Quantifying Financial Benefits from an Asset Performance Initiative

Reliability Improvement Initiatives: Proven, Rapid, and Sustainable Results

Bentley®

Reliability Improvement Initiatives: Proven, Rapid, and Sustainable Results

Asset performance improvement initiatives that are based on an increase in asset reliability are an excellent way to maximize financial return from your assets. These initiatives provide significant and sustainable benefits for relatively low financial investments compared to their capital expenditure alternatives. This white paper describes how to quantify these financial benefits as well as the possible metrics to use in managing the initiative. The paper includes a number of examples where such benefits have been achieved and provides a normalized compilation of results from work performed over the past 10 years.

Asset reliability strategies can help increase asset performance and asset life, reduce safety and environmental incidences and reduce costs.

Introduction

Industry is forever searching for ways to maximize financial return from its physical assets while responding to ongoing market changes and social requirements. As a result, the average system undergoes 30 to 50 physical and operational changes per year. This represents significant capital expenditure for most organizations. Unfortunately, most organizations do not achieve a measurable improvement in their assets' performance from year to year despite these efforts.

There is an alternative: asset performance enhancement through a reliabilityinitiative. Comparatively, reliability initiatives are much less expensive than capital projects and drive the culture change that is more apt to ensure sustainability as they include improvements to the systems and processes. They also provide a continuous improvement stream that leads to an increase in benefits beyond the project phase.

As with all projects and initiatives, reliability improvement initiatives need to be managed and therefore measured. The measures and expected results should be defined up front and used to scope out the initiative and track success. Asset reliability strategies can help increase asset performance and asset life, reduce safety and environmental incidences and reduce costs. For example, ArcelorMittal Mine Mont-Wright was able to reduce the operating cost of its haul truck fleet by 8.6%, more than double the fleet’s useful life, reduce the number of safety related incidences and cut costs by over CAN$ 7 million per year.

When embarking on a reliability improvement initiative it is essential to quantify the potential benefits, define and apply a suitable strategy that incorporates process improvements, best practices and technology, and establish, measure, and communicate the success metrics. This document defines the typical measurable financial benefits, gives a guideline to establishing Key performance indicators (KPIs) and provides a compilation of 10 successful reliability projects as well as specific details on five unique reliability initiatives. Examples are described throughout the paper, but care has been taken to scrub out confidential information.

Quantifying the Anticipated Benefits

We've grouped the benefits derived from reliability-focused asset performance improvement initiatives into four categories. The following are definitions of each with examples:

- **The overall equipment efficiency (OEE)** equates to availability x quality x machine speed. Increases in asset management efficiency and effectiveness translate into increased asset availability, better quality results, and the possibility of increasing machine speed without penalizing the first two. The result is an increase in production throughput.

Paper Machine #5	Last 12 Months	Benchmark	% Attributable to Equipment Condition	% Gains Targeted by this Initiative	Gain Targeted by this Initiative
OEE (technical limits 95.2%)	**81.6%**	**92.3%**			**85.3%**
Uptime	**89.3%**				**2.5%**
Scheduled Maintenance	**1.0%**	**1.4%**		**100%**	**-0.4%**
Unscheduled Maintenance	3.1%	0.7%		60%	-1.4%
Pulp Supply Shortage	**0.1%**		**70%**	**60%**	**0.0%**
Stream / Air Shortage	0.0%		100%	60%	0.0%
Downtime Due to Electric Shortage	**0.6%**		**0%**	**60%**	**0.0%**
Couch Breaks	0.0%		100%	60%	0.0%
Press Breaks	**3.0%**		**50%**	**60%**	**0.9%**
Dryer Breaks	0.1%		50%	60%	0.0%
Calendar Breaks	**0.7%**		**60%**	**60%**	**0.3%**
Real Breaks	0.3%		100%	60%	0.2%
Ropes	**0.2%**		**70%**	**60%**	**0.1%**
Quality	**91.9%**				**1.5%**
Cull Losses	**2.2%**		**50%**	**60%**	**0.7%**
Slab Losses	1.7%		50%	60%	0.5%
Unaccounted Losses	**21.1%**		**50%**	**60%**	**0.3%**
Speed	**99.4%**				**0.1%**
Speed Losses	**0.6%**		**50%**	**25%**	**0.1%**

