OCR in Ports and Terminals

A PEMA Information Paper

This Information Paper is intended to provide a high level overview of the use of Optical Character Recognition (OCR) in the ports and terminal sectors of the global container supply chain.

The document describes how OCR technology functions and discusses its applications in container port and terminal operations. Past, current and future adoption trends are reviewed, together with benefits and ROI scenarios for OCR.

The document concludes with statistical data on global adoption of OCR in the port and terminal markets.

PEMA
PORT EQUIPMENT MANUFACTURERS ASSOCIATION

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First published January 2013
This document is designated IP4 in the PEMA series of Information Papers

INTRODUCTION

DOCUMENT PURPOSE

This Information Paper from the Port Equipmnent Manufacturers Association (PEMA) is intended to provide an overview of optical character recognition (OCR) solutions and their applications for the global supply chain; specifically maritime port authorities, marine and intermodal container terminal operations, and other operational logistics nodes where cargo containers are handled.

The document describes the makeup of OCR systems as well as what benefits OCR adoption can provide as part of a larger process automation strategy.

DEFINITIONS AND TERMINOLOGY

Like any industry, some understanding of the language of OCR is required. There is a broad set of terminology used to describe technologies, applications and processes in relation to the ports sector of the extended container supply chain and for OCR itself. A lexicon is provided in Appendix 1.

The 'port' designation used throughout this paper is a simplified one, as the extent of the market transcends maritime areas to include operational locations of the extended container supply chain such as inland and river terminals, container depots, intermodal rail/train operations, warehousing and logistics centres.

For the purposes of this document, 'ports' include port authorities, port communities, shippers and beneficial cargo owners (BCOs), railroad operators, marine terminal operators (MTOs) and inland terminal operators (ITOs).

ABOUT THIS DOCUMENT

This document is one of a series of Information Papers developed by the Technology Committee (TC) of the Port Equipment Manufacturers Association (PEMA).

The series is designed to inform those involved in port and terminal operations about the design and application of software, hardware, systems and other advanced technologies to help increase operational efficiency, improve safety and security, and drive environmental conservancy.

This document does not constitute professional advice, nor is it an exhaustive summary of the information available on the subject matter to which it refers.

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OCR-based automated terminal gates

1 | EXECUTIVE SUMMARY

Optical character recognition, or OCR, is an automated identification and data collection (AIDC) technology. From document scanners and home use printers, to airport security and toll road collection systems, OCR has now become an integral part of our daily lives.

Just as OCR is used by consumers to automate document scanning and data extraction at home, container terminal operators are leveraging OCR to automate the identification of equipment and its key features as it is handled at points of work within a facility.

The basic concept of OCR is simple. An object to be identified, here a series of numbers or a unique pattern of visually distinct elements on a cargo container, is 'captured' electronically - much like a person uses a digital camera to capture a picture. This is the imaging or image capture process common to all applications of OCR. It is a passive process which requires visibility from some imaging device to the target.

Next, in a secondary process, specialised software interrogates the bits and bytes of the captured digital image to locate and extract pre-determined patterns within. When completed, the recognised patterns are assembled and an attempt is made to uniquely identify the object or objects within the image.

OCR is widely used for the identification of equipment markings (i.e. the written text of truck license plates, container number stencils, etc) and also to record the condition of the equipment itself. The key benefit of OCR is that it provides a reliable method of identification, without requiring application of any tag or device to the asset, that also includes a visual record of the asset at the time of reading.

What started as a market focused on the use of OCR for security purposes (e.g. identification of license plates at a port entry/exit gate) has since evolved to one of highly specialised process automation functions that touch each operational area within a port or terminal operation, including:

Asset visibility: identification and tracking of assets such as trucks, containers and trains within a port or across multiple supply chain nodes.

Operational control: providing real-time visibility of an asset and its location to enable process automation and control.

Safety: ensuring the safety of personnel and equipment, typically within a facility environment.

Security: providing manless access control at perimeters and validation of asset ID to eliminate the human element so common in theft, pilferage and other criminal activities.

Today, OCR system installations total over 1700 worldwide with the overall OCR turnover in ports comprising an estimated $50m per year. The largest segment of this is within port community and marine container terminals for automating gate, vessel and yard operations.

The application of OCR technology has so far been leveraged to deliver benefits including labour productivity, safety and security and increased asset and port utilisation. A key additional driver of growth in the port community and marine terminal market today is environmental sustainability.

Ports and marine terminals are highly visible and often located in or close to large populous areas. Their impact on the health of the surrounding communities and contribution to greenhouse gas (GHG) emissions have come under increased public scrutiny in recent years, particularly with regard to emissions from over-the-road diesel trucks, but also for internal vehicles and container handling equipment.

As all members of the global container supply chain seek to respond to these challenges, OCR has become an integral part of process automation initiatives proven to deliver emission reductions by reducing vehicle congestion and increasing throughput velocity.

2 | BACKGROUND

2.1 WHY OCR?

OCR is one of many AIDC technologies now available for asset identification and process automation in ports and terminals. Other technologies such as RFID (radio frequency identification technology), DGPS (digital global positioning system) and optics (laser scanners for barcode reading) are also proven and provide similar identification and tracking functions. So why is OCR important and why is it especially suitable in the ports/supply chain sectors?

OCR is unique in that it enables not only the automated 'hands free' identification and locating of assets, but also the recording of an object's visual condition at that time. Another key benefit is that OCR provides a device-less method of identification, without requiring the application of any tag or device to the asset.

