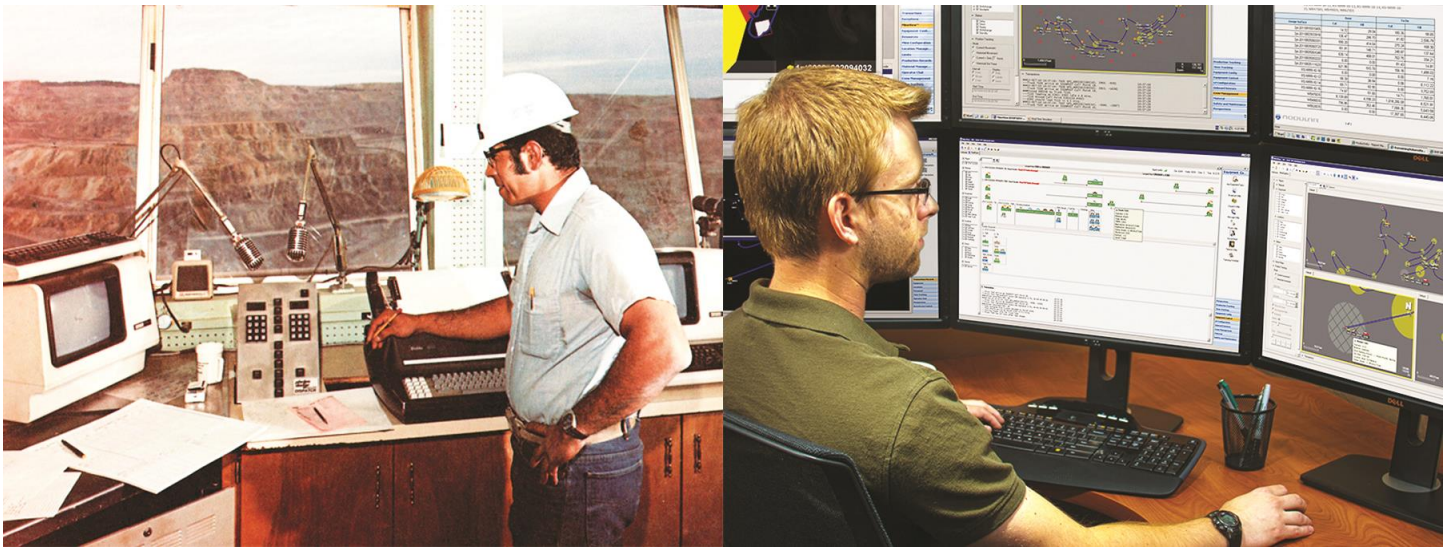
Standing the test of time

Modular Mining Systems looks at the way key events and technologies have shaped the evolution of fleet-management systems through some of its own products and milestones

Carly Leonida | 22 Apr 2016 | 10:50 | Feature |

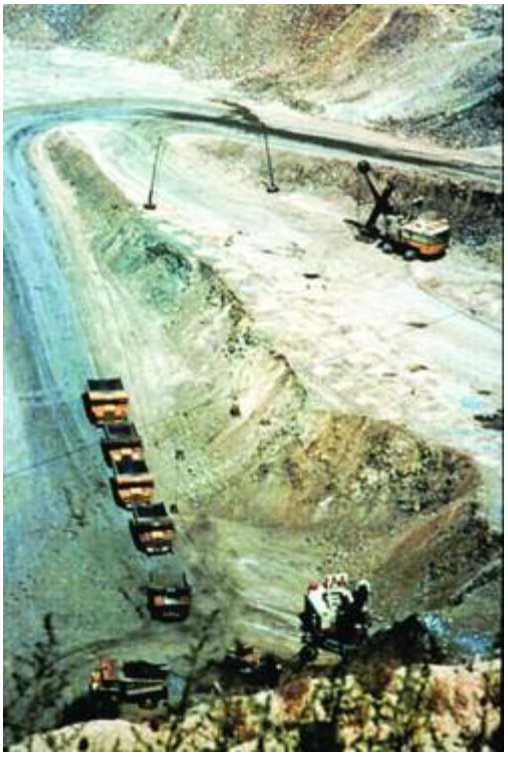


A comparison of Modular DISPATCH FMS equipment in the control room in its early days and today

As the mining industry has developed, a number of key events have changed the haulage landscape. Some of the more significant include: the patenting of the stationary steam engine and the use of animal-powered haulage in the mid-to-late 1700s, the advent of steam-powered rail haulage in the 1800s, and the use of converted on-road trucks in the 1920s.