In this example the anticipated benefits were based on the machine's current OEE results, failure history, benchmark data, and technical limit. Market and operational losses were factored out. A 3.7% increase in OEE was anticipated and deemed to be well within the possible. This represented a CAN$ 3.3 million/year operational gain.

Reduction in Quality Losses for Bottling Line 2		
	Value	**Unit**
Total Units Produced	1,200,000	hectoliters
% Shrinkage	**4.20%**	**%**
Total Units Scrapped	50400	hectoliters
Cost Per Unit	**CAN$ 12**	**$**
Shrinkage Targeted	2%	%
Gain Targeted ($)	**CAN$ 316,800**	

- **Conversion loss reductions (CLR)** include the excess use of energy, water and consumables due to inefficiencies in the process caused by poorly functioning equipment and/or consumed while the equipment was not used. CLR also includes the quality loss component of OEE (the benefits must not be counted twice). Quality losses include both the scrapping of the product and, when applicable, the cost to rework the product. In this example we anticipated reducing scrap levels (shrinkage) from 4.2% to 2% for an annual saving of CAN$ 300,000.

Reduction in Energy Usage per Year (UPG Ball Mill)		
	Value	**Unit**
Amount of Energy Used	CAN$ 4,215,649	$
% Used Due to Equipment Failure	**1%**	**%**
Total Opportunity Per Year	CAN$ 42,156	$
Gain Targeted (%)	**70%**	**%**
Gain Targeted ($)	**CAN$ 29,510**	

In this mining site the ball mill continues to turn and uses energy during line stoppages. We were able to calculate the amount of hours where the line was stopped due to failures of some line equipment. A 70% reduction was considered plausible and represented a CAN$ 30,000/year saving in energy. Lime is used in the production of kraft pulp. When the kiln is down for whatever reason, lime needs to be purchased. At this particular site the company purchases CAN$ 150,000 of lime per year, and 100% of this is due to kiln failure. At an improvement target of 60% this represented CAN$ 90,000/year.

Quantifying Financial Benefits from an Asset Performance Initiative

- **Maintenance cost reductions** (**MCR**) are the maintenance labor and spare part consumption benefits achievable from an increase in maintenance efficiency and effectiveness.

Labor effectiveness is a result of how pertinent the tasks are to maintaining the asset operating at the required level of performance. An effective asset care program translates knowledge into actionable information and is comprised of activities that reduce the amount of 'fire fighting' needed to maintain the equipment. This is often referred to as proactive work and is made up of predictive, scheduled restoration, scheduled discard, and state monitoring tasks. This same program must also minimize the amount of non-value added work that is performed. The organization maximizes effectiveness by ensuring that it performs the right work at the right time. In a world-class environment, 85%of asset care activities are proactive with no more than 5% being non-value added work. The labor impact of moving from reactive to proactive work is based on the estimate that reactive work takes three times longer to accomplish compared to proactive work. As it takes effort to be more proactive, a shift from reactive to proactive usually translates into a 20% to 25% reduction in maintenance effort.

Reduction in Manpower Due to Improved Effectiveness

	% Proactive Work		Reactive Work	Potential Savings	
	Current	Target	Number of Reactive Hours (Current)	Hours Reduced when Target is Achieved	Manpower Reductions
Target	30%	60%	53,609	4,595	2.6
World Class		85%		8,424	4.8

The organization maximizes effectiveness by ensuring that it performs the right work at the right time.