In short, OCR solutions provide visibility not only to equipment presence at key points of work, but also the condition of that equipment at the time of handling. And, should the automatic recognition of the object fail - which occurs in 3-5% of all attempts due to damaged numbering - a visual record (digital image) of the equipment ID is available for exception management and data correction.

Expansion of OCR solutions within ports and terminals has been driven by several key factors:

2.1.1 GROWTH IN AUTOMATION

OCR provides port and terminal operations with an efficient, hands-free means of asset identification, tracking and control. As more container terminal operators recognise the need for improved asset visibility and control, especially within automated container handling processes, OCR is often one of the lowest cost means of helping achieve these goals.

For instance, with OCR solutions deployed at the terminal perimeter, equipment is quickly identified automatically with a far reduced error rate versus manual recording. This equates to higher productivity from the reduced rates of mis-identified containers that make their way into the container yard.

2.1.2 ADVANCES IN TECHNOLOGY

The adoption of OCR has been largely due to the increase in computing power, the reduction of costs, the increase in features and functions and the reliability of the systems themselves. Taken altogether this is enabling more justifiable, widespread deployment of OCR systems that operate reliably and quickly enough to support live operations without delay.

2.1.3 EXPANDED USE OF TERMINAL OPERATING SYSTEMS

At their core, OCR solutions deliver visibility – namely to assets like containers and trucks moving within a facility. Using the human body as a metaphor, OCR systems act as eyes. How to act on the visibility information, and how to act strategically so as to impact the productivity and efficiency of an operation, lies generally with the terminal operating system (TOS).

The TOS acts as the brain of the operation, storing data but also business logic so that many formerly manual decisions can be executed automatically (e.g. where to route empty containers, how many loaded containers can be stowed to a specific area of a ship, etc). With the expansion of technology, aligned with the rise of containerisation, TOS solutions have now become standard for most terminal operations around the world.

2.1.4 EXPANDED DATA COMMUNICATIONS, CONNECTIVITY AND CAPACITY

All of these issues are underpinned by the ease of distributed data capture and processing through the use of advanced communications infrastructure such as wireless LANs, virtual private networks (VPNs) and the Internet. These advances bring the real-time capture of asset data and transmission to a point previously unachievable.

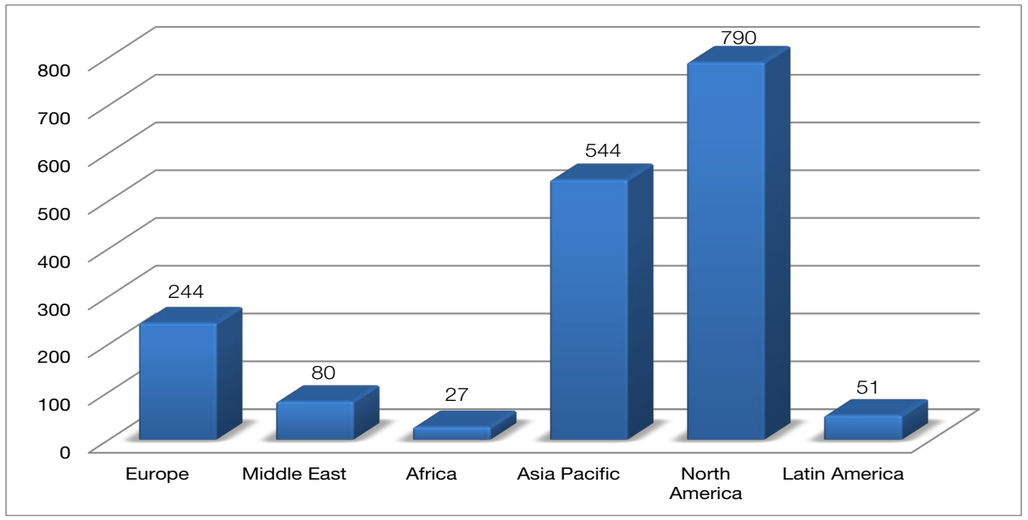
2.2 HISTORY OF OCR IN PORTS

The application of OCR in ports began in Asia in 1998 with the deployment of the first test systems for Shanghai United Asia Container Depot. As computing power increased and system accuracy and automation rates improved, adoption rates slowly increased as well in Asia, Europe and the USA. By 2005, nearly forty facilities around the world had deployed OCR systems into their live operating environments.

2.3 CURRENT MARKET

The current market is vibrant and has been steadily growing, even somewhat in spite of recent economic downturns. Most of the large scale deployments remain concentrated in the marine container terminal and port community areas, focused on applications for gate automation. New opportunities for OCR at a traditional container terminal include vessel and yard operations where equipment is identified at key points of work such as with quayside ship-to-shore (STS) cranes, as well as at handoff points to gantry cranes operating in the container yard and train areas.

Graph 1: 2011 reported OCR installations by region



Source: PEMA original research

2011 OCR adoption surveys cite 1736 installations at port and intermodal facilities, with the highest concentrations in North America and Europe. A breakdown of those installations is included on p7.

2.4 LOOKING AHEAD

Several trends are emerging that signal even further expansion of the technology within ports and terminals.

2.4.1 TERMINAL AUTOMATION

The mission critical nature of robotic, unmanned container yards demands 100% accuracy of container identification before entry into an unmanned area of the facility. Moreover, these same automated facilities require additional features from OCR solution providers such as container door direction, security seal detection, and IMO/hazardous placard identification.

