Integrated material handling in a steel service centre

An integrated handling system in a steel service centre helps cut process time by 50%, boost productivity by 75% and enhance safety.

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A prominent North American steel service centre has significantly improved productivity and safety, while drastically cutting costs, by fully integrating material handling into a metalworking process. The process involves plasma and gas burning of steel plates to make custom-designed parts for manufacturers. Until now, manual material handling had been an efficiency bottleneck and a safety concern.

The operation can be divided into two distinct phases: the high-technology torch operation and the dirty, labour-intensive handling of the pieces after they have been burned. During burning (cutting) the torch is manipulated by a computer that has maximised the utilisation of the plate, and the entire operation has minimal operator interface. After cutting, workers pull the individual pieces from the burn table, flip them over to clean the edges, and then package the pieces. This is the grimy side of the process where workers are prone to injury.

The majority of the cycle time and direct labour costs comes from the material handling phase of the process. With customers demanding higher quality components, faster on-time delivery and continuous price reductions, improving the material handling phase is crucial to meeting market demands and staying competitive.

Many companies have made incremental changes to the material handling operation, but the wholesale re-engineering of the entire process has not been successfully implemented until now. The service centre knew that it had to reduce delivery times and costs to enhance revenues, and decided to completely re-think the material handling operation and eliminate the constraints of past paradigms and long-established traditions. It took a significant leap forward and streamlined the process, going from four men handling the individual parts two or three times, to two men who never physically touch the parts. Processing time has reduced by more than half, resulting in significant additional uptime on the cutting torches.

● **Figure 1**
Overhead crane with magnet carrying burned plate above inlet table. The table has a steel mesh conveyor on it

The material handling phase begins when the torch bridge is rolled away from the burned plate. The large skeleton that is left may contain up to a hundred parts burned from the plate. These parts all have slag around the bottom perimeter, a by-product of the cutting process, and which must be removed by some mechanical method (grinding, scraping, machining, and so on) before the part can be shipped to the customer.

The conventional process usually starts by removing each piece with a magnet or other 'below-the-hook' material handling device and placing it in a pile next to the burn table. Individual pieces that drop through the slats into the water table need to be fished out by hand. The pile is then transported to a separate area where the pieces are flipped over and the slag removed with a hand scraper. The process is complicated by the fact that the pieces have multiple configurations and range in weight from 0.5 to 140kg. After all the slag is removed, the pieces are sorted by customer and stacked onto pallets prior to shipping.

The new approach

The company reviewed this process and established three ambitious goals:

- Eliminate multiple manual handling of individual pieces
- Eliminate the potential of injuries to workers
- Cut process time by 50%

● **Figure 2** ***Inlet table and barrel inverter. Inverter turns 3.6t plate over for de-slagging***

● **Figure 3** ***Outlet table (left) aligns with barrel inverter prior to receiving transferred plate***

Cost savings would naturally result if these three goals were accomplished. The key to success was to look at the entire task as one process and design the equipment around it. The final design resulted in an integrated handling system from Bushman Equipment Inc. comprising the following major components: special permanent magnet system, inlet table, barrel inverter, outlet table, skeleton removal crane, and packaging table system.

The first stage of the process involves a 100% duty-cycle magnet having 54 permanent AC magnets designed to lift an entire burned plate (skeleton and individual burned parts as one entity) at one time. The magnet can handle a 2.4 x 6m (96 x 240in). plate up to 50mm thick. Individual components that have fallen after burning can be realigned by the powerful magnetic field so that all the steel is transported from the burn table as one assembly.

An overhead crane picks up the magnet with the burned plate and moves it to the inlet table (see *Figure 1*). The inlet table consists of a steel framed table, topped with a large steel mesh conveyor designed to withstand high dynamic loadings. The magnet disengages the burned plate onto the inlet table and then returns for the next load. The inlet table contains a transition joint operated by an electrical actuator to provide a smooth transition between the table and a barrel inverter. When the control and safety switches indicate proper alignment between the table and inverter, the table conveyor and the barrel conveyor are activated, and the burned plate is transported into the inverter. Proximity switches, strategically placed throughout the process line, provide real-time information to ensure that the plate and its parts are moving properly. Once the plate is fully inserted into the barrel inverter, the conveyors stop, and the transition joint is automatically retracted.

