Joystick Test Module

OZ Century

Problem or Initiative

OZ Century uses 966 Liebherr Shovels (shovels) in its open cut mine operation to move ore into haul trucks. Joysticks in the cab of the shovel allow the operator to operate it the machine, in particular its bucket which can move up to 50 tonnes of material in one pass.The ore is then unloaded into the haul truck and transported to the ROM pad for processing.

OZ Century operates between one and six shovels at a time, depending on the location of ore in the pit and the mine plan being used. Between December 2007 and September 2008, sixteen joysticks were replaced at the mine[1].

For safety reasons, faulty joysticks are immediately removed from shovels for repairs and replaced with a new joystick. Previously, as there was no way of identifying the cause of a fault, an electrician would carry out general repairs on the joystick until it was deemed to be operating correctly – a “guess and check” solution. Furthermore, as there was also no way of remotely testing whether a joystick had been repaired successfully, shovel operations would cease while it was refitted and tested by an electrician. If the joystick was still not functioning correctly, an electrician would have to remove the joystick, carry out additional maintenance and then refit and re-test. This process would often be repeated several times before a joystick functioned safely. Due to the safety risks and labour intensity[2] of the repair process, if a joystick could not be repaired after several attempts, it was discarded at considerable cost.

Prior to undertaking any repairs or tasks on Century’s mobile fleet, personnel must complete a Personal Pre-start, a Job Safety Analysis and ensure that all hazards are identified. Despite this process risks still remained with the joystick change out process, including:

• The risk of heat stress as the ambient temperature in Century’s pit can reach 60 degrees and the shovel’s glass cabin tends to trap heat once the machine and air conditioning have been shut down.
• Risks involved with working at heights from climbing on and off the shovels, the cabin of which is approximately 9.5 meters from the ground. This also has the potential to increase fatigue as technicians are repeatedly climbing up and down the ladders. The temperature of the shovel from heat soak is also a major contributor to fatigue as the body adapts to these conditions.
• The risk of an electrician receiving an electric shock while connecting and tuning a joystick to within correct operating parameters from stored electrical activity.

1 Heavy Vehicle Maintenance records, December 2007 – September 2008.
2 The process is estimated to have taken about four hours.

• The greatly enhanced risk of an uncontrolled movement during the calibration of a repaired joystick as the “guess and check” approach used was not an effective way of testing the settings on a joystick. This had the potential to result in soft tissue injuries, strains and whip lash from these sudden uncontrolled movements.
• The risk of an uncontrolled movement from the joystick relaying an incorrect signal and inflicting injury to personnel or damaging vehicles in the immediate area.
• The added risk of uncontrolled movement damaging the high pit walls. This could have resulted in the face of the pit fracturing and the high wall failing, causing a major incident especially if there personnel in the area.
• The risks involved with light and heavy vehicle interactions in the pit, which was increased as a number of trips to the shovel in the pit may have been required. This risk also increases substantially during the wet season when heavy rains are common in the Gulf region creating slippery roads and water and mud hazards.

The process for repairing shovel joysticks also carried significant costs as shovels had to cease, often several times, while a joystick was refitted and tested, impacting on ore movement and such production. Furthermore, this process was very intensive, often taking up to four hours (including driving to and from the workshop) and costing up to about $240[3]. However, due to the “guess and check” nature of the repair process, the joystick may still not have been successfully repaired. Joysticks were discarded if they could not be repaired after several attempts. Replacement was at significant cost, with a single joystick for a Liebherr 966 costing about $9,000[4]. Transport, inventory and disposal costs associated with the purchase and discarding of joysticks are also especially high due to Century’s remote location.

Despite the extensive combined knowledge of Century’s Heavy Vehicle Maintenance team of the parts and equipment available for Liebherr shovels, they were unaware of system that would allow shovel joysticks to be remotely tested.

The Solution

It was determined that the Heavy Vehicle Maintenance team needed to develop a safe and cost-effective system that would allow them to remotely test the functionality of shovel joysticks. After discussing the needs of the system with the maintenance team, the electrician assigned to the task identified the following characteristics as necessary:

• The ability to be used remotely, eliminating the need to refit and retest the system. This included the ability to check whether the joystick was working as well as to determine whether the joystick was functioning within the appropriate voltage parameters.
• The ability to clearly show whether the joystick was functioning correctly.
• The system to be lightweight for movability, eliminating any risks associated with lifting heavy equipment.

