An approach in the classification of automation levels for multi-cargo ports.

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***Abstract*—** the current trend of cargo handling in ports is to use increasingly specialized terminals that allow systematizing processes by applying massive automation devices. The state-of-the-art in port automation is largely automated terminals where human presence in the yard is restricted to overseeing the processes. However, considering the existence of century-old port activity, there are important installed ports that handle different types of cargo, mainly grouped as CT-Container, DB-Dry Bulk, GC-General Cargo, LB-Liquid Bulk, using different standards of operation and safety protocols that require new practices using of specific mechanization and automation.

This article looks at general aspects of automation and its use in ports. It proposes a classification to the level of automation considering the participation of handwork, lifting and transportation equipment and automation devices. ***Keywords*—** Automation, Port Automation, Automation levels. Work Safety.

I. Introduction

The cargo movement in ports has undergone a worldwide transformation. The infrastructure of port waterfront, berths, facilities have evolved considerably, making it capable of supporting efforts from thousands tons arising from load requests of equipment and port facilities. The mechanization and the introduction of container led to the reformulation of shipping transport and the whole operation in ports. The automation of port systems brings continuous advances. Cargo handling reach increase amount, meanwhile, for workers, it is observed a severe reduction of jobs in the handling operations. This paper addresses this issue in three stages: automation, port automation port and discussion of the effects on safety of dock work.

1. Automation

ACCORDING to historical records dating back to 270 BC, Vitruvius studied possibilities of a clock powered by water, apparatus referred to as rudiments of automation.

In productive activities, it is considered replace work and human efforts by devices and equipment that have better overall result, concept called mechanization.

In an applied way, we have the progressive use of tools and systems based on physical principles related to: work, momentum, power, hydraulic and pneumatic pressure, wind, gravitational, thermal, electric, solar power, among other power systems.

The development of mechanisms and equipment and its incorporation into the organized production dates back to the period of so-called Industrial Revolution, with the classic example of the looms with drives the steam produced in boilers and mechanical sets of motion transmission as cylinders, piston, piston rods, shafts, pulleys, rotors, cams, distribution gears, and other mechanical systems.

According to Mamede Jr[1], "from the industrial revolution, muscle strength gave way to machines," by mechanized production.

The systematization of productive activities allowed the occurrence of the second industrial revolution, the implementation of the assembly line, in the early years of 20th century, with the large-scale production.

Therefore is widely accepted that the process of mechanization is a preliminary step in gradual trend on enroll in to automation systems.

Automation sets the basis for the third industrial revolution, the revolution resulting from the digital age. Thus, in a reverse cycle, a large-scale production provides a possibility for manufacturing using high technology even for few quantities with compatible costs, starting with sophisticated sets as jet engines.

II. Industrial Automation

Some authors indicate Automation as a neologism that refers to the use of technology to facilitate the work of human or extend their physical and mental capacity.

Control and automatic control refers to the use device (controller) that without the help of human action make a system behave the way it is settled for.

Among the areas of knowledge involved in automation, we have the inter sciences: mechanical, electrical, electronics, telecommunications and information systems.

[1] This paper is an extended version of "Port operation – increase of automated systems, decline of workforce jobs?", Aureo Emanuel Pasqualeto Figueiredo, Sérgio Hoeflich, Leticia Figueiredo, Ricardo De Deus Carvalhal, Sergio Luiz Pereira, Eduardo Mario Dias, presented at CSCC2015.

This consideration is quite important, as relates Zugge,[2], "the problem is frequent considerable that a lot of information does not create any knowledge". In addition, recommend for the improvement of systems the integration between IT (Information Technology) and AT (Automation Technology), "Nowadays some companies are investing a lot of money and effort to integrate IT and AT. However, some companies have not been achieving the success they expected "which indicates the complexity of this improvement".

III. HIERARCHY LEVELS OF INDUSTRIAL AUTOMATION

Industrial automation can take various roles in industries, since the automation of an operation to a large set of sequential activities, with the participation of so-called industrial robots.

