IMPLEMENTATION ENGINEERS®

CASE STUDY

Implementation Execution at a coal mine

Underground development

An Implementation Engineers Engagement

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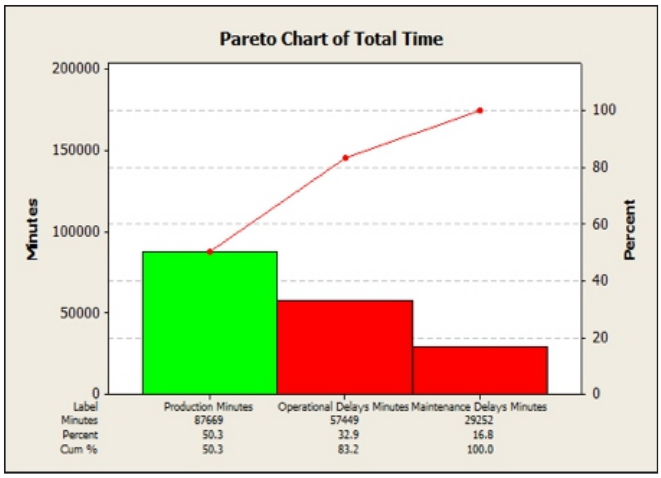
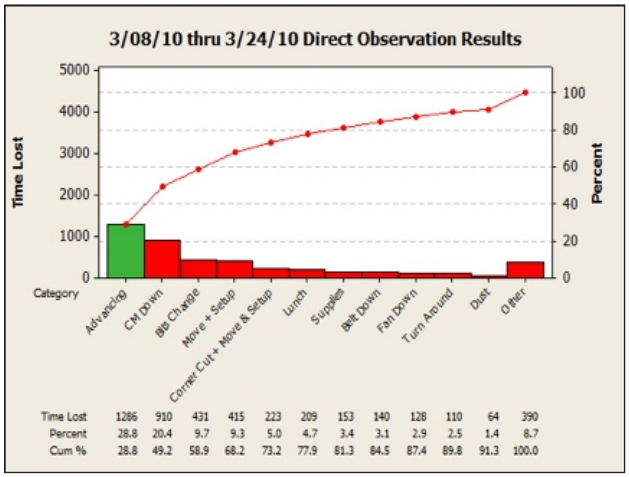
Continuous miner falls short; no solutions from previous firms

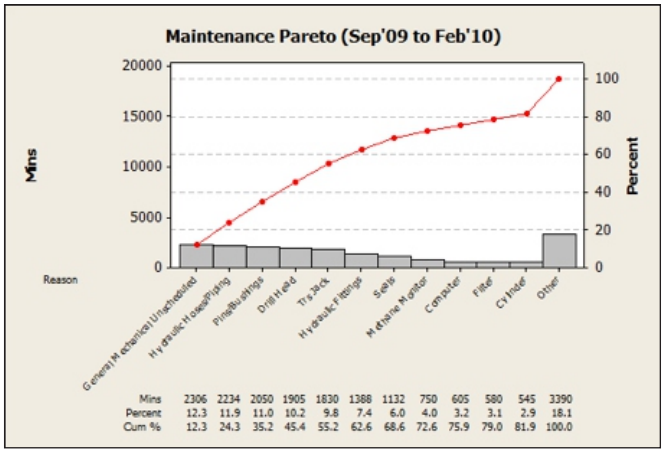
Our client, a Long Wall mining operation in North America, was falling behind in its development due to the underperformance of its Continuous Miner. It was only moving at an average rate of 60% of target or about 45 feet per shift. The company hired “consultants” on two separate occasions to help with the problem to no avail. We convinced them that our approach and methodology could quickly identify what was causing the underperformance, fix the problems and get it back on track. After getting the green light, we sent our team underground to work with the unionized workforce and observe the operation.

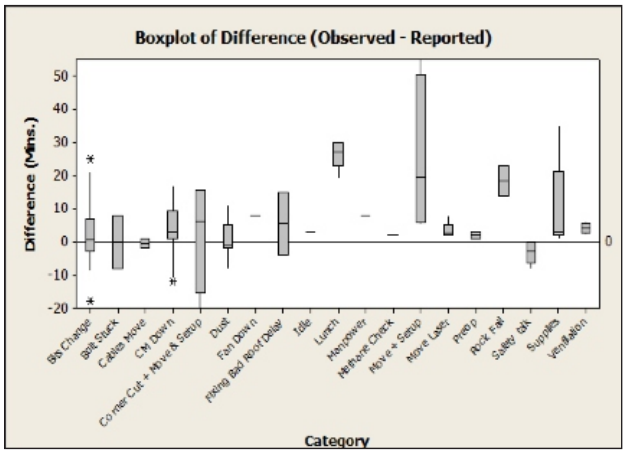
Approach

Our team worked directly with the crews across all three shifts and made observations over many days to understand how each crew worked and what issues they encountered during their shift. We analyzed the historical operational data as we wanted to learn what caused the delays of the Continuous Miner.









