Reduce damage and increase productivity with an extra set of eyes for the crane driver

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As container ship size grows with each new manufactured generation, so too must the ship-to-shore gantry cranes that service them, and crane speeds must increase accordingly to maintain container-handling productivity.

As a result, drivers of the newest mega-cranes have an especially challenging task. Their visibility is impaired due to the sheer size of the machines and the distances involved, and many distractions vie for their attention, as they must maintain responsibility for the operation of these larger and faster machines.

In response to these challenges, TMEIC GE developed the Maxview Smart Landing™ system, which acts as an extra set of eyes for the driver in this busy operating environment.

The smart landing system protects the crane, container load and vessel without reducing operational productivity. It is especially effective at preventing damage to the crane spreader, which common industry experience indicates is the root cause of up to 50 percent of crane downtime.

Preventing high-speed landings

The smart landing system prevents high-speed landings during container pick-up and drop-off, thereby eliminating a major cause of spreader damage. High-speed landings of heavily loaded containers are especially severe. Such landings impart an enormous amount of energy into the crane structure through the lifting system of the spreader, head-block and wire ropes. This energy transfer causes damage well beyond the spreader into the remainder of the crane structure, such as wire rope snags at the time of impact, and long-term damage due to the resultant cumulative stress on the crane structure.

State-of-the-art laser scanning technology

Spreader-based soft landing systems have been available for some time, but have gained limited acceptance since the container load blocks the sensor in these systems. As a result, they are not effective in preventing high-speed landings during container drop-off. In addition, spreader-mounted sensors are prone to misalignment and early failure due to extreme shock and vibration experience by the lifting system.

TMEIC GE's smart landing system uses state-of-the-art LIDAR technology. LIDAR (Light Detection And Ranging), or 'laser radar', is an optical remote sensing technology that measures properties of reflected laser light to determine the range and position of a distant target.

This laser scanner is a commercially available industrial-grade model with an unprecedented measurement range of 80 meters, which allows the smart landing system to 'see' into the holds of today's largest vessels from the sensor's fixed location on the crane trolley. The sensor also features Class 1 ('eye-safe') laser operation, and IP67 protection for the harshest outdoor environments.

The smart landing concept

As the crane trolley passes over the area, the smart landing system records a profile of the containers as well as other obstacles to spreader motion – including the ship structure, hatch covers, and even the crane itself, as represented by the green line in Figure 1.

The smart landing system also tracks the spreader position relative to the profile. This measurement, along with the stick inputs from the driver, determines the safe operating envelope for the spreader, as depicted by the blue box in Figure 1.

Most importantly, the driver has complete control over his or her actions up to the moment that the smart landing system determines that a collision is imminent; only then will the system moderate the motions of the spreader to assure smooth, soft container pick-up and drop-off.

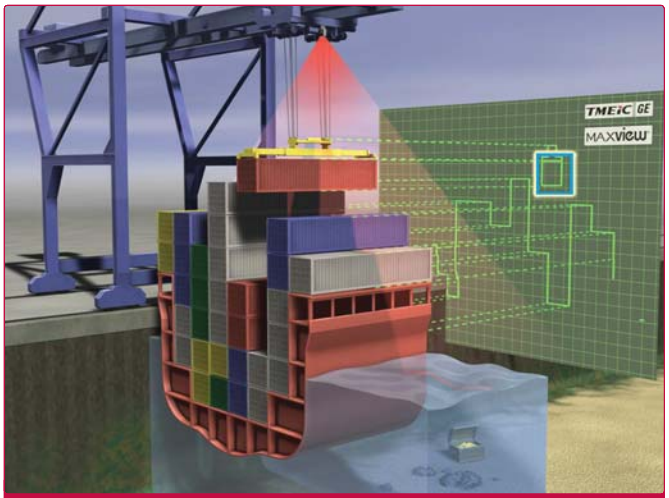

Figure 1. The Maxview Smart Landing Concept.

Figure 2. Landing in a deep cell – where to stop?

Figure 3. The Maxview system in service in Vancouver.

An important design criterion is that the smart landing system can be active at all times for truly 'hands-off' operation, similar to 'back-up' protection systems available on many modern automobiles; operation is only restricted when a collision is imminent.

As a result, the driver can lower at full stick into a cell below deck (as in Figure 2) yet the result will always be a soft landing.

Operational results

In the fourth quarter of 2008, the pilot smart landing system entered service on a new ship-to-shore crane at Vancouver's Centerm container terminal, which is operated by DP World (Canada) Inc. Performance results over the first 15 months of operation are presented in Table 1.

TABLE 1: SMART LANDING SYSTEM PERFORMANCE IN PREVENTING HIGH-SPEED LANDINGS

Sample Set	A	B	C	D
Container Operation	Pick-Up		Drop-Off	
Maxview System On/Off	Off	On	Off	On
Total Landings	7318	20280	9058	20786
High-Speed Landings	2616	119	6493	508
Percentage	35%	0.6%	72%	2.4%
Mass of suspended load	16.5 LT		41.1 LT (average)	
Average Landing Speed	13.2%	6.2%	15.5%	5.6%
Average Kinetic Energy	1437 J	220 J	4214 J	549 J

In this analysis, a high-speed landing is defined to have occurred when the hoist speed was greater than nine percent at the time of landing.

The average landing speed for each sample set listed in Table 1 is given by:

$$\bar{v} = \frac{1}{N}\sum_{n=1}^{N} v_n \quad , \qquad (1)$$

Where

N = Total number of landings in the sample set,

V_n = Hoist speed at the time of each landing,

$\bar{v}$ = Average hoist speed at landing.

Figure 4 indicates that the number of high-speed landings is significantly reduced when the smart landing system is on, especially for container drop-offs.