Facing to the diversity of production processes, there are different types of classification called Automation Level. The table below shows the traditional model Purdue Reference Model, levels basis for the standard ISA 95.

Levels	Description
5	Business Systems, strategic planning and corporative management
4	Plant level, production and programming, ERP, MRP and MES
3	Operation Unit Level
2	Machine/Process Automation Level
1	Controller Level
0	Sensor/Actuator level

Tab. 1 Purdue Reference Model PRM

Lydon,[3] points to a technology evolution that could simplify that level hierarchy, as "more controllers are supporting multiple Ethernet ports to interact directly with industrial and business network that exists throughout industrial plants".

In the way of "Lean Philosophy", Rother M Harris R. C , [4] describes a hierarchy that consider systems subdivision with different levels of automation in its subsystems or processes, also including semiautomatic stage, where there is partial involvement of manual action.

		Machine Load	Machine Load	Machine Discharge	Transfer Parts
LEVELS	1	Manual	Manual	Manual	Manual
	2	Manual	Auto	Auto	Manual
	3	Manual	Auto	Auto	Manual
	Main Division				
	4	Auto	Auto	Auto	Manual
	5	Auto	Auto	Auto	Auto

Tab 2 adapted from Rother M. Harris R, .LEAN directions

In addition, explains "level three offers the most efficient and flexible combination of the movements of the operator and materials."

IV. PROCESS AUTOMATION – INDUSTRIAL PLANTS

The production tasks makes the automation of processes in the industrial area a very important condition, with the increasing deployment in the assembly lines of automated procedures, using robots and mechatronic systems and devices.

In a compact physical space of the production line, robots replace humans with speed and efficiency, especially in repetitive and dangerous tasks with greater potential risk of incidents and accidents.

The nature for the related process has distinct impacts in result of production and operative conditions usually in industrial plants.

For production planning, the limitation of time and space, with constant repetition of movements, paths and routes are generally compatible to standardization and to be supplied within the degrees of freedom of movement of robots.

An important reference is called standardized time, or simply *takt time*, that Rother M, Harris R. [5] at LEAN methodology describe as "the rate at which the finished product needs to be completed in order to meet customer demand". Described mathematically, *takt time* is available time for production / required units of production".

Nowadays, like a *digital hortator* beats by software and hardware the rhythm of industrial operations.

V. PROCESS AUTOMATION – INDUSTRIAL PLANTS, DARK FACTORIES

Many industrial manufacturing units are named manufacture, referring to the latin word for to handmade, or handcraft, i.e. to make something by manual skills.

Industrial sector uses strongly automation on the assembly lines considering the usage of robotics, mechatronic integrated hydraulic and pneumatic and other types of automated systems.

Conditions defined for industrial plants as production and process characteristics can favor this transformation.

The increase of this production system induces, at its limit, to a highly robotized production environment, where the man participation is minimal, practically restricted to the supervision and control of the continuity of processes.

These automated production sites, where the drive process decrease the need for the lighting, result "manufacturing lights out" processes, and industrials plants also known as "dark factory". The need for lighting remain is the human controller of the process, at least for repairing, adjusting jam although mainly focusing on system supervision.

This production way was not yet effective for several reasons, including the complexity of the robots and their high costs of implementation and operation, requiring expensive specialists.

Still, some areas of production such as plastic injection, laser cutting and printing have made significant progress in automation.

The increased use of robots in factories will be possible with the advancement of technology, allowing less expensive costs

of acquisition and set up robots, in order to simplify the operations in great scale, and even more productive.

Currently, industrial production processes still consider as high valuable the participation of man, in new tasks in which the abilities and skills are useful.

VI. PORT AUTOMATION

Introduction

The use of automation in port processes of handling of goods led to structural changes.

As well known, the transportation of goods from the coast to the vessels along centuries was held by smaller boats - with the climatic difficulties of sea currents and waves.

This situation stimulated, where possible, the construction of precarious wooden structures to where the draft allowed positioning the vessel, for a dry access to the ships.

