



INCREASING TERMINAL CAPACITY BY 10%

A CASE STUDY IN YARD TRANSFORMATION

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**HOW TO DO SUCCESSFUL
CONTAINER TERMINAL
TRANSFORMATION?**



This paper examines the way Tianjin Five Continents International Container Terminal Co. Ltd. (FICT) in China resolved the ‘mega-age’ yard challenge by modernizing and automating its existing manual RMGs. The case study explains the solution and improvements in KPIs achieved by improving the efficiency of yard operations.

As discussed in earlier papers written by ABB, we inhabit the ‘mega-age’ of megaships and consolidated shipping lines. It is an era which has forced the need to re-equip existing terminals and improve efficiency and productivity into the spotlight. To avoid becoming a bottleneck, the yard of today needs to be equipped with solutions that can support the required increase in capacity and

productivity while retaining cost-efficient service to both waterside and landside operations.

ABOUT FICT

FICT, which is part of Tianjin Port Container Terminal Co., Ltd., is located in the Port of Tianjin. With 500 international port calls per month and total yearly volumes of 16 million TEU, Tianjin is the tenth busiest container port in the world and the largest in Northern China. The port is also the main maritime gateway to Beijing and serves as a link between the Northeast Asia, Central Asia and the Middle East.

The terminal was built in 2003 and was originally designed for annual throughput of 1.5 million TEU, which has become insufficient in the mega-age. In 2018

the terminal’s actual volume clearly exceeded the design capacity and reached 2.57MTEU.

The terminal’s perpendicular yard is equipped with 31 RMGs which were originally manually operated. It has capacity to store containers corresponding 32,000 TEU. The RMGs at FICT are not typical cantilever type cranes. They are specifically designed for this terminal and have two vehicle lanes within the crane portal on one side. This means that both internal and external chassis are served in the same lane whereas the second lane is used to allow the chassis to pass the vehicles in the service lane. In addition, some of the cranes have a rope tower, while some have reeving that resembles a ship-to-shore (STS) crane.



**YARD TRANSFORMATION
AT FICT, TIANJIN, CHINA**



THE BOTTLENECK

FICT identified the need to increase the efficiency of the yard early on, with congestion resulting in long truck turnaround times and the yard filled up with containers stacked 5-6 high. Work during the night showed low efficiency and there was a huge imbalance in the workload between the cranes and therefore between crane drivers. The difficulty of recruiting crane drivers and increasing labor costs added to the problem, further restraining the growth in terminal volumes.

The arrival of mega ships, with a requirement to handle 7,000 containers in 30 hours, created frequent peaks in production and placed new demands on equipment performance requirements. In effect, the yard had become a bottleneck hampering the future development of the entire terminal; therefore, the yard equipment and processes needed a total make over to support larger container throughput in the terminal.

RE-EQUIPPING AND AUTOMATING THE YARD

In parallel with the capacity limit, after 15 years in operation the electrical systems installed in the cranes had reached the stage where refurbishment was

needed. These circumstances created an opportunity for the terminal to raise the performance of its yard operations to a new level at the same time as it upgraded its crane control systems. Thus, a decision was taken to automate the yard operations, with the target of increasing the yard's production capacity while also improving cost-efficiency.

In the modernization project that was executed by ABB, the old crane electrical and control systems were fully retrofitted. The new systems were fitted in new innovative, containerized e-houses that were delivered pre-assembled to the terminal to enable faster project execution on site.

Major part of the process on the yard was automated. Pick-up and set-down of containers on internal terminal chassis are now fully automatic, since there is no twistlock handling and the automation system is equipped with a truck supervision function that ensures that the vehicle is in the right position and does not move during the set-down of the container.

As noted, both external and internal chassis are served in the same lane in a single-side two-lane operation at FICT. Therefore, ABB's 3D sensor based anti-lift system is used to scan the vehicle as

part of the vehicle guidance process and verifies the vehicle type to eliminate safety risks caused by interference in RFID signals caused by vehicles passing by in the adjacent lane. As the cranes were automated, the operators also moved to a new control room from where each operator supervises six cranes. The interface between TOS and cranes was also upgraded to support the automated process and work order handling

Re-equipping 31 RMGs in the yard while keeping the terminal fully operational during the project was a key requirement and careful planning was necessary. A 40-stage reconstruction plan was created in collaboration between nine departments affected at FICT. A close collaboration was also established between ABB as crane control and automation system supplier and TOS supplier Navis. The planning resulted in a rolling weekly construction progress program that made sure that enough equipment remained in operation while a part of the crane fleet was under refurbishment and modernization.

CREATING A FLOW

The introduction of an automated process requires the creation of a flow – a pre-defined sequence of events with triggers

that initiate the next step in the flow. In the operation of a perpendicular yard the relevant triggers are the vehicle positions.

