Introduction
The world’s first remotely operated ship-to-shore crane is now in commercial operation. The crane is operated from a remote control station, similar to a control station for automatic stacking cranes (ASC). The control station is located in a control room in the terminal office area. The remote operation system has been developed in close cooperation between ABB Crane Systems and Manzanillo International Terminal (MIT) in Panama.

The first phase: fixed cabin
The crane is equipped with a fixed cabin mounted on the crane leg. Aided by cameras, the operator can control the crane from a familiar environment; the fixed cabin is a replica of the trolley-mounted operator’s cabin with additional monitors for camera images.

After having delivered more than 300 remotely operated stacking cranes and with a suite of automation features for the STS cranes, it was a natural step for ABB to test automatic STS operation supported by camera images.

With a more upright operating position and by avoiding the acceleration/deceleration forces from the trolley, the operator gains a better working environment. Frequently occurring back problems can be eliminated and costs of sick leave are greatly reduced. This opens the way for future cranes with faster trolleys and shorter acceleration/deceleration times.

During the test period, ABB worked closely with the MIT team to evaluate and improve functionality. Engineers and operators were involved throughout the entire development and testing process to guarantee the best possible solution for operation. The goal was to prove that operation from a fixed cabin could be as productive as operation from a movable cabin. That goal was well achieved.

The second phase: remote control
After successful implementation of the fixed cabin, the next phase was to implement operation from a remote control station (RCS), similar to the one used for ASCs. Remote control was

Remotely operating quay cranes from a desk rather than a crane cabin means improved ergonomic working conditions for operators, with stress on the back and neck reduced to a minimum.
a logical step, given that ABB is the world leader in stacking crane automation, and also has an extensive range of automation solutions for quay cranes. The remotely operated quay crane is an excellent example of how one market segment can benefit from progress made in another segment.

The strategy has been to combine proven technology with cutting-edge camera technology to minimize risks and guarantee successful implementation. Being at the forefront of technology means working closely with suppliers; each new application poses demands never before encountered.

RCS
The remote control station is an operator's desk of the same type used for automated stacking cranes. The desk is fitted with joysticks and buttons for remote control of the crane, and monitors for camera images and information for the operator. The operator can communicate with people on the ground via radio, for example, getting updates on the load list.

The video system includes cameras for load tracking, control and area supervision. While remote operation means some limits to depth perception, the cameras can provide views and angles not seen from the traditional operator's cabin. These views are very helpful during fine-positioning of the spreader and improve safety for people onboard the ship.

Ergonomics
When operating from the trolley mounted cabin on the crane, the operator is leaning forward, looking downwards between his feet. With the fast accelerations and decelerations of the trolley, this position can be very hard on the back and neck. By using cameras the operator can sit in an upright position. The height of the desk and chair can be adjusted to vary the working posture. Stress on the back and neck is consequently reduced to a minimum, resulting in healthier operators.

When the acceleration/deceleration effects on the operator no longer need to be considered, the trolley can be designed for higher speeds and shorter ramp times. Tuning of the automatic sway and position control can also be more aggressive. This decreases cycle times and increases productivity.

Quay crane automation
The crane is fitted with a number of automation systems to facilitate remote operation. The main part of the crane cycle is performed fully automatically by the crane control system, with the operator only supervising the crane movements. A work order, initiated by the operator or generated directly by the terminal operating system (TOS), is sent to the crane and after acceptance by the operator, movement begins. With automation, the operator can focus on the final critical parts of the cycle.

If the crane is fitted with a lashing platform or a vehicle alignment system, landside operations can be fully automatic. With the implementation of automation systems for lashing and vehicle-guiding comes control of both the crane and people in the vicinity, meaning a safer environment for all people involved in the operation.

Production and planning
Comparisons between manual and automatic operation show that berth productivity increases with automation since the difference in operation will be evened out. Measured over a shift, all operators will benefit from automation and the production becomes more predictable. With the operators moved to a controlled office environment, they can work side-by-side with other operators, which improves their social situation and enables direct communication with the operations department. Since any crane can be controlled from any desk, short breaks can be taken without interrupting production.

The remote control stations can easily be adapted for control of multiple crane types. A pool of operators can handle both quay cranes and stacking cranes, thus enabling improved and flexible staff planning and more efficient use of resources.

If new cranes are delivered without an operator's cabin, the weight on the trolley is greatly reduced. This means that the trolley motor and drives can be scaled down, while still maintaining the same performance as a crane with a trolley mounted cabin. Apart from the lower initial investments, the smaller motors have lower energy consumption.

For ABB, unmanned operation has been one important step in a series of development projects targeting quay crane productivity, energy efficiency and operator ergonomics. There is an ever-growing interest in remotely operated quay cranes, and ABB is confident that this technology is now ready for large-scale deployment.