



Ensuring Effective Returns across your Terminals Equipment Fleets

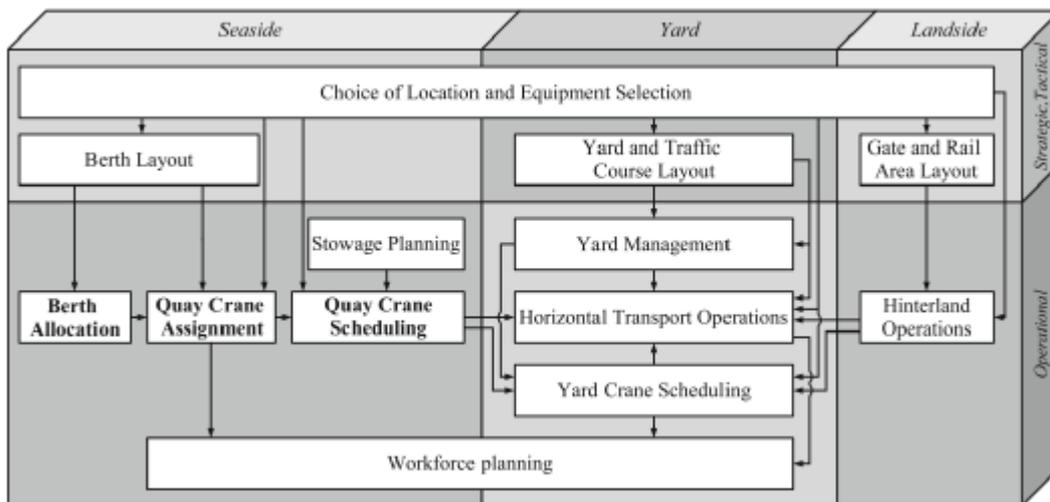
Terminal Management seek optimal Financial Returns across their facilities whilst pushing their Assets to the Max.

Today's Challenges

Over the last few years I have written several Industry papers that have focused on the changing face of Container Terminals and the challenges that the management of these facilities have had to encounter. Today the biggest concerns for Management is financial pressure to reduce operational expenditure, deliver higher service levels and become masters in the way they plan and handle the next generation container vessels that call their facilities.

Terminal Management have relied heavily on several key elements to achieve these goals these have included: -

- ✓ Terminal Operating Software – predictive data modelling on vessels, cargo flows, and optimal scheduling of job and work orders allowing terminal work force to engage and deliver against projected scheduling of vessel calls. Terminal Operating Solutions need to be flexible and adjust to changing conditions as Vessel and Yard Planning is fluid and can change but modelling can significantly help the Operational Teams predict trends.
- ✓ Terminals rely heavily on the performance of their Equipment Assets Deployed across their facilities, plans and scheduling are very reliant on the efficiencies of the machinery they have deployed.
- ✓ Workforce – although we are seeing a transition from Manually labour run facilities to semi and fully automated facilities -the work force still plays a key component in ensuring that the vessels are turned in the fast times whilst ensuring and maintaining the required Health and Safety requirements.
- ✓ Automation is being implemented across all areas of the Terminals Facilities to streamline and monitor every component of the daily operations.



So, the key to this paper is to evaluate the engineering and management of the terminals assets and the need to identify ways to maximize the way in which these assets are run and managed across the terminal.

Terminals Spend Billions on Machinery Annually

Terminals generate their revenue via their agreed THC rates, and these can vary significantly depending on the volumes and individual commercial agreements they have with their liner clientele. When you look at the breakdown on the THC rate the following elements will have to be embraced :-

✓ Terminal Infrastructure	- 60 %
✓ Machinery Handling Equipment	- 25 %
✓ Work Force / Management Costs	- 10%
✓ Technology and Automation	- 5 %

With Equipment being the 2nd largest capital expenditure for a terminal its critical that the Groups Engineering department can really focus on which manufacturer can deliver the most durable and cost-effective equipment available. When considering that equipment deployed will be in service for anywhere from 7 to 15 years and with terminals spending millions the question must be asked as to how to make the right decision and on what data is these judgements based on?