2.4.2 HEIGHTENED SECURITY

The.automated visibility provided by OCR systems is being leveraged not only for operational benefits, but also to increase security. OCR systems are commonly combined with radiation scanning systems deployed at major seaports around the world since they help provide real-time notification of equipment ID in the case of a positive scan for suspect cargo. Given that collusion between an insider and those looking to steal or breach a container is often involved in stolen goods cases, the presence of OCR has been known to both reduce the number of theft of pilferage attempts. From a historical perspective, OCR systems can also enable the confirmation of exactly which containers left a facility, when, and under whose control.

2.4.3 DAMAGE INSPECTION

Damaged cargo results in an estimated US$1 billion annually in losses either from insurance carriers or the companies responsible for moving goods within the supply chain. The visual nature of OCR solutions enable high resolution images of the container condition to be captured when the equipment moves at key points of the shipment. These images can be archived for later review, or in some cases, inspected in real time and hopefully before the cargo is further damaged.

2.4.4 EMISSIONS REGULATION

The environmental stewardship of shipping lines and the terminals that they call at has fast become a critical issue as environmentally-conscious shippers demand improvement from what has historically been a highly polluting industry. As recent studies have confirmed, OCR systems have a directly correlation on lower carbon emissions since they naturally speed the physical interaction and processing of containerised cargo at key points of work.

OCR damage inspection images

3 | TECHNOLOGY

3.1 OCR TECHNOLOGY

OCR systems are generally comprised of five basic but integrated elements:

- Presence detection and triggering
- Image capture
- OCR software algorithms for pattern recognition
- Exception management software applications
- Electronic data integration and communication with other systems

3.1.1 PRESENCE DETECTION

OCR systems typically do not 'activate' until told to do so. This signal or trigger informs the system that equipment is occupying an area and image capture needs to begin immediately.

Sensors on gate and rail may involve one or more types of presence detection sensors, such as induction loops to detect the magnetic presence of equipment overhead, radar, infrared or laser sensors.

Crane-based OCR systems, like those on STS or container yard cranes, are typically mobile and therefore need an alternate means of triggering based on other operational indicators as the equipment moves. In this case, OCR systems rely on integration with an on-board programmable logic controller (PLC) as a means of triggering.

OCR camera on quay crane sill beam

3.1.2 IMAGE CAPTURE

Once an OCR system detects certain conditions (e.g. a container within a gate lane), connected cameras are then instructed to begin recording images of the event. For a gate system, this may involve several cameras arranged to capture various fields of view of the equipment (e.g., front, back, sides, top of a container). Cameras used for OCR are typically one of two types: area scan or line scan.

Area scan cameras record multiple images of a view or 'area' per second and are not entirely unlike the more advanced digital cameras commercially available to consumers today. This approach allows OCR systems to be installed in any lane or on a crane, while still enabling high resolution images to be captured of the equipment.

Line scan cameras, sometimes used on gate or train systems, capture contiguous images of the sides

OCR line scane camera image

or top of the equipment, scanning it throughout its travel across the camera's field of view. The line scan approach can capture a more vivid image, but requires more intense lighting and electricity and a larger investment in infrastructure and space. Equipment must also remain at a constant speed as it passes by the camera.

3.1.3 OCR SOFTWARE ALGORITHMS

Following system triggering and image capture, OCR systems then interrogate the bits and bytes of the collected digital images in search of data. Data, whether alpha numeric or otherwise, is derived from the processing of images via specialised OCR algorithms in search of patterns. Once a known pattern is detected (e.g., the number five) its location and relation to other larger patterns continues throughout the entire image.

For example, the most common algorithm is one to identify cargo containers relative to the established international standard for markings, applied to most visible sides of the equipment. In this method, containers are identified as specified in the International Organization for Standards (ISO) Standard 6346: 1995, Freight Containers – Coding, Identification, and Marking. The basic nomenclature of this standard is as follows:

Owner's code: This consists of three capital letters that are unique. e.g., CCL. The owners' codes will be based on official registered codes, and additional codes that are known to exist.

Equipment category: Capital letter identifying the type of container, as follows:

- U for all freight containers
- J for detachable freight container-related equipment
- Z for trailers and chassis

Serial number: Six numerals (e.g., 123456).

Check digit: A digit that provides a means for validating the accuracy of the owner code and serial number. The check digit follows the ISO standard rules and algorithm.

Container size/type code: OCR algorithms also exist to extract container dimensions from size and type codes found adjacent to the equipment initial and number. OCR of these codes will be conducted via a separate process, but using the same images captured for container OCR.

3.1.3.1 Other OCR applications

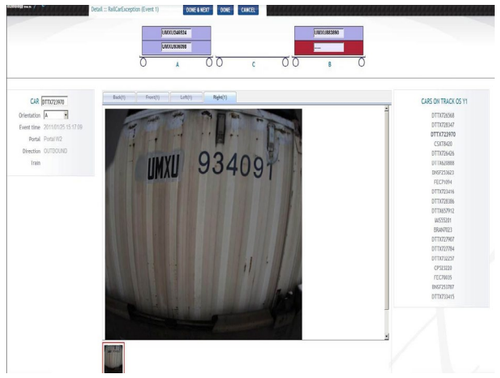
A host of other algorithms exist, or are under development, for port and terminal operations such as:

- License plate recognition
- IMO/hazardous placard detection
- Container door direction
- Damage detection

3.1.4 EXCEPTION MANAGEMENT

No process automation system operates at 100% accuracy and for this reason, exception management systems are used to capture these events in process and ensure that all data that cannot be extracted

Intermodal rail OCR



OCR exception management visual

automatically can be visually verified and corrected for further processing.