We created a mine model, which detailed the full cycle of the Continuous Miner, to help us understand the influence on performance that each step contributed:

Assumptions

Available Time / Week

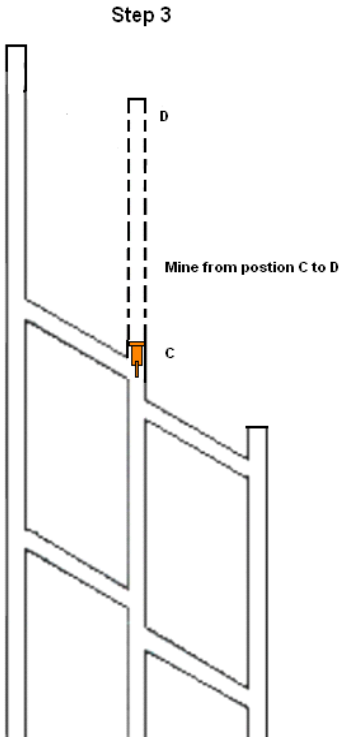
Shifts		3	Shifts
Work Days		5	Days
Hrs / Shift		8	Hrs
Lunch Time / Shift		0.5	Hrs
Belt & Power Move (2 x 4 Hrs)		8	Hrs
Total Available Time / Week		104.5	Hrs
Weighted Available Time / Shift		6.967	Hrs
Total Delays per Shift Observed		3.322	Hrs
Actual Available Time / Shift		3.645	Hrs

From Observations….

Screen installed between Straps	46.2	% of Time
Avg Distance Strap to Strap	2.96	Feet
Straps / Hr Without Screen	6.85	Straps
Straps / Hr With Screen	6.19	Straps
Weighted Ft / Hr	19.38	Ft / Hr

Observed Operational Delays

Activity	Average Time	
Move + Cut Corner	55.8	Mins
Move + Turnout	110.0	Mins
Move + Ventilation	69.2	Mins
Bit Change	26.9	Mins
Dust	4.2	Mins
Supplies	42.3	Mins
Preop	16.3	Mins



