Full throttle?

JUSTIN JOHNSEN AND GREG LANZ, MODULAR MINING SYSTEMS INC., US, DESCRIBE HOW TO TACKLE OPERATING COSTS WITH A MAINTENANCE SOLUTION.

The ability of a coal mine to control consumable costs can be the difference between positive and negative earnings in the volatile energy market. Items such as electric shovel ropes, tyres, explosives and fuel add significant variables to the cost/t equation. Coal operations spend long hours researching and implementing ways to reduce the variability in consumables and maximise their efficiency. Today, with the increasing capability provided by mining technology to capture, store and analyse data, there are more opportunities than ever for coal mines to improve in this area.

After observing operator behaviour, one South American mining operation recognised the potential to reduce fuel consumption by standardising operating practices at the dump. Using Modular Mining Systems software and services, the customer was able to analyse and implement improvements that helped reduce the cost/t in daily operations. This article explores how the mine identified, researched and corrected the problem, beginning with having the proper tools.

Interfaces

For maintenance software to have research capabilities, it must connect to a myriad of onboard systems and sensors that monitor and log equipment information. The maintenance systems and interface group at Modular Mining works directly with the OEM to provide and maintain the operational, electrical and mechanical data that industry customers have indicated as key areas of interest. Over 100 ModularReady® interfaces connect to the majority of opencast mining equipment types currently in use.

Systems

With direct interface connections to heavy equipment, customers gain the ability to remotely transmit, store and research thousands of individual vital sign parameters. The MineCare® maintenance management system consolidates this data into two key areas: real-time alerts and remote data collection. Integration with the DISPATCH® mine management system adds the ability to correlate operational data, such as operator and load count.

The study

The client knew that in an ideal dumping situation, its 240 t haul trucks automatically increased engine speed from a 700 rpm idle to 1500 rpm while lifting the bed. But according to sensor data, it was discovered that operators were frequently applying additional throttle (over 1900 rpm) in an attempt to lift the bed faster. Modular was asked to determine whether this practice actually improved dumping time, as well as its relationship to fuel consumption.

Data was gathered on two specific parameters: engine speed (rpm) and fuel burn rate (l/h). One of the primary purposes of the trending application is to specify what data to collect and the conditions desirable for data collection. Since this study focused on the fuel burn rate during dumping operations, the conditions were limited to collect data only during dumping, thereby eliminating the need to filter the data afterwards.

Dump time data was acquired from the mine management system, which captures the duration of every state of the haul cycle for every truck load. By correlating dump time to engine speed, it was possible to extrapolate the impact of applying additional throttle while dumping.

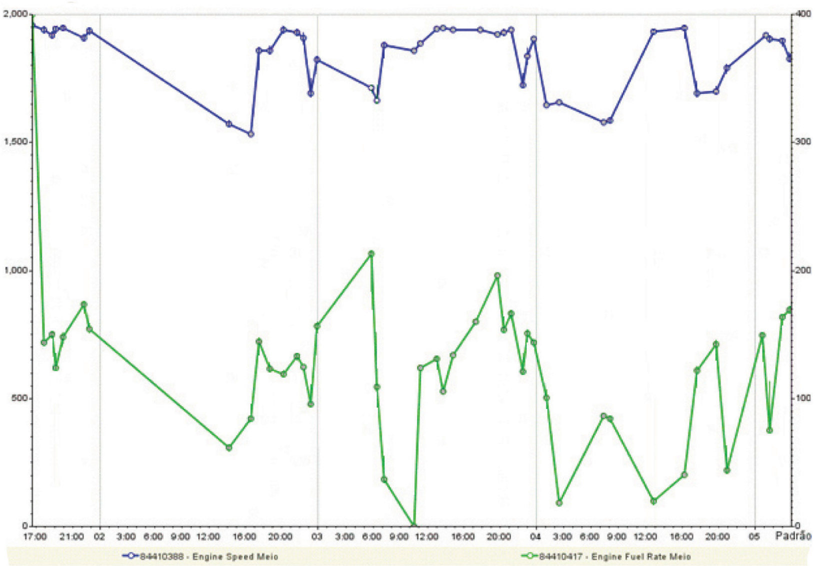

Figure 1. A trend graph shows the relationship between engine speed (blue) and fuel burn rate (green).

