THE ANSWER IS AUTOMATION

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discuss port automation best practices for dry bulk handling.

The increasing volatility in the global market, caused by geopolitical conflicts or pandemics and which have a considerable impact on maritime traffic and thus on cargo handling in ports, causes port and terminal operators to face enormous challenges.

Market changes require quick response times, and terminals must react securely to strategic and operational issues. Long-term competitiveness requires, among others, the following:

- Cost reduction and increase of efficiency.
- Flexibility to changing market conditions.
- Optimum utilisation of port facilities and handling equipment with a state-of-the-art maintenance and repair strategy.
- Securing the highest possible productivity rates and equipment availability.
- A sophisticated and intelligent IT-infrastructure to handle extensive data flow.
- Well-trained personnel.

But how can these essential survival targets be achieved? One answer could be to go for autonomous operation.

Autonomous operations

HPC, a leading company in the ports and logistics sector, has seen the effect that automation has had shaping the global port business in recent years, and believes it will continue to do so. As a member of PEMA, HPC cooperates and actively supports equipment and component manufacturers by exchanging know-how, experience, and expertise gained in various automation projects around the globe. A revolutionary breakthrough was achieved by designing and developing new generation 3D-laser and sensor technologies, in conjunction with intelligent software, communication systems, and data processing capabilities. Terminals incorporating and applying the latest technologies to their handling equipment and IT infrastructure are now much more competitive thanks to autonomous machines with less operating cost.

An increase in handling capacities and performance gains are usually seen with an autonomous operation. However, these results can vary between each terminal due to the different skills and performance of the manual operators or existing conventional automation solutions. Anyhow, benefits such as working through usually defined break periods help increase equipment utilisation.

Today, an operator in the remote control station can easily control eight stackers/reclaimers or four grab shipunloaders without being exposed to an industrial environment and improving the ergonomics of the workplace. At the same time, modern network technology allows for re-locating the remote control station to almost any location, even when 1500 km away from the terminal.

The return on investment of autonomous operation in the bulk business is usually between two and three years. Some terminals have reported even shorter times based on throughput, equipment utilisation, and upgraded number of machines.

Autonomous operations for dry bulk handling

In an increasingly competitive environment, all manufacturers and operators of stockyard machines and shiploaders and unloaders have been tasked with providing a higher level of automation, in order to provide additional value and reduce the cost of operation.

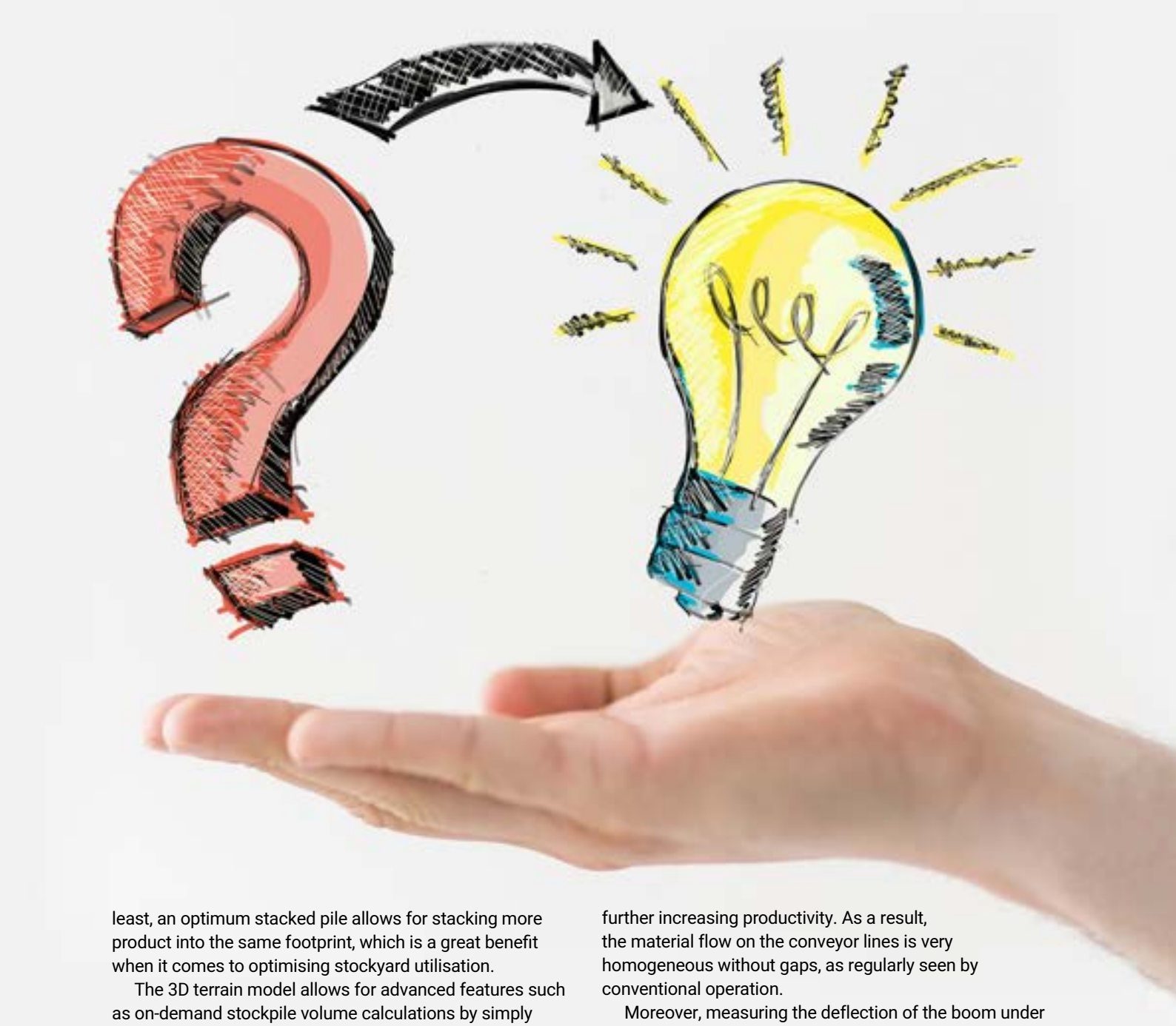
Case study: Hansaport, Port of Hamburg

iSAM AG, developed and implemented cutting-edge technology at Hansaport, Port of Hamburg and is available as retrofitting kit for almost any existing equipment.

