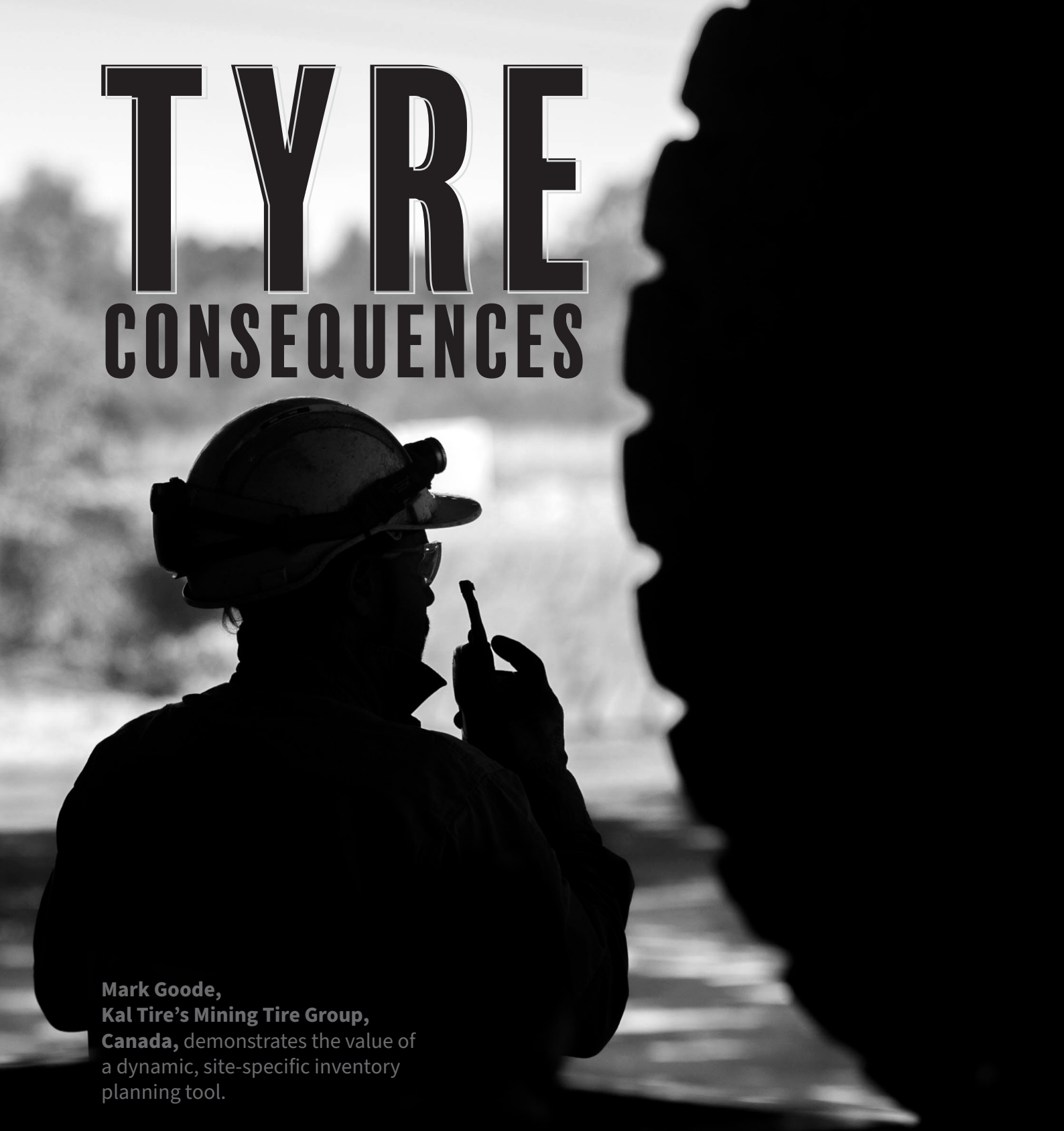
TYRE CONSEQUENCES



Mark Goode, Kal Tire's Mining Tire Group, Canada, demonstrates the value of a dynamic, site-specific inventory planning tool.

Managing spare tyre inventory is often overlooked as a critical contributor to mine site productivity: without tyres, mobile haulage equipment cannot run. Kal Tire's Mining Tire Group and its research partners recently conducted a study at a mine in northern Canada to investigate how tyre stock management and fitment plans can impact truck availability. The study's driving question: how can tyre inventory be managed, given seasonal changes, so that sufficient used spare tyres are available when needed to keep fleets running? And ultimately, to avoid costly unplanned downtime events.

In 2018, the company launched its proprietary Tire Operations Management System (TOMS) in order to ensure that tyre management teams had the visibility, communication, and reporting tools to focus on planned tyre work, productivity and tyre life. The system is in use at over 100 mining sites across five continents and allows customers to draw on Kal Tire's best practices so benchmarks can be set to improve fleet use.

This article reviews a study based on the data that was collected from the system.

Seasonal impact

In Canada, where wet conditions in spring and autumn can lead to premature tyre damage, seasonal variability plays a big factor in tyre fitment strategy and as a result, stock inventory levels. Equipped with TOMS data, the case study team was keen to find out how spare stock demand and availability changed throughout the year, and how those insights could inform tyre rotation intervals and spare tyre stock planning.