Table 1. Breakdown of alarms for excessive rpm

	Number of alarms exceeding 1900 rpm	Affected trucks (%)
Week 1	1564	27.14
Week 2	1928	33.45
Week 3	527	9.14
Week 4	2289	39.72
Week 5	2334	40.50
Average	1728	29.99

The data

The mine assigned 26 of its 72 240 t haul trucks to the study and collected trend data for a total of five weeks. One trend was used to capture burn rate data while trucks were operating under the desired, OEM-specified condition of rpm greater than 1500. A second trend recorded burn rate data whenever rpm exceeded 1900, and was also used to trigger a user-defined alarm each time the condition was met. A quick report from the mine management system showed that this sample set produced an average of 5763 loads/week, which was compared to the user-defined alarm count by week to calculate the percentage of affected truck loads (Table 1).

Exploration of the trend data revealed that the fuel burn rate nearly doubled when engine rpm exceeded 1900 rpm (Table 2). The average burn rate was found to be 74.50 l/h during recommended dumping operations,

Table 2. Relationship between engine speed and fuel burn rate

	Normal idling engine speed		Excessive engine speed	
	rpm	l/h	rpm	l/h
	1557	69.45	1918	128.68
Truck 1	1592	81.55	1913	120.96
	1590	71.92	1915	124.57
	1559	70.35	1908	129.65
Truck 2	1590	77.32	1915	141.81
	1598	75.03	1909	120.38
	1562	92.62	1935	148.96
Truck 3	1585	63.97	1934	133.84
	1566	84.06	1940	130.51
	1559	95.72	1920	135.40
Truck 4	1541	76.18	1928	121.28
	1531	84.07	1942	147.81
	1551	56.07	1897	140.76
Truck 5	1561	83.01	1921	119.72
	1560	78.66	1939	141.06
	1506	49.24	1936	135.41
Truck 6	1515	42.50	1945	137.86
	1586	79.96	1925	135.26
	1586	81.75	1929	150.99
Truck 7	1564	76.54	1926	128.71
	1551	74.59	1933	148.43
Average	1562	74.50	1925	134.38

Table 3. Breakdown of total potential fuel savings (using average quantities)

	Actual sample (30% of loads)	Theoretical worst case (100% of loads)	Best practice (0% of loads)
Dump time (s)	20	20	20
Fuel burn rate (l/h)	92.46	134.38	74.5
Fuel consumption while dumping (l)	0.514	0.747	0.414
Loads/week	222	222	222
Total fuel consumed while dumping/year (l)	5933.6	8623.4	4779.2

compared to 134.38 l/h when excessive throttle was applied. The average dump time across all loads was calculated at 20 s, with no observable improvement in time when additional throttle was applied by the operator.

Conclusion

Having proven that excessive engine rpm during dumping increases fuel burn rate without improving dumping time, potential savings can be calculated using the same data. If dumping practices were standardised to keep engine rpm at the recommended level, each 240 t haul truck would consume 4779.2 l/year of fuel while dumping. If the 26 truck sample is considered representative, only 30% of the dumped loads would involve excessive engine rpm, and each haul truck would consume 5933.6 l/year of fuel while dumping. The difference between these scenarios across the entire 72-truck fleet equates to fuel savings of over US$ 100,000/year.

The data can be further extrapolated to 100% of all dumping operations. In the theoretical worst-case scenario, each haul truck would consume 8623.4 l of fuel while dumping, increasing the total potential annual fuel savings to over 275,000 l for the mining operation (Table 3). This translates to preventing 736 t of CO_2 from being released into the atmosphere – the amount it would take 63.5 ha. of pine or fir forests to annually sequester, or equivalent to recycling 247 tpa of waste.

The study proved that substantial cost-saving opportunities exist within a 20 s part of a 40 min cycle, impacting the underlying cost of an otherwise efficient operation. More importantly, it demonstrates that a maintenance management system like MineCare can be used to identify and research operational opportunities.

Having remote monitoring tools that can capture data from several different sources is critical to performing such cost-saving projects. With complex systems and subsystems across dozens of manufacturers, research capability is a function of available interfaces. Furthermore, by integrating with operational data from the mine management system, an organisation can connect production to machine health and measure operator performance against manufacturer recommendations.