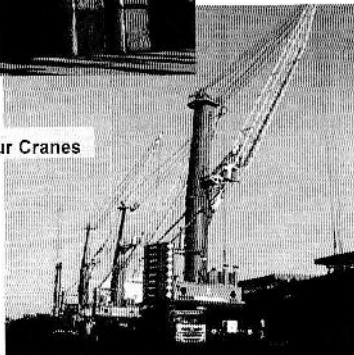


Straddle Carriers

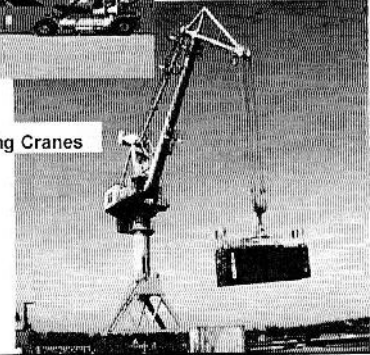


Reach Stackers

Mobile Harbour Cranes



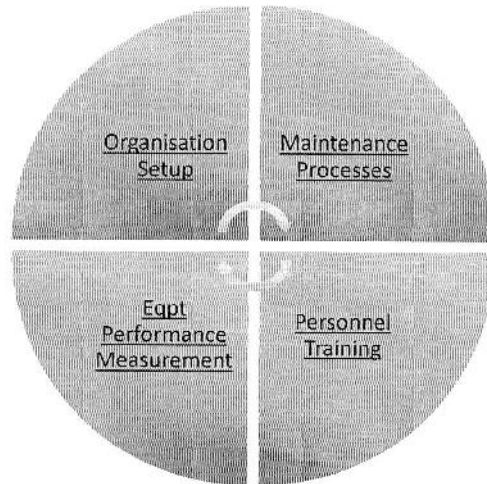
Level Luffing Cranes



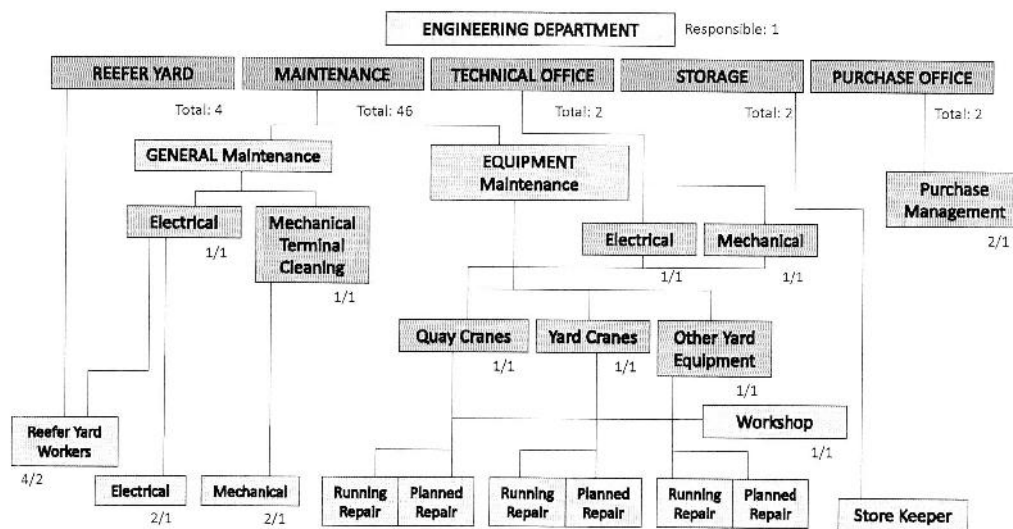
Equipment Maintenance System

- Maintenance on Port Equipment is very niche. To recruit experienced technicians and engineers from the market is difficult. PSA decided very early to recruit & train their own engineering staff. They have also developed their own equipment maintenance system to manage their work.
- The total current strength of the Engineering Division in PSA is about 800 to 1000 strong. They are maintaining
 - 223 Quay Cranes
 - 650 Yard Cranes (est.)
 - 1300 Terminal Tractors (est.)
 - 60 Empty Container Handlers (est.)
 - Other mobile equipment such as forklifts, operations vehicles, service trucks, cleaning vehicles etc..
- A systematic approach to maintenance of all these equipment is therefore critical.