3.1.5 DATA INTEGRATION

The end product, or data, from OCR systems is generally filtered, aggregated and formatted before presentation to a host system. In addition, the various reader devices must be monitored and managed. Finally, physical device information must be translated into a format that can be quickly transmitted in a message and understood by a host system. When implementing OCR, most suppliers will offer some form of middleware or SDK (software development kit) to enable the systems to electronically 'talk' to and manage their systems.

OCR networks are routinely integrated with TOS and other host applications such as gate operating systems (GOS), security systems, driver registration databases, etc. OCR solutions typically provide only visibility to equipment and its condition, and not the business logic or rule to be taken thereafter. A closely integrated electronic messaging interface is therefore needed with the TOS to enable the OCR data to be leveraged quickly so that analysis, command and control actions can be taken thereafter.

3.1.5.1 Data integration with other devices

Many allied data collection and automation used in the ports market can also be integrated with OCR:

- Gate operating systems (GOS) / automated gate systems (AGS)
- Weigh scale systems on cranes and at truck gates
- Equipment tracking or position detection systems (PDS)
- Radio frequency identification (RFID) systems
- Driver registration, security and access control systems

3.2 APPLICATIONS

The application of OCR in the ports market falls into four core areas:

Network asset visibility: These applications support the identification and tracking of assets typically

associated with multiple operations or nodes in a widespread network. Shipping lines, global terminal operators and large shippers are typical recipients of these data.

Operational control: These are applications intended to improve the productivity and efficiency of operations at a single contiguous facility. This is the most common application for OCR to date as it provides the highest ROI for the end customer. OCR systems, commonly deployed in conjunction with a GOS and/or TOS component, enable operators to automate manual work tasks at the facility. This automation leads to higher productivity and increased safety as personnel can be relocated away from dangerous positions in the facility. OCR applications such as this are found in each operational area of a facility - gate, vessel, rail and yard.

Safety: These applications use OCR to ensure the safety of people as well as hard assets. This is fast becoming a hotspot in terminal operations as terminal worker safety is increasing in importance. Operators that can enable a function to be completed remotely, versus on the ground in the terminal, typically benefit from far lower accident rates than manually intensive operations.

Security: Security applications use OCR to secure an asset or uniquely identify an individual. Here, OCR is

generally deployed in conjunction with other security technologies such as biometrics for port workers or radiation scanning technology, as used in the US Megaports projects at over 30 terminals worldwide. In these applications, OCR is used to provide visibility to the equipment in conjunction with other security data, adding context to the solution and higher value in knowing which container is associated.

3.2.1 NETWORK ASSET VISIBILITY

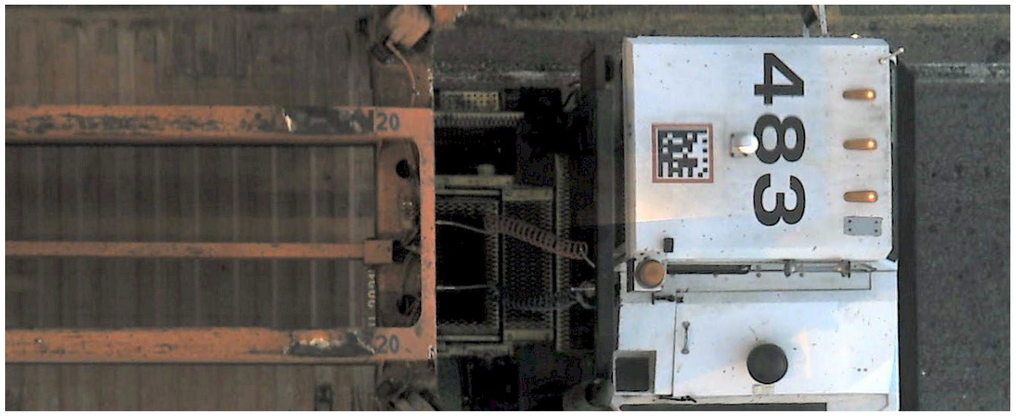
Within the global supply chain, efficient asset visibility equals higher profit margins and enhanced security for the enterprise. Global terminal operators, port authorities, shipping lines and railroads manage multiple asset and equipment types across a network of multiple nodes – including terminals, depots, distribution centres, storage yards etc. For these users, visibility and associated control of their valuable transport assets are paramount. These applications, either at a single port authority or across a global terminal or shipping network, are designated as network asset visibility (NAV) solutions. Examples of NAV applications include:

Containers: These are applications where the container itself is tracked after OCR identifies the unit initial and number at key points of work (truck gate, vessel, etc). With over 50 million ISO containers in operation today, OCR is the most commonly used technology to provide this function since it requires no device to be applied to the containers themselves.

Over the road trucks: Over the road (OTR) truck ID involves the unique identification and registration of street trucks so that they can be identified automatically upon entry into the port.

Visibility data from street trucks can be used to:

- Improve automated gate systems for seamless processing of trucks and their container loads, including checks for haulage company compliance/permissions
- Track the queue and/or turn time for operator accountability
- Automate truck handoff within the facility either at yard, rail or vessel cranes



2-D optical OCR tag on top of tractor cab

3.2.2 OPERATIONAL CONTROL

A key element of port and terminal operations is the ability to increase productivity and/or avoid additional labour costs. OCR applications are increasingly used to improve operational visibility and automate various processes. In the container terminal market, these processes are further segregated by location: gate, yard, quay and rail.