At FICT vehicles are monitored in real time using a RFID within the terminal's premises, with RFID antennas installed at the terminal gate, by the terminal's internal roads and on the yard cranes. The instructions and list of work orders issued by the TOS are processed through an equipment control system (ECS) that takes decisions on the sequence based on defined criteria such as time, priority or energy consumption.

The vehicles get instructions and drive to a specified block and bay close to the crane that will perform the pick-up or set down of the container. When a vehicle approaches the block, the ECS dispatches the work order to the crane based on information about the vehicle location. In the case of external trucks, the TOS schedules a work order based on the truck 'checking-in' at the terminal gate and on the location of the target block in the yard. Ideally, the crane is in the right position ready to perform the pick-up/landing when the vehicle arrives to minimize the waiting time.

The truck driver can verify that he has arrived at the right position from a screen attached to the crane which displays the registration plate. The crane also verifies that the vehicle to be handled matches with the work order with help of RFID. In case the vehicle does not arrive at the crane within the estimated time frame, the crane requests remote operator assistance.

RESULTS

The transformation project reached all of the targets set. Thanks to careful planning and collaboration, the terminal remained fully operational throughout the project's execution, and the whole project of modernizing 31 RMGs was completed in 13 months.

The KPIs show that automating the RMGs resolved the yard challenge. Yard congestion has disappeared as the entire crane fleet is now used more efficiently, with cranes consistently achieving 30 container moves per hour day and night. The equipment utilization ratio has increased by 35%. The higher and consistent production has also increased the speed of yard turnover, which in turn has resulted in fewer containers stored in the yard significantly reducing the need to stack 5-6 high.

The container handling capacity at the yard has already increased by over 20% and is expected to increase even further. The turnaround time for road chassis has gone down from 51 minutes to 18 minutes.

On the quay side the ship berthing time has reduced by nearly 20% and the STS cranes can now perform five more moves per hour than before. Measured at the terminal level, the yard transformation has increased the terminal's overall production capacity by 10%, which allows FICT to serve more vessels than before and provide more efficient and reliable service to its customers both on the water and landside.

It was also remarkable to see that the terminal's capacity increased already during the project execution itself. We can conclude that the transformation project was successful and delivered to the requirements and expectations of FICT. The FICT case also verifies that transforming an existing terminal and eliminating the bottleneck allows an existing terminal to increase its capacity and thus remain relevant in the 'mega-age'.

THE YARD TRANSFORMATION IN NUMBERS

- 10% increase in the terminal's production capacity
- 35% increase in equipment utilization
- 20% increase in container handling capacity at the yard
- Monthly average moves/hour at the yard: 30
- Number of moves/hour at the quay up by 5 moves
- Truck turnaround time down from 51 minutes to 18 minutes
- The yard was fully operational throughout the project
- The entire project was completed in 13 months.

TECHNICAL PAPER: TRANSFORMING TERMINALS IN THE MEGA-AGE

ABOUT THE AUTHORS

Björn Henriksson is the head ABB Ports Sweden. Prior to his current role, Björn was the Global Technology Manager at ABB Ports. He has extensive experience on container terminal automation and electrical systems through the various positions he has held over the years within R&D, engineering and commissioning, including several management positions. Henriksson joined ABB in 2001 via ABB's Executive Trainee program and has a Master of Science degree in Electrical Engineering from Royal Institute of

Lin Hong-Wei is the Vice General Manager of TCT (Tianjin Port Container Terminal). With over 15 years of experience on optimizing the production process in bulk and container cargo handling, including yard planning and management, he is one of the most experienced professionals in the field in China. He was also one of the key persons in the modernization and automation of FICT's RMGs.

Wang Hong-Liang is the Technical Director & Technology Engineering Branch Manager of TCT and possesses extensive experience in the maintenance of container handling equipment. He started his career at TCT for 20 years ago as a crane engineer and has since then held several positions in the company, including leading the company's technological innovations and equipment automation initiatives.

ABOUT THE ORGANIZATIONS

Tianjin Port Container Terminal CO., LTD (TPCT) manages and operates the three container terminals located in the port of Tianjin. Tianjin Port was built in 1980 and was the first port in China specialized in container handling. Over the past 10 years the container throughput of Tianjin Port has grown rapidly and today TPCT handles annually 7 million TEU. TPCT's total quay length is 3,540m and the container yard area totals in 1,160,000m². The container terminals operate altogether 13 deep-water berths and the terminals are equipped with 37 quay cranes, 68 RTGs and 31 ARMGs.

ABB Ports develops and delivers intelligent terminal automation solutions and services to make container terminals safer, greener and more productive. The solutions include automation and remote operation for all types of container handling cranes, and complete OCR and electrical systems. With the track-record of the largest installed base, ABB's systems help to optimise container handling from ship to gate in greenfield installations and in existing terminals.

ENQUIRIES

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