

Information technology applied to real time mining process: Information to manage

A Snow

General Manager – Sales & Marketing, Caterpillar of Australia – Mining and Earthmoving Technology Systems, Level 1, 686 Sherwood Road, Sherwood 4075, Australia, Telephone 0061-7-3278 3070

Abstract

The information age has definitely arrived and in fact has only begun to affect our business processes. Traditionally mining companies have been innovators and leaders with technology, but applying information technology systems to machines directly working on the mining extraction process poses challenges to those introducing the technology. Caterpillar is now presenting machine guidance and information systems for dozers, graders, blast hole drills, shovels, excavators, wheel loaders and trucks. These systems simply increase the flow of real information in real time and deliver it to the end users who can make informed decisions that effect real productivity gains and at the same time eliminate the role of the middle manager who used to monitor and control these activities.

Technology also offers cultural changes that appear intangible, but offer significant gains to those that implement technology. Critics state that these intangible benefits are still available to traditional processes, however these intangible elements are never identified nor managed without the introduction of technology enhanced processes.

The benefits of these technologies is real and dramatic, existing users offer impressive testimonials, but still the technology can be disproportionate in the time it takes to introduce to an operation. Caterpillar finds that senior to executive management needs to be a part of the technology introduction, to coordinate all departments and set technology strategies.

Introduction

The information age has well and truly ignited, leaving few of us untouched in both our personal and our business affairs, but as big as the changes have been, be assured this is only the beginning of how we go about daily business in the future. Some of the most common cliches used today are the “Information age” and “Globalisation”, these events are significant events on humanities time line and there is no industry that can ignore these for long.

Mining is an industry that has traditionally been an innovator and a leader with new technology and methodologies. As a vendor of technology products and services, Caterpillar often encounters attitudes that would suggest that mining companies are unsure as to the how's and why's of implementing information to real time mining processes.

Because the technology being offered by Caterpillar is new to the industry, it is necessary for this paper to give a brief description of the machine information technology now available from Caterpillar to control the traditional mining extraction processes in real time. Following are brief descriptions of Caterpillar services and products.

Caterpillar mining solutions alliance

Caterpillar has made a very definite entry in to developing and marketing information technology products for the mining extraction processes. Being world-leading mechanical engineers isn't enough to be suppliers to the mining industry; that beyond suppliers of iron-based technology, what Caterpillar is really delivering is a process of extracting, loading and moving ore and waste. Information technology has significant productivity gains to offer these processes and strategically Caterpillar is delivering on a strong desire to be vendors of products that deliver the ability to shift ore and waste for the lowest cost per ton.

To offer the best available technology products and services, Caterpillar has formed strategic alliances with the GPS manufacturer Trimble Navigation, Enterprise Asset Management and Mine Planning software developers Mincom, and the world leading blast hole drill guidance and monitoring systems manufacturer Aquila Mining Systems. This alliance is now delivering the most comprehensive and advanced IT products to monitor and control all mining processes, from planning, to extraction, to administration, to maintenance and to marketing of mine product. Caterpillar and Mincom term this the Enterprise Mining Solution.

Caterpillar machine information systems

The solution overview is shown in Figure 1.

Caterpillar/Trimble wireless data network

Caterpillar has developed machine based information and guidance systems for most common mining tools. The core engine that reduces the work load created by these information systems, links all machine processes together and adds value to the entire mine process information system is the wireless data network. This wireless network is a series of high bandwidth radios that transmits information from the LAN based applications to the mining machines and vice versa.

Aquila drill monitoring systems

Fitted to all common blast hole drills, the Aquila drill management systems allows the operator to accurately position the blast holes and automatically drills to the correct

depth and angle. The onboard computer system identifies material type and thickness and can transfer this information as required to the mine planning office. This results in better blasting practices with less explosives and improved fragmentation.