The building of safe pier docks with solid structures in areas protected from the weather (and also from pirates), brought the ship moored closer to waterfront, providing accessible platform for people, animals and land transport vehicles, and implementation of deposits near the berth, adjusting the ship traffic production.

The stable bases permitted to developed specific equipment for lifting and transport of loads that, according P. Alfredini, E. Arasaki .[6] "should consider the continuity of operations without times waist in intermediaries of equipment operations, by the use of temporary storage areas with multifunctional devices".

The use of automation requires accurate planning and expertise, as Jussi et al.[7] says, "a correct and reliable situational awareness solution will require an understanding of what are the real user-needs. Technical solutions are not essential if they are not useful."

VII. AUTOMATED VESSELS

The continuous advancement in technology brings every day new automated ways in the movement of goods. Therefore, ship supply companies started to design cargo carriers without onboard crew, considering remote operation.

This condition has resistance in several countries, facing to the current lack of security guarantees, mainly environmental.

On the other hand, presents itself as a perspective for the near future, operating in the marine environment like the drones aerial vehicles VANTs (unmanned) or VARP (remotely piloted).

VIII. AUTOMATED TERMINAL

In containers terminals, the fundamental rules of logistics guide the design of load plans by the ship planners, considering the sequence of ports at which the ship will operate, according that "the first a load is boarded the latter will be removed".

The relative position of the containers in the ship hold, (inside), or on the deck (outer), is referenced spatial orientation relative to the ship (bow, stern, portside, starboard), according to the position set on the loading plane array:

Bay (longitudinal) and row (transverse) consider a horizontal plane, and the vertical tier position.

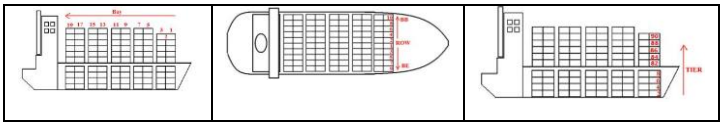

Fig. 3: Bay row tier positioning, containers loading matrix. Image adapted from Oceanica UFRJ.

Regarding its capacity containers, vessels are indicated as:

Number of TEUs	Vessels Types
< 1000	Small feeder
1001 - 2800	Feeder
2801 – 5100	Panamax
5101 - 10000	Post Panamax
10001- 14500	New Panamax
➢ 14500	ULVC Ultra Large Container Vessel

Tab. 3 Adapted from Oceânica UFRJ

Nowadays one of largest ship in operation at the time, CSCL Globe, with a capacity of 19,000 TEU, moored in Rotterdam in January 2015. It also announces the construction of a new ship for more than 20 thousand TEU.

For the East-West route, the main in terms of cargo volume, these super ships are supposed to operate mainly in the future channel of Nicaragua with planned capacity for vessels up to 25,000 TEUs or 400 thousand tons. The Panama Canal, even with the current expansion, had its capacity increased up to 15,000 TEUs or 150,000 ton (New Panamax).

IX. AUTOMATED OPERATION IN CONTAINER TERMINAL

When ship is moored at the pier and its position is validated, this condition can also validate up the spatial position of each container indicated in the matrix structure of the cargo plan, allowing the start of operations.

From the ship plan, based load plan, along with the movement of the lifting equipment, an automated operation the "carousel" of trucks driven by programming can start the journey with stroke and established operation, integrated with other equipment such as reach stackers, RTG (rubber tired gantry crane) RMG (rail mounted gantry crane) transporters and quarry gantry cranes.

Port operations Multi cargo ports:

Port operations can be held in many levels of mechanization

and automation. Equipment considered for each material and transport modal: road, railway, waterway and pipeline. In smaller scale, the use of lifts and airport connections systems.

Generic boarding algorithm

Producer to → Regulator yard→ Port Terminal → ship

X. OPERATION WITH CONTAINERS – GENERIC BOARDING ALGORITHM

Producer to	Regular Yard	Port Terminal	Ship
Truck Arrival Notification	Standby Scheduling Authorization Continues Trip	Access Identification Positioning Control Equipment Discharge (forklift/reach stacker /rtg) Loading Truck Transport Positioning Quarry Crane/LTM	Receipt Positioning Bay/Row/Tier Lashing Liberation Ship Deliver

This is a type of mechanized operation with good prospects for automation in ports and terminals.

