Dragline Performance Improvements Case Study

A MISOM Advanced Solution

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Mines are investing in equipment monitoring technology with the expectation of gaining large increases in equipment productivity and reliability. Simply buying the technology does not result in achieving the promised benefits. Only a holistic approach can achieve these benefits, considering people (analytical skills and culture), process (deliberate means of using the data), and platform (analytical technology).

The following is a case study using equipment monitoring technology as part of an operator performance system for a major machine asset: a dragline.

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MISOM's core competency is helping mines achieve maximum benefit from their data assets. Mines are increasingly investing in high-precision intense monitoring of their major excavators, namely shovels and draglines, becoming a key data asset. MISOM's Operator Performance Management system leverages near-real-time data analytics, a deliberate performance management review process, and leading indicator measures that help focus operators' understanding of their own performance. The program consists of three main phases:

1. **The foundation:** Draglines are complex machines that have many variables that impacts productivity and equipment health. High-precision (HP) dragline monitoring systems are usually purchased by mining companies to measure and report basic equipment performances. However, in most cases users can only access the data through OEM shift reports, which do not promote analysis and performance evaluation. MISOM's near real-time data warehouse (DW) uniquely integrates various data sets from dragline monitoring systems such as production, equipment health, and cycle information in a single environment to enable analysis. All available data and common elements (date, machine, operator, etc.) are captured by a HP monitoring system, sourced by MISOM DW regularly and the data is integrated in the lowest level of granularity possible. (every second or cycle) This multi-dimensional integration enables users to build their own automated reports, in depth analysis of a metric, correlation between different metrics, and many more. The data warehouse is scheduled to update every few minutes. (actual frequency depends on the data source)
2. **The analytical toolkit:** An analytical toolkit begins with understanding the controls available for mines to design, manage, and measure fragmentation through process mapping. Data warehouses provide a near limitless number of analyses options. But without direction, analysis paralysis may occur. This is when engineers and other site personnel are overcome by an overwhelming amount of data and more importantly do not know how to realize its full potential. The analytical toolkit provides a solution: a toolkit is a set of tools that allow systematic analyses that progressively tracks quality throughout the system, from design to end-point.
3. **DW enabled set of actions**: analysis alone does not solve issues. A series of actions are required to improve performance. These include regularly scheduled team-meetings to review a detailed scorecard which promotes action from the analysis. A particular KPI can be added to a scorecard that highlights an issue that needs to be addressed in a particular performance metric. A DW allows the ability to use complex scorecards, which require data to be automatically updated. This allows the team to focus on defining the actions which are needed to fix the problem, and measures to ensure that action is being taken.

CASE STUDY: COAL MINE

Large coal mine in the Powder River Basin purchased two HP dragline monitoring systems in second quarter of 2013. However, the return on investment (ROI) was not as high as expected. MISOM implemented a Dragline solution at this coal mine that improved productivity, equipment health and increased ROI.

Building the Foundation

The key element to a sustainable productivity improvement is having a solid data foundation. OEM reports typically are designed to summarize shift production; where data is needed to be analyzed for different time periods and various elements. When the monitoring systems were installed by a 3rd party vendor they were added as additional sources to the already existing MISOM DW. All available metrics were included and made available for quick data slicing and dicing. Data quality issues were immediately visible while building the DW. This is because DW's make accessing and trending data easy and intuitive. Working with technical personnel from the site, Key Performance Indicators for draglines were identified and added to the data warehouse.

The Analytical Toolkit

A toolkit is a set of systematic analyses that progressively track performance of a system to identify and solve long term problems. Toolkits are connected to the DW and can be updated simply by clicking refresh. Multiple MISOM toolkits were designed and configured at the mine from the DW. A first toolkit was designed to include shot quality. A diggability index was used to evaluate quality of the shot. Figure 1 has one of the many visualizations tools that compare diggability with productivity (cubic yards per dig hour).