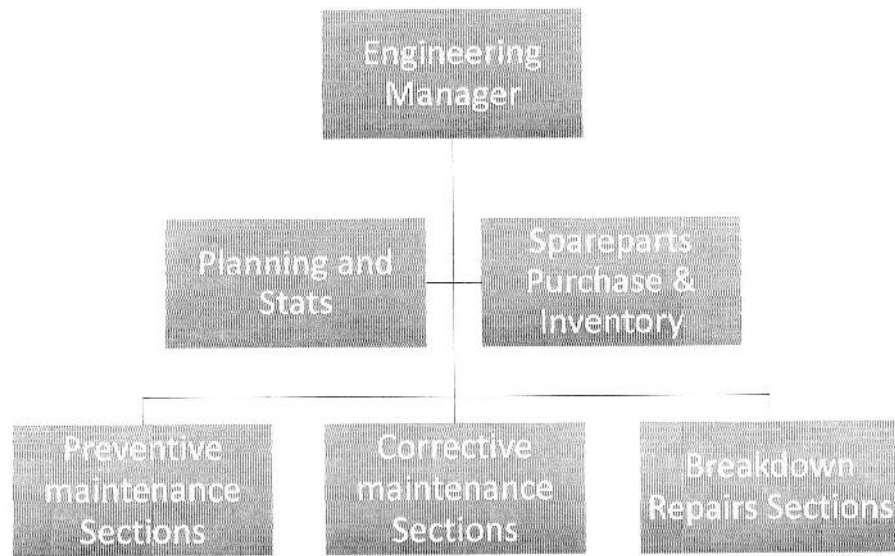
Implementation of Equipment Maintenance System



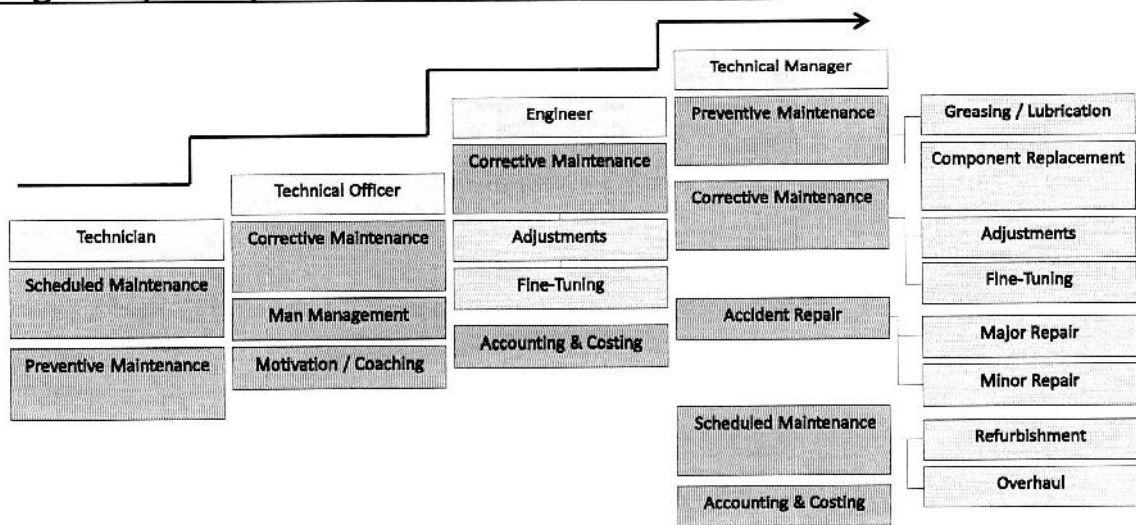
Org Setup : Example of an Engineering Department



