Truck and Loader Optimisation
5 April 2010

I have spent the last 6 articles discussing issues relating to optimising truck and loader sizing and how common it is to find poor matches. I find it incredible how you can go to two different mining companies and you get two completely different approaches to optimising output from their truck and loader fleets. Some mining companies believe you undertruck to optimise cost and others believe you should overtruck to optimise output. Both approaches are stupid. If we are ever going to be an efficient industry we should have the loaders and the trucks matched to minimise "waiting" time. You see Modular Mining and Jigsaw developed their optimisation systems to account for the fact that too many of us just couldn't organise empty trucks to go to unserviced loaders. We often had/have the situation whereby one loader has three trucks queued and another is sitting idle.

The approach to "optimization" depends on the strategic approach which a mine is taking. You would be surprised (although maybe you wouldn't be) at the number of site people who don't understand the strategic approach being followed by the mine they work at.
The following are the potential strategies;

1. Maximize output
    - Less focus on efficiency and cost
    - The ideal approach in an environment of high commodity prices and under supply
    - Minimise waiting on trucks. Don't worry about wait on loader and overall efficiency.
2. Balance output and cost
    - Focus on both output and cost
    - The approach in an environment of high commodity prices but limitations in supply
    - Target maximum overall efficiency, ie balance wait on trucks and wait on loader to minimise the unit costs of the truck / loader fleets.
3. Minimise cost
    - Focus on cost
    - The approach in an environment of low or

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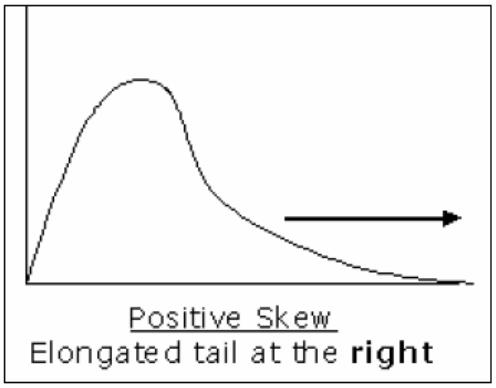
reducing coal prices or fixed tonnage contracts

- Target minimum cost to meet required output.
- System may produce less output.

Variation in performance can be a major contributor to reduction in efficiency and it is this variation which must be understood and controlled if the operation is to achieve optimum performance. In statistics, a result within three standard deviations of the average is considered to be under control. Given a normal distribution of results, 0.14% of cycles should be expected to be more than 3 standard deviations above the average. Under normal circumstances the key "interaction parameters" – Wait on Trucks and Wait on Loaders, will not be normally distributed and should be skewed strongly to the right or "positively skewed". (Skew or skewness is the lack of symmetry in a frequency distribution. Positive skew has a long tail to the right of the peak – high percentage of results with a low result.) The value of skewness statistic divided by standard error of skew (a standard measure of skewness provided by Tabachnick and Fidell (1996)) must be greater than 3.29 for the skew to be significant.



Most mines have both wait on truck and wait on loader very strongly and significantly skewed. A maximum skew (maximum frequency of low values with a long tail to the right) on both parameters is required for optimising efficiency. The higher the measure of skew the more efficient the operation. It is not unusual for the value of skewness statistic divided by standard error of skew to be over 100. A significant difference in skewness statistic / standard error of skew for wait on trucks cf wait on loader is an indicator of overtrucking (skew of wait on truck is stronger than wait on loader) or undertrucking (skew of wait on loader is stronger than wait on truck).

Another way of measuring the efficiency of truck and loader usage is the proportion of time where the truck and loader wait for less than 30 seconds

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(excluding spotting). An indicator of inefficiency is when these proportions are significantly different. For example you might find that wait on trucks is less than 30 seconds 90% of the time and wait on loader is less than 30 seconds 35% of the time. This demonstrates a strongly over-trucked scenario which could be argued to not be the most cost effective way to operate the fleet. However, if it is your mine's strategy to be overtrucked (do you know what your mine's strategy is and why??) then these results can be reported on a month by month basis to demonstrate the strength of the overtrucking (maximum wait on truck events less than 30 secs and minimum wait on loader events less than 30 secs), A method of benchmarking truck and loader efficiency is to multiply these two percentages together and compare a single percentage against other mines.

To the less mathematically inclined (and those too lazy to follow the logic) this probably sounds like double Dutch but it is actually really important to grasp to measure how your mine's performance in the field matches the strategy desired for the mine. The monitors are producing copious volumes of data now and it must be used to operate smarter.

Next week I will provide a case study showing how to use this analysis.

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