Gantry crane maintenance: Proactive or reactive?

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Figure 1. New Port of Miami cranes 11-12.

Crane design

Currently, the trend is to design and manufacture state-of-the-art cranes that can operate at ultra-high speeds in loading and unloading ships. The owner/operator can claim they have the newest, biggest, fastest and most advance crane in the world but to actually use the crane to its fullest potential; remains to be seen. Having a state-of-art crane, does not necessarily relate to efficiency in crane operation or maintenance. Here the rule of thumb is; keep it simple. The simpler things are the least problems one will encounter and the easier it is to maintain. This does not mean to ignore technology but to simply analyse and consider your needs with the results of using the components that your consultant is including in your new crane specifications.

For example, a popular electrical component is the anti-sway system. This automated control system effectively regulates the sway of the spreader and container while loading and unloading a ship. However, before deciding on its use, consideration should be given to the benefit over the popularity of this technology since it is an additional electrical component that maintenance personnel must maintain and troubleshoot when it breaks down while the crane is working a ship; this means additional downtime for the operation. It is simpler to implement its usage in a new terminal where the crane operators will operate cranes that all have the anti-sway system and not in a terminal where there is a combination of cranes with and without the anti-sway systems. For example, when a crane operator one day uses a crane without anti-sway and the next day he operates a crane with anti-sway system; it is very difficult for the operator to become accustomed and proficient with the different cranes. This inevitably results in reduced production. Typically, the operator with the most control of the crane will react quicker and be more productive than that which is dependent on the crane system to compensate for sway. And even though he is depending on the anti-sway system, the operator still has to land the spreader on top of the container or chassis while the crane system is controlling the swaying movement at the same time. This leads to conflicting control motions with one trying to become the dominant factor.

Case example; witnessing a crane operator working a 40 metre (131.2 ft) under spreader high crane, without using the spreader flippers (in the up position) to seamlessly land the spreader on-top of a container(s) continuously without missing the twistlock pockets. This proved that there are efficient operators that do not require anti-sway system. However, the question then becomes, are there such crane operators and/or can we train operators to be as efficient?

The primary design question which one has to ask regarding any of the additional components is: Do we really need it? We need to analyse each system, each component and formulate a logical response to ones needs:

- Is it going to make the operation more productive?
- Can it be easily maintained?
- Can it be repaired quickly if it breaks down?
- Can it be purchased easily, is it readily available?
- If it breaks down and it can not be repaired, will it stop crane operation or can the crane work with out it?
- Do we have to re-train all the maintenance personnel to service it?
- Are maintenance personnel trainable to the level required?
- What is the cost of repair or replacement?

Ask yourselves these questions and any other that affects your operation and base your design decisions on what is more efficient for you and your customer's operation. Remember, what works for one terminal or port usually does not work for another.

Maintenance programme

With all equipment, the manufacturer provides maintenance and operation manuals. Included in these manuals are the recommended maintenance schedules and procedures. These procedures are usually a very good starting point, but one also has to consider usage of the equipment in order to formulate maintenance schedules that can be performed efficiently. The manufacturer's recommended procedures are based on the average use of the equipment. As such, you may need to make changes depending on your requirements and environment, which will dictate your maintenance schedule. This is where the knowledge of the existing operation and the equipment's location usage is crucial in developing or modifying the maintenance programme.

The best maintenance programme is one which can be effectively used. A well thought out programme can be formulated, developed, manuals turned over to the maintenance personnel and the programme implemented, but, it does not mean the cranes will be properly maintained. It needs to take a proactive form in which the maintenance personnel can use it to perform the work efficiently and effectively. The plan needs to be in a language that maintenance personnel can easily understand and not in a legal or highly technical structure. Consider the size of the checklists and documents which the personnel need to use and use effectively; insure the checklists and procedures are detailed as simply as possible without being too elaborate. Do not implement a 25mm (1 inch) thick checklist booklet with maintenance procedure and expect the work to be performed in a day; be reasonable, there is

only so much work that can be performed in a given time period. And finally, maintenance should be scheduled around the cranes operation; a very difficult task at very busy terminals.

