Smart Solutions 2018

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Smart Solutions, UG

Smart Solutions

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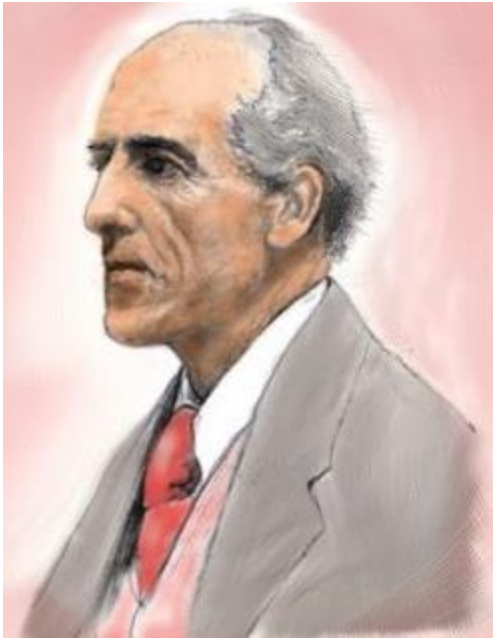
What Is Smart Solutions?

- Smart Solutions is best described as a **continuous improvement service**.
- Maximizing productivity is always a top priority for mines, but **identifying** where **inefficiencies** occur is not always easy, especially in an underground mine.
- Smart Solutions collects streaming and historical **data**, which is processed with our **sophisticated analytics software** to provide detailed assessments of operational characteristics.
- Eliminating recurring inefficiencies one event at a time leads to a culture of **maximum productivity**.

Pearson's Law

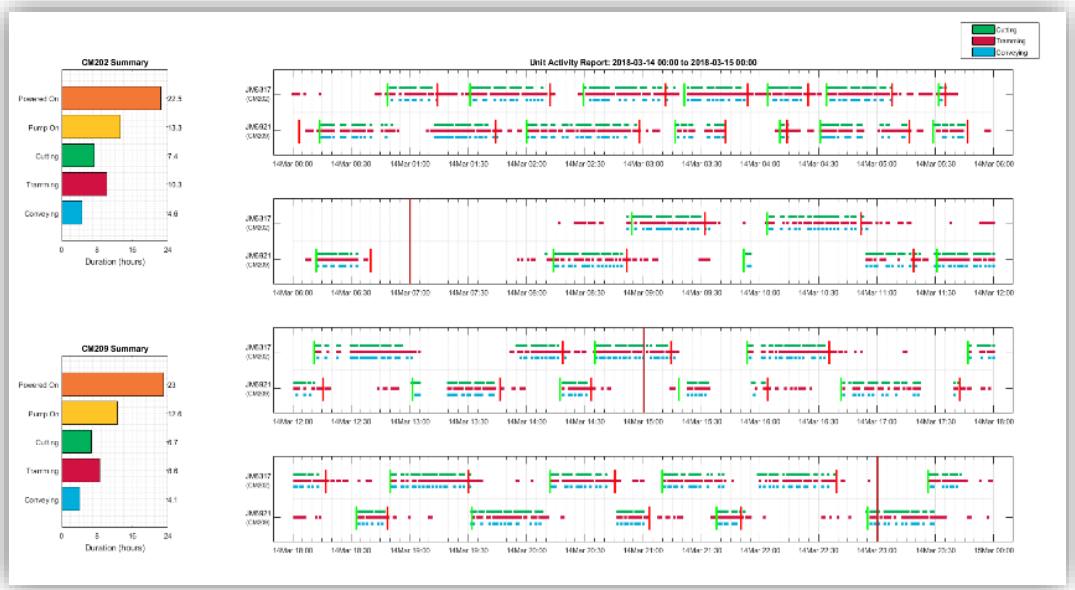
"When performance is measured,
performance improves.
When performance is measured and reported,
the rate of improvement accelerates."



Statistician Karl Pearson
1857-1936

Maximizing Machine Productivity =

How much **Time** is it working?



Maximizing Machine Productivity =

How much **Time** is it working?

How **Hard** is it working?

Maximizing Machine Productivity =

How much **Time** is it working?

How **Hard** is it working?

Why is it not working?

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Smart Solutions Continuous Improvement Process

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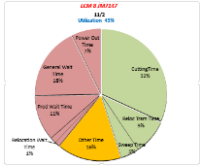
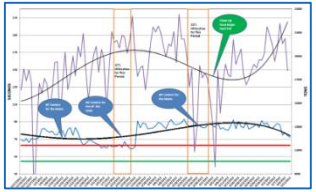
Productivity Analysts then compare operational characteristics to developed standards. Findings are validated with time studies and discussed in regular team meetings.