The barrel inverter has only one job – to turn over the metal plate. However, a 6m long plate weighs 3.6t and may comprise a hundred individual components. The 4.3m diameter barrel (see *Figure 2*) uses four hydraulic cylinders to clamp the burned plate between two special steel chain mesh conveyors. Top and bottom conveyors are required since the plate needs to be carried in and out of the barrel after rotation. The barrel is rotated using a heavy-duty worm gear brake motor linked to a variable frequency chain drive system. The drive ensures smooth operation of the large rotating equipment, and precise control when the unit stops after rotating 180 degrees. The barrel and outlet table are precisely aligned so the plate can be effortlessly transferred out of the inverter and onto the outlet table.

Outlet table

The outlet table is the workhorse of the process line (see *Figure 3*). This multi-function machine has three axes of motion and consists of a scissors lift, topped with a steel mesh conveyor, and integrated with a trolley drive system for lateral movement along a track. To start the transfer of the burned plate to the outlet table, the scissor lift is fully raised and the outlet table and inverter conveyors are aligned. Once properly aligned, the two conveyors are activated and the plate moves out of the inverter and onto the outlet table. When the control system confirms the plate is fully discharged from the inverter, the conveyors stop and the outlet table simultaneously lowers and trolleys horizontally along the tracks to a deslag area. Once in the deslag area, a modular crane system equipped with an overhead electric hoist, lifts the skeleton and deposits it in a nearby scrap pile for recycling (a one-man operation.) With the skeleton out of the way, the operator uses a chipping tool on the remaining burned pieces to quickly scrape off the slag which falls into a debris area for collection (see *Figure 4*).

After deslagging, the outlet table trolleys horizontally to align itself to one of the two packaging tables. Conveyors on both the outlet table and packaging table start up and the de-slagged pieces are transferred to the packaging table. When a sensor determines that the transfer is complete, the conveyors stop. An operator at the exit end of the packaging

● **Figure 4** ***Slag removal with chipping tool***

● **Figure 5** ***Packaging table***

table then takes control of the packaging table conveyor, and using a foot pedal control, slowly advances the pieces toward him so that they can be sorted (see *Figure 5*). Again, the operator never touches the pieces; instead he uses a high-speed hoist system coupled with a small magnet to easily lift the individual parts from the conveyor surface to a waiting pallet. The system takes the full load of the component up to 136kg, and the operator simply uses the control handle to direct movement of parts. The table setup is ergonomically optimised for the worker, and bending is minimised.

All limit switches, pressure transducers, proximity switches, variable-frequency drives, photo-reflective photo-eyes, and hundreds of other inputs are linked by a network to a simple programmable logic controller (PLC). A single console provides the operator with a clear picture of the current state of each piece of machinery, plus real-time monitoring of the multiple plates moving through the system. The operator can control each piece of machinery manually, or in automatic mode, the PLC automatically controls the manipulation of each burned plate. In addition, a touch screen provides real-time diagnostic information and alerts, and troubleshooting indications for the maintenance department.

Safety

One of the primary goals of the system was to eliminate worker injuries, and every step of the design and manufacturing process incorporated that goal. The most important safety feature is that the operator does not touch the parts, thus preventing hand injuries. Nor does the operator manually flip or lift parts, eliminating the potential for muscle strain. Occupational Safety and Health Act regulations were strictly followed with regard to walkways, railings, stairs, warning signals, and moving equipment. The operator has a clear view of all the operations, and equipment has been designed to minimise potential pinch points and is equipped with hundreds of interlocks and electrical safety systems to maximise worker safety.

In summary, significant technology has been implemented to improve the material handling sequence for burning plates. A process that focused on operator safety and improved productivity was installed. The company realised savings because the process changed from one that required four men to manually de-slag and package parts, to a process where two workers supervise automated equipment to do the same job in about half of the time – a 75% reduction in man hours. Further savings are expected as the burn-table operation is speeded up to keep up with the current process line pace.

System suppliers

Integrated handling system: Bushman Equipment
Permanent magnet system: O. S. Walker
High-speed hoist system: Gorbel
Control system: Device Net(TM) Rockwell Automation (Allen-Bradley)

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