

# OLD SHOVELS WITH DIGITAL CONTROL TECHNOLOGY RETROFITS GIVE NEW UNITS A RUN FOR THEIR MONEY

BY MARK R. DUSKEY



With digital technology, old shovels get a new lease on life and, in some cases, out perform new shovels.

Improving productivity in surface mining operations is an ever-growing concern. The mine operator may elect to purchase a new electric shovel at a cost approaching \$15 million to achieve necessary productivity gains. Or, the operator may consider upgrading an existing shovel with a new digital control system at a fraction of its replacement cost.

There are hundreds of older shovels in service with still-serviceable electrical and mechanical components that are operating at less than their original capability because of drive control shortcomings. In many cases, the equipment is controlled by obsolete hardware that the original manufacturer no longer supports and the operator can no longer maintain because printed circuit boards and other electronics are obsolete or can no longer be replaced or rebuilt.

In some cases, the equipment may have been originally produced by a manufacturer who is no longer in business and original specifications and documentation are no longer available.

One solution for improving under-performing shovels employing older control technology is a new digital drive control system optimally designed to improve the performance of shovels and draglines. These state of the art digital controls offer excavator-specific control functions to maximize performance and keep the machine operating smoothly and reliably at its physical mechanical limits. The after-market vendors that supply these systems should be capable of developing the required software and have the industry/power engineering experience to retrofit M-G sets, analog-controlled static DC drives, and early digital DC or AC drives.

## BUCKET OF BENEFITS

Properly engineered and applied digital drive control upgrades allow the mine operator to retain existing motors, generators, isolation transformers, field wiring, bus bars, SCR power bridges, and other costly, yet still-serviceable, components. Control hardware can be software-configured and programmed to the mine's specific shovel and mining conditions, allowing upgraded shovels to deliver "better-than-new" performance.

Recently upgraded shovels have outperformed larger shovels from the same manufacturer that are more powerful because of improved cycle times. The improved cycle times result from drive systems designed and optimized for the application, and not employing general purpose drives that, by design, compromise performance to fit common industrial applications.

In combination with the latest PLCs, upgrades can include maintenance software packages to streamline on-site maintenance and enable remote monitoring via Ethernet radio link by the drive manufacturer's service personnel.

## OPEN-HARDWARE SYSTEMS

These retrofit systems serve the mine best when they are designed as "open-hardware" systems that use widely available components and controllers. This allows the mine the freedom to identify and purchase service/repair parts from local supply houses avoiding extended, expensive downtime waiting for parts only available from the excavator OEM. This also allows the mine to minimize spare-parts invento-



The static drives on a Marion shovel had become unreliable and obsolete (left), they were replaced with Avtron Firing Modules (right) and machine availability improved dramatically.



ries where multiple pieces of the mine's equipment use these controls.

Commitment to long term hardware support is critical for excavator applications. The shovel OEMs do an excellent job of supporting the mechanical components on their equipment, but do not have control of the rapid obsolescence of mass market electric drives. Open hardware systems also provide the mine the flexibility to incorporate additional upgrades over the life of the machine.

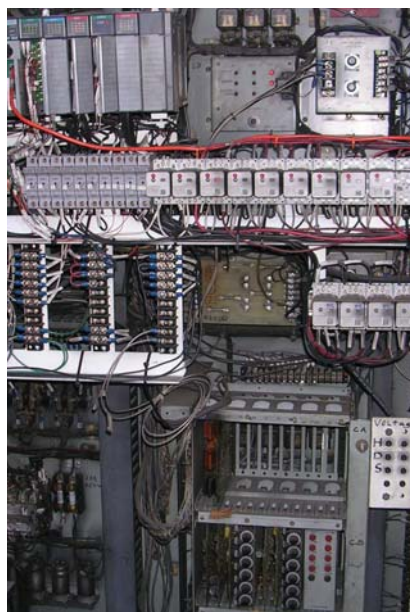
The upgrade control system manufacturer should generally be able to provide on-site start-up and field service using factory service personnel or factory-trained service associates anywhere in the world. The manufacturer of an open hardware system will also furnish complete drawings of the upgraded drive control system in a mine-maintainable format, allowing mine personnel to perform most maintenance and repairs.