The contributions of these and other breakthroughs enabled mines to become more efficient and productive in less time. However, despite advancements in the way material moved from mine to mill, the manual process of equipment assignment and dispatching, including paper instructions, using binoculars to notice inefficiencies in the field, and radios to communicate changes, would remain unchanged for years to come.

In the late 1970s, Dr James White, then an associate professor of chemical engineering at the University of Arizona (UA), was employed as a consultant at Phelps Dodge's Tyrone mine processing plant. One day, while looking out over the New Mexico mine site, he and Mike Arnold, a UA graduate student, noticed an imbalance in the distribution of fleet-management resources.



Trucks waiting idle at a mine. The challenge of the earliest FMS was to prevent scenes like this by making more efficient use of equipment

In one area, a number of trucks sat in line waiting to be loaded, while in a second area, a shovel sat idle with no trucks anywhere near it. While watching the bottleneck occurring in the pit below, Dr White remarked: "There has got to be a better way to allocate trucks to shovels".

At the same time, Phelps Dodge was coming to the conclusion that to increase efficiency and productivity the company needed an automated process to manage its haulage cycle, and challenged Dr White and his team to pursue this.

Dr White, with three of his students, devised, and subsequently rejected, numerous methods to determine which trucks go to which shovels and, in essence, how to optimise the haul cycle. After settling on a concept, the team pitched the idea to mine management in November 1978. The Phelps Dodge board contracted Dr White's team in February 1979 and, in October of that same year, Modular Mining Systems was officially incorporated.

The result of the team's R&D efforts, the DISPATCH fleet-management system (FMS), was commissioned at the Tyrone mine in September 1980. Once implemented, the FMS delivered an 11% increase in productivity – gains that were directly attributable to the optimisation of truck assignments.

Encouraging uptake

Before the advent of the FMS, mines had three options for routing heavy equipment:

- The locked-out option, which consisted of fixed assignments of trucks to specific shovel and dump points, with no regard for bottlenecks or slowdowns at the pre-determined locations;
- Radio dispatch, in which dispatchers visually assessed the operations in the pit and verbally communicated routing instructions to equipment operators via radio; and
- Computer assist, in which dispatchers still made visual assessments of pit activity, but assignments were transmitted to the operators via computer.

In contrast, the DISPATCH system performed calculations to determine the most effective assignments and most efficient routes for each piece of equipment. The FMS optimised the haulage cycles throughout every shift, and continuously provided information to operators as it happened. Today, there are few mines with more than 15 trucks operating without an FMS; their presence has become standard in the industry.

In the early years, however, the concept that a computer system could manage the haulage cycle more effectively than an experienced dispatcher was often met with derision. In many cases, mine organisations simply saw no need

for change. Dr White recalls that on numerous occasions, his attempt to explain the benefits of the DISPATCH system to mine managers was met with much resistance.

Advancements in IT have eliminated some of the challenges Modular once faced when attempting to convince mines that an FMS was a wise investment. For example, the DISPATCH system's central computer initially required a Digital Equipment Corporation VAX (an instruction-set architecture developed by DEC in the the mid-70s). Despite being the first servers capable of processing one million instructions per second (MIPS), the US$430,000 hardware price tag presented a huge hurdle. In contrast, the central computer that the DISPATCH system runs on today is exponentially faster and less expensive than its predecessor.

The early Modular FMS ran on DEC VAX servers. These room-sized servers had less processing power than a single modern smart watch

"At the time, fax machines were leading-edge technology; there were no laptops or cell phones," Les Zoschke, vice-president of business improvement at Modular, tells *MM*. "In fact, today's smart watches have more processing power than those bulky, room-sized VAX servers."

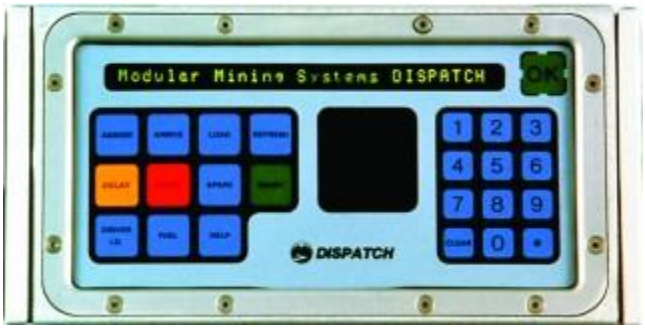
The FMS' mobile hardware has also undergone substantial changes. The oversized original remote computers used fighter-aircraft buttons, a simple three-digit display, and relied on 'hard coded' assembly-language processing instructions.