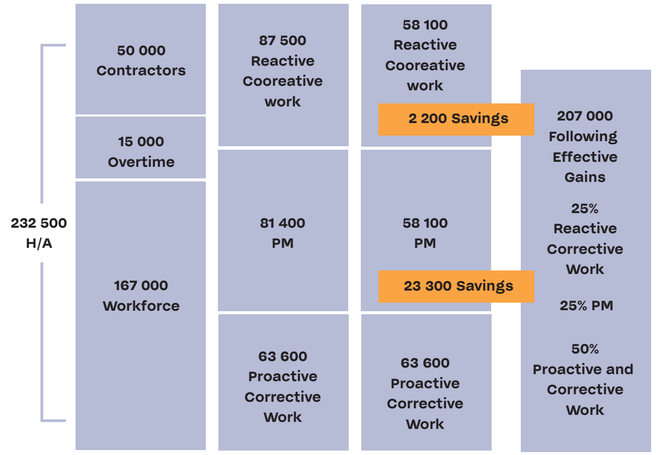
In this area of a metal refining plant we targeted a shift from 30% proactive to 60% proactive for a reduction in the maintenance effort of 4,600 hours per year.

Reduction in Parts Usage Due to Improved Effectiveness

	% Proactive Work		Reactive Work	Potential Savings
	Current	Target	Cost of Parts Used for Reactive Work	Reduction in Material Usage Once Target is Achieved
Target	30%	60%	CAN$ 655,200	CAN$ 140,400
World Class		85%		CAN$ 257,400

Material usage on work converted from reactive to proactive will also drop by a factor of two to four. In this case we anticipated a saving of CAN$ 140,000/ year in consumed parts.

In this site we moved from 35% to 25% PM; world class is 20%. This represented an annual saving of 23,000 hours.



Combined with the rest of the effectiveness gains the plant can move to a ratio of 25% PM, 50% proactive corrective work, and 25% reactive corrective work.

Labor efficiency of the reliability process is a result of how well we plan, schedule, and support the execution of the asset care activities. This can be related to the percentage of work planned and scheduled, and the percentage of available time that is wrench time. Efficiencies come from adherence to the reliability process, the easy-to-use implementation, access to enterprise-wide information and standardization of repetitive tasks. The identification and reduction of work inefficiencies translates into more available manpower and less equipment downtime due to maintenance activities. World-class objectives are 85% planned and scheduled and 60% wrench time.

In this plant a shift from 40% to 70% planned and 35% to 45% wrench time represented a 6,000 hour reduction in maintenance effort.

Reduction in Manpower Due to Improved Effectiveness

	% Planned		% Wrenchtime		Potential Savings	
	% Hours that are Planned and Executed as Planned (Current)	% Hours that are Planned and Executed as Planned (Target)	% Wrench-time (Current)	% Wrench-time (Target)	Hours Reduced When Target is Achieved	Manpower Reductions
Target	40%	70%	35%	45%	6,170	3.5
World Class		85%		60%	21,908	12.5

Efficiency and effectiveness are closely linked as effectiveness is about doing the right work while efficiency is about doing the work right. Therefore, a more effective organization will be more efficient while a more efficient organization is better positioned to take advantage of the effectiveness strategies.

- The final benefits category is the **indirect cost reductions.** Indirect costs include such things as operator overtime, excessive spare parts inventory, demurrage charges and penalties, work in progress, excessive finished goods inventory levels, and capital expenditures. Some of these are directly impacted but most require additional steps to achieve the benefits.
- Reliability-related operator overtime reductions apply to operations that are market limited. That is, where the equipment is not used 24/7. A market limited production has spare capacity and staffs its operations according to demand. Equipment availability issues often require the organization to compensate by running the equipment during the scheduled non-production periods. This in turn creates a requirement for extra operators.