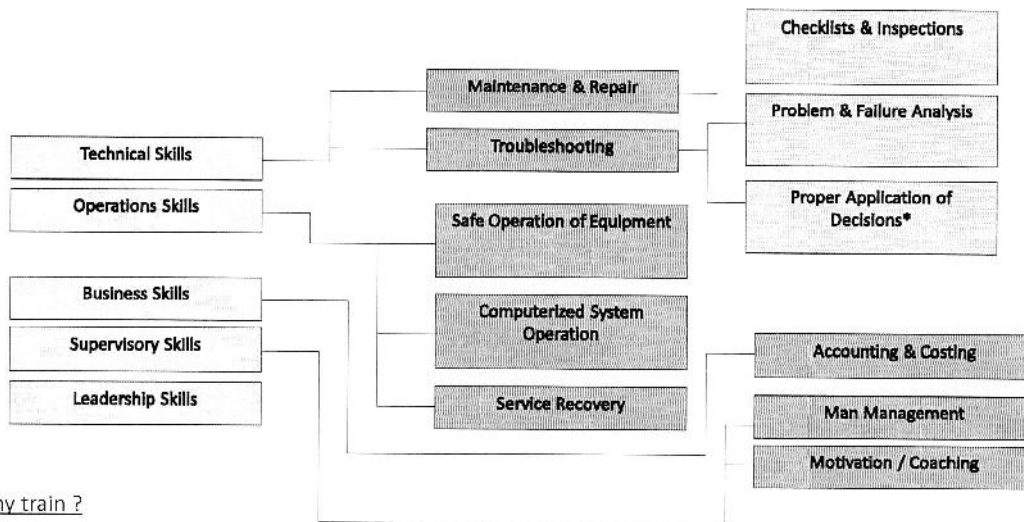
Org Setup : Basic Functional Engineering Department setup



Org Setup: Responsibilities of Different Roles



Training: Competencies to Acquire



Maintenance Processes: Principles to effective maintenance

- Plan, rather than react.
- Be equipped correctly.
- Follow the plan.
- Seek feedback and advice to improve processes.
- Adjust plan when needed.
- Keep all stake holders informed.

<https://www.linkedin.com/pulse/six-principles-effective-maintenance-management-olapade/>

Maintenance Processes: Types of Maintenance jobs

- **Preventive Maintenance (PM)** is scheduled ahead. Ops would release equipment to maintenance teams to work on the PM. They include routine oil & filter change, greasing, adjustments, visual checks etc. The main objective of PM is to make-good & thus prevent anything that could break down in the future from happening.
- **Predictive Maintenance (PM*)** is also scheduled ahead. It's objective is to rectify problems or to replace components on the equipment just before their predicted lifespan. So if done effectively, PM* would be more cost saving and causes lesser downtime on the equipment. To be able to implement PM* well, engineers have to have very accurate data to determine when failure would occur.

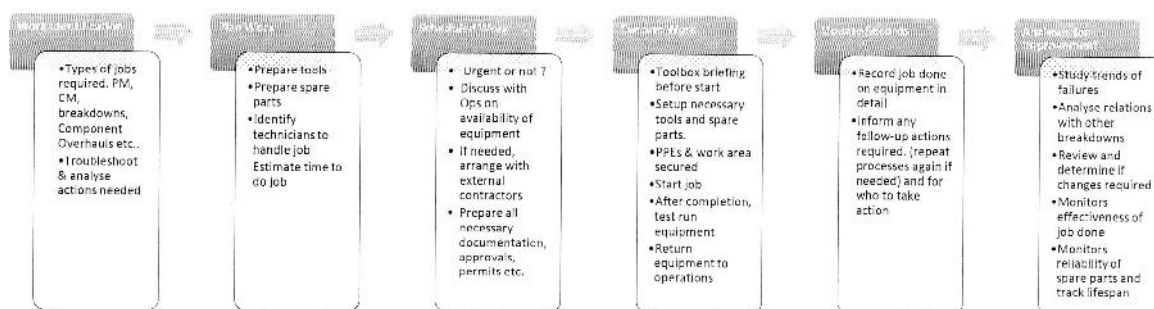
Maintenance Processes: Types of Maintenance jobs

- **Corrective Maintenance (CM)** is also scheduled ahead. CM is required when possible failures are observed in-between PM. Therefore, equipment is scheduled for CM to have the fault rectified.
- **Breakdown Maintenance (BDN)** is unscheduled. It's objective is to rectify problems that have occurred during ops ASAP. When the equipment is deployed. BDNs are very disruptive to ops (NUMBER ONE ENEMY). Therefore, the main objective of the maintenance team is to eliminate BDNs during ops. When a major breakdown occurs, they are generally also expensive, as the damages would be more serious.