3 Based labor cost charge out rate of $80/hour for heavy vehicle maintenance technicians.
4 Based on cost investigations carried out by heavy vehicle maintenance team in January 2009.

The electrician then developed the Joystick Test Module to incorporate these characteristics. The joystick module case is constructed from a universal electrical housing that is readily available. This lightweight material allows for easy transportation while ensuring that the test module itself is protected. The test unit has been designed so that while manoeuvring the joystick on an axis - simulating working conditions - LED lights illuminate informing the electrician that the joystick is functioning correctly. This also informs the electrician of any faults that have not been repaired, ensuring that the repaired unit is confirmed as fault free before installation.

The test module can be connected to data logging software, enabling the electrician to ensure that the joystick is operating within stringent electrical parameters and is completely safe for use. The joysticks and test module have been standardised by deutsche plugs, thus enabling joysticks to be tested without any modification or alteration.

The Joystick Test Module works as follows:

1. The faulty joystick is removed from the shovel.
2. The electrician carries out repairs on the joystick. Usually, this involves changing the universal joint at the top of the joystick.
3. The electrician connects the shovel joystick to the Joystick Test Module for testing via deutsche plug (Appendix 1, Photo 1).
4. The electrician moves the joystick in each direction. Flashing lights illuminate as the joystick is manoeuvred in each direction if it is functioning correctly (Appendix 1, Photo 2).
5. If all lights do not illuminate, the electrician plugs the Joystick Test Module into a laptop computer and the electrician carries out additional repairs and maintenance.
6. If all lights illuminate, the electrician plugs the Joystick Test Module into a laptop computer and connects it to a data-logging program.
7. Using the data-logging program, the joystick is tested again to ensure that it is operating within appropriate parameters (Appendix 1, Photo 3).
8. If functioning correctly, the joystick is then refitted into a shovel for immediate use or stored for later use.

Benefits/Effects

By allowing joysticks to be remotely tested for functioning, the Joystick Test Module has eliminated or reduced many of the safety risks involved in the process of manually refitting and testing faulty shovel joysticks.

Most importantly, the development of the Joystick Test Module has:

• Eliminated the potential for soft tissue injuries, strains and whiplash from sudden uncontrolled movements by ensuring that a joystick meets all OEM specifications prior to installation, alleviating the need to manually tune the joystick in the shovel cabin.

• Eliminated the risks of an uncontrolled movement causing injuries to bystanders by ensuring that the joystick being fitted meets all OEM specifications prior installation, alleviating the potential for an incorrect signal to be relayed from the joystick to the main control valves.
• Eliminated the risk of exposure to electrical shocks as the technician does not need to tune the joystick in the machine.
• Decreased the risk of heat stress by reducing time spent in shovel without the engine or air-conditioning running.
• Reduced the risks associated with working at heights while also reducing the risk of fatigue by decreasing the number of trips required to climb up and down the boarding ladder. Further, this minimises the electrician's exposure to heat build up from the engine cooling system situated in front of the boarding ladder.
• Reduces the risk to pit personnel by reducing the amount of trips needed to conduct the necessary repairs to the joystick in the machine currently being worked on.

As well as these important safety benefits, the Joystick Test Module has produced significant cost savings. While the system cost only about $300[5] to build, it is expected to produce more than $494, 000[8] of savings in 2009 as a result of reduced shovel downtime and resulting production loss, labour costs[7], part replacement costs, fuel usage, inventory and disposal costs[10]. In many cases, it was found that a faulty joystick could be repaired with electrical work and by replacing the universal joint.

It is also expected that the Joystick Test Module will reduce carbon emissions by 19.43 tonnes in 2009[6] by reducing unnecessary start up and shutdowns of the shovels and light vehicle use.

Transferability across Industry

While the Joystick Test Module was developed for use with Liebherr 966 shovels, the design
of the system means that it can be easily applied to various electric over hydraulic control
circuits within the mining and industrial sector, with little if no alterations to the test unit.