<div style="text-align: center; background-color: black; color: white; padding: 5px; font-weight: bold;">Straddle Carrier</div>  <p>Circulate over container piles. Can go over stacks up to 3 in height. Density of 500 to 700 TEU per hectare.</p>	<div style="text-align: center; background-color: black; color: white; padding: 5px; font-weight: bold;">Rubber-tired Gantry</div>  <p>High storage densities (1,000 TEU per hectare). Difficult to move from one stack to the other. High acquisition but low operating costs.</p>
<div style="text-align: center; background-color: black; color: white; padding: 5px; font-weight: bold;">Front-end Loader</div>  <p>Use container top anchor points. Handle most containers. Can reach stacks up to 3 in height.</p>	<div style="text-align: center; background-color: black; color: white; padding: 5px; font-weight: bold;">Rail-mounter Gantry</div>  <p>Highest storage density (wide span; +1,000 TEU per hectare); mostly used at port terminals. Lowest operating costs. Fixed to rail tracks.</p>
<div style="text-align: center; background-color: black; color: white; padding: 5px; font-weight: bold;">Reach Stacker</div>  <p>Flexible side loaders. Can reach stacks up to 3 full or 5 empty containers in height. 500 TEU per hectare.</p>	<div style="text-align: center; background-color: black; color: white; padding: 5px; font-weight: bold;">Portainer</div>  <p>Load and unload containerships. Various sizes (Panamax and Super-Panamax).</p>

Decisions What are these based on

Terminal Management plan their operations carefully and of course depending on which type of facility they establish will play a major component in the selection of the manufacturers and the equipment they purchase. So what are the current decision steps :-

- ✓ The Manufacturer (The reputation of the Company)
- ✓ The range of Equipment on Offer
- ✓ Innovation and Design of the Equipment (Cutting Edge setting the bar / moving into alternative designs)
- ✓ Quality of the Equipment
- ✓ The Environmental Green Solutions that are the Manufacturer are embracing (clean burn Hybrid, and Full Electric units.
- ✓ The Service and Customer Support Network
- ✓ Local Service Centres and the ability to source spare parts quickly.
- ✓ Parts and Service Support on a Global, Regional and Local Level
- ✓ Price (Initial Purchase)
- ✓ Total Cost of Ownership

So these are the initial touch points that the engineering department will assess in their selection process. Of course, terminals must look further into the reliability and durability of the equipment they select with decisions have major potential repercussions.

Terminals Assessing the Performance of Equipment

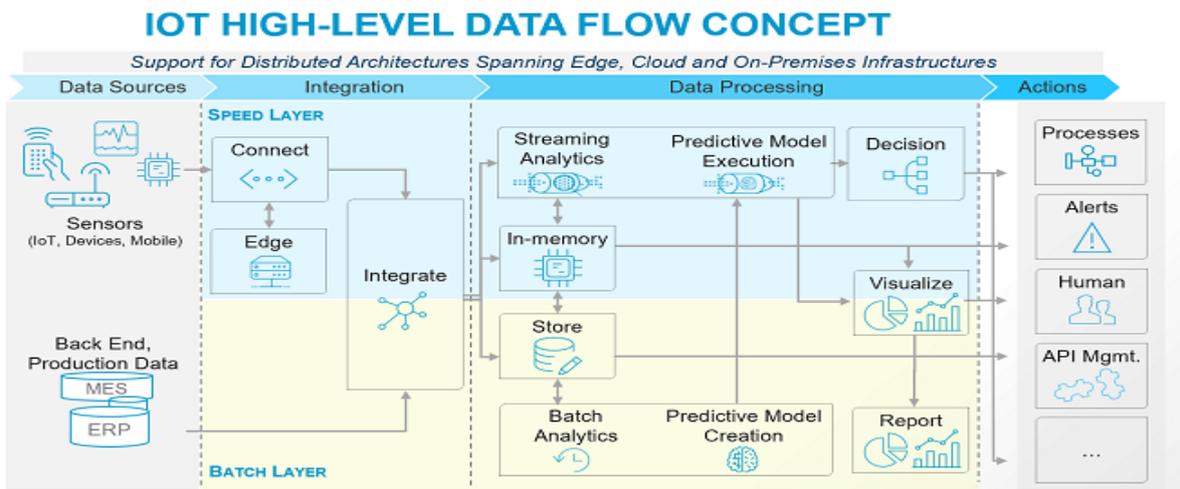
So selection must go to another dimension this will be to consider the optimization of the equipment and ensuring that they can conform to the operational levels and volumes of cargo that is anticipated to be handled during the life time of the equipment deployed.