The Mine Model is based on a 184' complete cycle

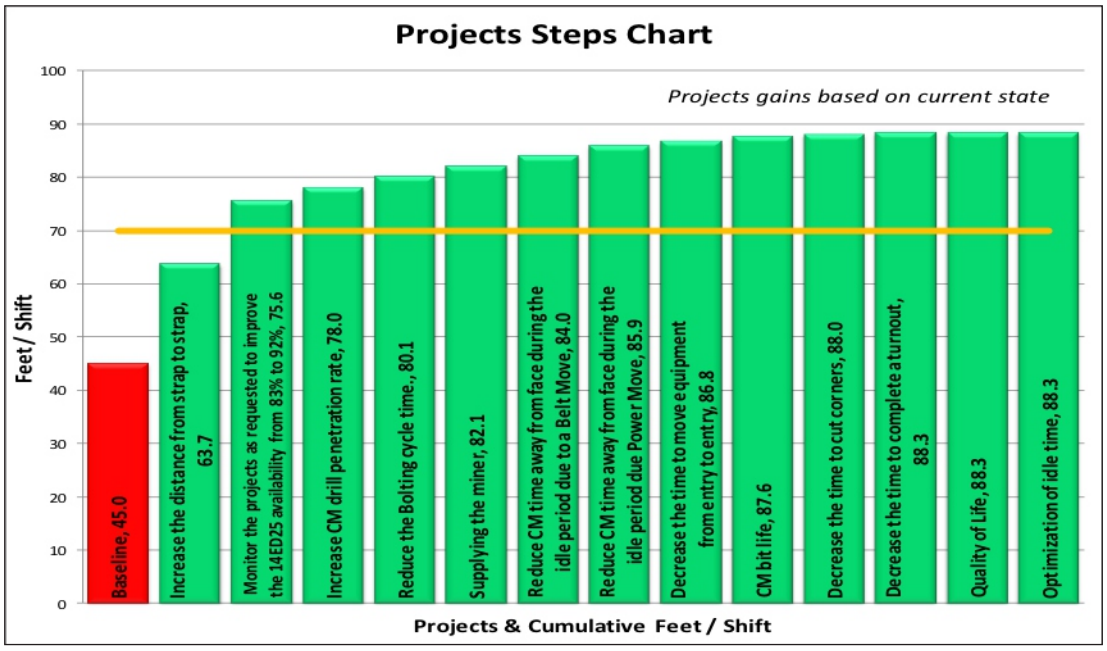
Complete Cycle Definition

Step	Process	Advance Distance	CM Time Expected	Number of Straps
1	Mine 1	184	9.50	62
2	Move from 1 to 2		1.15	
3	Mine 2	184	9.50	62
5	Move + Turnout		1.83	8
6	Mine 2 to 1	99.5	5.13	34
7	Move + Cut Corner		0.93	4
8	Move from 1 to 3		1.15	
9	Mine 3	184	9.50	62
10	Move + Turnout		1.83	8
11	Mine 3 to 2	99.5	5.13	34
12	Move + Cut Corner		0.93	4
13	Move to 1		1.15	
	TOTAL	**751**	**47.74**	**278**

After four weeks, we identified the root causes of the slow movement. Two significant ones were apparent.

- The Continuous Miner was stopping every three feet to apply the screen to the ceiling by drilling two holes, then strapping it into place.
- The crews spent a lot of time changing the drill bits on the head of the Continuous Miner.

There were other factors which contributed to the loss of advancement feet. We assigned a project to each and put together an implementation plan that included our estimate of how many additional advancement feet each project would produce once implemented. A summary of that plan is shown below and indicates that they have the potential to exceed 80 feet per shift of advancement:



The implementation plan included project charters for each of the projects that detailed the project and its associated analysis; the approach to implementation; the team and implementation duration; and the measurement to be impacted and by how much.

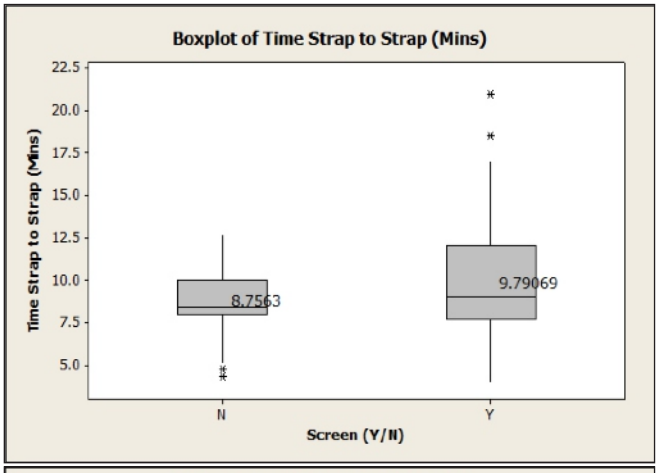
Hours / Shift = 8	Actual	Future	Projects
Weighted Schedule Time / Shift (Hrs)	6.97	7.17	Reduce CM time away from face during the idle period due Power Move Reduce CM time away from face during the idle period due to a Belt Move Optimization of idle time
Maintenance Availability (Hrs)	5.78	6.61	Monitor the projects as requested to improve the CM availability from 83% to 92%
Maint. Availability (%)	83%	92%	
Operative Time / Shift (Hrs)	2.80	3.79	Supplying the miner CM bit life Decrease the time to move equipment from entry to entry Decrease the time to cut corners Decrease the time to complete a turnout
Percent Remaining to Process	40%	53%	
Percent of Total Hours	35%	47%	
Rate of Advancement (Min / Feet)	3.16	2.15	Increase CM drill penetration rate Reduce the Bolting cycle time.
Feet / Strap	2.96	4.00	Increase the distance from strap to strap
Morale	☹	☺	Quality of Life Project
Feet / Shift Calculated from Observations	53.2	105.80	

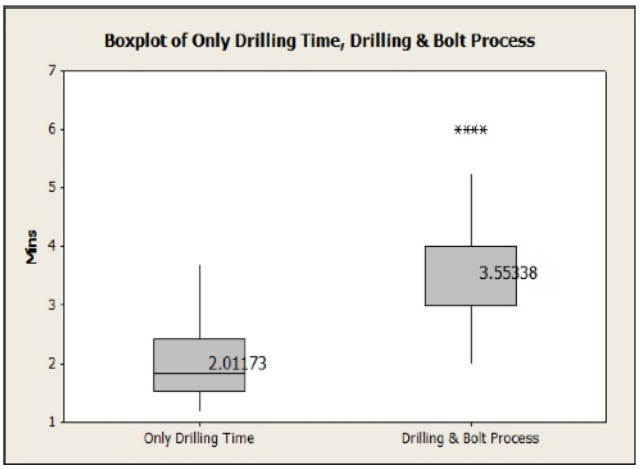
Next, we implemented the work plan by working directly with the crews to fix the problems. We showed them the data from our observations and discussed the most significant factors in delays. The crews agreed with our analysis and revealed that the delays made their jobs more difficult and were excited about fixing these problems.