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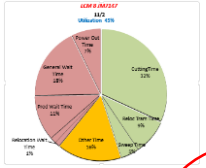

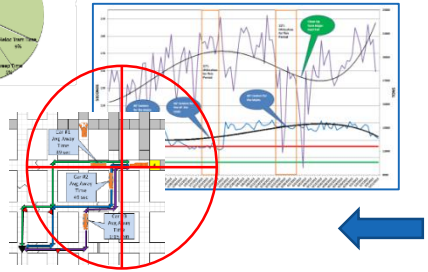

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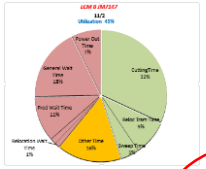

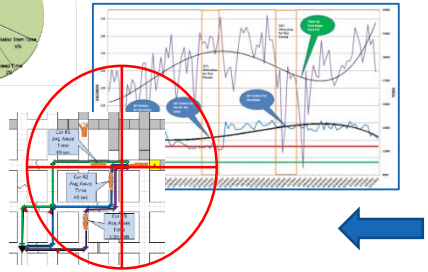

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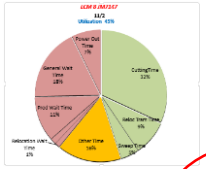

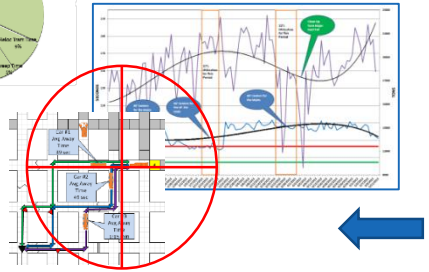

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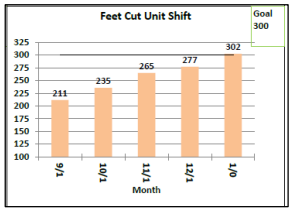

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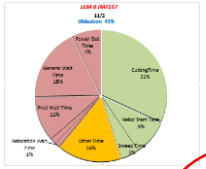

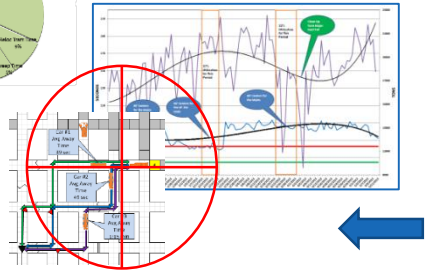

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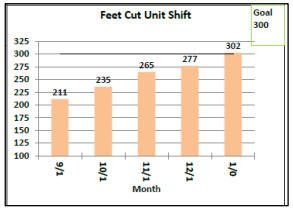

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Continuous Improvement is a loop that ends only with perfection or lack of will.

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Opportunities Example

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Given Parameters

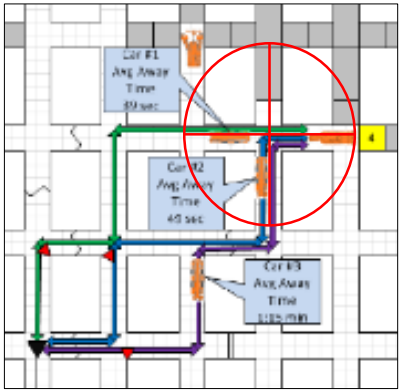
Average loads per shift	120
Shifts per day	2
Average minutes per place cut	40

Goal

Seconds Gained per load	**2**

Impact

Seconds gained per shift	240
Seconds gained per day	480
Minutes gained per day	8
Minutes gained per week	40



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Gains: First Production Hour

Gaining 124,000 tons per year at no cost.

Project Challenge:

Personnel at a mine knew their methods of operation were holding back production levels, and had tried to implement procedures to promote efficiency, but kept defaulting to a pattern of reduced capabilities.
Mine crews were craving information, and eager to make positive changes, but lacked adequate bench marking or daily progress reports.

Solution Design:

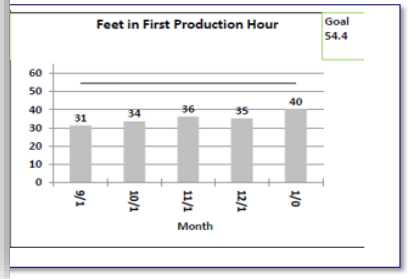
In partnership with the customer, Smart Solutions began tracking the mine's "feet mined in the first production hour" as a standard reporting package. The goal was to start at the beginning and identify all opportunities through the shift.