Computer Aided Earthmoving System (CAES)

CAES has 2 basic applications: grade control relative to a design plan for cutting/pushing machines, and ore identification for loading tools. Grade control is suitable for bulldozers, graders and scrapers and ore identification is suitable for excavators, shovels and wheel loaders.

Grade control applications provide a real time engineering plan in the machine that allows operators to quickly see how much material needs to be cut or filled, allowing material flow to be optimised and rework eliminated as built surface elevations are transmitted back to the office by the wireless network. Typical 20% to 30% productivity gains are experienced.

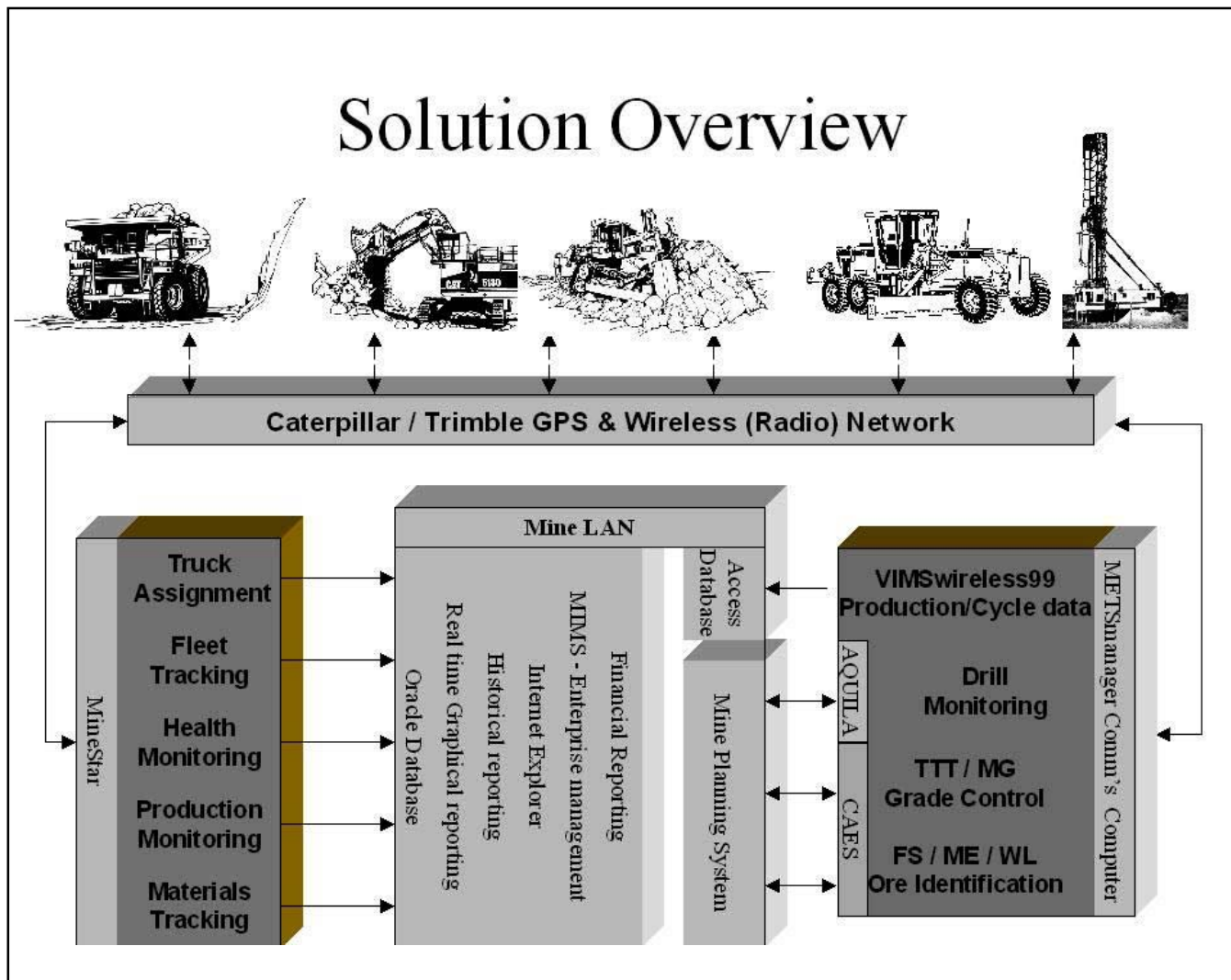


Figure 1. Caterpillar machine information systems overview.