Maintenance Processes: Types of Maintenance jobs

- **Accident repairs (AR)** happened mainly due to human errors. For minor accidents repairs, they are generally temporary repaired and the equipment is sent back to operations. If the AR is major, generally the equipment could be unavailable to ops until repaired. For PSA, ARs are usually outsourced to external contractors.
- **Component Overhauls (CO)** is also scheduled. It's objective is reworked on major components on the equipment such as engines, transmission, gearboxes, brakes, which are expensive to replace with brand new ones when they fail. Overhauls would change most of the worn out parts in these components and then they could be reuse up to 80% of previous lifespan.

Maintenance Processes: General process flowchart

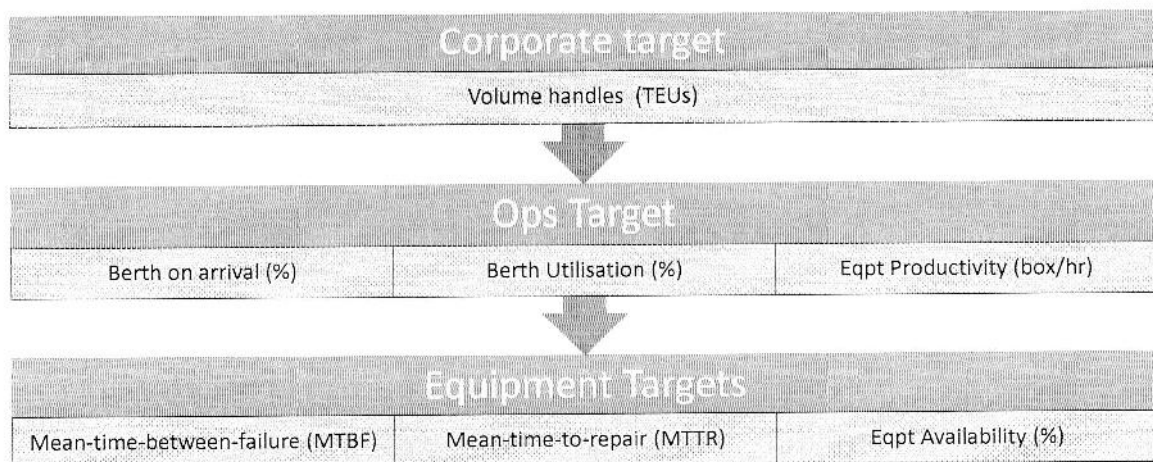


Eqpt Performance: Measure of performance

- Equipment Performance Measurement (EPM) track and monitors if the equipment deployed meet the service level expected.
- For Equipment Performance Measurement (EPM) to be meaningful, they must ultimately complement and contribute to the port's ability to meet the Port's Major Performance Measurement.



Eqpt Performance: Measure of performance



Eqpt Performance: Performance Indicators

- General performance indicators are
 - Mean-time-between-failure (MTBF)
 - Mean-move-between-failure (MMBF)
 - Mean-time-to-repair (MTTR)
 - Equipment Availability (%)
 - Equipment Utilisation (%)
 - Cost of maintenance per box/TEU

Eqpt Performance: Critical Data to Monitor & to Analyse

- Breakdowns Frequency (types of breakdowns, which equipment, duration of breakdowns)
- Maintenance status of equipment (backlogs of maintenance, frequency of different types of maintenance requirement per week, per month)
- Equipment downtime status (number of equipment down for maintenance, estimated downtime of equipment)
- Cost of Maintenance per Equipment

