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THE EVOLUTION OF MINING TRUCKS

IS CHANGING INTERACTIONS AND PRODUCTIVITY AT MINE SITES

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The mining industry is constantly developing and introducing new technologies to make operations more efficient, safer and ultimately improve the bottom line. From mining equipment and processing plants to the mine plan itself, technology in the mining industry has evolved throughout the years and must continue to evolve to meet the needs of this dynamic environment.

Over the past decade there have been numerous changes in the way high production, low cost mines have operated. In addition to more efficient processing technologies and improvements towards human relations, the most notable and obvious change has been the increase in equipment size. Following the general concept of "bigger is better," larger equipment – often referred to as "ultra class" equipment – has emerged and become commonplace among the major mining companies of the world. Nearly all major greenfield projects are now planned with mining equipment specifications for trucks with a minimum 240 t payload, and often specifying trucks with a payload of 290 t and above. With the increases in truck size classes, rope shovel and hydraulic excavator manufacturers are now seeing near constant demand for the largest equipment that they have to offer.

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As mines evolve towards larger equipment, relatively stationary loading tools, such as excavators, rope shovels and draglines, do not have much interaction with each other. Yet trucks must interact with one another on a regular basis and the evolution towards larger and newer technology creates interactions that were not seen with the previous generations of mining haul trucks.

Making the Transition

The evolution of the mining industry in order to develop larger equipment is an arduous process. Some mines are unable to grow past a certain size due to varying site factors that are too insurmountable for the anticipated economic benefit of the larger equipment to overcome. Thus minesite equipment evolution falls into three categories: mines with hard constraints; mines with soft constraints; and greenfield mines with minimal constraints.

The first category includes the mining operations that do not have the ability to accommodate larger type equipment to coincide with their own evolution. A number of mines have expanded in size but are not able to grow beyond the 240 t class size due to various conditions specific to their site. Mine design, mining selectivity, pit layout, crusher dump widths, shop size and bay door widths all act as hard capital constraints to mines growing to larger size equipment. These reasons are why it is cost prohibitive, geologically and/or physically impossible to operate with trucks over 240 tonnes.

The second category consists of mines that were initially designed to accommodate 240 t size trucks and for which the logical step is 290 t trucks. Estimates in crusher dump widths, shop bay doors and haul profile widths are typically conservative enough that this step is not impractical and would not require significant capital investment to widen or extend these distances. These projects often reap the benefits of the larger equipment quicker, as there is minimal capital investment required for the new trucks to integrate themselves with the existing mining operation. Many sites are even able to accommodate the ultra class-size trucks as replacements for the 240 t trucks when the pit geometry is suitable. In these cases, the mine will make investments towards infrastructure for greater shop space and maintenance areas, but the production increase and reduction in cost/t – with equipment having payloads over 60% higher than the original fleet – quickly offsets this capital investment. The rate of return will almost always be higher for larger equipment than smaller equipment when operating on the same deposit with a typical mine life.

The third category is the mines that have not yet been developed. Greenfield operations with production potential that would require ultra class trucks and rope shovels are in the best position to have the greatest and fastest return on their investments.

Because they can design their mines to accommodate the largest equipment available, their cost/t will ultimately be the lowest. Although the capital investments will be very high, this will be quickly recouped by having lower operating costs and higher levels of production. With infrastructure built specifically for the ultra class equipment, the maintenance and servicing of the equipment will be fit for purpose with the proper tooling and working areas needed for such large equipment. This will result in more efficient and higher quality maintenance and repairs than the previous cases of the mine and the shop space retro-fitted to accommodate equipment that it was never originally intended.

These three cases illustrate the evolution of the surface mining industry to take on larger equipment and a few limitations that are present within this initiative to achieve the lowest possible cost/tonne. Of these cases, however, the second case is the most common. Only a small percentage of mines have evolved from 50 t class trucks up to the 240 t class and cannot grow any larger due to mine design and infrastructure limitations. As for the greenfield sites, these ultra class suitable operations are many in number but take time before moving into active production. This is due to the size of the capital investment required for the ultra class equipment fleets and supporting infrastructure, as well as the difficulties in logistics due to remote locations of some of the major greenfield projects, and the general politics and timing of the operation to coincide with favorable commodity prices. There is currently a gap, in a sense between the technology of the ultra class trucks and the timing of the greenfield projects resulting in a veritable disconnect. Numerous major surface mining projects exist on the horizon in countries such as Australia, Chile, Indonesia, Pakistan, Peru, the Philippines and the US (in Alaska), but these projects are all slow to develop and equipment procurement is one of the final steps after final project approval.

The second category of mines, which are looking to operate larger equipment to achieve higher production and lower cost/t, are making a gradual transition by keeping their smaller trucks during the transition stage. Older equipment is being slowly phased out as the cost/t advantages of the larger equipment are proven. Yet significant operating hours are spent running mixed-size class fleets. Therein the issue of haul truck interactions lay, between dramatically different fleet sizes.