Start delays seemed to fall in an expected range. The higher priority was determined to be the slow rate at which units came up to full production.

Feet lost in the first hour can never be gained back.

Data produced by Komatsu's smart, connected products revealed **the customer was averaging a rate of 27.6 feet in the first production hour of a shift**. This was measured as an average of the footage reported 60 minutes from the time the conveyor was first turned on during the shift.

Komatsu crews then looked into what factors were limiting production at the start of the shift. During site visits, it became clear, previous shift workers were not leaving workspaces ready for a new shift to begin production in a timely and productive fashion. **There was no systematic approach to readying the unit for a new cutting cycle or ensuring that equipment was serviced and staged properly**.



Bits often were left in poor shape, rocks and debris covered the machine, adequate cable was not pulled up and available, and the machine was left in areas already completed or not yet ready to cut.

The customer had made previous attempts to establish better processes between shifts, but employees returned to old habits in a matter of weeks because there was limited tracking or results.

The shifts needed to work as a team to promote change. But a lack of information and expectations meant the crews and workspaces were not working efficiently.

The Solution:

Using interviews with production crews, Smart Solutions personnel were able to compile a list of priorities. Using the list, the customer defined what constituted a "ready unit" and began training employees.

In partnership with the customer, the responsibility to achieve more "feet mined in the first production hour" was handed to the idle shift crew. When higher levels of production were achieved, that crew then got the credit.

Using data produced by its smart, connected products, Komatsu provided weekly reports on what teams were contributing to higher production rates. Connecting the efforts of one shift to the results of the following, was a new approach that promoted teamwork across shifts.

Bringing all the working crews into the process gave a boost to the team approach.

By providing the actionable data defining low production levels, and then helping crews set and track methods to improve efficiency, Komatsu helped the customer bring accountability to the mine.

The Results:

By the end of 2017, comparison data showed a gain of 6.1 feet per Continuous Miner, per shift, over the year prior. **The gains resulted in an estimated 124,440 tons produced per year.**

These additional tons are credited to efficiency. There was little or no added cost to adopt this change. The gains were pure tons on the belt.

Analyst were able to identify opportunity in the setup procedure on an Idle shift. When a "ready unit" was defined and a cut sequence agreed upon, operators and repair crews were given specific tasks. Then, standards were recorded and workers trained so that the unit was exactly as expected every day. The start time efficiency rebounded. Savings were considerable.

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Case Study

A Data Analyst was able to contact the longwall operator at a customer's mine when he saw a newly installed ranging arm warming up faster than expected. The component was ultimately found be overfilled with oil, and the breather was not installed. This scenario can lead to catastrophic failure of the drum seal and subsequent internal damage.

In addition to the cost to repair the arm, the 2 or more shifts to coordinate and replace the arm was averted.

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Shearer Case Study

Possible Ranging Arm Seal damage averted

Project Challenge:

Over the years, we have seen several seal failures on the start-up of replacement ranging arms. The ultimate cause was linked to oil overfilling and no vent. These failures can cost tens of thousands of dollars in repair, and several shifts production.

The Solution:

- Shearer ranging arms are always in Komatsu inventory. These arms are built generically, no butt plate, covers or drums installed. Because they may sit for long periods of time before being issued to a job, they are prepared for long term storage.

"This may have led to a huge repair bill and days of lost production"

Long term storage includes filling the oil reservoir to the top, and removing any path for moisture ingress, the vents. A sign is always included on the arm to alert of this condition.