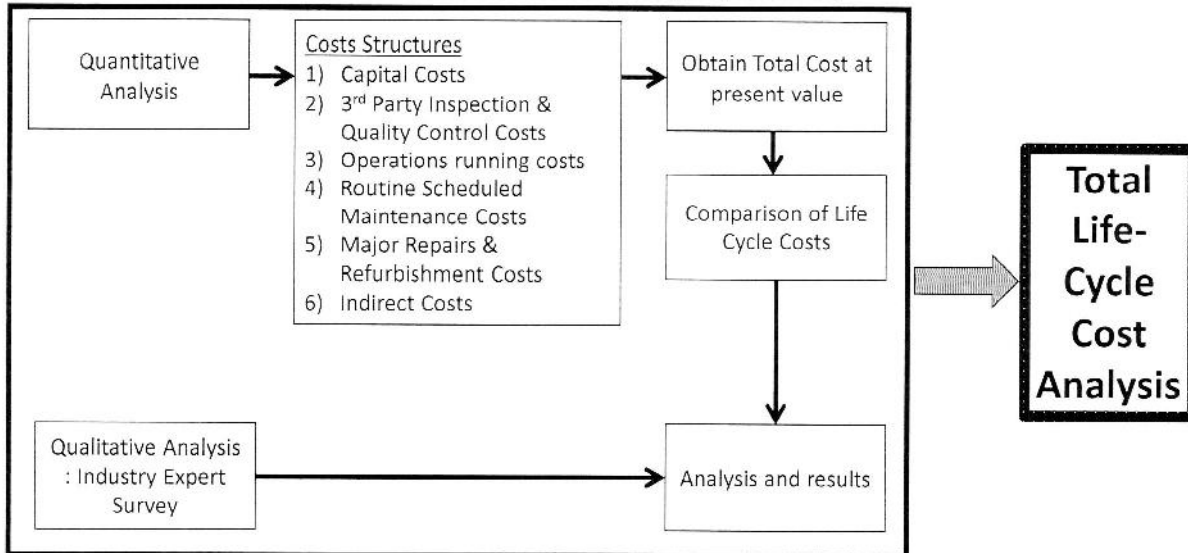
Eqpt Performance : Improvement and Corrective Measures

- Information collected must be analysed continuously to improve and hone the processes and tackled problems on spare parts, premature failures and breakdowns.
- Therefore, ideally, there should be systems to manage the scheduling and planning for all the different types of maintenance and repairs and records to be kept.
- A system to manage the spare parts inventory to record and forecast the needs of spare parts and when to make purchases
- These systems should be made to tie up with the accounting system where costs incurred in maintaining equipment and infrastructure could be tracked and evaluated for asset replacement policies.

Procurement & Selection of New Equipment: Main Considerations

- Price Price
- Manufacturer's track record (expertise, past records, credentials in other ports)
- Equipment Specifications (Operational capabilities)
- Equipment Specifications (Design & quality)
- Aftersales & spare parts support
- Provision of Training to port personnel
- Other consideration – Transportation, fabrication work-site, commissioning of equipment, third-party inspectors

Procurement and Selection of new equipment



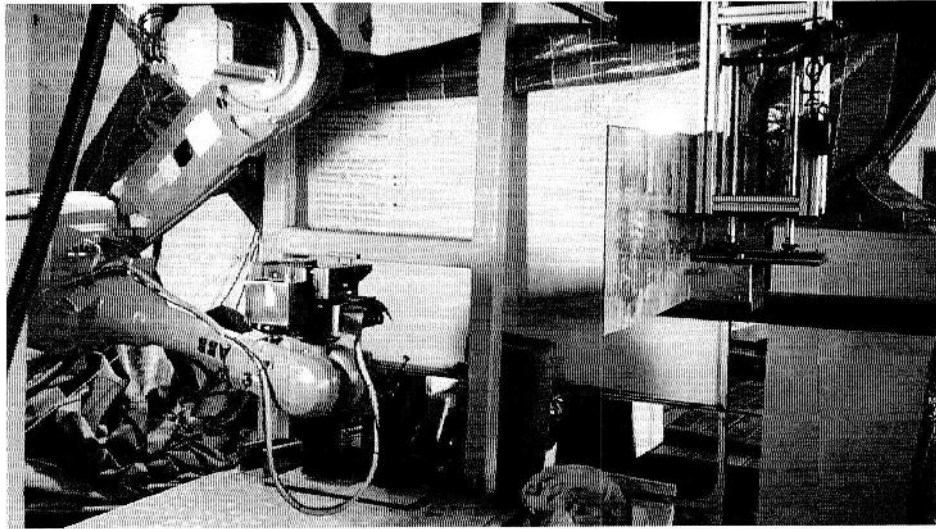
Innovating for the future

Port operators today face challenges on many levels, from the consolidation of shipping lines to new industry norms such as mega-vessels and complex shipping alliances, amid ever-growing competition. A key part of PSA's strategy lies in investing in world-class infrastructure and technology to meet customers' needs. PSA's Port of Tanjung Pelepas uses advanced port equipment and intelligent systems to assist in operations, making it a model for the future. [Visit port](#)