- ✓ Comparing Operational efficiencies of the various Manufacturers. (with most companies claiming the robustness of the equipment deployed – it becomes very difficult for terminals engineers to obtain truly independent assessments and this only comes from being able to run equipment over periods of time across an operation. The larger Multi Terminal Facility groups have greater abilities to test different equipment and provide assessments. So what will these engineers look from Big Data Analytics :-
 - Equipment Type
 - Service Schedules (Running Hours)
 - Warranty Claims (How the Units perform over the duration of their life – number of recalls, warranty claims)
 - Service Downtime – How often the Units are out of service – time taken to run routine maintenance schedules.
 - The cost of the spares.
 - Mechanical Failures and Breakdowns – How often do the Units breakdown or fail?
 - Running Costs – (Fuel, Spares, Servicing, depreciation)
- ✓ The Equipment (Units deployed) will also be impacted by climate conditions and potentially will impact the overall performance.
 - Cold Weather can increase fuel consumption
 - Cause pipes and Hydraulics to become brittle and fail.
 - Excessive rain, snow can cause deterioration of the units – and lower the overall performances.
 - Battery Life can be radically shortened in Cold Weather climates and this might impact hybrid technology.
 - Electronics can also be affected in cold climates.
 - Likewise, Hot climates can create humidity and excessive corrosion, dust and dirt can also impact the performance of the units.

- Weather in general can seriously hamper the performance and running costs of the terminals operating equipment.
- ✓ Terminals will also be able to look at the overall performance and capabilities of the equipment they select in terms of :-
 - Lifts per Hour
 - Cost of Lifts

So how Can Technology Play a Key Role in Achieving Better Decision Making.

Well by introducing a combination of advanced IOT devices coupled to Data Analytics performance monitoring can be achieved. IOT devices are not new to the industry and have been used to measure and capture physical moves around the terminal from the handling equipment, chassis and physical containers that flow thru the facilities.



Manufacturers are implementing IOT on their equipment to provide telematic information on the overall running performances of the unit from engine, to hydraulics can be monitored and data captured. With real time health checks being provided by the on-board systems the units can predict when services are due, if certain components are stressed and the overall performance of the unit can be captured.

As fuel costs continue to rise and equipment is run longer with the overall number of moves, they also increase their annual mileages as they run between the stacks and vessel which can escalate operating costs and shortening the life expectancy of the units. So IOT devices and better work order management needs to be embraced to resolve these issues – by reducing the physical moves and distance travelled by yard hustlers between the stacks to quay cranes, considerable benefits will be achieved :-

- ✓ Higher Levels of Productivity
- ✓ Reduced Fuel and Consumable costs
- ✓ Less Mechanical breakdowns

- ✓ Reduced Maintenance and Repair Costs.
- ✓ Extending the expected Operating Life of the Equipment.

These factors all helping to increase the margins that are becoming harder to achieve based on the current THC's that Terminal Operators are achieving.



Predictive Maintenance for Key Assets.