To fix a bug or apply an update in the mobile application software, the team had to remove and disassemble the mobile device from the piece of heavy equipment, install a new chip containing the revised set of instructions, and then reassemble and reinstall the device. Today the old-style hardware has been replaced with touch-screen devices that can be updated remotely across the entire fleet via the mine's wireless network.

70s and 80s: iconic installations

In the decades that followed the advent of DISPATCH, Modular continued to expand its footprint. In the late 1970s, 1,200 bits per second (bps) was considered the cutting edge for communication speed. However, the company wanted to push beyond the norm and develop a better solution. Leveraging the packet switching concept introduced by the Rand Corp in the late 1960s, Modular developed and patented its own Packet Radio Technology (PRT) for more efficient data processing.

In the spring of 1982, the Quintette coal mine in British Columbia (now inactive) determined that to achieve maximum efficiency at its recently opened site, it would need to employ advanced computer-based technology. Quintette presented a number of challenges. The geography of the pit and incidences of fog and snow meant that equipment position could only be confirmed by voice radio. In addition, changes in pit conditions and blending requirements, which required very precise record keeping, demanded dispatching beyond human capabilities.



The operator interface on an early version of Modular DISPATCH

"After evaluating the handful of products being marketed as a commercial dispatch system, we determined that in terms of demonstrated productivity and analytics, Modular's DISPATCH FMS was generations ahead of the competition," recalled Zoschke from his days when he worked as a mining engineer at Quintette, before joining Modular.

By May 1984, benchmark testing at Quintette had revealed that version 3.2 of DISPATCH was providing a 10% increase in productivity. In addition to a variety of hardware and software improvements, V3.2 was the first system release to include a successful real-time, face-to-dump blending module.

In 1984, Bougainville Copper (BCL) in Papua New Guinea (now inactive) used an in-house computerised mine-production system developed in the 1970s. The system worked well for the need to batch-allocate trucks to shovels as mining conditions changed, but by the early 1980s, the mine operations had expanded beyond the capabilities of the existing system.

After considering various alternatives, BCL selected DISPATCH to replace its home-grown system. The mine also purchased Modular's first full-colour graphics mobile devices and a tyre utility for use by lube-bay operators.

Just over a year after being put into service at BCL, DISPATCH was delivering a 13% productivity improvement compared with the mine's old system.

Shortly after, Iron Ore Company of Canada (IOC), now managed by the Rio Tinto Iron Ore group, called on Modular's services. At the top of the company's list was a need to control multiple pits separated by several kilometres, and a need to generate numerous custom reports.

IOC adopted Modular's technologies in 1985, and has since become Modular's longest, continuous-use customer. With many upgrades and expansions put in place over the years, IOC has had the DISPATCH system in operation for more than three decades.

90s: Data transfer and GPS

In the 1990s, standard data-transfer speeds took a huge leap forward, resulting in more widespread support of telemetry applications. Capitalising on these advances, Modular developed, tested and produced a 900MHz, 56kbps communications system. However, recognising that its latest offering would not satisfy the industry's changing needs for long, the company continued to improve its products, the efforts of which became the MasterLink wireless network.

With its initial release in 2001, MasterLink-enabled mobile devices communicated at speeds of up to 2Mbps. Soon thereafter, enhancements to the system enabled data speeds of up to 11Mbps across the network backbone. The current-version wireless network, MasterLink Enterprise, delivers data-transfer speeds of up to 300Mbps, dual-frequency radio communications, stronger data security and increased bandwidth.

For decades, the use of GPS technology was restricted to the US military. A plane crash in 1983 set in motion a year-long process to declassify GPS and make it available to civilians around the world. Leveraging this newly available technology, Modular replaced radio frequency (RF) and infrared (IR) with GPS in the DISPATCH FMS in 1994. This change enabled continuous position-monitoring, which ultimately improved data accuracy and productivity, and in 1998 Modular integrated high-precision GPS technology into its ProVision machine-guidance solution for excavators.

2000s: Maintenance, safety, autonomy

Today, haul trucks that were once considered large at 170t capacity are now dwarfed by those topping the 400t mark. And along with greater haulage capacity have come a number of advanced features and OEM interfaces.

In 2002, in support of its parent company Komatsu, Modular patented its bi-directional autonomous haul-truck concept. Today, with many leading mining companies testing autonomous technology, and some adopting it for commercial usage, it is certain that advancements such as this represent the future of mine haulage.

The mining industry has also become increasingly focused on concerns related to operator safety; a trend that prompted Modular to release its first-generation proximity-detection system in 2006. Today, regulatory agencies and mine organisations continue to strive for a zero-incident workplace, a fact which has mines placing even more emphasis on both standalone and FMS-integrated mine management and safety solutions. In response, Modular will soon introduce its fourth-generation collision-avoidance system to the market.