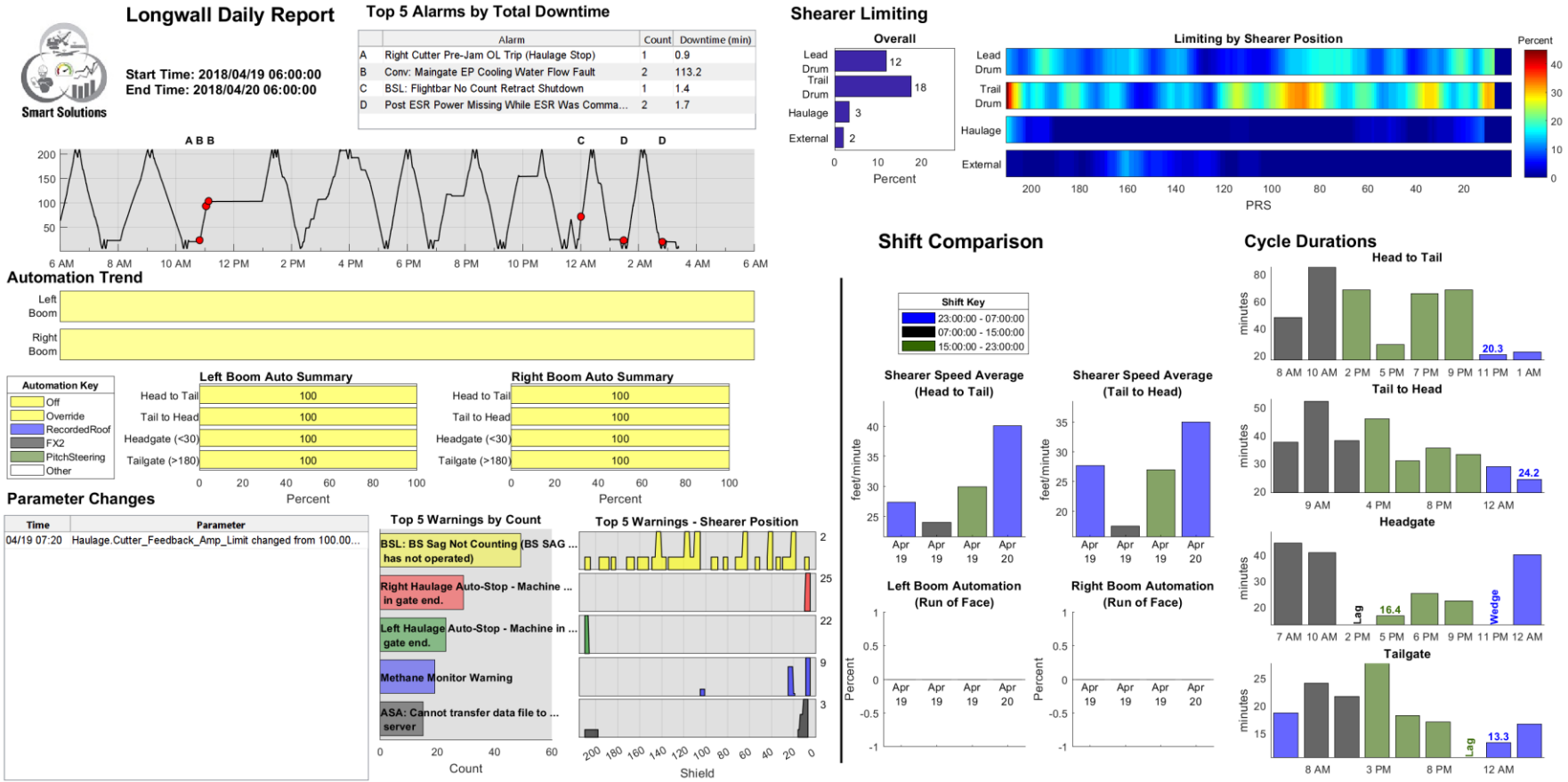
What happened in this condition? As the arm was brought to the shearer, the signs were inadvertently removed. The repair crew was not alerted to the oil and vent condition. When the job was completed, the shearer was returned to service.

The Results:

- The ranging arm, having RTDs installed and being monitored by Smart Solutions, started sending alerts almost immediately. Fearing the worse, Smart Solutions began franticly trying to contact the operator. Within just a few minutes, the concern was relayed to the Longwall Coordinator.