Since receiving the container in the terminal entrance, access control, positioning in the courtyard, integration into the cargo plan, the mobilization to the sideline, loading on board in ship hold or deck.

On arrival at the port of destination, repeat the sequence in reverse order, according to the containers schedule.

XI. OPERATION OF DRY BULK – GENERIC BOARDING ALGORITHM

Producer to	Regular Yard	Port Terminal	Ship
Truck Arrival Notification	Standby Scheduling Authorization Continues Trip	Access Identification Positioning Control Equipment Discharge (Hopper/Elevator/ conveyor/Tripper) Load (Carrying Shovel) Hopper/Elevator/ conveyor Ship loader	Cargo Hold Receipt Liberation Ship Deliver

The solids unpackaged, bulk are generally derivatives from products:

Vegetable - sugar, cereals (maize, soybeans, wheat, and others) pellets. These products are dependent of protection against moisture and must be stored in appropriate warehouses.

Minerals: sulfur, phosphate rock, bauxite, salt, coal and raw materials for fertilizers among others. According to the particle size and other physical characteristics, the products could stay in an open yard.

The packaging of bulk solids requires protection systems and environmental control, and to workers. According to the particle size and other physical characteristics, plant products are flammable and require protection systems and firefighting.

Ships for bulk solids transport must be equipped with the appropriate holds to receive loads with cargo equipment or continuous discharge.

Following table describes capacity for bulk carriers:

Capacity dwt	Vessels Types
10.000 to 30.000	Handy Sized
30.000 to 50.000	Handy max
50.000 to 80.000	Panamax
80.000 to 200.000	Capesize
>200.000	Very large ore carriers
400 mil ton	Valemax

Tab. 4 adapted from

http://www.worldtraderef.com/WTR_site/vessel_classification.asp

The solid bulk for export is received at the terminal from trucks, waterways barges or rail cars with discharge hoppers.

For the unloading of trucks is often the use of the truck lift system, and gravity unloading the posterior position of the cart.

Railway wagons have bottom opening and systems to discharge directly into the hoppers.

The hoppers are willing transported on belt conveyor for yard or warehouse, conforming trapezoidal piles from mobile discharger from a mobile tripper.

Another form of storage are warehouses of grains, generally circular and high dimensions that generates concentrated loads, which require special soil foundations.

At the boarding operation, bulk is loaded with belt conveyor that carry the products directing to the holds using ship loaders. When are used bags the ship loaders are provided with a dispensing reel.

In reverse operation, the ship unloader, the discharger removes the vessel's hold material with grabs or suction, according to the product characteristics. Hence, after discharge into a hopper, it is carried to the warehouse or directly to trucks and wagons.

XII. LIQUID BULK – GENERIC BOARDING ALGORITHM

Producer to	Regular Yard	Port terminal	Ship
Ducts Notification Pumping	Receipt Stock Scheduling Connection Ducts Notification Pumping	Receipt Stock Scheduling Connection Ducts Notification Pumping	Cargo Hold Receipt Liberation Ship Deliver

Traditionally, liquid bulk is one of the most automated forms of goods handled in ports. The predominant cargo are fuels of mineral or vegetable origin, vegetable juices, liquefied gases, chemicals.

They always are careful operations that require strict compliance with safety standards and safety protocols very restrictive, to avoid disastrous occurrences.

The placing product in tanks requires outsiders holding basins for any leaks, level control devices, pressure, and temperature. In the discharge and suction operations, the safety valves have special care, as well as grounding systems and prevention systems, monitoring and automated firefighting.

It is known that even small electrostatic charges may cause sparks and harmful consequences in environments with potentially flammable materials and explosives.

The liquid bulk from tanks is pumped into the vessels hold; must have compliance with the preventive measures the terminal itself or port PAM - Mutual Aid Plan - when necessary.

