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Advice paper

Towards productivity-centred crane fleet maintenance

Guidelines on organizing crane maintenance to increase performance and productivity

1. Introduction

Since cranes are among the more critical¹ tools in an industrial plant, companies generally attach high importance to the maintenance of this equipment. As a result, most companies have gradually improved their crane maintenance practices over the past few decades, and more specifically with a greater focus on preventive rather than corrective maintenance. However, traditional preventive maintenance still falls short in many respects because it doesn't support strategic goals such as increasing the plant's productivity.

This paper advocates a more comprehensive crane maintenance strategy known as productivity-centred crane fleet maintenance. It highlights the shortcomings of traditional preventive crane maintenance, outlines the basic principles of productivity-centred crane fleet maintenance, and discusses a number of real-life cases to illustrate the benefits of this more proactive crane maintenance approach.

2. Why traditional preventive crane maintenance is not enough

Systematic preventive maintenance - following a maintenance plan based on supplier guidelines - assures reliable operability during the entire designed lifetime. Preventive maintenance plans are tuned to fit the plant's production schedules and thus minimize downtimes. Good preventive maintenance (in combination with sound operation practices) should also reduce the number of costly corrective interventions to almost zero.

Industrial companies are of course well aware of the importance of preventive maintenance, especially when it concerns core manufacturing equipment, including cranes. What's more, industries have learned in recent years to treat secondary equipment with equal concern. They understand that even cranes outside the core production process are often of critical importance for ensuring the continuity of daily operations.

However, the traditional approach to preventive crane maintenance falls short in a number of respects. Let's have a look at five points of concern with respect to crane fleet maintenance:

- **Timely identification of issues** - Rigorous adherence to the crane maintenance plan will generally assure timely identification of the most common issues, allowing for corrective actions in due time. However, traditional maintenance often fails to thoroughly investigate the root cause of problems, which means it treats symptoms instead of cause. For example, worn guide wheels might be replaced without addressing the alignment issue causing the damage. In general, the more hidden issues might often be left unnoticed until they lead to severe damage and productivity loss. Examples also include vibrations leading to fatigue or inappropriate crane operation.
- **Compliance with regulations** - A traditional preventive maintenance approach does not necessarily include the continuous monitoring and follow-up of changing regulatory requirements, for example with respect to safety.
- **Continuity of plant production activities** - Despite the planned nature of preventive crane maintenance, the maintenance company often disturbs or interrupts ongoing production activities. Their preparation primarily focuses on optimizing the maintenance activities themselves, while failing to consider alternative scenarios that would benefit plant productivity.
- **Alignment with plant evolution and strategy** - A plant's cranes and its maintenance plans

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are designed to take account predefined loads and use cycles. However, plant production cycles may change over time, often leading to changes in the way cranes are used. This may significantly impact crane wear and hence productivity.

- **Identifying improvement opportunities** - Traditional preventive maintenance tends to focus on keeping the crane in its original state. Over the longer term this can lead to high costs for replacing obsolescent components. This conservative approach also tends to miss opportunities for significant productivity improvement through smart upgrades.

These five concerns in fact tell the same story: adherence to the defined preventive maintenance schedules will prevent the most common problems from occurring but it will be suboptimal with respect to a plant strategy for continuously increasing productivity. This is an important insight, especially in the current post-crisis period with its renewed focus on productivity. This makes the case for the more proactive approach known as productivity-centred maintenance.

3. The 5 basic principles of productivity-centred maintenance

A more proactive approach should put the focus on maintaining or increasing plant productivity rather than merely on preventing issues. How can this be achieved? Here are the 5 basic principles of productivity-centred crane maintenance:

1. Crane maintenance is organized as a business-critical project.
2. An analysis is carried out prior to each maintenance campaign.
3. Maintenance activities are optimized to protect plant productivity.
4. The maintenance report includes advice for the longer term.
5. Lessons learned are implemented effectively.

Productivity-centred maintenance focuses on maintaining or increasing plant productivity rather than merely on preventing issues.

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Let's have a closer look at these principles.