Loading tool operators can use CAES to identify differences in material and to control pit floor designs. In turn, this information is relayed to the mine office, accurate mining and reduction in misidentified or mis-routed loads is achieved. Typical studies yield results of 7% gain in ore productivity or over 50% reduction in mis-identified ore loads.

VIMS/VIMSwireless

Vital Information Management system is the onboard computing system for trucks, loaders, tractors and hydraulic shovels. Comprehensive machine health data and productivity data is captured either for manual retrieval or wireless retrieval and reporting. Typical information types available are: payload, cycle times/distances and health event alerts. This information allows for basic productivity monitoring and proactive maintenance, reducing maintenance costs and increasing machine availability.

VIMS provides the core productivity and health information for the MineStar systems.

MineStar fleetcommander

Fleetcommander is a truck assignment algorithm that ensures that short and long hauls meet mine planning requirements, shovel utilisation is maximised and truck wait times are minimised so that operating costs are lowered and productivity is maximised. Assignment decisions can either be linked to the mine plan or the mine business model.

MineStar machine tracking

Machine tracking identifies where all GPS equipped machines are, as well as what they are loading and what they are hauling. With this information the mine manager can analyse and evaluate dump movement, haul road congestion and speed constrictions.

MineStar material tracking

With peer to peer communication between the loading tool and the truck, the mine can now accurately track material in real time to ensure hauling to the correct location, consistent material control and balancing of stock pile volumes.

MineStar health

Continuous machine health information is collected through VIMS and transmitted back to the office for remote monitoring and diagnostics of all VIMS equipped machines. Now it's possible to see when and where a problem is occurring from the maintenance facility, checking against archived data enabling a proactive maintenance regime, lowering maintenance costs and increasing machine availability.

MineStar production

MineStar provides real time production information during the shift for improved management control. As each machine

works, its action is incorporated in to the MineStar office database. Web based reporting tools allow mine personnel to view reports anywhere in the world.

MineStar business enterprise

By utilising the latest information technology on board the mining machines, with the wireless data network it is now possible to link directly to the mines accounting, mine planning, asset management, maintenance and human resource systems, providing accurate near real time administrative and financial information on the mines activities.

Why use information technology?

It is not unusual to encounter responses after presentations of technology that would suggest that the audience has enjoyed the presentation, found the technology to be interesting but the core need for the technology has not registered.

The concept is in fact a very simple one. The more information you have on a process the more correct your management decisions will be.

If you are in a position where you will share in the responsibility of introducing information technology applications to mining processes there is a very important piece of homework that is recommended Business @ The Speed-of-Thought by Bill Gates. Gates is ultimately selling his products, but his messages are real and directly applicable to the mining industry.

One of Gates' very clear messages is that you need information to manage your business. In the past, businesses were too often run on assumptions and guesses. What if we knew exactly how efficient our trucks were at any point in time? What if we could instantaneously identify an above grade section on a haul road? What if we could build a drag line pad without several iterative attempts at cutting (or filling) to the optimum level? What if we could free up mining engineers and supervisors time from interpretation of data and controlling machine processes? What if we had picked up that sudden 40% drop in oil pressure last month? What if we can reduce the amount of ore trucked as waste?