XIII. General Cargo - Generic Boarding Algorithm

Producer to	Regular Yard	Port Terminal	Ship
Truck Arrival Notification	Standby Scheduling Authoriza-tion Continues Trip	Access Identification Control Equipment Discharge (Forklift/Reach Stacker/Rtg) Loading Truck Transport Positioning Quarry crane	Receipt Positioning Bay/Row/Tier Lashing Liberation Ship Deliver

Products not classified as containers or bulk are referred as general cargo.

Several products are moved packed in bags of various sizes. More recently, in large bags. Also drums, coils, profiles, ingots, bales, etc.

Handling modes could be combined on wooden pallets or tied pieces or slings

Still under the general cargo designation are included big parts of project cargo or special sets or large unit equipment, spare parts or sets with heavy weight e/or large volumes.

These includes equipment such as turbines, electric transformers, rotors, locomotives, cranes, propellers of wind generators, quarry cranes, RTG cranes, wagons, locomotives, rails.etc If necessary, are used specific vessels for special transport.

For this study highlights the cargo of large wind propellers difficulties for lifting, positioning and locking of packaging. There is limited automation in this handling and lashing.

XIV. Prospects For Automation – In Addition to Efficiency, Safety Automation in to the Ports

About security in domestic and foreign concept of a port or terminal, highlights the IHMA- International Harbor Masters Association.[8] is:

"Most, if not all, navigable rivers, channels, ports, harbors and berths are subject to danger from, for example, tides, currents, swells, banks, bars or revetments, traffic density and changes in depths.

In addition, continues: "Such dangers are frequently reduced by lights, buoys, signals, warnings and other aids to navigation and can normally be met and overcome by proper navigation and the handling of a vessel in accordance with good seamanship.

In addition, concludes: "The reputation of a port is largely dependent on its safety record and efficiency. Any damage to a port's safety record may effect on its reputation and by extension, its trade"

Many ports have their own VTS – Vessel Traffic System, for controlling the arrival, port operations and depart of ships.

About safety, the commotion caused by accidents and personal injuries must be considered as the port environment influences directly to the worker safety and integrity, his family, the work team, and even relationship social circle that feels the impact of any accident with port worker.

Accidents causes breakdown of the teams motivation, contaminating the work environment, and underscoring due to their frequency and severity.

The society acknowledge accidents as presented in IMO-FSA.[9], the moral and social losses are exacerbated by the ratio of fatalities and perception as it says:

"Society in general has a strong aversion to accidents with multiple victims. There is a clear perception that a single accident victims in 1000 is worse than 1000 accidents in which dies (kills) a single person."

If, on the one hand there is a spectacle more severe injuries, on the other notes to popularization of smaller, affecting the balance of his analysis and correction.

By this way, both frequency and severity must be considered, as Kuramoto et al [10] observe: "The risk of the process may be determinate through a process hazard analysis. In short, the way of measuring the risk is based on the product of the frequency at which a certain event occur (F) by the consequences resulting from the occurrence of an event (C) . So, Risk - F x C".

Mechanized equipment and automated systems must to have operation conditions that preserve people that makes the workplace.

XV PORT, AUTOMATION AND PRODUCTION WORKFORCE

Discussion and related work

Several authors have reported the importance of information technology. FONTANA et al [11] observe: "the integration of computational intelligence allows the optimization of the

waiting time of trucks and reducing the operating time of vessels, the timetable for service trucks, and occupancy rates of equipment and optimizes the layout of the cargo terminal".

As ZUGGE et al,.[12] registered, Information Technology and Automation Technology are both import for port operations: "The integration of IT with AT provides data from the ground-floor to the management level of enterprises. Owing to the advance of technology, hardware and software architecture, automation systems enable the acquisition of a huge quantity of information that can assist in decision-making of companies"

In another paper, FONTANA et al,.[13] explains that "Information Technology and communication can help computerize the operation processes of the terminal, by introducing concepts of monitoring and management, and the introduction of devices that can collect information in real time and thus reduce time to improve quality in services. A point of attention is that the port terminal consists of various activities and operational procedures that are interconnected, so that the applied technology requires great efficiency, because a failure in one component affects the entire value chain."