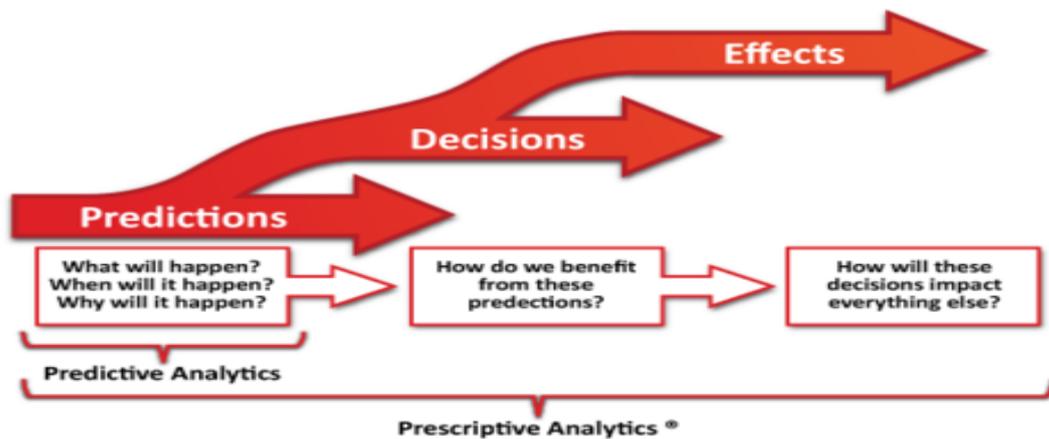
Predictive and Remote crane and vehicle maintenance can lead to a 30 to 50% reduction of total machine downtime, increasing the availability of critical terminal assets such as the STS, RTG Cranes and Yard Hustlers.

Predictive Maintenance Economics

The three maintenance types that are, generally, referenced in this report include the following:

- Predictive maintenance, which is analogous to condition-based maintenance, is initiated based on predictions of failure made using observed data such as temperature, noise, and vibration.
- Preventive maintenance, which is related to scheduled maintenance and planned maintenance, is scheduled, timed, or based on a cycle
- Reactive maintenance, which is related to run-to-failure, corrective maintenance, failure-based maintenance, and breakdown maintenance, is maintenance done, typically, after equipment has failed or stopped.

Predictive analytics can be deployed to help prevent potential mechanical failures and highlight that additional services and checks can be made when routine services are scheduled. Another area where IOT devices can provide valuable data is measuring whether the units can be operated for longer periods between the manufacturers warranty schedules. As units age running costs can escalate and the ability to track when a machine could fail is vital from an operational and health and safety standpoint.