The infographic illustrates various port innovations. It features a central image of a port terminal with several callout boxes:

- Mechanical winch:**
 - When a vessel berths, a mechanical device attached to a vessel helps to reel in the mooring ropes.
 - This also allows the need for physical labour while enhancing safety and efficiency.
- Automated wharf supervision:**
 - Two cranes are equipped with optical imaging and image processing technology along with radar systems, to read container numbers and identify storage from 80m cranes and trucks.
 - This allows the crane operator to handle his queue made up of one or more 40-foot containers.
- Automated Crane Operations Centre and automated container yard:**
 - PSA's Tanjung Pelepas 4, 5 and 6 are equipped with proprietary intelligent and chaining systems.
 - Automated 40-metre gantry cranes as high as 12-storey buildings load and unload containers with precision, aided by a suite of computers, sensors and cameras. All these systems assist cranes and operated manually.
 - Staff monitor the cranes at the Automated Crane Operations Centre.
- Smart machines:**
 - Drivers are being trained to inspect equipment and assist in troubleshooting.
 - These systems provide information for video analytics, which engineers can use to detect errors in breakdowns and maintenance operations, the while reducing cost and improving efficiency and productivity.
- Sustainable environment:**
 - Green technologies – solar power, wind and liquid natural gas – are used to actively manage energy consumption, reducing CO2 in operation.
- Automated Guided Vehicles (AGVs), AGVs and autonomous truck platooning:**
 - Drivers and battery-powered AGVs transport containers between the quay side and the container yard.
 - Autonomous truck platooning – in which one human drives truck, with a convoy of driverless trucks – is being tested for 20-40-ton container haulage.