Socioeconomic aspects and conflicts at work.

The implementation mechanisms with increasing production capacity has correspondence with the reduction of jobs in these activities. This situation led to armed conflict as referred to historically Luddism, social movement in the second decade of the nineteenth century.

Led by Nelson Ludd, aggregated workers who mobilized against replacing workers with machines, invaded industries and breaking equipment. Afterwards, unions appeared to collectively fighting over workers' rights.

About actual conflicts origin, D.Prochaskova.14] reports that "conflicts originate e.g.: man vs. the environment; technology vs. the environment; man vs. techno-logy; man vs. man; man vs. computer, etc… Knowledge and experience accumulated shows that is a limit for human activities, which cannot be exceed"

Automation and work

On systems with a high level of automation, the human presence in operation area should be avoided, and restricted to authorized circulation areas, so should not remain people circulating in order to avoid accidents, even with warning sound from handling equipment when moving.

Terminals where automation is implemented progressively reduce the human presence in the courtyards. Specialized operators control and supervise remotely the process steps. Centralized automation system provides a possibility for the operator to monitor and control field area by checking high-resolution cameras. An actual example is the Euromax terminal in Rotterdam.

These terminals due to their level of automation seem like "ghost" terminals, where is not allowed people circulate in the handling cargo area.

Its main feature is the reduction and even elimination of direct human participation in the activity, with the man in the monitoring and supervision. Safety first, other results cost reducing from energy and materials saving, improving the accuracy and quality of operations.

The automation of operations and processes frees man from work in repetitive activities and unfavorable conditions in which there is discomfort and potential risk of accidents and illnesses. The reduction of costs related to the work reflects the ratio between lower application hours and bigger production.

So with less human involvement, expected better quality and productivity, with fewer accidents due to fatigue and tiredness. Additionally fewer complaints and wage demands.

However, even in the most automated processes in "dark factories", have not yet reached projected results, the basic finding of the operational difficulties of adjustment processes, which confirms the finding that the most important in the production process are people prepared to realize it and driving it.

Hence the contribution that experience and knowledge are fundamental to success in the processes. They should be the subject of care in their preservation and enhancement for transmission to reviewers.

Port jobs and workforce

Process automation - terminals and non-specialized port facilities

The goods handling environment in the ports of various loads differs significantly, almost in opposition, from processes in industrial plants, since in multicargo ports are noted the diversity of goods, work areas, actions to develop and mainly of agents who perform, the port workers.

For the workers, every period change the places where carry out the activities, ships to be operated, the corresponding goods and procedures, co-workers, the hot / cold climatic conditions, the periods of day / night, natural light or artificial, or even the night pitch of the paths between rows of containers.

When terminals use permanent workers, it is natural to develop collective skills, interaction for knowledge, in synergy characteristic of work team that allows influence for improvement.

For temporary teams, alternating hierarchy and members at every turn, knowledge also requires frequent training to perform multiple tasks, lead and organize.

The intensive use of human labor under hard working conditions, characterized long period until start the utilization of large equipment mechanization that caused the deployment of people.

Zotto .[15] relates that, at the beginning of the use of clamshells as implements of cranes for bulk handling about the gunshots from angry workers in the first grabs, similar to actions such as the attacks and destruction of equipment of the industrialization period.

From the port worker point of view, even arduous working

conditions are important to support subsistence of themselves and their families. Hence the historical reaction to processes that reduce jobs.

However, for a long time, the man remained the major force element in the movement of goods on board ships and ashore.

The use of lifting equipment and cargo handling evolved the capacity of quickly load ships to increase the number of trips and dispose of goods to destination markets.

Evokes the observation of K. Marx..[16] in his book The Capital, in the mid-nineteenth century "You can well ask if all the mechanical inventions made so far lightened the daily work of any human being." Since the true intention of the capital which was to reduce the price of the goods.