In fact Caterpillars technology today provides exactly this information, providing hard data so that correct mining and maintenance decisions are made. MineStar Assignment makes sure Trucks are assigned to shovels to achieve the current production plan. MineStar production provides instantaneous production numbers informing the mining engineer of exact and real time material quantities delivered to ROM stockpiles. The CAES grader operator discovers a section of haul road out of design grades and decides to go ahead and correct the gradient without even needing to notify the roading engineer. The dozer operator on dragline pad preparation knows exactly when to stop cutting confident in the knowledge he won't be called back to rework the pad and lift it another metre because of a lack of survey information. The dozer on the drop cut doesn't need to let his machine idle for three hours while the

surveyor attends to another urgent set out request. The drill and blast engineer has discovered that with more control of the blast hole spacing that the burden and spacing can be widened by 10% and fragmentation is still maintained, saving millions of dollars per year on explosives. The maintenance supervisor gets the oil pressure health event warning automatically Emailed to his cellular phone repeatedly and decides to call the truck in for inspection. On inspection mechanics find an oil pump failure that would have otherwise resulted in a catastrophic crankshaft failure and the truck then being removed from production for two weeks. The excavator operator picked up a \$20,000 gold ore block the geologists missed setting out.

These are all real life, everyday instances of information technology providing information to manage.

In my real examples above, note that now real information is presented in real time to the machine operators, that machine operators are now empowered to make decisions and take action, where before experienced supervisors or mining engineers were required to interpret data, identify problems, prepare and communicate instructions. The 'middle management' and old style laborious information routes are eliminated.

Figure 2 illustrates the basic processes in a typical mining operation. Each process has a continual feedback loop that requires information to control the process, then analyse the process for improvement and then plan out the next phase. This can only be done with information, and typically it is only information technology products that can deliver that information comprehensively and in real time.

For example, Caterpillar's D11 Carry dozer on a production dozing assignment can present significantly differing

productivity results between operators. To maximise the use of this 2 million dollar capital investment, wouldn't it be financially advantageous to be able to identify the operators with a less productive technique before the end of the three week pre-strip project? The answer of course is yes, and with instantaneous feedback with CAES we can present the current volume productivity and the basic performance statistics of each machine cycle.

To summarise, Caterpillar is demonstrating that information technology has a real and practical application in mining processes and in fact Caterpillar's objective with supplying technology products is to provide miners with information to enable process improvement and improve mine profitability.

Culture

Introducing technology enables a process culture change which itself ads productivity changes. For example, one of Caterpillar's competitors typically claims that just by switching on their dispatch system a 10% increase in truck and shovel productivity is normally found. This is purely attributable to removing intangible old fashioned processes and changing people's behavior. All though too early to capture hard data, Caterpillar fully expects that MineStar Fleetcommander, combined with MineStar production will deliver in excess of 6% on truck and shovel fleet performance for the same reasons.

A simple, documented example measured by the Phelps Dodge Morenci mine, independent of Caterpillar, is the effect CAES has on the ore identification when installed on cable shovels (see Figure 3).

There is the expected figure, that 7% of loads that were clearly being misidentified with the old practices are no longer being