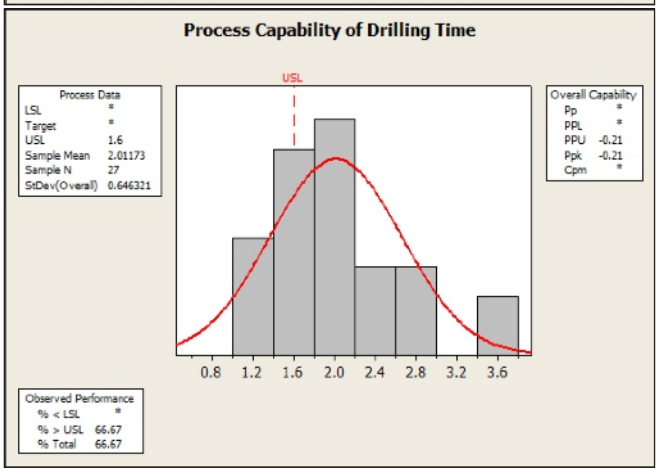
In the case of the Continuous Miner stopping every three feet, we decided that if we used longer screens, the Miner would stop every four feet extending the stopping distance by 33%. Via a Kaizen event, we showed that we could work and reduce the screening without any risk to safety. The continuous miner is designed to carry enough material (straps, bolts, etc.) to complete a cycle. With the increase in strap distance, the miner did not have to pull out prior to completing a cycle to restock material.

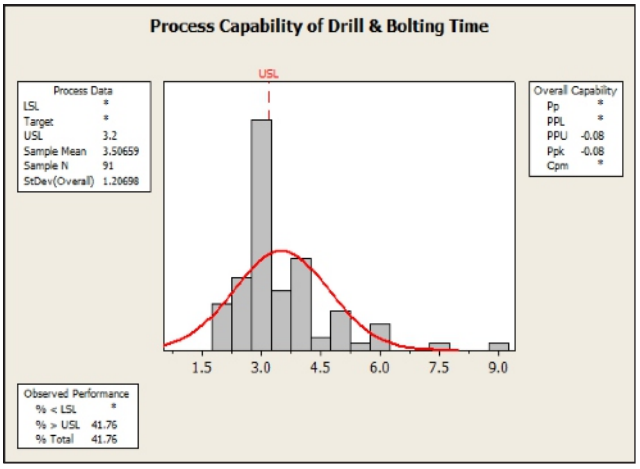
The next blitz was to reduce the drill / bolt cycle time. Changed the current bolts to 8' point anchor bolts and utilized a quick drying resin. The results were a 25% decrease in cycle time

Sample Size	Avg Time Strap to Strap with Screen	Feet/Hr Advanced with Screen	Sample Size	Avg Time Strap to Strap w/o Screen	Feet/Hr Advanced w/o Screen	Percentage of Screens per Section
103	9.79	18.14	45	8.76	20.29	70%