Reduced Operator Overtime		
	Value	Unit
Unscheduled Downtime	500	Hour
Excess Scheduled Downtime	200	Hour
Total Recoverable Downtime	700	Hour
Operator Overtime Cost Per Hour	CAN$ 125	$
Total Opportunity Per Year	CAN$ 87,500	$
Gain Targeted (%)	60%	%
Gain Targeted ($)	CAN$ 52,500	

In this example we projected a reduction of 420 hours/year in the number of operator overtime hours.

Reduction in Energy Usage per Year (UPG Ball Mill)		
	Value	Unit
Amount of Energy Used	CAN$ 4,215,649	$
% Used Due to Equipment Failure	1%	%
Total Opportunity Per Year	CAN$ 42,156	$
Gain Targeted (%)	70%	%
Gain Targeted ($)	CAN$ 29,510	

- Spare parts inventory reductions require a spares optimization exercise before the benefits are achieved. This said, to be sustainable an inventory reduction exercise requires an efficient and effective maintenance organization as this will increase part requirement visibility and provide proper part identification. World-class organizations have a parts inventory to replacement asset value ratio of 1% to 2%. At this site we estimated that the inventory level will be reduced by CAN$ 2 million for an annual saving of CAN$ 340,000.

- Demurrage charges and penalties include penalties for late delivery or poor quality, penalties for not respecting government regulations such as environmental discharges, and penalties for breaching safety regulations. The latter two may also have a significant impact on people's lives. Reliability initiatives focus on mitigating the consequences of failure and have less probability of leading to transgressions.

- Work in progress (WIP) and finished goods inventory are a significant source of cost for organizations, and initiatives, such as supply-chain management and JIT, are used to minimize these levels. The strategy is to determine the right balance between carrying costs and the risk of not meeting customer demands. Improving asset performance through improved reliability increases the organization's confidence in its ability to meet demands. This in turn is a key factor in reducing WIP and finish goods.

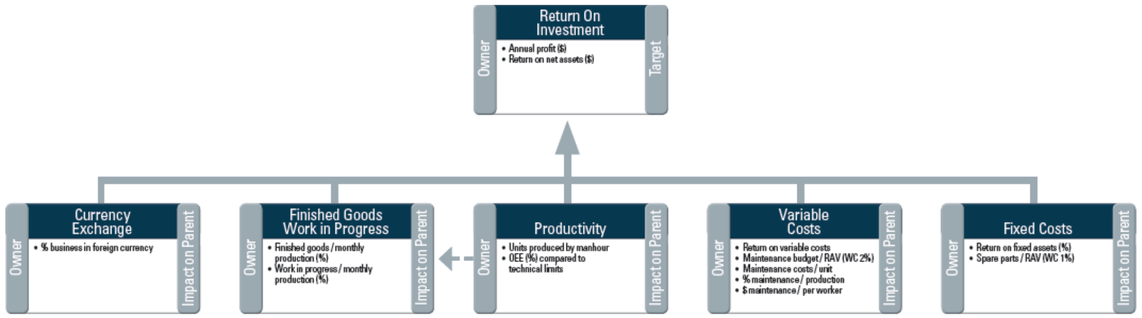
- Capital expenditure savings from a reliability initiative relate to improvements in the asset's performance through more efficient and effective maintenance. If the performance gains are sufficient to meet demands, the purchase of new equipment can be differed or even eliminated. For example, ArcelorMittal Mines was able to extend the life of its 190T haul trucks from 50,000 to over 100,000 running hours.

Using Key Performance Indicators

KPIs are very popular, most say they are a must, but unfortunately many organizations do not adequately benefit from their use. KPIs exist as a means of positively affecting results by affecting individual and group behavior. For KPIs to be effective the results we are targeting must be in line with the corporate objectives; the targets selected have to be attainable and a communication strategy must be in place to create awareness of the KPI with those whose behavior we are attempting to influence. The six basic rules of KPI development:

- **There must be an owner.**
- **You must establish an aggressive, meaningful, and attainable target.**
- **Impact on the parent KPI needs to be clearly defined.**
- **The measuring method needs to be identified and should be as automatic as possible.**
- **An action plan must be defined and agreed upon in the event that the target is not met.**
- **There needs to be a communication plan in place prior to launching the KPI. The plan needs to include a regular review of the KPI.**

KPIs are used to manage the process to ensure successful results. KPIs, such as return on investment, measure results of the process and in themselves cannot be managed. These are called lagging KPIs. The leading KPIs measure the process that will lead to the results. These can and should be managed. The relationship between the leading and lagging KPIs can be clearly defined, as shown in the following graphs.