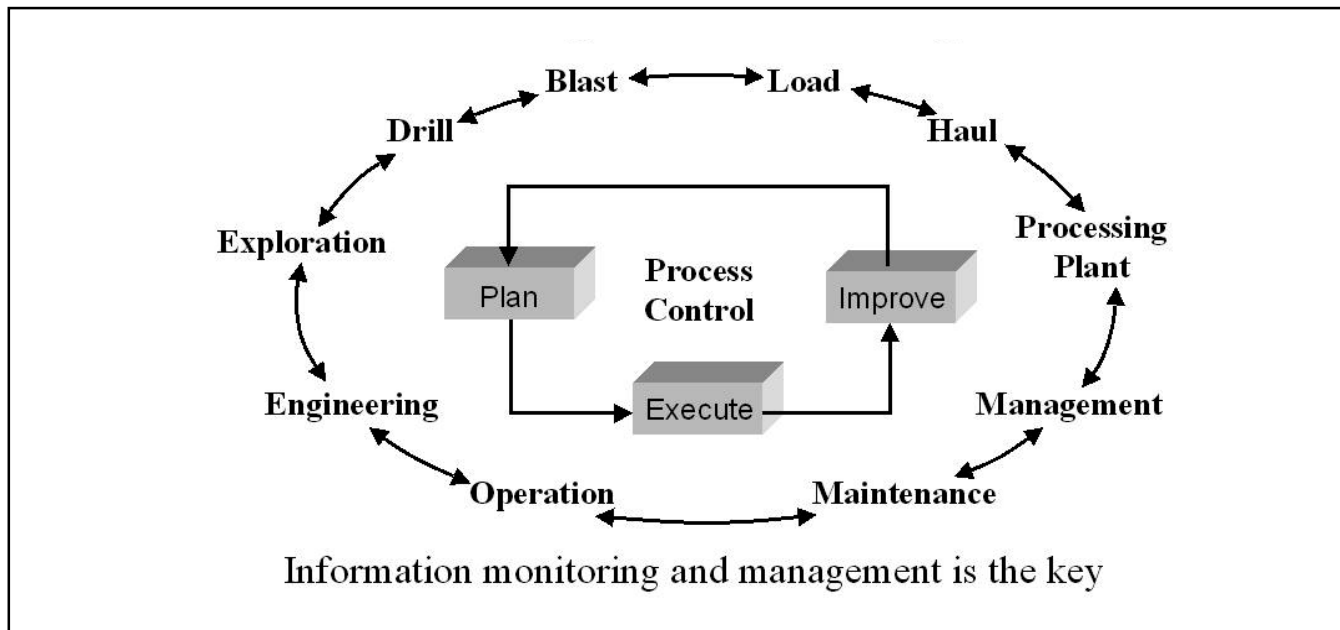


Figure 2. Process control lowering total mining cost.

misidentified with CAES. But there are cultural changes identified, which indicate there are practices developed that are better than before. It now appears as though the old standards of allowing misidentification to be accepted should it occur in within a 5 m tolerance zone of an ore boundary are an antiquated standard that can be tightened up. Note that before CAES, 24% of misidentified loads were caused by not having sufficient mapping, with CAES there has been a 6% gain in correct load identification purely by increasing mapping activity that would not have occurred with out adopting the technology. These are real examples of the benefits of technology enabled cultural changes.

The technology critics will say that these cultural changes could be achieved with out the technology. Sometimes they are correct, but what we see is that these cultural elements that could be changed, are in fact not identified or in fact unidentifiable before the introduction of the information system. Even worse, that the mining operations do not have the desire to acknowledge and change these elements.

Introducing technology

As stated earlier, there is a sharing in the responsibility of introducing these information technology products. This was a deliberate statement.

Mining operations have a well-worn path to the machine vendors, ordering ten off highway trucks for 200 Million USD is a routine, and nearly automatic buying process, however implementing technology is not.

Caterpillar's last Australian CAES sale was for 2 x shovel guidance CAES systems and a third tractor system which took 12 months to complete with an approximate value of 290,000 USD. Why did this take so long where, with an approximate guess by Caterpillar, the system pays for it self in three months, or, viewing this differently, these systems could be saving the mining company between 1 to 2 million dollars per year?

My explanation is two fold, that there is a definite element of the fear of the unknown, and that with these sorts of decisions there are multiple points inside the mining company that need to be convinced of the power of these information technology products.

The fear of the unknown is understandable, however the local reference sites are building up and the references are more than favorable.

There are many influences in the decision to employ technology. As Gates states, this in fact must be led from the head of the company. For mining operations, this translates to at least either the mine manager or general manager, the actual technical evaluations need to occur at the operations level but a technology strategy needs to be decided upon and supported from senior management. Even financial controllers need to be involved they write the cheque, they could be the recipients of that 1-2 million dollar cost saving, but even more importantly with MineStar Business Enterprise, real time production statistics and costs can be made available to the accounting department. They are now integral users of machine information technology products. For these reasons, I now make a standard recommendation for mine managers through to CEOs to read *Business @ The Speed-of-Thought*. It outlines good reasons why this level of management needs to take an active role in the introduction of technology.