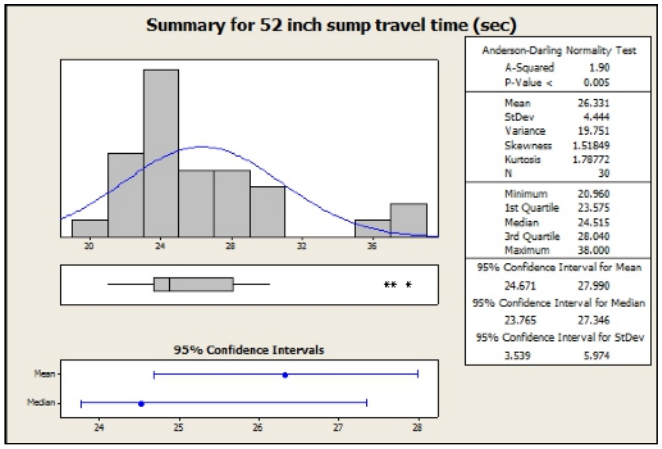


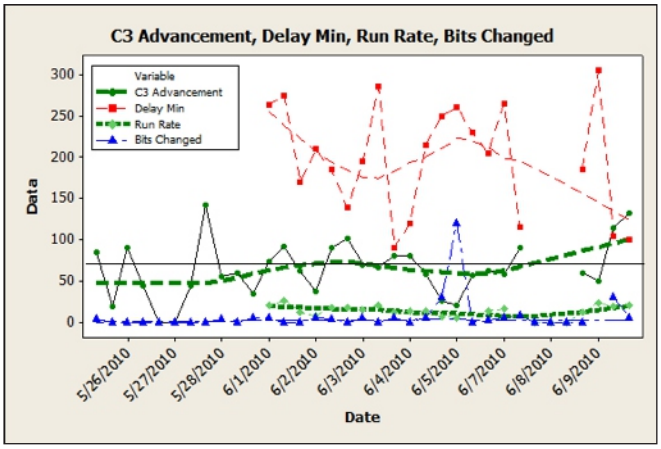


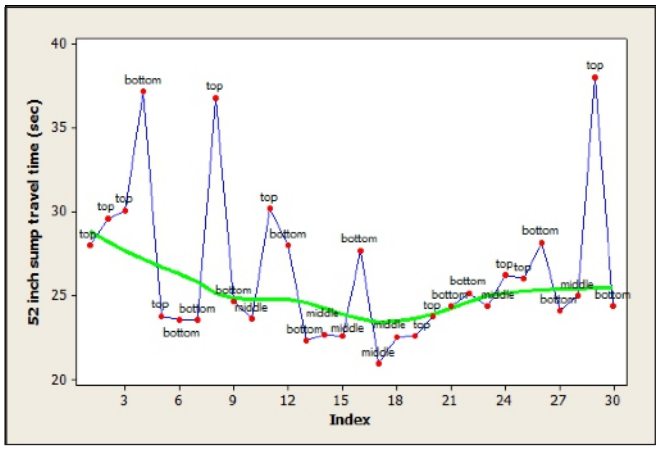


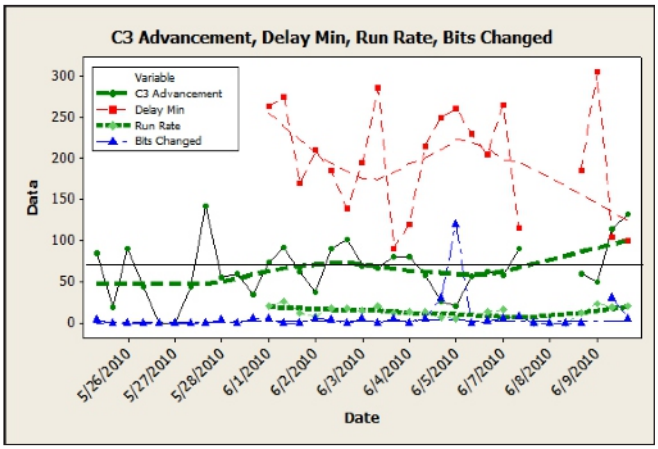


Second, we performed a Six Sigma Design of Experiments (DOE) on the drill bits and learned that their bits were wearing out far more quickly than other specific bits on the market. We chose a new bit, which was about the same cost as the former bit, and the result showed 21 bits were changed over a 10-shift pilot test period. Previously, they averaged 36 bits changes per shift.