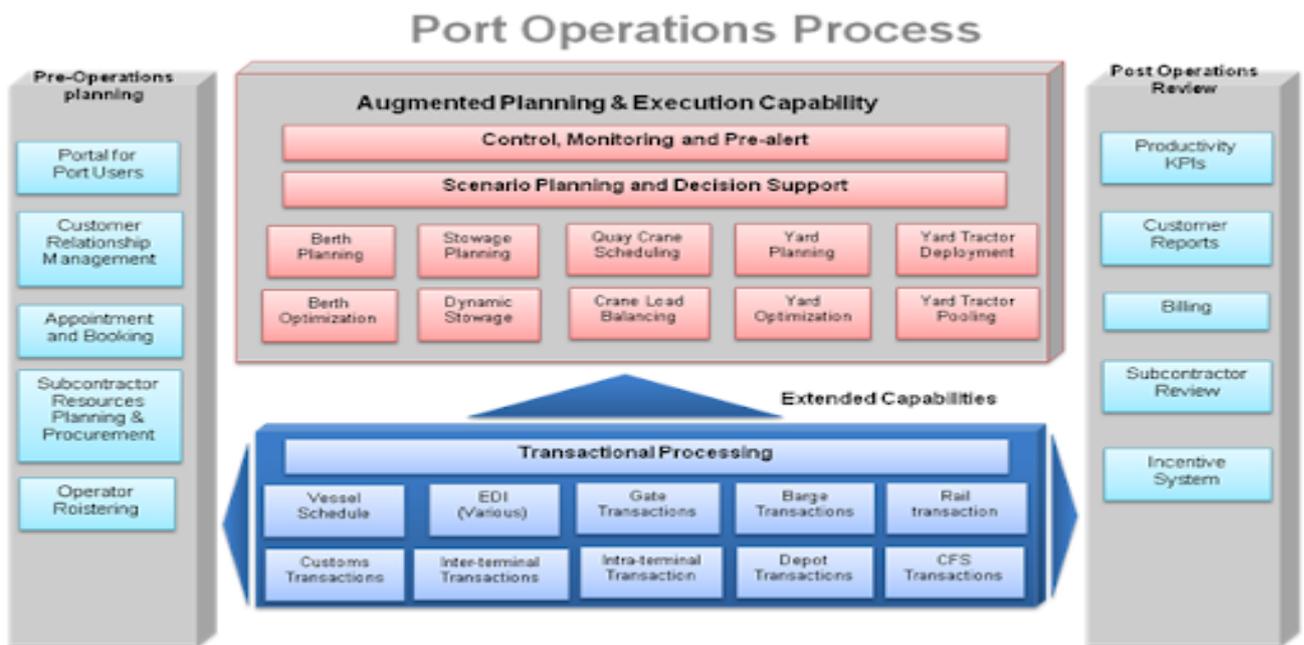


Linking Engineering back to the Terminal Operating Systems but more importantly to have the ability to process work orders on the Fly.

Terminals Operating Systems have dynamic capabilities – analysing their terminal processes in terms of the overall volume that will flow thru their facilities – they rely heavily on predictive planning from the following :-

- ✓ Containers / Units to be handled
- ✓ Number of Moves per Hour
- ✓ Crane Lifts per Hour
- ✓ Vessel Berthing Times
- ✓ Labour Workforce allocated to the Yard Work
- ✓ Number of Units / Equipment they have access to complete the work.

This is when engineering analytics and equipment management comes into play -the need to ensure that enough machinery is readily available to suffice the work orders, Engineering need to keep maintenance scheduling in line with the commitments that the Terminal Planners schedule. Preventive maintenance can certainly help reduce potential equipment failure during busy times and more terminal engineering divisions are taking this approach to preventive maintenance. Terminal Management must also assess the overall life expectancy of the units deployed.



So What Other Benefits can be Achieved thru Multi Terminal Equipment Monitoring.

I have already mentioned that the high capital costs for the equipment can be considerable and as most of the Global Terminal Groups spend billions of dollars annually across their Empire on Assets. So, arming the Engineering Teams with the most comprehensive information available will help them to better evaluate the various equipment being deployed.

Of course there are certain tech products on the market that look at monitoring and managing assets but these tend to be part of an overall larger ERP Solutions and tend to be more generalist in functionality and most require considerable system enhancements to address the needs of the terminals engineering team.

So lets look at how a bespoke developed Asset Management solution could deliver :-

Inventory Data (When Purchasing Equipment)

- ✓ Manufacturers details
- ✓ Equipment Selection (Type, Model, Serial Numbers etc)
- ✓ Purchase Price
- ✓ Delivery Dates
- ✓ Purchase Price
- ✓ Optional Equipment Selected
- ✓ Date entered Service

Operational Data

- ✓ Durability of the Equipment
- ✓ Maintenance Tracking (Scheduled, Preventive and Predicated Maintenance must all be tracked)
- ✓ Actual running hours between Services – tracking against Manufacturers Scheduled program.
- ✓ Warranty Claims – Factory recalls or actual in-service failures during the warranty period.
- ✓ Damage Incurred with the Machines either accidental or thru component or equipment failure.
- ✓ Tracking the amount of wear across all component parts.
- ✓ Tracking the level of Spares and Extra Ordinary items used to maintain the equipment / unit in peak performance.
- ✓ Indications on the overall climates the equipment is being operated in – from extreme heat, wet and monsoons to severe cold weather all these elements can be tracked to evaluate the actual performance of the equipment.

Cradle to Grave Tracking

- ✓ The Equipment / Units will encounter a lot of operational challenges and the actual running costs will vary significantly - as mentioned above the ability and need to tie running work orders into the TOS will certainly help to reduce these costs.
- ✓ Tracking the Overall costs from Date entered service to the time the Equipment is Sold or scrapped.
- ✓ Every Manufacturer will claim their equipment is the best, but most Engineers have only their knowledge and information they have gathered across the industry and of course any data that might reside in their engineering records. (This might vary with some terminals implementing automated tracking and others running manual reporting and recording data).
- ✓ By deploying a centralized Engineering Solution, the ability for Engineers to bring up there collective data that can be shared and compiled across multiple Manufacturers Equipment will really start to deliver tangible results.

