Skew Control for
Gantry and Overhead Crane

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INTRODUCTION

Gantry and Overhead cranes with driven motors on both sides can be susceptible to one side moving faster or farther than the other. This “Skew” in position can cause major control problems and wear to critical mechanical parts. If the skew between sides gets large enough, cranes can experience “walking” or one side catching mechanically then the other. This can cause mechanical wear and even failure. Avtron has developed a stand-alone package that can be used with most brands of AC and DC drives, that will control the amount of skew seen by the crane.

BACKGROUND

For years, large gantry and overhead cranes have been victims of skew when operating. Overhead cranes were manufactured using a single drive-shaft which offered some relief due to the mechanically coupled sides. Gantry cranes do not have this flexibility. Most gantry cranes follow a set of rails mounted on the ground. The physical layout of the rails determines the cranes path. Movement is created by motors on each side driving the wheels. Typical configurations can have anywhere from two to twelve wheels per side.

As the separation distance between the rails gets wider, problems can arise. Larger distances between rails or the “Span” allow more flexibility in the structure. This can cause the gantry legs travel to become un-parallel to each other. As the crane travels, one set of wheels starts to run into the rails experiencing more resistance and slowing down one side of the crane. Because the other side is running faster, the crane starts to point to one side causing the wheels to run into the rail with more force causing more wear. If the skew gets significant, the crane can physically stop. Measurement of the difference between the sides travel is called “Skew”.

Figure 1 – Skew direction on Rails

Typically, skew is measured in five inch increments. Values in the range of 5 to 25 inches can be seen. Skew tolerances are typically provided by the original equipment manufacturer (OEM). Control is dependent on the design of the crane and its use. Some typical rules of thumb include::

- Gantry cranes with a span of 65 feet or less typically do not need any type of skew control.
- Gantry cranes with a span of over 100 feet will almost always need some form of skew control.
- Gantry cranes between 65 and 100 feet may need skew control depending on the location and application of the crane.
Overhead cranes with spans over 100” will almost always require some form of skew control.

**PROJECT SCOPE**

A Finishing area crane in Nashville, Tennessee had such skew issues. Built in the 1990's, the crane services railroad car repairs and other types of work. Operation is frequent and the crane must be available at all times. Skew control was provided on the crane but never functioned to the users satisfaction. Over time, the system was no longer operational which caused many issues. Because of the demands on the crane, wheel wear was frequent and caused down-time due to repairs. In addition, the end trucks eventually failed causing additional problems. The user needed a solution that would integrate with its existing drive control systems but would also provide the skew tolerances needed for the crane.

Avtron worked with Foley Material handling to provide a package for the skew control problem. Foley Material Handling provided all the mechanical and installation labor for the project with Avtron providing a new skew control panel that would interface with the existing drive system. This provided a low cost solution for the end user by not having to replace the entire drive control system.

**SKEW CONTROL SYSTEM**

**Position Feedback**

One of the most critical pieces of data to be measured for skew control is the position for each side of the crane. Feedback must be reliable and accurate so that the control system can do its job. Several methods are available to perform this task with the two most popular being laser and rotary position feedback.

Laser feedback can be very accurate and does not need any calibration or homing for operation. A typical configuration is to have a laser mounted onto the moving crane that emits to a fixed target on the ground. As the crane moves, the laser can continuously measure the distance from itself to the target. This information is then calibrated to calculate the crane's position at all times. The drawbacks to this type of feedback is the cost of the lasers and routine maintenance required to keep the optics and target clean. Environmental conditions can also come into play like severe weather, steam or smoke that could falter the lasers operation.

Another method is to use rotary encoders that are driven from either the motors or gantry wheels. Rotary encoders provide a pulse train based on the revolutions of the encoder's shaft. By knowing the relationship between the number of turns on the encoder and the linear distance of travel, an accurate measurement of feedback can be obtained. Encoders are fairly economical in price and easy to install.

Using rotary encoders does pose some challenges. Wheel slippage can cause erroneous distance or position feedback. As the wheel slips, pulses are generated by the encoder. Although the crane has not moved, the control system calculates movement. This is especially the case when an operator is running the crane at full speed in one direction and then reverses the crane to run in the opposite direction. Weather can also cause slippage due to rain, snow or ice.

To solve this problem, the system needs points of reference to re-calibrate itself without slowing the operation of the crane. This is achieved by the addition of proximity switches on each side of the crane. Marker flags are installed at a known distance apart near the tracks. Each time the proximity switch is triggered, the system knows that it has traveled a known distance. Each time the crane moves a known distance, it is compared to the actual feedback and calibrated accordingly. This provides an economical, low maintenance solution.
Skew Control
Of an Industrial Gantry Crane

**Skew Control**
A central processing system provides the skew control for the system. A new panel was provided and installed within the existing drive system enclosures. Mounted on the panel is a new PLC system that will provide the control of the skew on the crane. Master switch references are rewired to analog inputs on the new PLC panel. An analog output is then sent out to the existing gantry drives proving a new speed reference. After the new proximity switches are mounted, they are also wired back to the control system panel. Additional interlocks are brought back to the panel and a system fault contact is sent out also.

Skew control is possible when there are separate motors running each side of the crane. This enables the control system to adjust the speed of one side to keep the crane within tolerance. One method of control is to look at each motors position relative to the other. When the crane is outside of the tolerance window of control, the system could slow one motor down and speed the other motor-up to bring the crane back into acceptable limits. In practice, this is hard to do and reduces the amount of control available by half due to correcting half the distance on each side.

Better control can be achieved using a master-slave arrangement. The master sections receives the main speed reference and follows the operators desired inputs. It functions just as if there was no skew control active. A second reference is fed to the slave section. Position and speed are monitored for both sections and compared to the allowable tolerances for the crane. If the crane moves outside the skew window, the slave section is either sped up or slowed down to bring the crane back into tolerance. Controlling the skew in this manor eliminates overcorrection or unstable control seem with systems that try to correct on both sides.

**Operator Control**

Interface to the skew control system is through a human machine interface (HMI) located in the operators cab. Information from this unit allows the operator to enable or disable the system and display information that is important for operation. One of the most important pieces of data is the skew difference between the two sides of the crane. This tells the operator real time the skew distance between the sides.

*Figure 2 – Skew Difference*
A screen is also available showing the position of each side of the crane. This tells the operator how close the crane is to being square and where each side is relative to the total position.

**Figure 3 – Skew Position**

The HMI display also provides diagnostic information to the operator should a failure occur in the system. A fault will stop the system from operating until the operator turns the skew control off. An alarm is set in the system and the HMI screen turns red so that the operator can clearly see that there is a fault in the system. This information can then be relayed back to maintenance personnel so that the problems can be resolved.

**Figure 4 – Skew Fault Display**

**CONCLUSION**

Operation of large gantry and overhead cranes can be effected quite significantly by skew. By not correcting the effects of skew, structural and mechanical wear can result. Significant maintenance costs will result along with a shortened crane life. Skew compensation will eliminate this problem and provide a more reliable and dependable crane. Having a system that is flexible and non-evasive to the existing drive control system, makes skew control a very affordable option.