Gate operations: In gate operations, the OCR of the truck is first associated with a container, then processed through the gate area. This is an increasingly significant application of OCR as it increases the throughput capacity of a given facility, enabling it to process more trucks per lane/hour with minimal interaction required to identify the equipment as it enters and exits a facility.

OCR has been, and continues to be, the preferred technology for the container and optionally the chassis. It also serves as a low cost alternative to RFID for identification of trucks and other assets. Unlike RFID systems, where devices must be applied to equipment and readers installed, the use of OCR leverages existing labels or identifiers already on the equipment. For example, standard stenciling provides visibility to chassis assets within an AGS and also supports additional applications:

- Enabling accountability of chassis leasing by linking the chassis to a particular haulage company at gate check-out
- Helping to track chassis pool availability based on check-in at a yard
- Optimising utilisation and deployment of pool or shipping line owned chassis

Additionally, OCR can be used to identify and track the movement of reefer container gensets and personal vehicles through terminal gates.

Yard operations: Use of OCR in yard operations focuses mainly on container transitions or handoffs with container handling equipment (CHEs) in the yard. CHEs include terminal tractors, straddles, RTGs, RMGs, fork lift trucks, top loaders, side picks, and reach stackers.

In this application, OCR uniquely identifies the container and/or truck waiting for service at the CHE. The CHE operator is then presented with the next work instruction to be carried out, such as which container to select from a stack, based on known 'pending transactions' authorized from prior events at the terminal perimeters (gate, quay crane).

OCR ID of trucks and internal terminal vehicles (ITVs) also allows automated job stepping by 'knowing' the precise location of a truck and automatically reporting this to the TOS, which will then 'step' the job without human intervention. This minimises labour friction and optimises driver productivity.

Quay operations: Typically in quay operations, a deck clerk will manually input container ID and CHE ID (either an internal transfer vehicle (ITV) or straddle/shuttle carrier) as containers are moved to and from STS cranes.

Replacing this manual process with OCR allows containers and CHEs to be automatically identified and matched under the quay crane. This improves worker safety by removing staff from under the cranes and also enables subsequent transitions will also then be automated.

Rail operations: As the integrated supply chain extends further into the hinterland, trains are fast becoming the optimum method of transport. Costs to transport goods over even short distances now favour intermodal transport over road trucks. Add to this the environmental and congestion aspects of traditional road truck haulage and its easy to see why so much more containerised cargo is moving via rail.

Although early in the adoption cycle, process automation and OCR applications for rail operations are proving tremendously valuable for both major freight railroads and intermodal terminal operators alike.

OCR systems, namely OCR portals installed at the perimeter of a facility, have been used to automate the identification of containers and the rail wagons that carry them since 2007 both in the US and Europe.

As with truck gates, this is an increasingly significant application of OCR technology as it automates the train inventory process and increases the speed at which the trains can be serviced, enabling the facility to process more containers per lane/hour without the need to deploy clerical staff to the dangerous train yard.

The end result is a 100% accurate picture of the entire contents of a train noting wagon ID, container IDs and their exact location.

3.2.3 SAFETY

The application of OCR for safety purposes addresses several areas:

Relocation of dangerous work: Container terminal operations and their handling of cargo containers of up to 40 tons are, by default, dangerous in nature. OCR solutions that help automate manual processes at the key points of work have been proven to reduce the risk of accidents by relocating the worker from the area and allowing them to confirm and review the events from a safe, remote location.

Hazardous control: Classification of hazardous materials within a cargo container is another key safety concern, especially when so many containers travel in close confines aboard a ship.

OCR solutions are available to help automatically detect not only the presence of hazardous markings (applied to the exterior of a container) but also to classify the contents relative to an IMO standard.

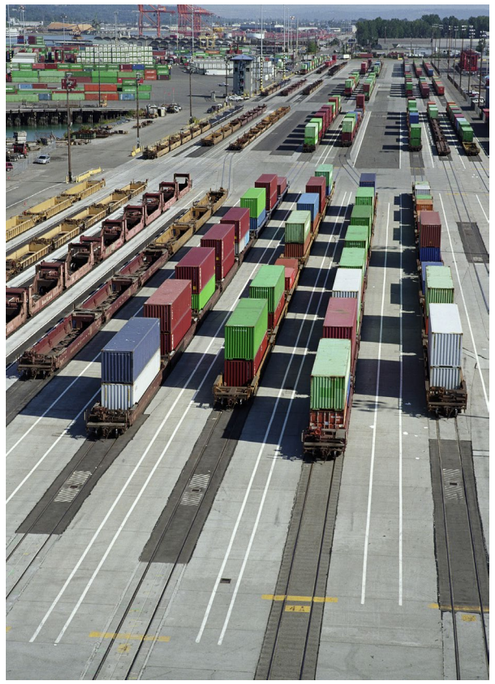
3.3.4 SECURITY

The use of OCR for security purposes includes:

Supply chain security: The illicit movement of nuclear materials through the supply chain is a tremendous security challenge. The use of OCR to provide manless validation of equipment ID, for instance during the entry or exit gate process, ensures that any radioactive materials detected by other systems can be associated quickly to a specific container and that visual proof of the event is recorded in real-time.

Equipment/asset theft: The use of OCR to provide a manless validation of equipment ID, for instance during the entry or exit gate process, ensures that collusion between willing employees and external personnel cannot occur without warning and visual proof of the event.

Cargo tampering and pilferage: The ability of OCR systems to deliver high resolution images of equipment enables the detection of container security seals, locked doors, holes, etc.