Stacker/reclaimer

A key to optimum reclaiming performance is stacked piles correctly. Using a real-time 3D model to control machine movements ensures that piles are always stacked with a perfect and homogeneous top within the desired footprint. This is achieved by constantly measuring the angle of repose of the already stacked product and adjusting the stacking path accordingly.

At the same time, even over-stacking remnant piles or connecting to a partially reclaimed pile is possible while maintaining the same optimum pile shape. Last but not



least, an optimum stacked pile allows for stacking more product into the same footprint, which is a great benefit when it comes to optimising stockyard utilisation.

The 3D terrain model allows for advanced features such as on-demand stockpile volume calculations by simply clicking on a pile. Combined with features like storing product data, such as the density per layer or section within the pile, this allows for smart inventory management without the need for frequent aerial surveys.

For reclaiming, the face-up of the machine results in cutting into the pile with the first slew. Utilising real-time 3D scan data allows for calculating optimised slew turnaround points, effectively avoiding 'air-digging'. As an advanced autonomous control system is able to 'see' the stockpile, this is independent of the shape of the pile; i.e. even if the pile was modified by dozers or landslides happened due to rain, the machine always performs optimum movements.

Predictive slew control combines the feedback from existing torque/active power metres with a predictive algorithm calculating the bucket overlap immediately ahead. Combining the actual bucket wheel load and the known stockpile shape allows higher slew speeds without overload trips and faster acceleration in areas with reduced overlap.

Knowing the bucket wheel overlap in real time also allows using dynamic turnaround points, which is a key for further increasing productivity. As a result, the material flow on the conveyor lines is very homogeneous without gaps, as regularly seen by conventional operation.

Moreover, measuring the deflection of the boom under load during reclaiming in real time allows for adjusting the boom height for a perfectly even bed in the lowest layer, without digging into the ground or leaving product behind. In this way, the machine movements are optimised during stacking and reclaiming, reducing the environmental impact during operation, saving on energy or significantly reducing dust emissions.

Virtualisation technology minimises the amount of equipment required on the machine to new sensors and a compact distribution cabinet. A centralised and scalable server system processes all sensor information and feeds-back the required control data to the machine programmable logic controller (PLC). The only requirement is a Gigabit fibre network link that most modern machines already have and can be retrofitted for older devices.

Shipunloaders

Significant progress in reliable and safe autonomous operation has been achieved with ship unloaders in recent years. For instance, features such as redundant calculations and energy models for the grab control ensure

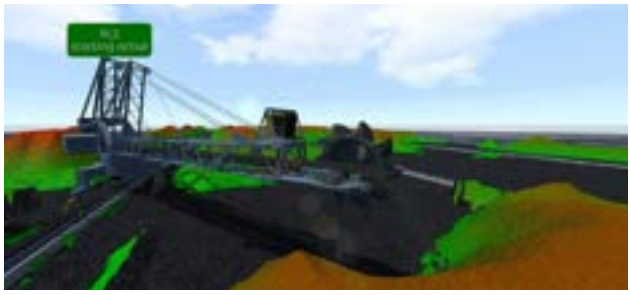


Figure 1. 3D real-time view of virtualised stockyard during autonomous stacking.

Figure 2. Grab shipunloader at Hansaport, Port of Hamburg, during an autonomous operation.

that the grab can never hit any visible object or the hatch coaming - even if a power outage or E-stop happens at full machine speed.

At the same time, using a 3D hatch detection with redundant processing of the results by the autonomous control system and the machine PLC ensures that the grab can only move within these boundaries. Terminals experience a significant reduction in equipment and vessel damages – often causing massive demurrage payment claims – of up to 90% compared to manual operation.

Besides that, autonomous operation significantly reduces wear and tear compared to manual or conventional automated operation by ensuring that the load on the equipment is always within the design specification, an aspect that can also be observed on stacker/reclaimers.

However, this is not only a result of uniform drive control. For example, enforcing a hard limit on diagonal pull on the crane ropes in line with the original equipment manufacturer's specification substantially reduces the load on bearings and gears. This is achieved by a complex real-time energy model of the grab movement with resulting predictions of the rope angle for each cycle.

A human operator can only estimate or anticipate this from experience. Thus, the movements can be observed to be either too conservative, resulting in poor performance, or too ambiguous. This can result in increased maintenance costs due to faster wear and tear or even direct damage to the equipment.

Conclusion

In recent years, technological achievements have been made in developing new 3D laser scanners and sensor technologies, commencing a trend of shifting from conventional to autonomous operation. Having applied the latest automation technologies to their handling equipment, bulk terminals were able to significantly improve their operational processes and increase equipment utilisation and performance. Moreover, the return on investment for autonomous operation in the bulk business, usually between two and three years, is manageable considering the advantages of such an investment. DB