Crane downtime

What is downtime? We define 'downtime' as that time which is recorded when the crane stops work while loading or unloading a ship as a result of crane system failure not caused by the operator, stevedore and/or nature. Downtime is not just a matter of proper maintenance. There are many other factors that impact downtime such as crane design, maintenance programmes, operations and personnel.

Assuring limited downtime begins with having cranes with systems and components that can easily and quickly be repaired. On existing cranes there is not much we can do except refurbishing the crane with efficiently maintainable components. However, when new cranes are being purchased, we have the option to insure that during the crane's design, we keep it simple. We need to properly train the personnel that are going to maintain the cranes not only to understand the systems (mechanical and electrical) but on how to efficiently trouble-shoot a problem.

To further insure the crane is ready to work a ship, we perform a Pre-Operational inspection prior to placing the crane in operation. And, once the crane finishes work, we should perform a Post-Operation inspection. Both checks identify deficiencies which may result from normal wear-and-tear or from system or component failures. Once a deficiency is detected, they need to be repaired. However, immediate repairs may not be possible since numerous times a ship is waiting on the crane to commence work. Then, it becomes a matter of finding the time to perform the repair or remove the crane from service to perform the required work and scheduled maintenance.

And finally, we have the operational side in which there are several steps one can take to minimise downtime:

- If all cranes are not working, leave a spare crane between ships in case a crane breaks down, one can gantry the spare crane into operation


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Figure 2. Post-operative checklist.

Figure 3. Technicians responding to spreader breakdown during operations.

- Have spare spreaders available to replace any that break-down that can not be repaired quickly
- Insure knowledgeable maintenance personnel are on duty and ready to respond immediately upon notice of a crane having system problems
- Have adequate staffing during crane operations

These operational steps are much more complicated than they appear. Operationally, one needs knowledgeable supervisors that can easily notice a problem developing and is able to respond by directing personnel to resolve it quickly. This knowledge of operations and maintenance only comes from many years of practical experience in this type of work and not obtainable in just a few years of work. We also need personnel with proper educational background and experience in the related fields.

Crane refurbishment

If you assess that although you have a good maintenance programme in effect and the maintenance personnel are performing at an optimum level, yet the cranes still break down frequently, this obviously means that the crane component(s) is no longer working properly and has reached its useful working life. Then, it is time to consider replacing the component, refurbishing the crane, or purchasing a new crane. Additionally, evaluate the cost of maintenance, extra-ordinary repairs, and the cost associated with downtime operations and repairs before making a decision.

Crane refurbishment can range from upgrading a particular crane component to refurbishing the complete crane. Which of these is performed, depends on the condition of the crane, the needs of the users, the terminal, or the port, and most importantly, it depends on the associated cost. Such cost can be as little as US$100k to as much as US$3-4 m per crane. If the estimated cost is several million and the existing crane is a Panamax, then consider purchasing a new Post or Super Post-panamax crane. However, if there is still use for the small crane, do not hesitate in refurbishment since it will give the crane an additional 10-15 years of work as long as the structure is in good condition.

Figure 4. New electric panels, cable raceways and wiring after crane refurbishment.

Figure 5. Crane gantry after refurbishment.

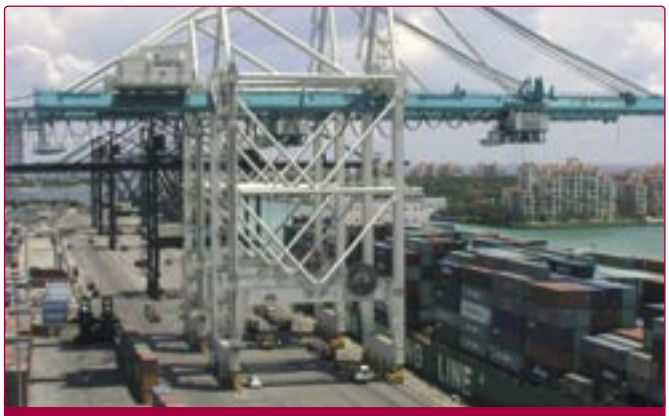

Figure 6. Crane operations.