3 | THE MARKET

3.1 MARKET SEGMENTS

The port OCR market is broadly defined as that where OCR technologies can be applied to port-related environments, including.

3.1.1 MARINE TERMINAL OPERATORS

These are facilities which load/unload and process ISO containers from/to container ships. They range from simple mobile crane operations to fully automated terminals. There are over 1400 container terminals globally.

3.1.2 INTERMODAL TERMINAL OPERATORS

These are terminals associated with rail-based container transport networks. In the USA, there are six major rail carriers managing container transport. Globally, rail networks are typically state owned, but intermodal rail services and terminals are increasingly provided by private operators.

3.1.3 NEAR PORT AND CONTAINER LOGISTICS

This type of facility includes container storage and consolidation locations located near a marine container terminal and possibly even within a port cluster area itself. These terminals provide additional space for empty container storage, warehousing activities where containers are unloaded and consolidated for further movement within the supply chain.

3.1.4 RORO FACILITIES

Marine terminals where equipment is physically driven on and off a vessel (Roll on, Roll Off) require idenfification.

3.1.5 CHASSIS POOLS

In North America, the management of chassis has been increasingly given over to chassis pool managers which do not own the equipment, but oversee the storage and handling of empty chassis. This relieves the shipping lines from managing and maintaining their chassis.

3.2 MARKET SIZE AND GROWTH

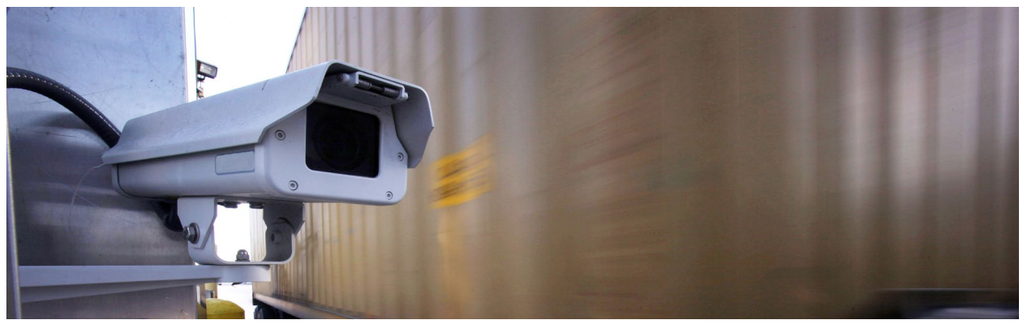
3.2.1 MARKET SIZE

In 2011 PEMA commissioned an independent survey of container OCR installations around the globe and within the extended supply chain. The objective of the survey was to determine overall market size globally, noting specific delineations by geographic region and by port/city, as well as by the type of system deployed.

The survey included both PEMA and non-PEMA supplier questionnaires which were validated with port operator references and publically available data. Results of the survey are shown in Appendix 2, indicating over 1700 OCR installations, dominated by gate OCR and license plate recorgnition applioations.

3.2.2 MARKET GROWTH

The overall marine segment for OCR is expanding by 12-15% annually with different submarkets experiencing varying growth. The port and marine terminal segments are estimated to be the highest, enjoying 25% year-on-year growth. In 2011, the total marine market for OCR-centric system sales was estimated to be worth around USD $50m.



4 | GETTING THE ROI FROM OCR

The TOS was once considered the life blood of a terminal, fulfilling its entire technology system requirement. Integration to back office systems, monitoring and measurement systems and peripheral technology were not considered of significant value.

Today, peripheral systems have become a necessity due to the operational requirements to remove costs (both labour and equipment) and increase throughput. As such, automated gate systems, OCR, DGPS, RFID, video streaming and archiving, biometrics, security systems, automation of cranes, navigation for AGVs etc. are being installed throughout the world.

4.1 NETWORK ASSET VISIBILITY

Users evaluating return on investment for network asset visibility applications are advised to focus on the following areas:

4.1.1 INCREASED ASSET UTILISATION

As noted, real-time management and tracking of marine related assets such as trucks, chassis and gensets improves their availability while reducing downtime in the usage life cycle. Network visibility systems can provide the critical core information to execute advanced decision making on the movement of containers and other transport assets, enabling improved supply chain process management and thereby saving time and/or money. Utilisation is a major cost reduction driver and must therefore be considered a key ROI metric.

4.1.2 IMPROVED CAPITAL DEPLOYMENT

The fundamental issue with assets is cost. Asset purchase and subsequent depreciation has a significant effect on cash flow, the balance sheet and P&L. Protecting this investment and minimising the ongoing need for expenditure is a key ROI element of NAV systems.

4.1.3 ASSET LOSS REDUCTION/PREVENTION

Asset loss reduction has substantial impact on a company's bottom line. For example, asset-heavy operators like ferry companies may experience 10-40% lost assets. Loss consists of non-locatable assets in the supply chain, i.e. unable to be used, as well as true loss. In either case, new assets must be purchased to refill the available pool.

4.1.4 CONTENT LOSS REDUCTION

"Track the asset and the contents follow". In addition to the asset loss prevention described above, a key benefit of NAV systems is the prevention of content loss. Content loss through theft, mishandling or expiration can be considerable.

For the shipment of high value items such as pharmaceuticals, the use of sealable plastic pallet boxes is common. Optimising the identification of contents through the use of OCR or barcodes combined with security devices and effective cycle tracking is paramount.