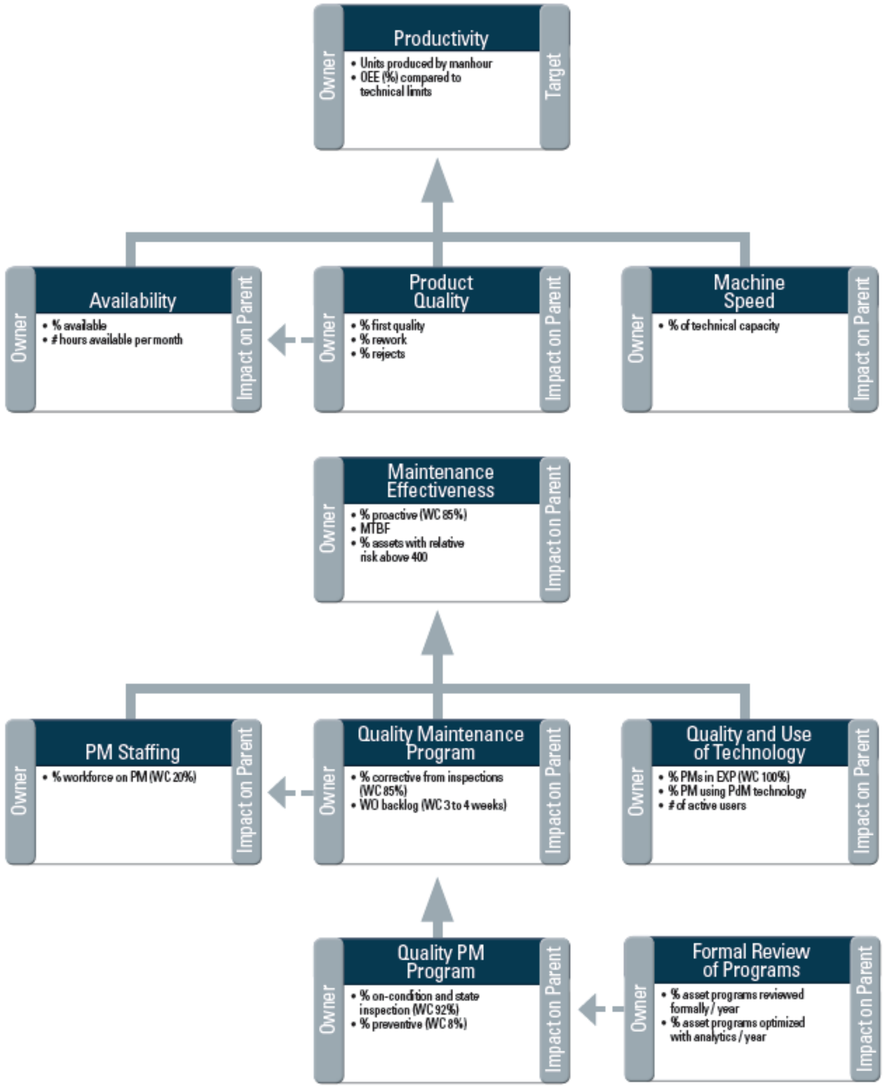


As shown in the opposite, return on investment is impacted by the currency exchange, finished goods, work in progress, productivity, variable costs, and fixed costs. These, in turn, are impacted by lower order KPIs. Examples of possible KPIs for each grouping are listed in the boxes. Please note that the finished goods and work-inprogress levels are indirectly impacted by a reliability initiative and have a dotted line from productivity. As the organization develops more confidence in its ability to meet market demands through higher, more stable productivity levels, these can be reduced. Each of the groupings can be subdivided many times, as shown in the two following graphs. The impact of each lower-order KPIs on their parent KPI can be defined.