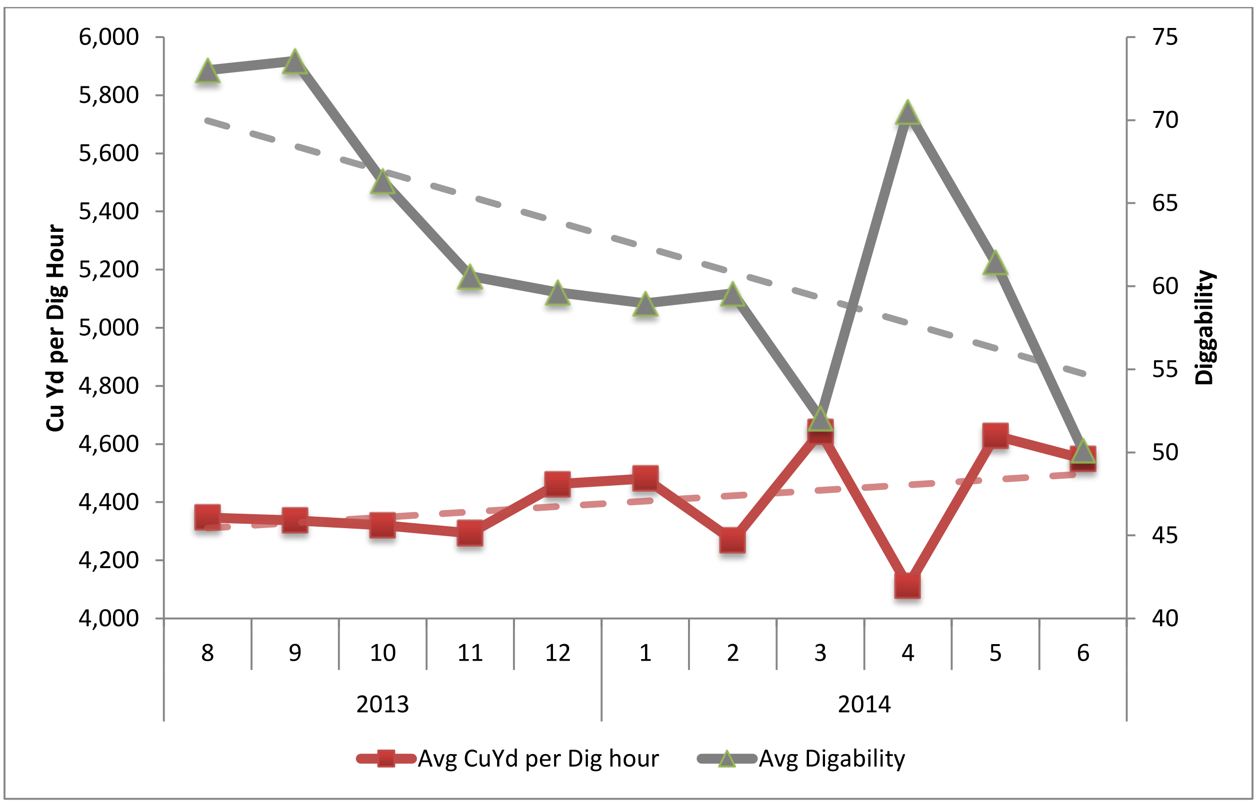

Figure 1 Impact of dig ability on Productivity of Dragline 4

A second toolkit was developed to measure operator performances on draglines. Scorecards were developed for dragline operators, crews, and the entire mine to measure performance for selected periods for KPIs using the DW.

The individual performances of operators were compared with crew and mine averages, and best performances in crew and in mine. The metrics were chosen with input from both MISOM and the department manager. Figure 2 illustrates operator performance for a selected period.