4.1.5 MAINTENANCE/REPAIR COST REDUCTION

A final benefit of NAV systems is maintenance and repair cost reduction. Assets require cyclical preventative repair as well as repair for damage in handling. Many NAV systems support the identification of required preventative repair as well as status control of damaged assets

4.2 OPERATIONAL CONTROL

The key benefits of OCR based operational control systems are recognized through:

4.2.1 INCREASED PRODUCTIVITY

Most OCR operational systems within the terminal are focused on increased productivity associated with an operation or point of work within a facility (e.g. a gate). The solutions discussed previously have been proven to dramatically improve throughput capacity and effective time to process each transaction due to the removal of manual data capture. The net effect of this increased productivity is confirmed by the terminal operation being able to process more containers without physical expansion or additional labour.

4.2.2 IMPROVED EFFICIENCY

Automation of manual processes may sometimes result in the relocation or reduction of resources required

to complete the job (e.g. gate clerk, tally clerk, etc). This often allows terminals to operate more efficiently and competitively due to lower overhead costs.

4.2.3 IMPROVED UTILISATION

Increased visibility of assets gives system planners the opportunity to improve asset usage. The use of job assignments based on actual, not assumed, position should increase throughput and decrease travel times by as much as 40%. At the same time, excess assets can be deployed elsewhere or eliminated.

4.2.4 IMPROVED PLANNING

Better visibility to asset location and condition allows system planners to assign tasks more optimally.

4.2.5 INCREASED DATA ACCURACY

The solutions outlined herein aim to reduce or eliminate manual data input (and the associated errors) at key points of work.

4.3 SAFETY AND SECURITY

The key benefits of OCR based safety systems should be measured through:

4.3.1 INCREASED VISIBILITY

Equipment operators often cannot see personnel on the ground. Using OCR for detection of personnel with corresponding alert mechanisms within the CHE will help prevent accidents.

4.3.2 FACILITY SECURITY

Since 11 September 2001, there has been significant attention focused on improving the security and safety of public venues and facilities. Consideration has been given to monitoring security personnel so that in case of an event, the security person nearest the event can rapidly be contacted to investigate the incident.

Organisations have also reviewed how to use technology to provide an additional means of identification that can be used to provide or limit access to specific areas of a facility.

Both for prevention and in dealing with the aftermath of an event, knowing the location of security personnel and visitors may increasingly become a necessity. OCR provides low cost identification of staff for access control as well as locating

4.3.3 ASSET SECURITY

Equally challenging is preventing equipment and assets from 'walking out of gate' There are countless stories of container loss. Being able to detect a potential theft before it happens requires real-time visibility, and information on the location and status of the item. Additionally, that information must be integrated into the existing host systems so that decisions and actions can be taken in real time. OCR enables this to be achieved.

APPENDIX 1: TERMINOLOGY

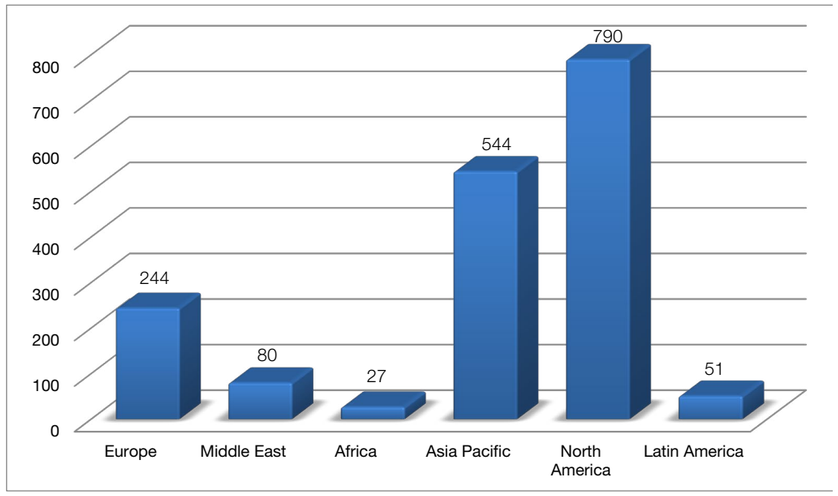
AIDC	Abbreviation for automated identification and data collection, a term used to denote a range of technologies for automated identification and tracking
AGV	Abbreviation for automated guided vehicle, a driverless vehicle used to transfer containers between the terminal yard and quayside
AGS	Abbreviation for automated gate system, an application typically combining software and hardware to enable automation of terminal gate processes
CHE	Abbreviation for container handling equipment, a generic term used to denote mobile equipment and vehicles used for handling and transporting containers
GOS	Abbreviation for gate operating system, a term used interchangeably with automated gate system (AGS)
GPS	Abbreviation for geospatial positioning system, a method for determining location using satellites
ISO	Abbreviation for International Organisation for Standardization
ITV	Abbreviation for internal terminal vehicle, a transport vehicle used exclusively within a facility to move containers and cargo
LPR	Abbreviation for license plate recognition, an application of OCR for reading vehicle license plates
Middleware	Software which communicates to and manages readers for collection, filtering, aggregation and formatting of data
OCR	Abbreviation for optical character recognition, a technology for automated identification and tracking
OTR	Abbreviation for over the road, a term used to denote street trucks within a port facility, as distinct from internal terminal vehicles (ITVs)
PLC	Abbreviation for programmable logic controller, a microprocessor-based device used to control cranes and other container handling equipment
PDS	Abbreviation for position detection system, a system to automatically identify the location of containers, usually within yard stacks
RFID	Abbreviation for radio frequency identification, a technology for automated identification and tracking
RMG	Abbreviation for rail mounted gantry crane, a type of crane for handling containers in terminal yards
RTG	Abbreviation for rubber tyred gantry crane, a type of crane for handling containers in terminal yards
SDK	Abbreviation for software development kit, a means for an OCR reader to talk to a host application without middleware
STS	Abbreviation for ship to shore crane, a type of crane for handling containers to and from vessels
TOS	Abbreviation for terminal operating system, a software application for planning and managing operational activities at marine and intermodal terminals