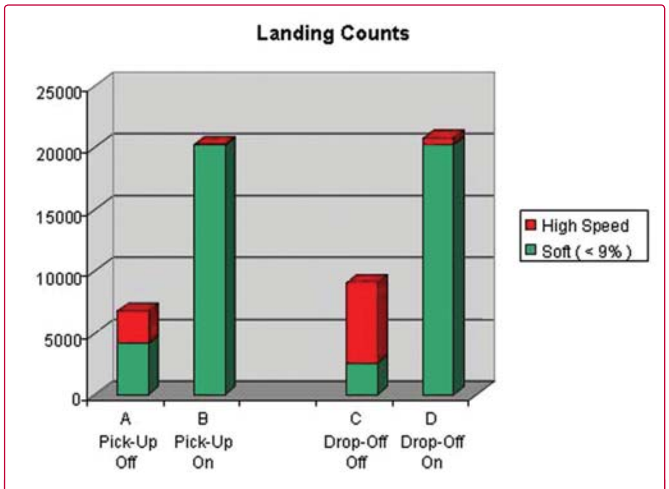

Figure 4. Total landing count of container pick-ups and drop-offs, with the smart landing system on and off.

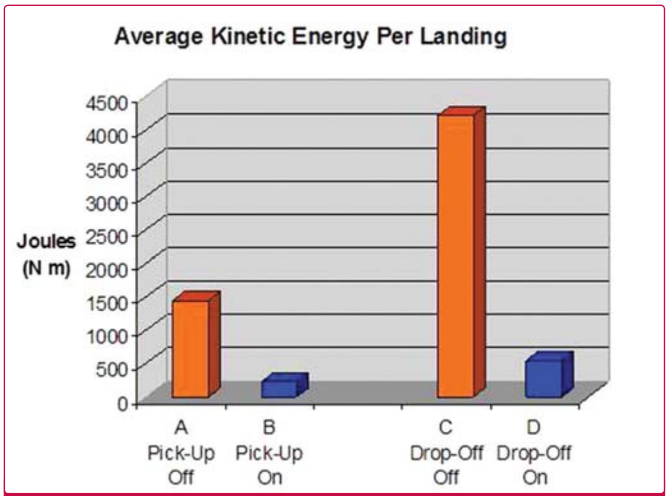

Figure 5. Average kinetic energy per landing for container pick-ups and drop-offs, with the smart landing system on and off.

The average kinetic energy at the time of landing is given by:

$$\overline{E}_k = \frac{1}{2N}\sum_{i=1}^{N} \quad , \qquad (2)$$

where

N = Total number of landings in the sample set,

m = Mass of the suspended load [kg] (the container load is the average over four months of operation),

v_n = Hoist speed at the time of each landing [meters per second],

$\overline{E}_k$ = Average kinetic energy at the time of landing [Joules].

It is important to note that as per equation (2), the energy transferred from the suspended load to the crane structure at the time of landing does not increase linearly with hoist speed, but rather with the squareof the speed.

Figure 5 makes it clear that the energy imparted into the crane structure, load and vessel is greatly reduced when the smart landing system is active – thereby preventing the high-speed landings that cause so much damage.

In addition to these quantitative results of the operational trial, system operation was proven in adverse weather conditions, including heavy rain, snow and fog, with no attention required from the terminal maintenance staff throughout the trial period.

The savings in maintenance provided by the smart landing system quickly became apparent; during its fourth full calendar month in service the crane made more than 2,100 lifts with no unscheduled downtime.

A subsequent installation on two new ship-to-shore cranes at a second terminal is also of interest. To facilitate rapid driver transition to larger and faster machines, the smart landing system has been enabled at all times (the driver cannot switch it off). These cranes have made more than 24,000 combined lifts since entering service in late summer 2009, confirming that the system design goal for 'hands-off' operation has been met.

The smart landing system has achieved the overall design goals by reducing crane landing speeds and associated damage, without decreasing crane productivity.

Protecting customer property

One of the benefits that cannot be directly measured is the protection of customer property: both the container and its contents. Containers are frequently filled with cargo such as sensitive electronics (DVD players, LCD TVs, laptop computers, and so on). High-speed landings are an avoidable occurrence in terminal operation, and the effort to eliminate them should be driven by both the terminal operator and the shipping lines. The smart landing system reduces cargo damage and associated customer complaints and insurance claims.

Conclusion

Drivers of today's mega-sized ship-to-shore container cranes are faced with a wide array of challenges during operation. High-speed landings are a natural result of the distractions and pressures placed on them.

Furthermore, spreader damage due to high-speed landings is a major source of ship-to-shore crane downtime and maintenance costs. Effective, 'hands-off' and proven prevention of high-speed landings is available today via solutions such as the TMEIC GE's Maxview Smart Landing system.

ABOUT THE AUTHORS AND COMPANY

Maksim Mihic is the Manager, Engineering & Maintenance at DP World (Canada) Inc., in Vancouver, British Columbia. A BSEE graduate of Sarajevo University, former Yugoslavia, he has more then 20 years of experience in industrial controls, with the last 15 years in the port industry, improving equipment performance, business processes and managing terminal expansions and port equipment acquisitions.

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TMEIC GE is a global joint venture between industry leaders Toshiba, Mitsubishi Electric and GE formed to focus their combined product and application expertise on the industrial drive systems business. With a large staff of industry leading application experts, TMEIC GE has a long history of successful crane automation system installations at nearly every port around the world. As the global leader in Crane Automation solutions, from simple drive upgrades to fully automated cranes, TMEIC GE is committed to "Delivering Customer Success, very Project, Every Time".

ENQUIRIES

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