In contemporary terms, T. Picketty [17] manifests one of the expressions of this bias automation in his work "The capital in the XXI century", which argues that (r) rate of return on capital will fall slower than (g) rhythm economic growth.

Hence, if it is sufficiently easy to replace workers with machines, if the elasticity of substitution of capital for labor is greater than one, widen the gap between *r* and *g*. thus concludes an immediate consequence of redistribution of income, workers in return for capital.

Changes in dock work - Containers, production and jobs

Port work at early years of the twentieth century was still essentially manual. Huge queues of workers carrying bags in the back were the typical views of labor between warehouses and ships.

At the end of the twentieth century and the beginning of the current, was the multiplication of cargo movement, fostered by the dynamics of the economic situation and facilitated by the automation of processes, with the "revolution" world due to the intensive use of containers, with loads of all kinds put in charge safes.

This conceptual change leads to what Fabiano et al.[18] refer to "the simple thing the container did was sharply lower the cost of shipping goods from one place to another. However, the container revolution also changed the mechanics of shipping: the logistics, the speed and capital's structure ".

"the use of containers provided for the conditions, to the mechanization of the operations, the automation of the terminals. But, as reported by Levinson (2006), the containerization is a monument to most powerful law in economics, that of unanticipated consequences".

And about jobs reduction, continues Fabiano .[18] : "labor leaders feared the container, but even they were not prepared for the speed with which destroyed "water-front-job", against the prediction of 30% reduction, in reality 75% has vanished by 1976".

In a comparison of industrial works and port operation, is useful to hear from Florea,.[19] "Process control and optimization represent the current base for safer and more efficient industrial plants, while risk management represents the base for new control algorithms and strategies. There is a stringent need for the enhancement of process operations at plant production management level, because plants should often operate near criticality, meaning conditions far from ideal ones from the point-of-view of control and stability. Risk hazard control is for sure one modern approach to keep plant running even under big perturbations or uncertainty.

Port activities implementation are traditionally held by temporary contracted workers, strongly aggregated into their own unions, with great tradition of defending their categories.

Equipment manufacturers developed simulators systems with workplaces similar to the operating equipment, sensors, controllers and speed adjustment devices, range, and other control measures of the operation

Modern equipment has operational characteristics that allow the operator to go through a preliminary training simulator to know the movements and possibilities. Then, when it is demonstrated the ability (skills) enough, supervised training takes place in the real equipment under limited conditions to acquire the resourcefulness needed to take the solo operation.

Thus, the increasing mechanization and automation in port and multipurpose cargo terminals are incipient, and progressively increased by the incorporation of technologies directed to the speed and intensity of movement, creating complex situations that require permanent attention.

PROPOSED CLASSIFICATION OF AUTOMATION LEVEL

As discussed here, a form of automation level classification is considered in Lean Directions, by R. Harris.[4].

This paper presents a way of classification, considering the port handling activities, shown at tab 5

Levels		Machine Load		Transfer	Machine Discharge		Cargo
		Port Terminal	Ship		Ship	Port Terminal	
	1	Manual	Manual	Manual	Manual	Manual	
	2	Manual	Manual	Auto	Manual	Manual	GC
	3	Manual	Manual	Auto	Auto	Auto	DB Ct
	4	Auto	Auto	Auto	Auto	Auto	LB
	5	Auto	Auto	Auto	Auto	Auto	

Tab 5 Classification of automation levels adapted over Rother M. Harris R,.LEAN directions.

This classification adds an evaluation of the four basic types of goods as CT-Container, DB- Dry Bulk, GC-General Cargo, and LB-Liquid Bulk, and allows associated studies of various characteristics of the port activities, i.e. work safety to different levels of automation.

CONCLUSION

About automation influence in production activities, McMillan.[20] observes that: "People make errors. Automation has been very successful at reducing these errors although it may just be relocating human errors to another level."

In addition, continues, "A person is still needed for performing cognitive-based tasks, as another system check and provide needed flexibility for unexpected events".

When part of experienced people is been pushed away from the workforce, more specialists systems are required, to support decisions. The results may be not the same.