Using Key Performance Indicators

One of the factors that impacts availability is maintenance related outages, and this is impacted by maintenance efficiency and maintenance effectiveness. The latter is impacted by staffing, program quality, and the proper use of technology.

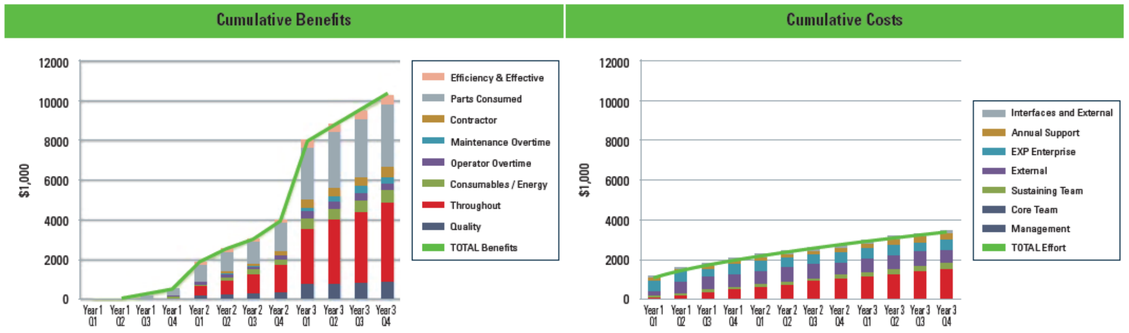
Further, children groupings can be defined. In some cases the leading KPI may affect more than one parent. We should only define KPIs that impact the results we are trying to achieve and limit the number of KPIs to that which we can properly manage and communicate. A deluge of KPIs will only confuse people and reduce the overall effectiveness of the metrics. A progressive introduction of KPIs is
always preferred.



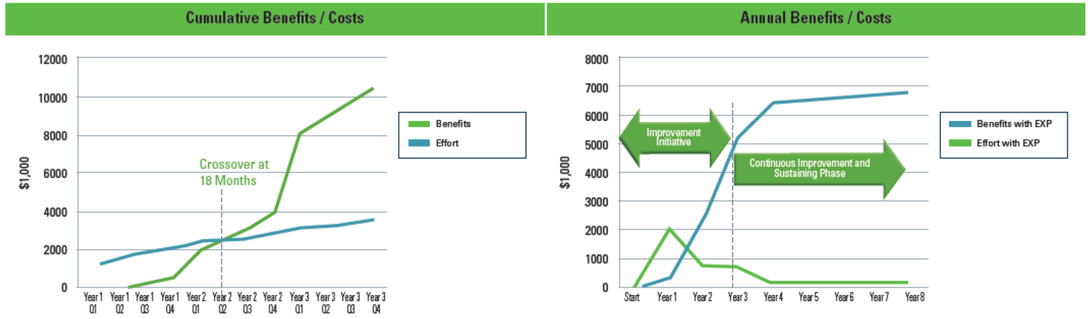
Compiled Results

Unfortunately few organizations will publish detailed information concerning their results as this could help their competitors. Nonetheless, working closely with these companies, we were able to quantify the benefits while ensuring anonymity through a normalization exercise. In turn, this provides an ideal model that can be scaled to fit your specific situation and organization.
The following data does not include reduction in spares inventory, work in progress, or finished goods. In all cases we only used labor savings related to contractor and overtime reductions and did not consider the internal resource reduction savings as the latter is often limited by the existing union agreement.