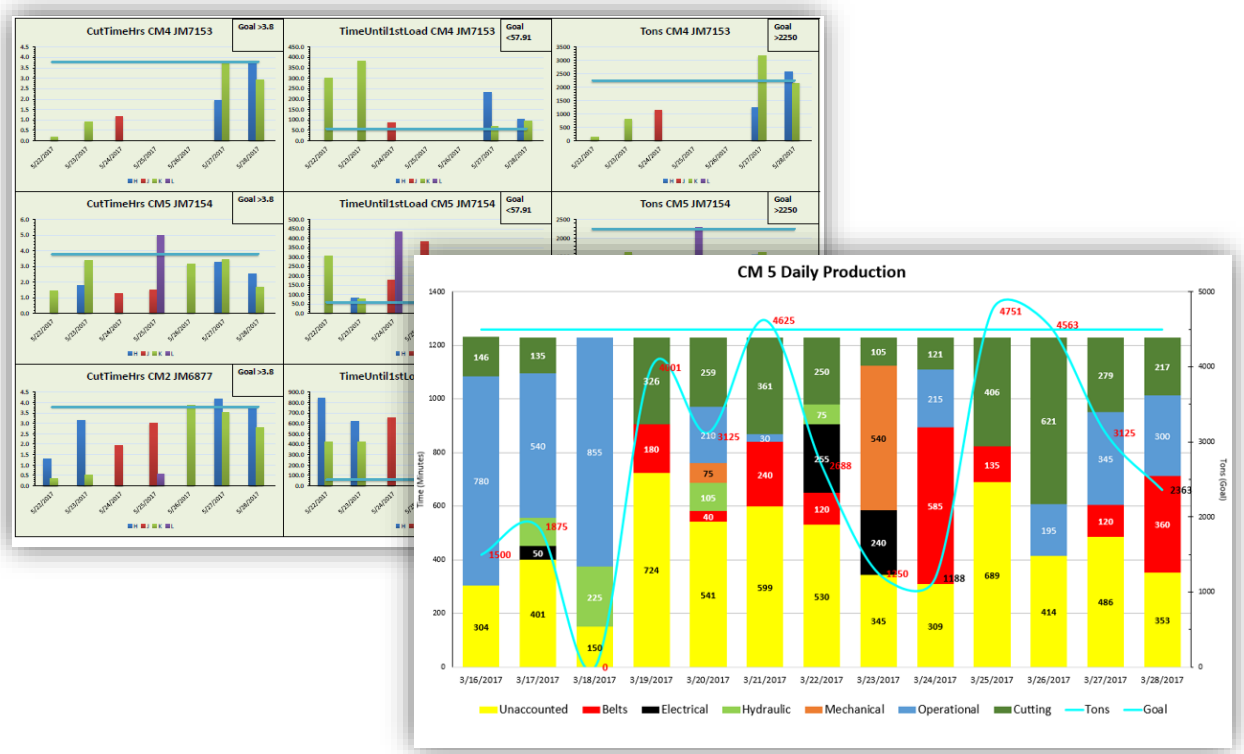
With the Shearer now stopped, the repair crew returned to the shearer. Confirming they had checked that the arm had oil to start, they then checked for over filling. The level was adjusted and the vent was installed. The shearer returned to service, with only minor delays.

Daily Reports



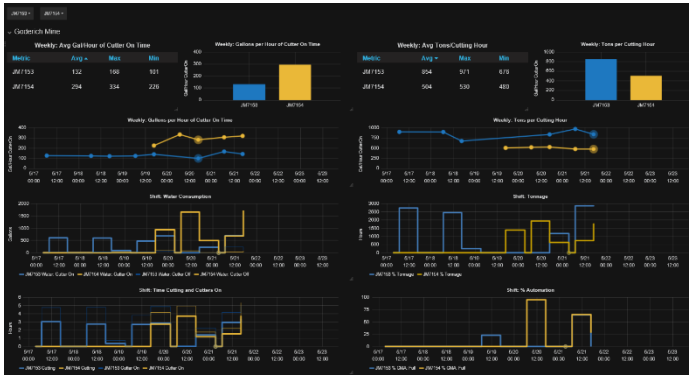
Weekly Dashboard

Weekly productivity dashboards are used to monitor trends. Shift and crew data can be graphed and charted on a host of KPIs. Continual monitoring allows a view of subtle changes in productivity. Early diagnosis of inefficiency in the process is key to maintaining maximum productivity.
This summary is also helpful in identifying opportunities. This report identifies cutting hours per day as a possible opportunity.



Customer Access Data Trending Tools (newly developed)

Typical Faceboss Machines have in excess of 400 data tags. Data tags are points within the computers that change status as events occur. To view these tags, we use Graffana.
Recent developments have allowed Komatsu to share access to this data with our customers. Combinations of styles and trends allow near unlimited comparison of machine data, both live and historic (30-day).



Products and Deliveries (Example)

- **Remote Health Monitoring**
  - Data Analysis
  - Custom Analytics
  - Help Line
- **Productivity Analysis**
  - Shift/Daily/Weekly Reporting
  - Process Analysis
  - Mine site/Unit Analysis
- **Machine Condition Monitoring**
  - Monthly Conditions Assessment
  - Wear Analysis
  - Oil Sample Analysis
  - Vibration Analysis
- **Training/Coaching**
  - Maintenance Training
  - Operator Coaching
  - Custom Systems Training
  - Hands-on at the Machine Training