Making the decision to refurbish a crane is complicated. However, if you do and it is performed properly, you insure having an efficient crane for many years of operations. Which ever decision is made, insure it will result in the most efficient for both you and your customers.

Terminal operations

How do you ensure the terminal is running at optimum efficiency? By terminal we mean gantry cranes, yard and equipment (tractors, reach stackers, RTGs, RMGs, etc...). Consider a terminal that has gantry cranes, tractors with chassis in tow and yard stackers. In order for the operation to be productive, the storage yard needs to operate in unison with the cranes and visa versa. That is, the chassis needs to be waiting under the crane when the crane is unloading, and, the crane has to be ready to pick-up the container when the tractor brings the container under the crane. Also, the yard stackers play a critical role; unloading and loading the chassis in the yard which the tractor shuttles to-and-from the crane. Any of these falling out of sequence will deteriorate production. Therefore, not only does a crane, one component of the team, breaking down affect production, but any of the other two will deeply affect production as well. For example, current technology on the new cranes can record how production is progressing. We have seen crane cycle time of 36-60 seconds which usually means that all these components are in unison and running at optimal performance. On the same ship we have seen cycle times of over 5 minutes which means, if there were no crane failures, one of the other components was out of sequence. And as a result, the crane was waiting for a container or chassis for almost 5 minutes (hanging time).

It needs to be noted that actual crane productivity calculations are complicated since there are many factors involved, such as lost-time for cell hatch and ship's gear removal. The operation also loses time while gantrying over to another ship cell to work. Provided below are some simple non-theoretical calculations of the cycle times to show one aspect of calculating crane productivity.

One hour =	3,600 seconds	(60+36)/2 = 48 seconds (average)
One move =	48 seconds	One move = 5 minutes = 300 seconds
3,600/48 =	75 moves/hour	(incredible rate; not achievable because of other factors impacting production calculation)
3,600/300 =	12 moves/hour	(unproductive; and it will be worse because of other factors the impact production calculation)
Average	(75+12) / 2 = 43.5 moves per hour	

Conclusion

Having all of these critical components implemented, and making them work, is the most important, but also the most difficult task of management. However, management as well as their consults must be experienced and have detailed knowledge of each of these components in order to have an efficient crane and terminal operation.

Interlaced with crane maintenance and efficiency, is the cost associated with the work. One should consider whether to either keep spending the additional money on the continuous maintenance of the crane, refurbish the crane, or simply replace the crane with a new one. This decision is usually a difficult one since it is not only based on being efficient and cost effective, but it also includes consideration of the user's requirements, which may change due to change in the ships calling at the terminal.

The primary goal of the maintenance organisation is keeping the quay cranes operating efficiently with limited downtime. However, this is usually easier said than done since there are many different factors that affect crane efficiency. Hence, have a simple well thought out plan which maintenance personnel can follow and be able to perform efficiently. Maintenance personnel must be knowledgeable, trained, proactive and not reactive. It is most critical that personnel are ready to resolve a crane problem quickly and efficiently. With all this said, make your best effort, follow your maintenance plan, be pro-active and do not hesitate to change the maintenance plan or procedures when improvements can be realised.

ABOUT THE AUTHOR

Mr. Bello is currently the CEO of Port of Miami Crane Management, Inc., reporting to the company's Board of Directors. He obtained a Mechanical Engineering degree from Florida International University in Miami, Florida, US and is currently a licensed Professional Engineer in the State of Florida. He has worked both in the private and public sector where he was the Assistant Port Engineer for the Port of Miami. Mr. Bello organised the company, implemented the policies and procedures, and currently manages and maintains the gantry cranes at the Port of Miami and any crane related projects.

ABOUT THE ORGANISATION

Port of Miami Crane Management, Inc., is a non-profit crane management and maintenance company created by Miami-Dade County to maintain container handling gantry (quay) cranes. The company has been in operation and responsible for managing and maintaining the gantry cranes at the Port of Miami since October 1, 2002. Currently, the company is responsible for twelve (12) quay cranes operating on 1,905 metres (6,250 ft) of wharf.

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