For the purpose of this exercise we have scaled the results to represent an asset intensive organization with an annual production rate of CAN$ 100 million, a maintenance budget of CAN$ 15 million and 90 tradesmen. This organization has four planners, six supervisors, two maintenance engineers, and one maintenance manager.



The cumulative benefits of an average three-year reliability improvement initiative (normalized) is CAN$ 8.6 million by the end of year three and the cumulative costs (internal, external, and technology) are CAN$ 2.6 million for a benefit to cost ratio of 3.3. An interesting fact of reliability improvement initiatives is that they start paying dividends early in the deployment rather than once the project phase is completed.



The average break even on these initiatives was 18 months and the initiatives continued to generate benefits once the project phase was complete. Post project phase annual gains/savings is CAN$ 6.8 million with an annual cost of CAN$ 200,000.

As a result, the organizations achieve a recurring benefit equivalent to 44% of the maintenance budget and 6.8% of the annual production rate. This data is a compilation of 10 sites with extrapolations made where necessary.

These results do not take into account reductions in spares inventory, work in progress, finished goods, and internal resources through attrition. As well, reliability initiatives usually reduce the number of safety incidences, environmental regulation issues, and the overall risk. In two cases the organization was able to renegotiate its insurance policy based on a better asset management record.

Reliability improvement initiatives start paying dividends early in the deployment rather than once the project phase is completed.

Quantifying Financial Benefits from an Asset Performance Initiative

Other Results:

ArcelorMittal Dofasco Steel

A division of ArcelorMittal steel company, the world's largest steel company with 320,000 employees in more than 60 countries.

Benefits:
- **14% improvement in asset utilization**
- **Increased production totaling an additional 5,600 tons/month**

Domtar

Domtar is second largest integrated manufacturer of uncoated free sheet paper in the world and has over 14,000 employees. Domtar Espanola employs 590 employees

Benefits:
- **Improvement in Pulp Mill efficiency: 5% in just three years**
- **Reduced maintenance spending: >15%**
- **Improvement in Pulp Mill uptime: >5%**
- **Maintenance overtime reduced : >7%**

ArcelorMittal Mines

This is one of the leading producers of iron ore products in North America with an annual production of 18 million metric tons of iron ore concentrate. The company also operates a pellet plant, a rail road, and a port.

Benefits:
- **Mine production levels up 28% without additional resources.**
- **Mobile equipment maintenance costs down by 8.6%**
- **Spare parts inventory values down by CAN$ 10 million**
- **Haul truck useful life increased from 50,000 to +100,000 hours**

West Coast Main Line

This is a busy mixed-traffic railway route in the United Kingdom. It is central to the provision of fast, long-distance intercity passenger services between London, the West Midlands, the North West, North Wales, and southern Scotland.

Benefits (Fleet savings over 10 years):
- **Total Materials: Saving: 29%**
- **Total Labor: Saving: 72%**

Conclusion

Asset performance initiatives based on asset reliability improvements have helped many organizations maximize financial return from their assets. Benefits start early in the project phase, the cost is relatively low and, when properly conducted, the results are sustainable. Quantifying these financial benefits before starting the initiative serves as a rallying point to ensure commitment from all levels of the organization and can be used to develop success metrics and KPIs. These in turn help to properly define and manage the initiative ensuring the desired results.

But the benefits are much more than monetary. A reliability-driven initiative positively impacts safety and the environment, and helps organizations manage their assets. On the latter point Guy Boisé, superintendent of mobile fleet, ArcelorMittal Mine, said it best:

> **“Up to one-and-a-half years ago I used to be called at home every night. In the last year and a half, I have received zero calls. That’s what reliability means to me.”**

About Bentley Systems

Bentley Systems provides innovative software to advance the world’s infrastructure – sustaining both the global economy and environment.

The Asset Performance Services division of Bentley helps owner operators of complex assets reduce costs, boost profits and mitigate risks through advisory, implementation and data management services.

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