5 Based on estimated cost of materials and labor (3 x $80/hour heavy vehicle maintenance technician chargeout rate = $240).
6 Based on replacement cost of $9, 000/joystick, labour and materials cost and assumption of an average of three shovels working throughout 2009. Also includes repaired joysticks that were to be discarded.
7 Based on cost difference of about $160 per joystick. Figures are drawn from average cost of repair using old method (4 hours x $80/hour labour charge out rate = $320) and average cost of repair with Joystick Test Module (1 hour x $80/hour labour charge out rate + $80 cost of universal joint).
8 Based on a 7.8 kilometre return trip in a light vehicle from the Heavy Vehicle Workshop to Stage 6 of the mine and reduction of ceasing and restarting 966 shovel.

Other features which make it easily transferrable for use throughout the mining industry include:

• The use of deutsche plugs to connect the joystick with the Joystick Test Module. Deutsche plugs are commonly used in joysticks and other equipment with electrical wiring, meaning that electricians or technicians within most industries will be able to immediately use the system with minimal adaptation.
• The Joystick Test Module has also been developed to work with any data-logging program, meaning that operators at any site can connect the system to existing software, reducing initial cost outlays.
•As the system is easy to use – operators determine if a joystick is functioning correctly by manoeuvring the joystick in each direction and monitoring LED lights – very little training is required before the Joystick Test Module can be used in the workplace. This improves its transferability across the industry by further reducing initial outlay costs.
• As the system is lightweight, it can be easily transported and moved by one person to a different location in the workplace. This means that the Joystick Test Module can be utilised in various locations in a workplace, eliminating the need for an organisation to purchase multiple systems.

Innovation

The development of the Joystick Test Module drew on the Heavy Vehicle Maintenance team's extensive knowledge of the joystick replacement process, 966 Liebherr shovels and available parts. The electrician assigned to the task drew on this knowledge and experience when identifying necessary features for the remote-test system and received feedback from the team during initial testing.

The electrician used materials readily available at Century to develop the Joystick Test Module. This was done to ensure that the lowest possible cost was attributed to the design and enable the quickest available turn around between development and use. Extensive knowledge was pooled together on site from personnel from different departments to ensure that all available options where utilized. The use of existing equipment already on site (for example, the data logging software) also ensured that development cost was kept to a minimum.

The electrician also gained feedback from the site's safety team system and worked with them to carry out a Job Safety Analysis (JSA) and Safe Work Instruction (SWI) so that other technicians could carry out joystick repairs.

This innovation reflects Century's commitment to safety, cost-containment and continuous improvement. At Century, every activity is regularly examined to ensure that it complies with strict safety standards, and whether any safety risks can be further minimised or eliminated. The Joystick Test Module illustrates that by drawing on in-house expertise and supporting innovation that safety can be enhanced and significant cost benefits achieved.

Appendix 1

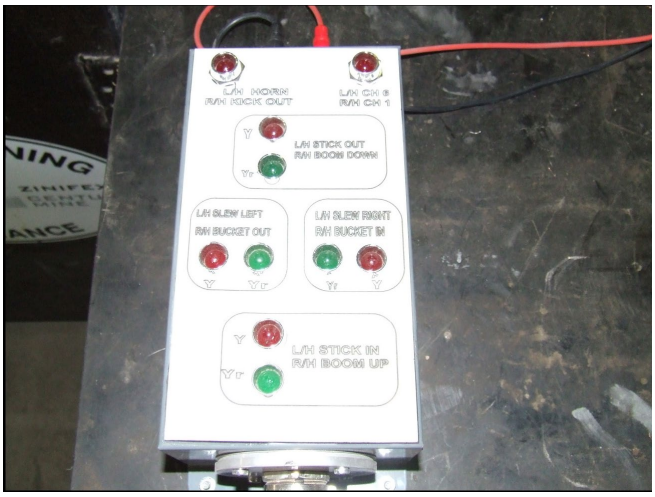

Photo 1: The Joystick Test Module allows shovel joysticks to be remotely tested. The system was developed to reduce the safety risks associated with the need manually refit and retest joysticks after repair.

Photo 2: Once the electrician has repaired the joystick, it is connected to the system via deutsche plugs. The joystick is then manoeuvred in each direction, with LED lights illuminating in the appropriate direction if the joystick is functioning correctly.

Photo 3: The electrician then connects the Joystick Test Module to a laptop to measure the voltage the joystick is operating at. This allows the electrician to use existing datalogging software to confirm that the joystick is running within appropriate voltage parameters and safe for use.