

# **Information Communication And Control Technologies In Transportation**

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**Abstract:** Transportation has evolved with the development of human culture. Researchers believe that the first means of transportation that is “fixed wheels on carts” was invented way back in 3500 BC!!! Since then transportation has developed tremendously and has now reached a stage where IT and automation play a major role in transportation.

We intend to take this automation to a higher level by proposing to have a completely automated container port for ships with only a few people required for monitoring purposes and if this is achieved, a lot of time and manpower could be saved thus optimizing the process.

**Keywords:** Automation, IT, Optimization of transportation

## **Introduction:**

Transportation is the commercial enterprise of moving goods and materials. Different modes of transportation are road, rail, air and sea. 90% of the world trade (by volume) is carried out by sea.

Control technology or Automation is the act of implementing the control of equipment with advanced technology; usually involving electronic hardware. "Automation replaces human workers by machines", thus saving time and improving the efficiency.

Transportation has reached a stage where it is impossible to operate without automation and Information Technology (IT). Currently, achieving automation is not possible without using Information Technology.

In our paper, we shall be focusing on the automation only in marine transportation which includes ports and ships; especially container terminals and container ships.

### **Automation presently used:**

A classic example of automation used in the marine industry is the **AGV (Automatic Guided Vehicle)**. An automated guided vehicle or automatic guided vehicle is a computer controlled, unmanned and electric powered vehicle capable of handling material. It is a mobile robot that follows markers or wires in the floor, or uses vision or lasers. AGV in some of the modern container terminals carries containers (by following a computer program) to and from the loading terminal (quay) to the place where the containers are stacked (stack yard) prior to loading on a ship. The main benefits are reduced labour costs and a more reliable performance.

The first AGV was built in the year 1953. It was used to pull a trailer and follow an overhead wire in a grocery warehouse. Initially they were most often used in industrial applications to move materials around a manufacturing facility or a warehouse. Application of the automatic guided vehicle has broadened during the late 20th century and they are now no longer restricted to industrial environments.

The shipping industry has not only focused on improving ship structure and the reliability of ship systems in order to reduce human error and increase efficiency and productivity, but also on the automation that goes into the shipping transportation procedures. Introduction of AGVs for the purpose of handling containers in a container terminal was a major step in this direction. These automatic guided vehicles were first introduced for the carriage of containers in the early 90s.

The ECT Delta Terminal in Rotterdam was the first container terminal in the world to be equipped with a complete fleet of AGVs.

Automated Guided Vehicles can hold 20', 40' and even up to 45' containers. Thanks to computer control, they fulfil their travel orders on-schedule, working almost silently at high speed with position accuracy of within +/- 3 degrees. They can travel in forward, reverse and even sideways direction. They can even overtake each other. Even refuelling takes place automatically. They are controlled and supplied with data and orders by computer software, and so-called transponders, i.e. electro-magnetic route markers embedded into the ground of the terminal.

**AGVs are available with two drive options: Diesel-Hydraulic and Diesel-Electric.**

**Initially the former was used for many years. The diesel electric drive was introduced in the new AGVs in the year 2005.** The diesel-electric drive has all the technical features that already characterise the diesel-hydraulic AGV. The benefits of the electric drive being: a greater degree of efficiency, greater availability and cost-effectiveness, improved environmental friendliness.

The new AGVs are equipped with fuel-saving diesel-electric drives, and comply with the European EuroMot IIIB exhaust gas standard that has been in force since 2011.

Consistently continuing to develop the drive technology used in the transport systems for horizontal container transport, contribution is made towards optimising automated maritime ports.

The future-orientated drive concepts of the AGVs contribute sustainably to reductions in harmful emissions and support in the progress towards the green port.

The latest development in this sector is the fully automated battery powered AGV.

The first fleet of fully-automated battery-powered Automated Guided Vehicles (Battery AGVs) was put into regular service at HHLA Container Terminal Altenwerder (CTA) in Hamburg, Germany in 2011.

New AGVs emit zero CO<sub>2</sub> and require 50% less energy than previous models.

This new model of AGV is completely carbon neutral. The AGVs are powered by batteries, which are automatically changed at a charging station on the terminal apron. The changing station is capable of swapping used batteries with fully charged ones in just five minutes. Recharging each battery takes around six hours. The battery technology is also fully recyclable.

The lifespan of the batteries is measured in full cycles, so the acid batteries, which we have been implemented in the AGVs, have a cycle time of 1200 cycles so you can charge the batteries 1200 times, fully loaded. The battery AGVs] are in operation at Hamburg are currently operating approximately 6000 hours per year and running for 24 hours a day. Calculations have been made that approximately you can run with one battery in that range for 2 to 2.5 years. After that you have to change the battery again.

Worldwide container traffic is growing: tonnage, vessels and cargo-handling volumes are increasing. This means that terminal operators face major logistical challenges: boosting the productivity of their terminals while expanding existing terminal infrastructures and building new ones. Environmental issues are also gaining in importance. Not only should the equipment achieve a high level of performance, it must also be environmentally friendly.

This thought in mind gave rise to a new aspect of automation in the container terminals: the **Automatic Stacking Crane (ASC)**. The containers in the stack yard need to be densely stacked but logistically arranged; access time must be short and performance optimised. ASCs perform fully-automated housekeeping and management of container stacks.

Automatic stacking cranes (ASC) are rail mounted cranes used for yard stacking and in-stack transportation of containers in the storage area. ASCs deposit and pick up containers from dedicated transfer areas at both ends of the stack. Stacks are located usually perpendicular to the quayside in order to minimise the travelling distances of feeding equipment.