Towards Automation and Environmental friendly solutions

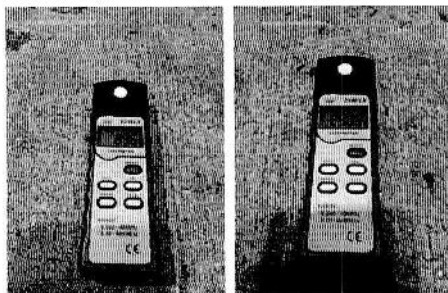


Robotic arm
Coning &
Deconing
System

Towards Automation and Environmental friendly solutions



Before : 1,000W lamps After : 300W LED



Energy savings : 70%
Brightness : +200%



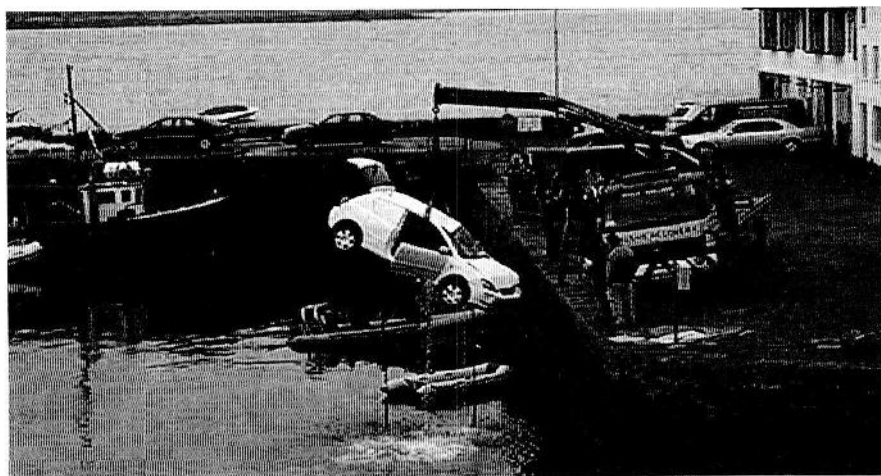
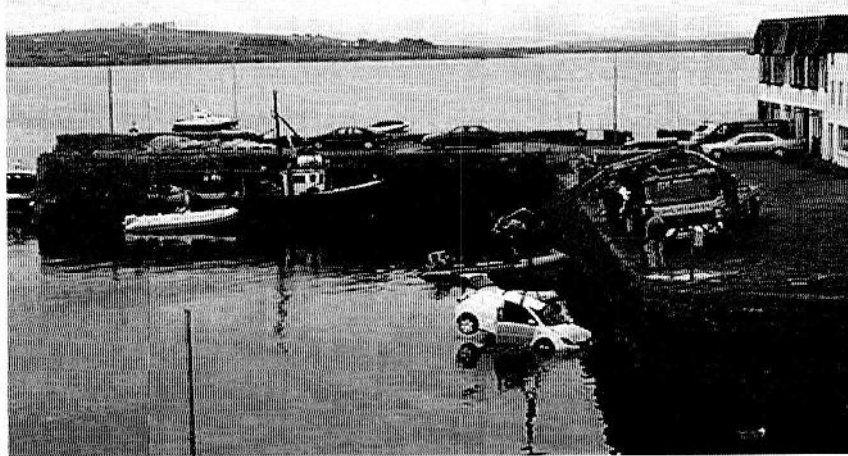
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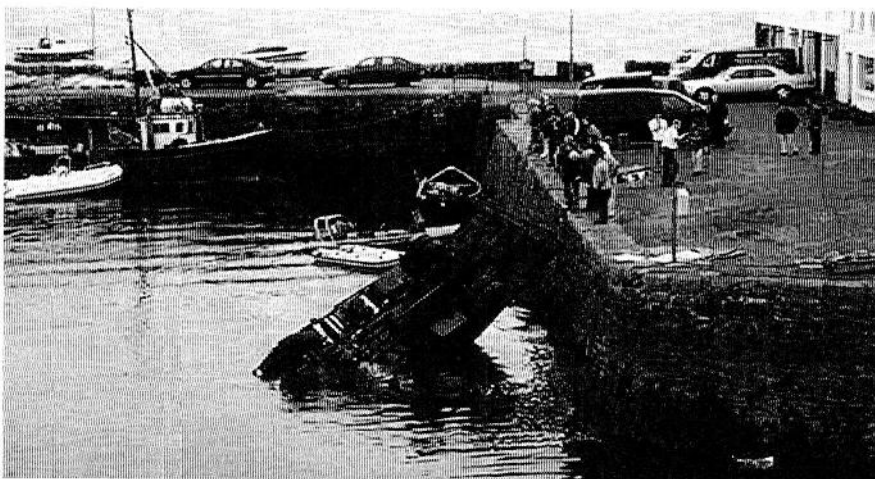
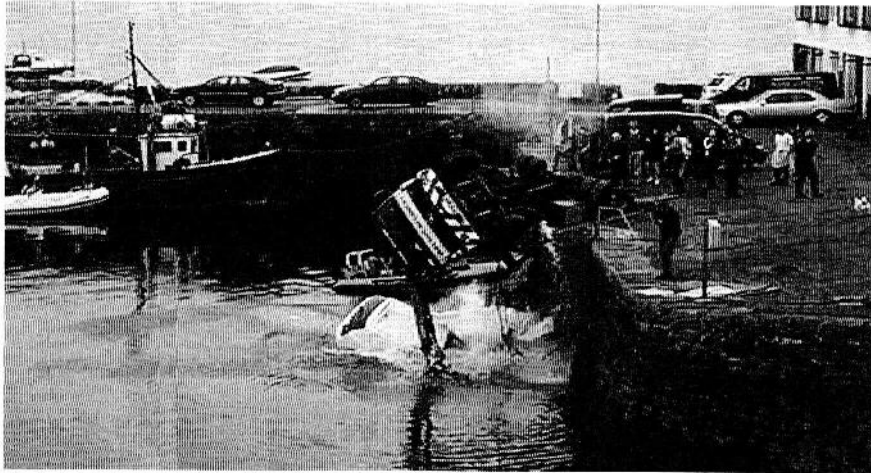
Equipment Management