Dragline 1

Operator Scorecard

Equipment	122

Name:	[redacted]
Crew:	Crew 4
Selected Period:	9/1/2013 to 12/31/2013

Volume Metrics	Employee	Crew	% of Crew	Mine	% of Mine
Operating Hours	124.8	306.1	40.8%	1,406	8.9%
Cycle Count	7,594	18,334	41.4%	80,835	9.4%
Yards	572,017	1,349,667	42.4%	5,990,045	9.5%

		Average		Best Operator	
Productivity Metrics	**Employee**	**Crew**	**Mine**	**Crew**	**Mine**
Yards per Cycling Hour	4,809	4,559	4,387	4,809	4,809
Bucket Payload (yards)	75.3	73.6	74.10	75.3	77.3
Total Cycle Time (sec)	56.4	58.1	60.9	56.4	55.8
Bucket Fill Time (sec)	11.4	11.9	12.2	11.4	11.2
Swing Time (sec)	21.4	22.1	22.5	21.4	21.0
Dump Time (sec)	1.5	1.5	1.7	1.5	1.3
Return Time (sec)	22.2	22.6	24.6	22.0	20.1
Swing Angle (degrees)	120.3	124.7	134.0	120.3	99.2
Fill Distance (ft)	70.3	70.9	67.6	70.3	62.6
Fill Velocity (ft/sec)	6.2	6.0	5.6	6.3	6.3
Dig Depth (ft)	-28.4	-30.1	-31.7	-28.4	-27.2
Dump Height (ft)	67.6	67.1	69.1	60.5	35.1

		Average		Best Operator	
Reliability Metrics	**Employee**	**Crew**	**Mine**	**Crew**	**Mine**
Stress Index (psi)	10,072	10,233	10,248	9,972	9,692
TSL % of RSL	115.7%	113.9%	114.4%	111.2%	111.2%

Figure 2 Dragline Operator Scorecard

A third toolkit was designed for equipment health. This toolkit was designed to demonstrate performance of stress on the boom for operators, crews, and all mine for each dragline. Figure 3 shows the improvement in reducing the stress for Dragline 1.

The managers and supervisors were trained on how to use the toolkits and their feedback was used for minor modifications in the toolkit. It was decided that supervisors were to have monthly meetings with each operator for individual performance reviews. In such meetings the operators were shown how their performance compared to other operators and the mine averages in the different metric catagories. This helped each operator identify their weaknesses and help to develop a plan to improve performance through the use of training simulators and best practice shares from top operators.

The toolkits also helped to analyze drilling and blasting performance. Particularly, diggability index and operator productivity. This process gave a wealth of information about the shot performance, which increased coordination between the dragline and drill and blast departments. (see Figure 1)