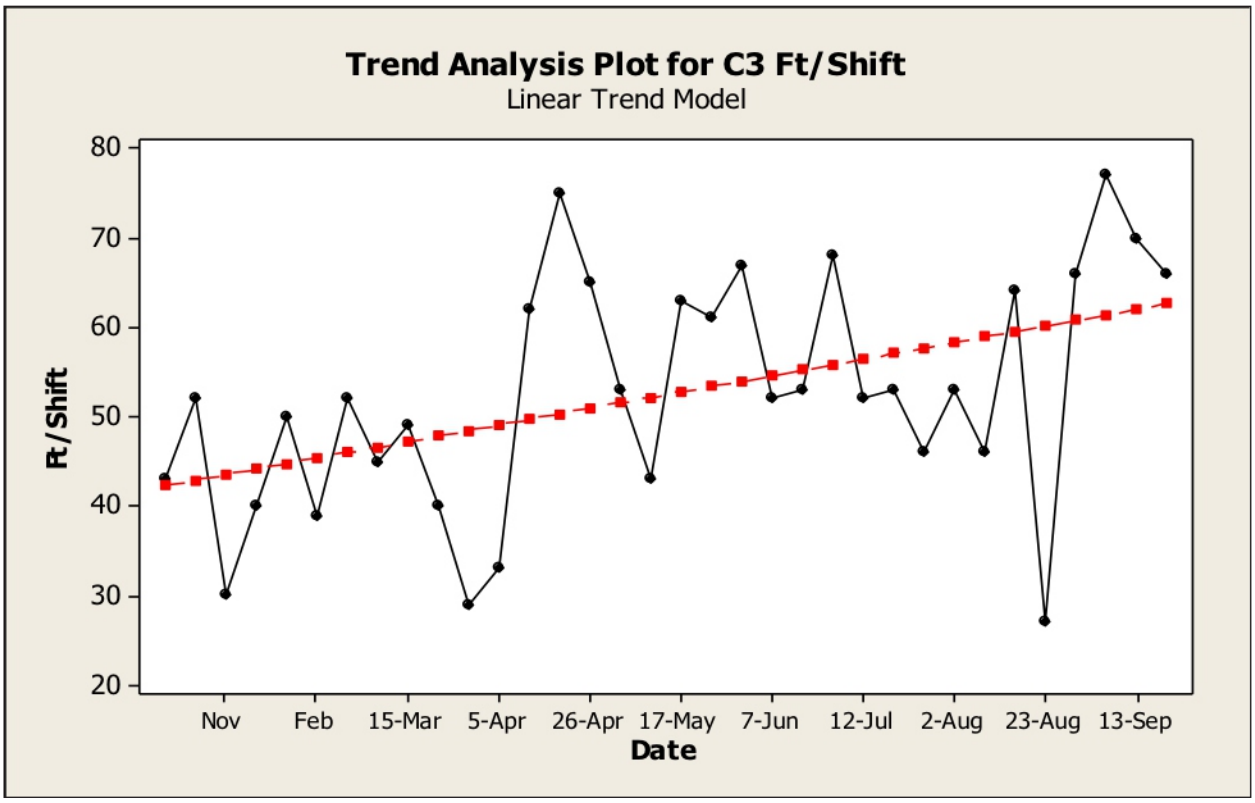


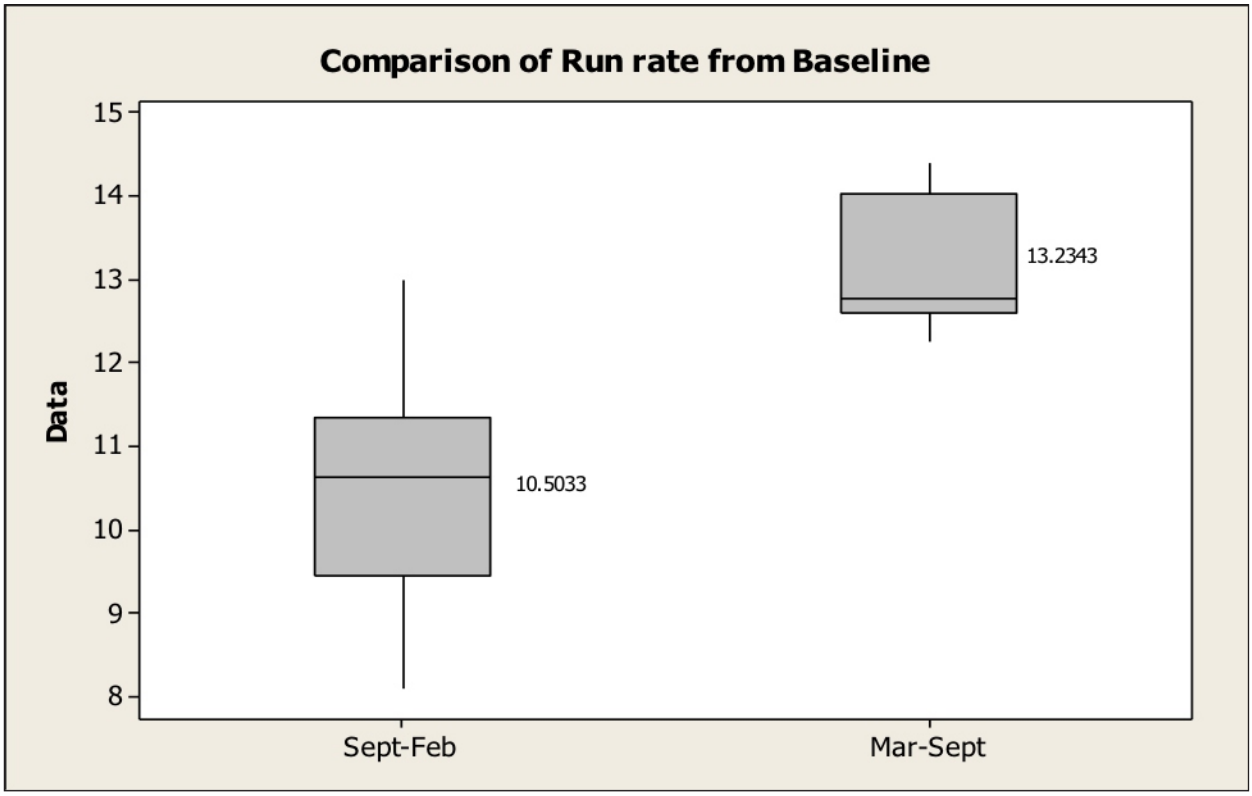


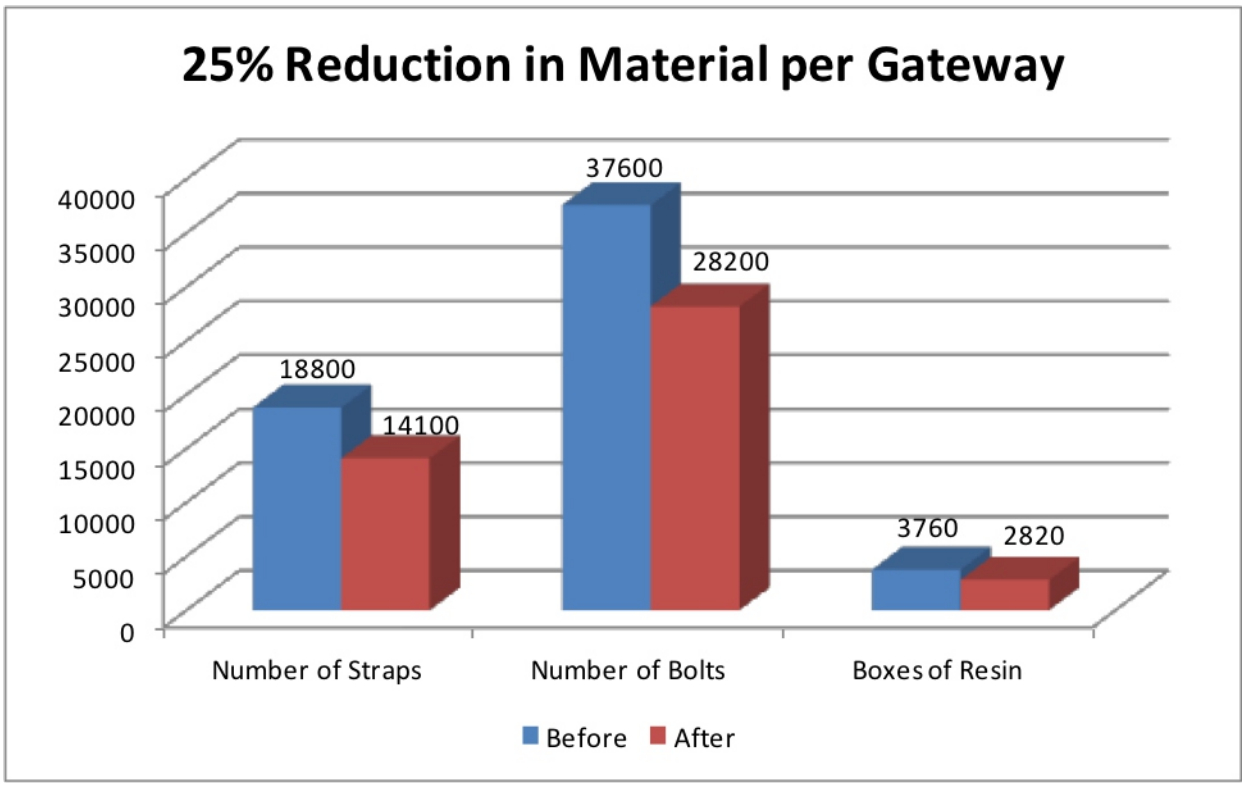


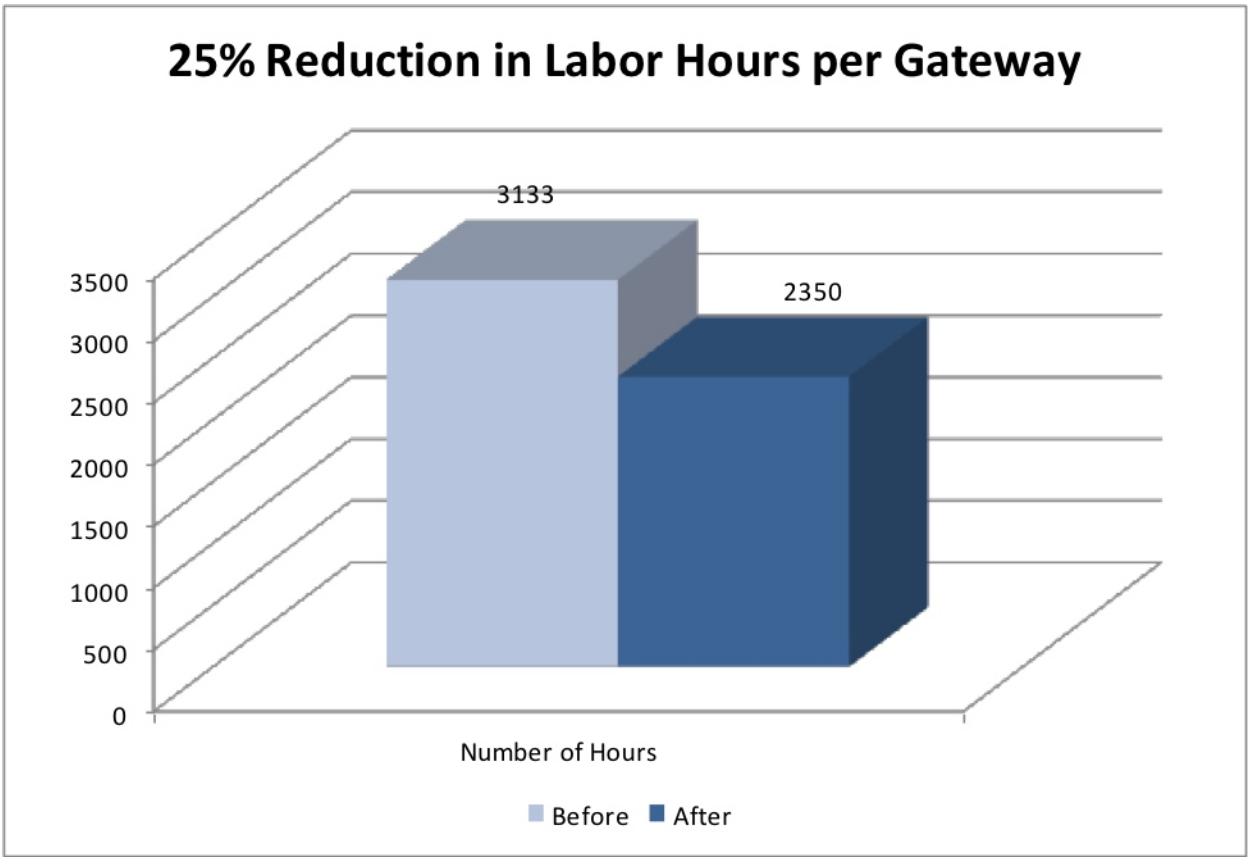
Results

Once implemented, these two improvements alone extended the average Continuous Miner movement from about 45 feet per shift to more than 70 feet per shift. Other projects we had identified helped further improvements and sustainability. Now, more than a year later, the crews are performing consistently at a rate of more than 75 feet per shift. This achievement exceeded the planned advancement and ensures the Continuous Miner development work is completed in time to move the Long Wall mining equipment into the area.


Trend Analysis Plot for C3 Ft/Shift