Another fact that all operational and executive management must get used to is that technology costs. It costs to purchase, it costs to run and it costs to maintain. Business should not look upon this negatively, and as long as correct investment decisions are made, it is irrelevant what the costs are, what is important is what extra production is gained or what costs are reduced.

A typical cultural mindset we encounter in coal mining is an artificially created attitude that coal companies can not spend. A recent example of Caterpillar's is of a coal mining company with a two-year rehabilitation project in front of them. We demonstrated that if they can accept that CAES does allow a 20% production gain, then a 380 000 dollar investment provides the mine with a 360 000 saving net after all direct CAES purchasing, running and maintenance costs, just for the two-year period (does not include any financial penalties for not attaining correct design specifications). The engineer concerned feels they can't spend this money. Surely senior management should be creating an environment where proper investment spending is not only acceptable but rather, it is required.

Practically, the advice is for all departments to be involved with evaluating their own technology needs, to formally

	Loads Correctly Identified	No Map	Mistaken Loads - but within acceptable 5 m boundary tolerance	Clearly Mistaken Loads
<i>Before CAES</i> (CAES runs in background)	59%	24%	10%	7%
<i>After CAES</i> (CAES Ore Map)	77%	18%	~2%	

Figure 3. Lost revenue - copper site study. 588 truck loads - two shovels.

coordinate their evaluations and develop a strategy for implementing technology systems.

Senior or executive management needs to make a clear statement as to direction on implementing technology. With clear directives, operational managers will progress technology evaluations with out the unnecessary burden of fearing the great white elephant, or without the fear of upsetting the status quo on how machines are managed.

Another barrier is a technical capability one. There are few mining engineers in mining operations that have a good understanding of information technology products and the processes that these products support. Traditionally a mining company at this point would employ consultants to provide directional advice on which products to implement, but the mining consultants are in most cases further behind the mining companies on applying technology. The answer, certainly in the case of Caterpillar, is to utilise the technology vendors' intellectual resources. Caterpillar and Mincom employ a significant number of mining engineers, electronics engineers, software engineers and real time positioning specialised surveyors. All these people are from professions, have world standard qualifications and are world leaders with their experience base. Certainly with Caterpillar, these professionals are available for application advice, feasibility study advice and even formal consulting. Caterpillar's advice is to use

these resources and not to shun the offer based on a perceived bias.

Conclusion

Technology offers the next single biggest step forward in gaining efficiencies in the mining process. Caterpillar has made a definite strategic decision, identifying that it is in the business of supplying to customers the ability to extract and shift huge volumes of material from one place to the next and supplying information technology products is part of it's business.

Information technology has definite application to monitoring, controlling and increasing the efficacy of mining machines allowing correct and timely information to be presented to the end users.

Not just the primary and stated benefits of technology will be available to those that employ technology, but intangible, valuable cultural changes are enabled by technology.

Introducing technology is sometimes a slow and unfamiliar path for those at the mining operations level. Caterpillar has found that the best responses are achieved when senior and executive management set strategies for implementing technology and provide coordination amongst departments.

Author

ADRIAN SNOW is a New Zealand registered surveyor and a member of the New Zealand Institute of Surveyors. Adrian is now employed by Caterpillar of Australia to establish a mining technology company to market sell and support machine guidance and machine based information systems to the Australia-Pacific region. Previous to Caterpillar, Trimble Navigation employed Adrian in Brisbane as the Australasian marketing manager for precise positioning products to the mining, construction and agricultural industries. This role involved introducing machine control and positioning technologies to these industries and providing the appropriate feedback to Trimble development. Prior to this Adrian was based in New Zealand where his hobby of flying led him to the management, development and world wide marketing of Trimble's precision airborne guidance system for aircraft. Before joining Trimble Adrian worked two years as a hydrographic surveyor in South-East Asia and five years as a consulting surveyor in cadastral and land development activities.