3.1 Managing maintenance as a business-critical project

Each crane maintenance intervention should be considered as a business-critical project with potentially significant impact on plant operations. As a result, a professional project manager should be charged with assessing the potential impact and making the necessary arrangements. The bigger the potential impact, the more the project manager should be involved in the planning, preparation and execution of the maintenance activities.

3.2 Preliminary analysis

The project manager always conducts a preliminary analysis, studying site organization and identifying project risks. For example, an apparently routine quarterly crane maintenance operation could involve higher risk when there is a refurbishment project ongoing at the premises.

As part of the preliminary analysis, the project manager also gathers all relevant information that in some cases might be missing, including technical and historical information on the cranes, maintenance plan details, and details of plant operations.

3.3 Planning and execution of maintenance activities

The project manager plans and prepares crane maintenance activities in such a way that they allow plant productivity to be protected as far as possible. Any interference of maintenance activities with other plant operations is thoroughly investigated. Where needed, detailed scenarios for maintenance activities are developed and discussed with the plant manager. These will include defining safety perimeters, temporary storage areas, and available time slots for all the activities involved.

During the execution phase, a direct line of communication with the operations manager is maintained to allow unexpected circumstances to be addressed rapidly and safely.

3.4 Post-maintenance reporting and advice

The post-maintenance report lists all observations made and activities carried out. It also outlines the state of health of the main mechanical and electromechanical components.

In a separate section, advice is given for the long term. This could include:

- Proposals to plan the renovation, renewal or replacement of selected mechanical or electromechanical crane components to ensure further safe and reliable operation. This would include addressing possible issues with the crane rails or even the support structure.
- Opportunities to increase crane performance, reduce operational costs, and improve long-term reliability by upgrading or replacing selected components.
- Opportunities to improve crane operation practices, update maintenance plans, and set up crane monitoring programmes.

Note that this requires the maintenance company to have access to particular expertise:

- They should be able to carry out a comprehensive lifetime assessment analysis of the cranes, including assessing the long term robustness of the crane's structure.
- They should have the necessary engineering expertise to determine appropriate upgrades of electronic parts and renovation of mechanical parts.
- They should be able to accurately assess crane rail alignment and stability.

Maintenance firms must be able to carry out lifetime assessment analysis and must have access to comprehensive mechanical and electromechanical expertise.

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Without this expertise there can be no comprehensive advice with a solid long-term perspective, nor the deployment of reliable services to carry out the necessary corrections and upgrades.

3.5 Implementing lessons learned

The feedback from maintenance campaigns should be implemented effectively:

- Renovation or renewal proposals should be thoroughly studied and evaluated, including a solid risk analysis as well as an ROI calculation. Priority must be given to carrying out updates that either address high risks or promise a rapid return.
- In some cases, issues identified during crane maintenance may be attributed to inappropriate crane operation, for example improper use of the emergency stop (possibly by operators unaccustomed to working with frequency-controlled drives). Where this

is identified, appropriate training should be organized. In some cases, technical features could be introduced to discourage inappropriate operation.

- Every opportunity should be taken to optimize planning to ease maintenance, make it more effective and take into account technical or operational changes and recent strategic decisions. This might involve increasing the frequency of particular maintenance activities, for example simple tasks such as cleaning and lubrication. Successful maintenance scenarios could also be retained in the plan for future reference.
- In some cases, a programme to monitor the behaviour of some of the cranes can be set up. This could include installing automated data logging or just simply provide a checklist to be completed whenever particular problems occur.

Each maintenance campaign is an opportunity to finetune the maintenance plan to make it more effective.

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4. Examples of productivity-centred maintenance

That's the theory of productivity-centred crane maintenance, but how does it work out in practice? Let's look at some real-life examples.

4.1 Increasing productivity using state-of-the-art radio control

Radio control has become a standard feature of overhead cranes over the past two decades. This evolution has enhanced crane operation comfort, efficiency and safety, and radio control continues to revolutionize the way we control cranes. Handheld control devices have become more sophisticated and versatile, opening up a range of opportunities to further improve the productivity of existing cranes.