Fleet Interaction

With minesites now running mixed fleets of older 240 t class equipment and either 290 t or ultra class equipment, there are a number of interactions that were not present when it was a single fleet of 240 t trucks. The larger equipment not only has higher horsepower engines than the smaller equipment, but the ratios of power to weight are higher. Like battleships and airplanes, the larger the mining truck the faster it can go. Looking at the leading two 240 t class mining haul trucks over the past several years, the average power per gross vehicle weight (GVW) is 6.4 hp./t. The average power per empty vehicle weight (EVW) is 14.9 hp./t. Looking at the current leading three truck types with 290 t+ payload, the average power/GVW is 6.7 hp./t and the average power/EVW is 16.2 hp./t. This means that the newer trucks are capable of running faster, especially loaded uphill, than the trucks they are intended to replace. This creates situations where mines have their new, 290 – 360 t payload mining trucks being slowed on the ramp by the smaller and older 220 –240 t mining trucks. The result is a higher cost / t and longer cycle times for the new truck fleet as compared to the numbers used to justify their purchase.

Additionally, loading times will be increased with the new, larger trucks if matched with the existing small sized loading equipment. If new loading equipment is purchased, the older, smaller trucks will be subjected to two-pass loading, which can be damaging to all structural and suspension components of the trucks. This offset of loading times created from two to five-pass loading, depending on the truck and shovel matches, will create queuing at the dumpsites. Spotting and positioning at the loader in the event of double-sided loading will require more careful attention and, in general, truck queuing at the loading areas will need to be more closely monitored to prevent over-trucking. These interactions would not be as prominent with a single-size class fleet with equivalent engine power ratings. In some cases the fleets can be separated to reduce these impacts.

The number of new truck interactions due to mixed fleets create longer loading times and a greater number of trucks operating at once until the smaller fleets are phased out. These interactions can have an adverse effect on the return on investment of the new, larger sized equipment fleet. What is needed is a tool that can account for the varying performance of the smaller trucks in relation with the larger trucks. Minesites typically have numerous active loading faces and multiple dumpsites. The dispatch operator knows in real-time which loader or dozer has gone down for unplanned maintenance, and knows to route trucks to another loading or dumping site. Yet planned truck interactions to avoid larger trucks from having their production reduced, due to not being able to overtake smaller trucks on a ramp, is something that needs to be analyzed before the shift commences. This is in addition to knowing when different trucks are leaving the loading and dumping areas and where to route the trucks so that they are not slowed by each other on the return trip to the loading areas. To provide a solution for this issue of determining when trucks will interact with one another and how to avoid impacting the production of the truck fleets by routing smaller trucks away from larger trucks, while still integrating them within the mine plan, a new mine profile evaluation tool is about to emerge.

Technology Solutions

Runge Ltd., a leader in technology and software services, has provided the industry with a line of software packages to assist with all phases of mine planning and financial modeling since the 1980s. TALPAC, the flagship software used for truck and loader production simulations, has also evolved to adapt to the ever-changing mining environment. The latest product in development is designed to remedy the issues derived from having multiple truck types and multiple loading and dumping areas. This new haul profile evaluation tool is called Haul Network.

Haul Network will use truck performance curves, weights and user inputted fuel consumption data from the same database that TALPAC currently uses. With Haul Network multiple dumping and loadsites, as well as stop signs, speed limited areas, fuel refill locations and other areas of truck congestion, can be analyzed to determine the haul network which trucks can be routed. The user will then, in conjunction with TALPAC, be able to both route trucks to avoid interactions that may reduce productivity and to optimize each loading area with the proper number of trucks to minimize both truck and shovel wait times. Extremely visual in nature, the network will have a vibrant graphical interface that can interpret multitudes of x-y-z strings to create easy-to-use haul profiles, while simultaneously overlaying these profiles on the existing mine layout. This process creates a very clean and visual interpretation of the haul profiles from the various loading sites in the pit and how they route to the different dump sites located around the mine. Leveraging from future versions of TALPAC, Haul Network will provide a robust complement to the existing standard for haul simulations. Once the profiles have been processed by Haul Network they can be exported to TALPAC to take advantage of the many detailed functions TALPAC has to offer for specific haul route simulations. Having both software programs available will give the user a great deal of flexibility to approach more complicated haulage scenarios with greater confidence in the results. Available to the industry for over 30 years, TALPAC software is considered the industry standard for calculating truck travel time. Yet its main limitations are that it cannot account for truck interactions and multiple load and dumpsites. While TALPAC is continually improved with new versions and database updates released regularly, Haul Network and TALPAC combined will provide the next step towards complete haul profile analysis and simulation. The future functionality will not be limited to sites with various truck types either, as it can be used for running truck fleets with equivalent truck types as well. This will create a powerful package of software programs that build on the existing industry standard for truck and loader productivity simulations.

The mining industry continues to evolve and as mines and equipment grow, so must the technology behind them. Runge complements its flagship TALPAC software with a new, highly visual haul profile development tool, Haul Network. Now, minesites that have evolved to use truck fleets spanning multiple size classes can optimize their productivity. Haul Network helps make this possible by calculating areas of congestion and potential truck interaction and allows mines to route their hauls accordingly to achieve the lowest possible cost/t.

From the deepest copper and sprawling iron ore mines in South America to the mammoth surface coal and oilsands deposits in North America, from underground diamond mines and remote gold mines in Africa to enormous coal and uranium mines in Australia, all mines around the world will benefit by using accurate tools for truck cycle time calculations and haul profile analysis.