At the beginning of 2008, the Komatsu Autonomous Haulage System (AHS), which incorporates Modular technologies, was implemented commercially for the first time at a Chilean copper mine. Following the successful two-year trial of five Komatsu 930E-AT driverless haul trucks, the milestone event marked the initial use of AHS vehicles in an open-pit environment. Today, Komatsu and Modular have over 10 years of in-pit operational experience and over 500Mt of total surface material moved worldwide with autonomous haulage.

Today: Big data, integration and analytics

Today, there is a growing demand for instantaneous information distribution and a movement towards the consolidation of IT infrastructure. In response, many mines have decided to relocate key fleet-management functions away from the mines and into remote operation centres.

Another key trend is the transition from multiple, disparate systems to fully integrated solutions that encompass real-time mine operations, engineering, maintenance and ERP functionality. Integration of safety platforms into the FMS is especially desirable, as regulatory agencies, mine management and mining operations strive for a zero-incident workplace.

Modular's MineAlert Safety Management tools were designed with this in mind. The platform detects potential safety hazards and provides real-time notification to mine personnel, enabling immediate action. The CAS notifies operators of potential vehicle-to-vehicle collisions, thus increasing operator safety while helping to prevent equipment damage, haul-route congestion and unscheduled downtime.

Traditionally, maximising productivity and increasing operator safety were viewed as independent goals. In reality, however, adherence to safe operating practices doesn't necessarily equate to a decrease in productivity. "A safe mine doesn't have to be a less productive mine," Michael Lewis, VP of product innovation at Modular, emphasises.

A modern touchscreen display

The ability to bi-directionally share data, in real-time, among business systems and mine-management systems promotes collaboration across the entire value chain and results in incremental gains in efficiency and productivity. Modular recently formed a strategic alliance with RungePincockMinarco (RPM) to deliver an integrated solution to bridge the gap between planning and operations for elevated precision and optimised efficiencies. The alliance builds on RPM's expertise in planning and scheduling and Modular's expertise in mine management solutions and systems integration.

The integration of the systems will support bi-directional communication between the companies' products – RPM's Xecute ultra-short term planning software and Modular's DISPATCH Fleet Management and ProVision High-Precision Machine Guidance solutions.

Shift plans and production targets will be used as control parameters for execution by the DISPATCH and ProVision solutions. The real-time execution progress is then automatically fed back into the planning to refine the next interval schedule, fostering collaboration among all stakeholders from planning, production, maintenance and operations.

With an increasing amount of online condition-monitoring data available for mining equipment, the concept of 'big data' has emerged in maintenance organisations and customer appetite for this data is growing at a fierce rate. In response, Modular incorporated cloud-based data storage and analytics into the MineCare 3 maintenance management solution. The system, which was first launched in 2002, now has a cloud-based software as a service (SaaS) model, which eliminates costly IT infrastructure investments and data storage obstacles. It also simplifies installation, upgrades and management.

“There are significant benefits to cloud computing, which enables big data management and enterprise-level visibility. Just as the consumer world is moving towards the Internet of Things there is a continuing trend towards connecting, collecting, correlating, and extracting value from all assets in the mine,” explains Lewis.

“As we enter more challenging economic times, more mines will be looking for solutions to make step changes in performance at their mines and across their corporations while utilising existing assets. As such, in addition to the cloud-based MineCare 3 maintenance management system recently released, we are researching a number of big data analytics technologies that will enable mines to look at trends within a discrete mine, or at an enterprise level.”

Advances in high-precision global positioning systems (HP-GPS) and global navigation satellite systems (GNSS) is another area that will have a significant influence on mine-management solutions. “With the evolution of four constellations, the landscape of GNSS is greatly advancing and extending the reach of satellite positioning technologies,” Lewis tells *MM*. “The BeiDou system, currently offering services in China, is expected to increase satellite availability throughout the Asia-Pacific region in the coming years.

“The EU’s Galileo constellation, currently under development, is scheduled to come online within the next few years as well. On activation, the expanded availability and coverage from these constellations is expected to increase real time kinematic (RTK) satellite navigation availability by several percent.”

The evolution of these and other satellite systems, as well as the proliferation of lower-cost, high-accuracy receivers, will expand availability and coverage, even for steep walls and deep pits common in mining, and increase the benefits in current applications such as machine guidance and collision avoidance, expand HP-GNSS into more mainstream production and fleet-management applications, and drive the development of many new applications to come.

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