By introducing automation, it is possible to reduce overall operating costs and increase the utilisation rate of equipment. ASC systems are gaining popularity as they offer high stacking density with low labour usage.

An automatic stacking crane (ASC) operation has proven to be cost-effective when total life cycle costs are considered. Storage capacity is very high resulting in effective land usage. Up to 10-wide container stacks can be maintained with little space between the container slots and stacks since no truck or straddle carrier lanes are needed. Housekeeping can be done effectively during off peak hours maximising throughput at peak hours. ASC systems are operated nearly unmanned. However, supervising personnel is required to remotely monitor the operational process. The systems enable constant quality independent of external factors such as visibility or weather, and the process itself limits the possibility of human errors.

ASCs produce very little noise and low emissions per a handled container as the cranes themselves do not emit exhaust or evaporative emissions. ASCs are electrically powered with AC drives requiring minimum maintenance. With modern drive systems, regenerated power can be fed back to the power net further lowering energy consumption.

ASC systems minimise usage of diesel powered equipment to be used for additional stacking as they take care of the in-stack transportation of the containers within the terminal. With efficient housekeeping in the stacks, the waiting time of road trucks can be optimised, resulting all together in both low particle and noise emissions.

**Automation control system:** The terminal operating system (TOS) is used to manage the machines and the location of containers in the yard. The central ASC control system executes the commands received from TOS, taking into consideration factors such as optimal speed, route and collision avoidance. Accurate automated crane movements are achieved with measuring systems and sensors. The central ASC control system is monitored by control room personnel.

Control stations are used to supervise and control the system as well as handle the remote control systems used for example loading and unloading road trucks. The automated block areas and the manually operated areas of the terminal are usually physically separated to meet safety requirements and protect those working in the yard. Access to the automated area by service personnel and vehicles is controlled by a separate safety system.

A diagnostics system is used for recognizing, notifying and displaying errors and failures. It is applied to each individual crane, the automation subsystems and the central ASC control system.

Typical characteristics of ASCs are:

- Rail span. . . . .6-10 containers wide
- Stacking height. . . . .1-over-5 containers
- Hoisting speed. . . . . 45-90 m/min
- Trolley speed. . . . . 60 m/min
- Gantry speed. . . . . 180-270 m/min

Together with the AGVs, the ASCs form fully-automated, integrated system solutions – from the quayside to the stack yard. Or they replace conventional stacking cranes and straddle carriers or work on the quayside in conjunction with existing fleets of straddle carriers.

The benefits of ASC technology:

Maximum utilization of space and stacking density thanks to:

- i) Twin ASCs on a single pair of rails
- ii) 1-over-5 solution for high-cube containers

Accurate positioning even at high winds of up to force 10 Beaufort ascribable to:

- i) rigidity in all three axes, which is a result of the
- ii) fixed-leg concept and rigid guiding beam

Innovative systems including:

- i) management
- ii) anti-collision and
- iii) Innovative brake system

The entire operation in the container terminal can be summarized as follows:

Containers are unloaded/ loaded from the vessel by means of a ship-to-shore crane (STS). These are gantry cranes. These are operated by a driver located in a cabin on the trolley about 50m above the quay.

The container is loaded on an AGV (automatic guided vehicle) which takes the container to a storage area. This area is divided into blocks, each covered by automatic stacking cranes (ASC).

The container is picked up by one of these and moved to the desired position in the block – this operation is performed fully automatically. The location of the container in the

storage area is chosen by the Terminal Operating System (TOS) – an advanced process control system from which the ARMGs receive their work-orders.

Containers to be forwarded by land are loaded onto road trucks or onto internal trucks for transport to a railway loading point inside the terminal area.

Hence it can be seen that almost the entire operation is automated; but not completely.

### **Our Proposal:**

We intend to carry this process of automation further for loading/ unloading of containers on ships from the shore.

We intend to propose an idea which involves computerization of the complete loading/unloading procedures of containers in a port and link it up with the AGVs and the ASCs. This would provide a complete automated container terminal!

The container loading/unloading plan is made ashore with the help of software. But the execution is done manually by the gantry crane operator which may involve human error.

We feel complete automation can be achieved by implementing the following steps:

An electronic device could be installed in the gantry crane which can receive digital instructions.

An interface could be created between this device and the cargo planning software.

This device will then receive instructions from the control system (in which the cargo plan is made) and will execute the instructions automatically without the requirement of a gantry crane operator. The instructions received will be such as which container is to be loaded/ unloaded, the position of these containers on the ship (bay number, row and height), etc.

The device would receive the commands from the control system in the form of wireless communication.

This automation of the gantry cranes would eliminate the concerns of human fatigue and mental stress of the crane operator. Also, it would provide for high level of synchronization in the loading/unloading operation.

Thus we propose to have a port which is equipped with such highly automatic gantry cranes which require only a hand few of people for monitoring purposes which can be

done from a separate control room in lieu of being present at the actual site of cargo operation.

If such complete automation is achieved, the advantages will be:

- Reduction in time of operation
- Reduction in manpower
- Human errors will get eliminated as there will be no requirement of crane operator
- Increase in efficiency of the entire operation and thus increase in profit

Thus if this transportation technology is implemented it will help us in optimizing the port operations in a container terminal.

Our innovation explores the opportunities under the subtheme of this seminar – “Information Communication and Control Technologies in Transportation” as well as the main theme – **“Transportation Technologies- Optimization and Challenges”**

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