Thus, for multimodal terminals and ports, the present situation is certainly still far away from the so-called *ghost terminal*, where intense automation and consequent reduction - *invisibility* - the absence of human work would be the counterpoint to the *dark factories* of industrial activities.

If, for an advanced culture is understood that automation displaces people from dangerous function, painful and exhaustive, more and more the training people to work in automated systems and massive training are required for repositioning of workers.

Automated systems on port applications still require for the foreseeing future the workers contribution, based in skills and experience, ability for prevent and improve problems solution.

REFERENCES

[1] J.Mamede Jr, "Instalações Elétricas Industriais", Capítulo XIV Automação, Ed. LTC, 2007, p 633.

[2] C.T.Y. Zugge, S.L. Pereira, E.M. Dias, Integration of Information Technology and Automation: Facilitators and Barriers". WSEAS transactions on systems and controls, issue 5, v 5, 2010 p 372.

[3] Lydon, B. "Simplifying Automation System Hierarquies" 2012 Editor Automation.com acess march20,2015.

[4] Rother M. Harris R,. "Creating a continuous flow" Publ. LEAN Enterprise Institute, 2001 p13.

[5] R.Harris, "O nivel de automação ideal" acess march 2015 http://www.lean.org.br/comunidade/artigos/pdf/artigo_43.pdf,

[6] P. Alfredini,,;E. Arasaki, Engenharia Portuária, p 770, Ed. Blucher, Brazil 2014

[7] Jussi Simola, Esa Jokinen and Jyri Rajamäki "How situational awareness can be improved by using real-time video? Case: simulated natural disaster at the Viksu 2014 camp. International journal of systems applications, engineering & development, vol 9 2015

[8] Harbour Master Nautical Safety and Port Environment. http://www.harbourmaster.org/hm-port-safety.php access in march 2015

[9] IMO International Maritime Organization - AMENDMENTS TO THE GUIDELINES FOR FORMAL SAFETY ASSESSMENT (FSA) FOR USE IN THE IMO RULE-MAKING PROCESS (MSC/Circ.1023 - MEPC/Circ.392) FN Diagrams oct16 2006.

[10] KURAMOTO ASR, BUENO NM, FRAZÃO FILHO WS, , DIAS EM, FONTANA CF, Automation of Port Facilities for Import of GNL , Proceedings of the 13th WSEAS International Conference on SYSTEMS, 2009

[11] FONTANA CF, PAPA F, SAKURAI CA, Technological Framework for Offshore Terminals, Recent Researches in Telecommunications, Informatics, Electronics and Signal Processing, 2013

[12] ZÜGE CTY, PEREIRA SL, DIAS EM, Enablers and Inhibitors of integration between IT and AT , RECENT ADVANCES in SIGNAL PROCESSING, ROBOTICS and AUTOMATION, Cambridge 2010

[13] . Fontana C.F., PAPA, F., MARTE, C.L., YOSHIOKA L. R., SAKURAI, C.A "Intelligent Transport System as a part of Seaport Terminal Management System" International journal of systems applications, engineering & development, vol 8 2014

[14] D. Prochaskova, Critical Facilities Safety, International journal of systems applications, engineering & development, vol 9 2015

[15] T.C. Zotto, "O trabalho de Estiva – Modernização e Tradição, os desafios da tecnologia e da gestão no cais, SP LTr, 2002.

[16] K.Marx The Capital Livro 1 n 1, Ed. 70 Lisboa, 1979 p. 69

[17] T.. Picketty The Capital in the XXI Century,

[18] B. Fabiano, F.Curro, A.P.Reverberi, R.Pastorino."Port safety and the container revolution, A statistical study on human factor and occupational accidents over the long period" – Chemical and processes engineering department "G.B. Bonino" University of Genoa, Italy. Safety Science 48 (2010).

[19] G.Florea, R. Dobrescu, "Risk and Hazard control hosted on cloud", International journal of systems applications, engineering & development, vol 8 2014

[20] McMillan, G.K. "Process Industrial Instruments and Controls Handbook", McGraw Hill 5th ed. 1999, pg 8.18