Linear Trend Model
Ft/Shift
80
70
60
50
40
30
20
Nov
Feb
15-Mar
5-Apr
26-Apr
17-May
7-Jun
12-Jul
2-Aug
23-Aug
13-Sep
Date


Comparison of Run rate from Baseline
Data
15
14
13
12
11
10
9
8
10.5033
13.2343
Sept-Feb
Mar-Sept


25% Reduction in Material per Gateway
40000
35000
30000
25000
20000
15000
10000
5000
0
18800
14100
37600
28200
3760
2820
Number of Straps
Number of Bolts
Boxes of Resin
Before
After


25% Reduction in Labor Hours per Gateway
3500
3000
2500
2000
1500
1000
500
0
3133
2350
Number of Hours
Before
After

NEXT STEPS ›

- Schedule a meeting with our team to learn about our enCompass® methodology and how IE can improve your operations.
- Interested in learning more about the topic covered in this case study? Call us at 1-312-967-4162 and reference the paper you're interested in. We would love to discuss your initiatives.
- Visit www.implementation.com to find out more about our services.

IMPLEMENTATION ENGINEERS®

At our core, Implementation Engineers is a data-driven, global firm with a razor-sharp focus on enhancing mining and manufacturing operations.

We have volumes of success stories, and they can all be attributed to our revolutionary enCompass® methodology. This industry-first approach gives us not only the knowledge to inform you of what needs to be done, but the power to actually implement those solutions for lasting impact.

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1-312-967-4162