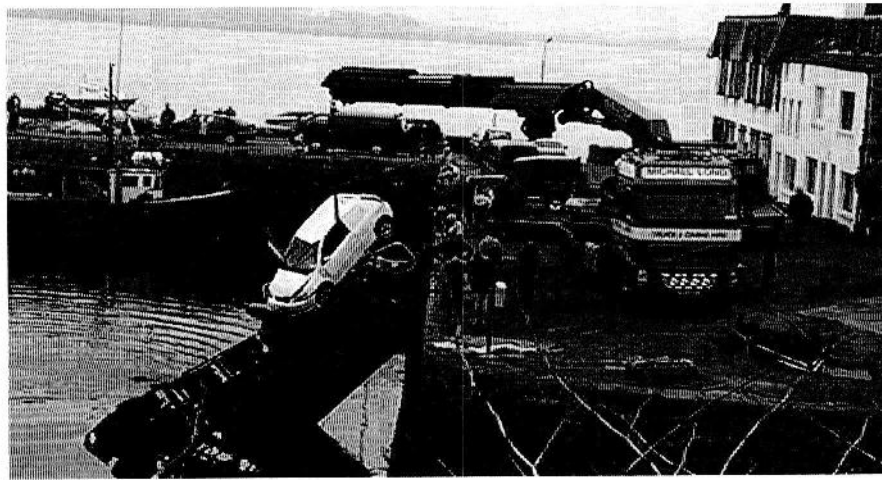
- Equipment for ports are critical to ensure Ports meets their business objectives
- To have quality equipment and high performing equipment is crucial (quality procurement)
- But equipment has also to be maintain correctly. (effective maintenance plans)
- Skilled team of engineers and technicians are needed (technical training and development)
- Increasing competition requires constant improvement of container handling ability (adoption of technologies and innovations)

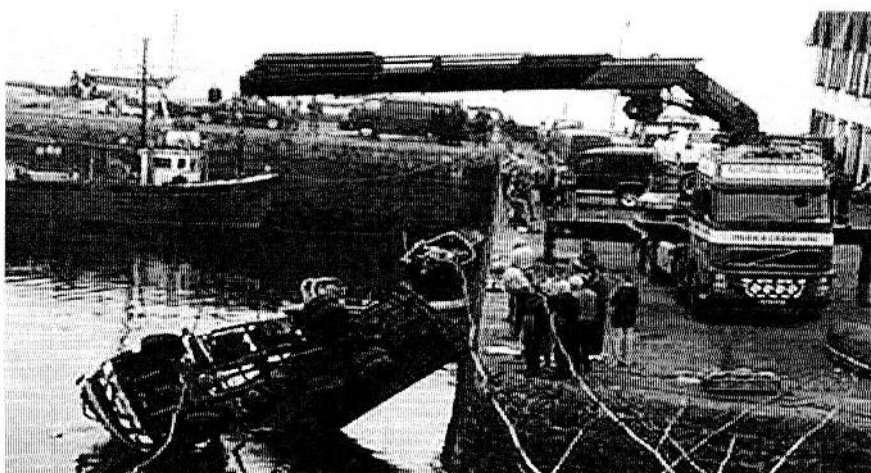
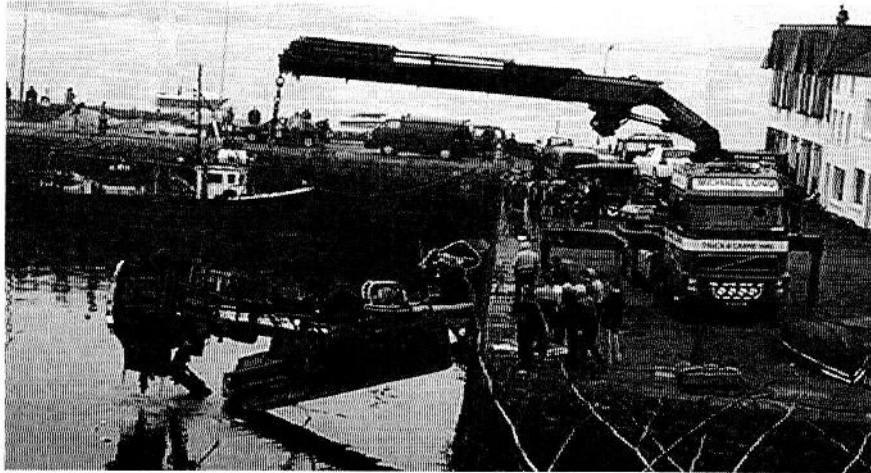
Question?

Result of the lack of Training











Question?