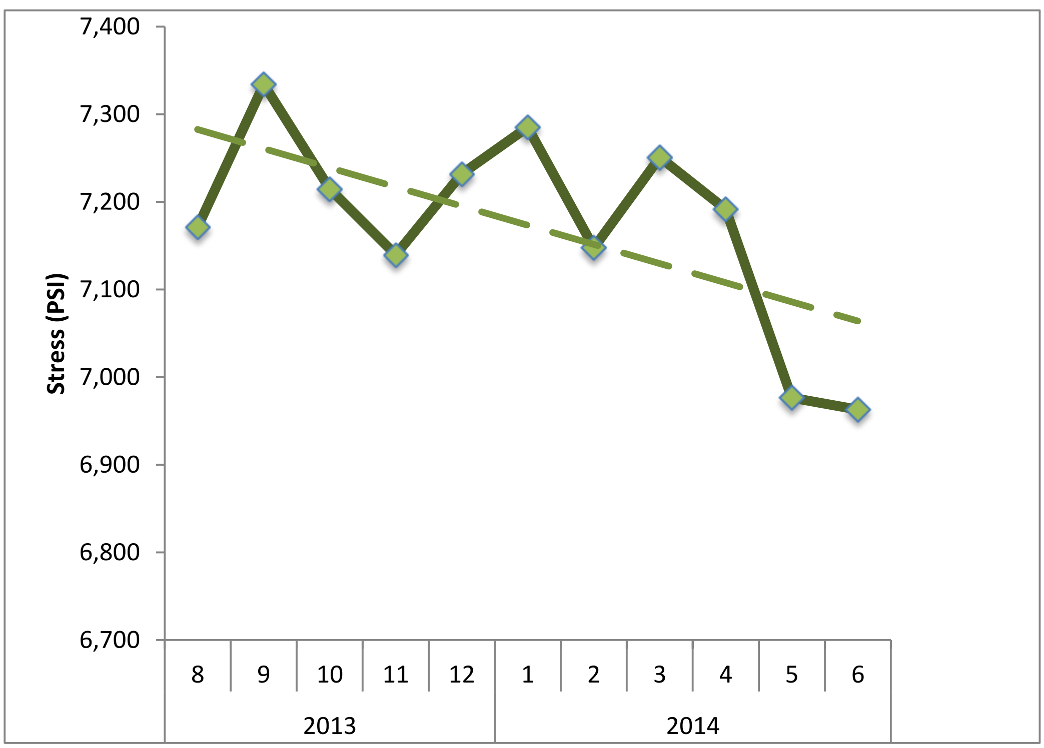

Figure 3 Productivity and boom stress on Dragline 1

Conclusion

Development, training, and deployment of MISOM's Dragline Performance Improvement program took aproximatley four months. The program helped initiate a complete cultural transformation. With this program coordination and comunication between departments were increased and monthly performance reviews for operators were started. Operators were motivated by seeing their performances and had the opportunity to improve their skills.

Using data from the dragline monitoring systems, continous coordination, and performance metric monitoring using MISOM toolkits increased dragline productivities by 4-8%.. Figure 4 shows productivty over time period for the three draglines.

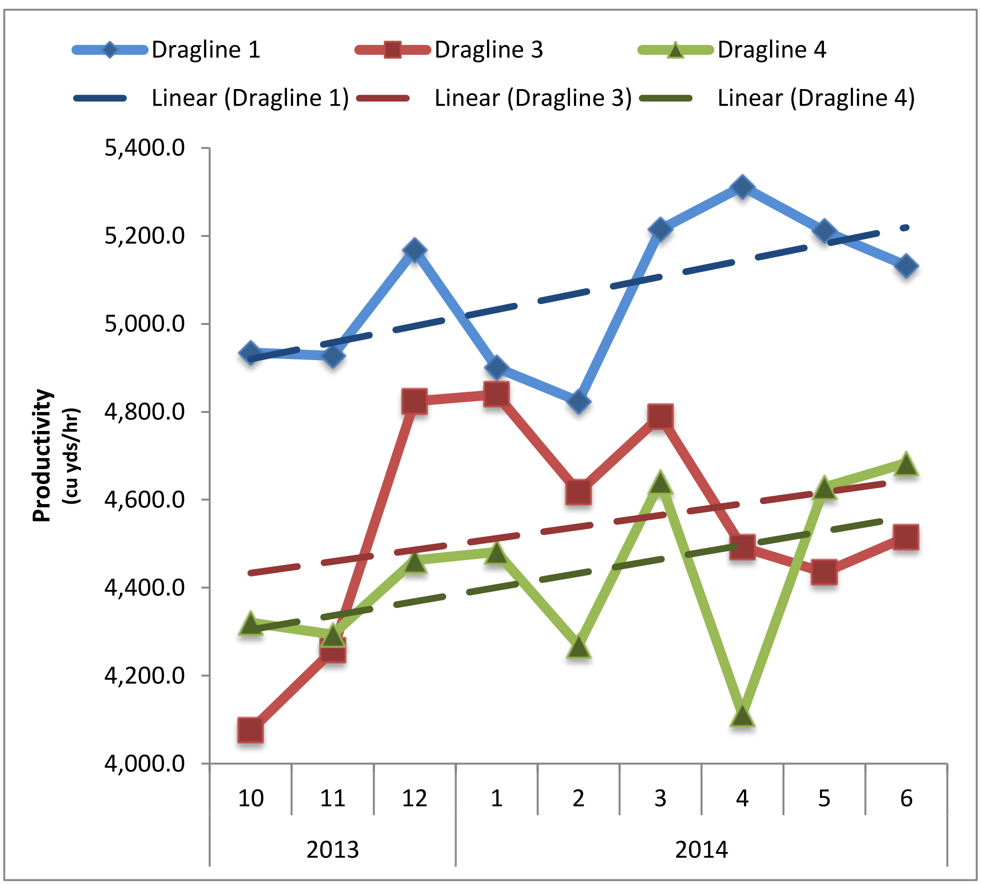

Figure 4 Productivities of all draglines