APPENDIX 2: OCR SURVEY DATA

Table 1: 2011 reported OCR installations by region

Region	No of systems reported (specified by type)	No of systems reported (confirmed installation)	Total
Europe	186	58	244
Middle East	76	4	80
Africa	21	6	27
Asia Pacific	179	365	544
North America	774	16	790
Latin/South America	48	3	51
Global total			1736

Graph 1A: 2011 reported OCR installation by region (numbers)



Graph 1B: 2011 reported OCR installations by region (percentage)

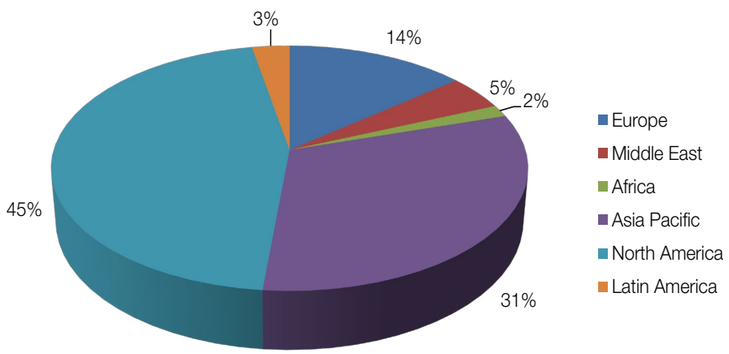
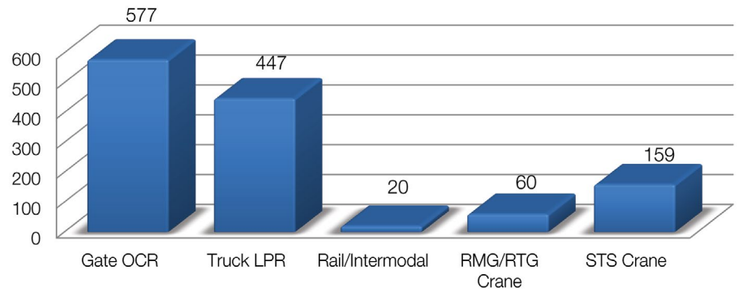


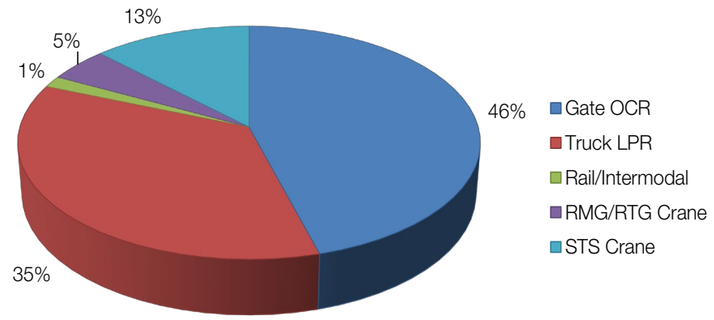
Table 2: 2011 reported OCR installations by type

System type	No of systems reported
Gate OCR	577
Truck LPR	447
Rail/intermodal	20
RMG/RTG yard crane	60
STS quay crane	159
Total	1263

Graph 2A: 2011 reported OCR installation by type (numbers)



Graph 2B: 2011 reported OCR installations by type (percentage)



Note: Market adoption statistics researched exclusively for PEMA under strict terms of confidentiality. Data combines publically available information and direct OEM reporting,

ABOUT THE AUTHORS & PEMA

ABOUT THE AUTHORS

This paper was researched and authored exclusively for PEMA by Allen Thomas, APS Technology Group Inc. with contributions from Dave Walraven, Hi-Tech Solutions Europe and Peter Westerholm, Visy Oy. Market adoption statistics were researched exclusively for PEMA by Brian Robinson, an independent container and transport consultant, under strict confidentiality conditions.

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ABOUT PEMA

Founded in late 2004, the mission of PEMA is to provide a forum and public voice for the global port equipment and technology sectors, reflecting their critical role in enabling safe, secure, sustainable and productive ports, and thereby supporting world maritime trade.

Chief among the aims of the Association is to provide a forum for the exchange of views on trends in the design, manufacture and operation of port equipment and technology worldwide.

PEMA also aims to promote and support the global role of the equipment and technology industries, by raising awareness with the media, customers and other stakeholders; forging relations with other port industry associations and bodies; and contributing to best practice initiatives.

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PEMA membership is open to:

- Manufacturers/suppliers of port equipment
- Manufacturers/suppliers of port equipment components
- Suppliers of technology that interfaces with or controls the operation of port equipment
- Consultants in port and equipment design, specification and operations

Please visit www.pema.org for more information or email the PEMA Secretariat at info@pema.org

PEMA CONSTITUTION & OFFICES

PEMA was constituted by agreement dated 9 December 2004 as a non profit making international association (association internationale sans but lucratif /internationale vereniging zonder winstoogmerk) PEMA is governed by the Belgian Law of 27 June 1921 on “associations without a profit motive, international associations without a profit motive and institutions of public utility” (Articles 46 to 57).

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