- ✓ Shared data can also highlight common faults and issues on particular equipment / units and these helps to form a more focused decision on whether these manufacturers can actually meet and beat customer expectations.
- ✓ Shared Engineering and Maintenance data can also help resolve problems or create awareness to the Manufacturer of a major issue or continual failures that occur across the equipment.
- ✓ As volumes container volumes can increase machinery will be pushed harder and be run for longer periods to meet and keep up with Customers service level agreements. These will ultimately shorten the life expectancy of the equipment – so making the right decision on the best equipment to start is essential.
- ✓ Other factors including the after sales support, spare parts and manufacturers service levels should be kept and monitored – again this can vary significantly in different parts of the world and can make a big impact to ensuring that equipment is kept in service for as long as possible.

Big Data – The Benefits

- ✓ Decision Making on which Manufacturer can deliver the most reliable equipment. (These might not always be the cheapest, but the data will provide these statistics.)
- ✓ Group Purchasing Power – once information has been analysed – the Terminals Engineering, and Procurement teams can select the most appropriate equipment and have reliable data to support their decision. (With the larger terminal Groups higher levels of discounting could be negotiated to provide better overall pricing and cost savings.
- ✓ Machine Learning and the adoption of AI derived analytics will help to manage repetitive transactions or learn when things should be checked and vetted and will help to save engineers time and drive decision automatically – thus potentially reducing equipment downtime.
- ✓ Measuring Spares and Stock control is also vital – having the ability to monitor and record when equipment components might fail or will need to be readily available in stock when scheduled maintenance is due is essential. Machine learning and Predictive trends will monitor current stock and create orders for replacement spares.
- ✓ Measuring Manufacturers Performance Claims – being able to compare their data with actual front-line live data.
- ✓ The ability for Group / Corporate Engineering teams to better review the overall equipment running costs and budget more efficiently.
- ✓ Real time Data on Engineering issues allowing the collective team to understand and potential look at resolving issues – that might have been impacting equipment and causing more downtime.
- ✓ Overall Working performances – KPI monitoring – analysing job performances number of moves, lifts, distances travelled and working these back to a cost per move basis. (Thus, allowing for much better scrutiny on the unit / equipment cost and performances.

Embracing IOT and Data Analytics across your Terminal

So like many technology driven projects there will always been an associated cost for the development and ultimate deployment of the solution. IOT based active tracking systems have become quite cost effective and when matched back to the relevant Engineering Solution can be

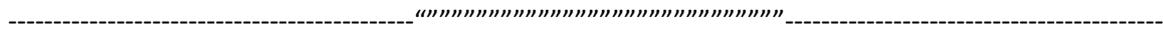
highly effective. Of course, the number of units that your facility operates will be the biggest deciding factor as to implementing a solution, with active tags most container terminal facilities already have RFID and Geo Fencing Solutions in place and much of the data will be transmitted via this Infrastructure. I have already highlighted the key drivers for such a solution to be deployed. When considering the capital investment, a terminal group makes on machinery and the tremendous pressure that is exerted on this equipment to ensure that vessels are turned faster and the units deployed will provide reliable service to the Terminal.

The work force and Yard activity planning aspects also comes into play as Terminal Operations are fluid and although the TOS can provide yard and vessel planning – they are not that flexible in nature and can only be compared after the event – having the ability to adjust work orders on the fly will play an essential component on how equipment and units are used and will ultimately help to increase the life of the units a terminal deploy.

Summary

Although I have focused on the Key elements on the technology and the benefits that a centralised solution could provide – I will prepare for those interested parties a more detailed drill down on the key functions that the system could deliver.

I welcome your comments and observations and would welcome the opportunity of engaging with your teams to explore these solutions in more detail.



About the Author – Richard Butcher has been involved in the Maritime Technology Markets for over 30 years. Having been engaged on multiple consulting assignments revolving around Smart Transportation Technology. Richard brings a wealth of knowledge and as an independent Adviser has delivered many tangible results to his diverse customer base. For More information or to reach me – please contact – rabconsultant66@gmail.com or call my UK Cellphone - +44(0) 750 3337188