**CASE HISTORIES**

A 10-year-old P&H 4100A shovel with a digitally controlled static DC drive was relocated from New Mexico to Wyoming. During the recommissioning of the shovel, the mine wanted to install larger motors for increased performance. However, the original "closed and proprietary" digital drive control hardware could not be reconfigured to achieve maximum performance from new motors.

Working with the supplier of the new motors, Avtron engineered an "open" digital solution incorporating Avtron Firing Modules (AFM), with shovel-specific software that optimized the performance of the new motors, and an A-B ControlLogix PLC that communicates with the firing modules. Because the new digital system was designed for software configurability in the field, it was possible to exactly match the shovel performance to the mine conditions.

Old M-G sets with analog field controls were experiencing excessive downtime (left), and were replaced with an Avtron ADD-32 DMG field regulator.



Reconfigured, the shovel now provides a 13.2% reduction in cycle time, resulting from faster transfer time from the dig mode to the propel mode and back and optimized hoist, crowd and swing speeds. With the new motors and controls, this shovel is able to produce between 30 and 75 additional truck-loads per shift, outperforming even the latest OEM digital control system on a new shovel at the same mine with similar digging conditions.

In addition to improved performance, the mine enjoys reduced maintenance since the new system has fewer components, with fewer faults than the old system. The entire control and drive system is configured for remote monitoring and diagnostics. Because of the performance increase, the customer purchased three more upgrades for existing shovels and has realized similar increased productivity on each machine.

Three Marion 301 static DC drive shovels, operated by a coal operator in British Columbia, were experiencing excessive downtime and lost production as a result of unreliable and obsolete drive and PLC control hardware which the OEM's could no longer support. Additionally, the shovel manufacturer had been purchased by a competitor in 1997.

Avtron provided digital control upgrades based on the Avtron AFM firing modules



to control hoist, crowd, and swing armature drives. Three-phase digital field controllers provided more voltage forcing, enabling faster response in the field current loop, for faster field weakening, faster cycle times and increased production.

Another benefit experienced by the mine was extended motor life between rebuilds. This resulted from the optimized control of the digital regulators for the motors. Not only has this lowered maintenance costs, but has led to increased production because of fewer shutdowns.

The drive logic controller was upgraded as well. The PLC platform featured rugged, "mining-hardened" hardware, and based on past experience, will enjoy long-term support from the manufacturer. Extensive operator and maintenance displays were also provided, along with a high-speed Ethernet connection for remote troubleshooting and production monitoring.

Three old (more than 25 years) Bucyrus 295 M-G set-controlled shovels, operated by mines in North Dakota and Labrador, were experiencing excessive downtime and lost production as a result of unreliable, and obsolete drive hardware.

To remedy these problems, existing analog field controls were replaced with Avtron ADD-32 DMG digital motor and generator field supplies. As with the other shovels described previously, upgrade benefits included reliable and supportable hardware, improved diagnostics, remote monitoring, and the capability to add accurate load weighing technology.

Replacement of the antiquated relay logic with a current PLC also improved reliability and enabled easy interface to a modern operator display and improved diagnostics. Avtron also engineered, programmed and installed a new operator information screen and joystick that improved operator ergonomics and operator performance across all shifts.

#### **GIVE UP OR UPGRADE?**

Before giving up on that older, yet still-serviceable shovel, evaluate a digital drive upgrade. Whether your current system is an M-G set, an analog-controlled static DC drive, or a digitally controlled AC or DC drive, the latest excavator-specific digital technology can significantly reduce the price of productivity improvements in your mine.

#### **Author Information**

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*has more than 30 years of experience in providing digital regulators for older analog drives. Avtron digital drives, bridge firing modules, PLCs and operator stations are currently used on more than 100 mining machines throughout the world. This article was reprinted with permission from the April 2006 edition of Coal Age. ©*