- Handheld devices are increasingly equipped with a colour LCD display and some have real-time video support provided by crane-mounted cameras. This can be very useful in complex working environments, avoiding the need for an additional operator.
- The user identification feature reduces the risk of unauthorized use and allows constraints to be set depending on the user who has logged on, providing enhanced safety and security without increasing the procedural burden.
- With state-of-the-art radio control, all the commands used can also be logged, providing valuable information to optimize maintenance planning.
- Different receivers can be installed on individual crane drives or components. This can eliminate the need to install and maintain trailing cables between components.

Upgrading crane control can significantly improve operational efficiency.

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These examples demonstrate that there are a number of opportunities to improve the productivity of any existing crane. A thorough productivity-centred maintenance approach can reveal and highlight these opportunities.

4.2 Adapting equipment to harsh operational conditions

This example concerns crane grippers for bulk load handling. Such grippers often have a hard

time, operating in dusty and dirty environments, inviting wear and damage by colliding with obstacles, or scraping along the floor, and many other risk scenarios. Regular and systematic maintenance of all the parts is crucial to keep them serviceable. However, the standard grippers often installed on bulk load handling cranes are not necessarily ideally suited to the actual operating circumstances, leading to rapid wear and a reduced lifetime. In this case, a comprehensive overhaul can make the gripper more robust and reliable, increasing its productivity. Improvements could include:

- Reinforcing the shell by renewing and improving welding joints, replacing cogs, and applying appropriate coatings.
- Installing wear-resistant and maintenance-friendly hinges and sockets. For example, bronze sockets can be replaced by high-grade steel sockets, which are much more robust and need less frequent lubrication, simplifying maintenance.
- Making arrangements to prevent damage to electrical components from moisture ingress.
- Installing more robust hydraulic cylinders.

4.3 Crane servicing on the premises

This example is about optimizing crane maintenance to reduce downtime. A business-critical overhead or portal crane with worn-out splined connections needs a thorough service. To avoid the crane being unavailable for an extended period of time, onsite machining can be used to carry out the maintenance operation. This involves removing metal using mobile equipment, eliminating the need to dismount the worn-out piece to be serviced in a workshop. While offsite servicing can take several weeks to complete, a carefully planned and well-organized onsite service can often be completed in just one day.

Examples include face milling of machined surfaces, face grinding of gears, and reworking of shaft connections by machining faces and diameters.

4.4 Pro-active servicing of crane electronics

Electronic components are the elements most subject to obsolescence in a crane, especially given the rapid developments in the electronics market. Manufacturers launch new frequencies and radio controls at a fast pace, while support for older models is phased out and spare parts become increasingly difficult to find. This can have very unpleasant consequences in the event of a breakdown. It is also important to understand that electronic components are interconnected. When a damaged component needs to be replaced by a more recent version, its compatibility with the entire system should be examined. This may additionally lead to other components needing to be replaced, increasing the cost and complexity of the intervention. And in some cases, the delivery of new components could take several weeks, with possible severe consequences for production.

Productivity-centred maintenance can uncover opportunities to proactively service crane electronics and replace components reaching obsolescence. Proactive renewal of the electronics can be carried out at limited cost, but the benefits are clear: no failures, no unexpected costs, and absolute peace of mind. Also note that such a renewal intervention can be carefully planned and carried out quickly, with limited impact on operational activities. And it means that the installation benefits from the newest developments in electronics.

Proactive renewal of crane electronics prevents failures and unexpected costs, leading to absolute peace of mind.

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5. Conclusion

Productivity-centred maintenance is the more proactive approach to crane maintenance. Giving priority at every level to plant productivity (along with safety), it considers maintenance as a business-critical project, aiming at long-term equipment reliability and productivity as well as undisturbed continuity in all related plant activities. It does require, however, that maintenance companies have access to comprehensive mechanical and electromechanical expertise.

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- i. This paper focuses on cranes performing specific tasks in a plant's operational processes. It does not apply to cranes used for maintenance purposes only.
 - ii. It is interesting to note that many industrial companies tended to economize on crane maintenance during the period 2008-2016, blaming reduced production volumes. Since production volumes are now rising, crane maintenance should again receive proper attention.