Figure 1. A haul truck carrying a full load on a mining site.

Figure 2. A team member directs a haul truck into the bay for tyre service.

Figure 3. Inspection teams identify any issues to improve tyre life, costs and productivity and uptime.

Typically, on an opencast mine, new tyres are fitted to the front axle of a haul truck. Once those tyres reach close to a third of their life, they move to the rear as a tyre on the rear axle is more vulnerable to damage and premature failure. Therefore, rear axles are typically fitted with used tyres. Tyre management teams either set rotation intervals to occur more often to generate spares, or they adjust rotations to change tyres less often and extend truck uptime.

Over the course of 2019, the system's data revealed that rotation intervals varied significantly, taking place between 26 – 47% of average tyre life. At the test site, the average scrap tyre life was approximately 4500 hours; at 1500 hours, these tyres reached a third (or 33%) of its life – near the middle of the observed rotation intervals.

Plotting out the number of rotations and the average rotation hours as a percentage of tyre life, researchers found intervals became much shorter from July onward as more spare tyres were needed to replace damaged tyres, and spare tyre inventory was consistently low. Decreasing rotation intervals saw tyres coming off the front axle earlier in order to replace damaged tyres on the rear axle. That damage was amplified by the seasonal weather conditions.

This pattern creates several challenges. More truck downtime is created at the busiest time of year for tyre work, putting tyre teams at higher risk of potential incidents. There is another negative impact: pulling tyres early to fit them to the rear can potentially increase the risk of operational damage.

Operational damage, weather, a suboptimal fitment strategy, and tyre quality can all get in the way of tyres reaching their expected average life. As tyre life decreases, overall tyre spend increases.

Since mine sites expect unplanned events such as tyre damage or premature failure, this study returned to its driving question: how can tyre inventory be managed, given seasonal changes, so that sufficient used spare tyres are available when needed to keep fleets running?

The repair balance

To gain greater context, the research team reviewed a range of data from 2018 and 2019, including scrap tyres, tyre fitment policy as well as the impact of tyre repairs on inventory levels. A number of findings came out of this analysis.

The repair balance (the difference between tyres sent to repair and those that came back from repair) was important to analyse. If there is a significant difference it can affect the availability of spare tyres. At the study site, the repair balance was close to zero in 2018, while the summer and autumn of 2019 experienced a large amount not returning from repair.

What the repair balance data indicated was that it is not always possible to rely on tyres returning from repair to the spare pile. Spare inventory needs to be maintained

at a level that acknowledges that a percentage of tyres sent for repair have to be scrapped.

When the team looked at scrap tyres between the 2 years of study and across seasons, they saw a greater percentage of scrap tyres in summer and autumn months. This can be explained by spring potholes and increased amounts of standing water that make tyres more susceptible to punctures and cuts. Winter, conversely, offered the best road conditions, which resulted in minimal scraps over the winter season and into the spring.

A 'stolen event'

Looking at the fitment data, the study revealed a particular unplanned occurrence that appeared to have a costly downtime impact and was worthy of highlighting. When a tyre failed on a haul truck and a suitable spare could not be found in inventory, another truck was often taken out of service to change over a tyre for the haul truck in need of a spare. This was described by the research team as a 'stolen event'.

A stolen event impacts shop availability, manpower, and, most importantly, leads to downtime for two trucks. With average truck downtime at the test site in 2019 being 11 hours, the study team estimated the annual downtime value of total stolen events was equivalent to the cost of 13.5 new tyres, or more than CAN$800 000/yr. If there are higher tyre failure rates in summer and autumn (as identified in the scrap tyre comparison), the likelihood of stolen events is higher if sufficient spare inventory is not available.

Inventory planning tool

Having completed a review of the data, the team developed a series of experiments to test their impact on equipment downtime and spare inventory levels. As a means to support these, an inventory planning tool was developed.

Based on historical tyre inventory flows, the tool defines pre-determined target inventory levels and optimal rotation intervals. The rotation interval allows spare tyres entering inventory to compensate for tyres being scrapped; simultaneously, the tool depletes or replenishes inventory levels.

Next, the research team established a target inventory level. The final step was to define a rotation interval according to the target level and the inventory levels from the previous month.

To set the target inventory level, the team determined a simple rule: if the number of tyres exiting the system (scrapped) the previous month was more than a certain percentage of the maximum number of spare tyres used the previous year, the maximum number of spares was the target inventory level; if it was less than this percentage, then half the maximum used the previous year was the target inventory level.

To make a decision about ideal rotation intervals, the following criteria was used:

- A base rotation level was defined as ⅓ of tyre life.
- A high rotation level was defined as ⅓ minus a factor of working hours.
- A low rotation level as ⅓ plus a factor of working hours.

The last step was to determine spare tyre inventory by adding the previous month's inventory to new tyre fitments minus the number of tyres leaving the system in the current month.

Now the experiments of using the inventory planning tool could begin. Two sets of experiments were developed and run using the 2018 and 2019 historical data. The first saw fitting new tyres only to the front (as per usual practice), with three sub-experiments on rotation intervals: 1) only base, 2) base and high, and 3) all three levels. A second set of experiments included testing fitting new tyres to both the front and rear, with the same sub-experiment rotation intervals. The researchers were interested to test how an alternative fitment strategy might impact inventory levels and, just as importantly, truck downtime. Results were deemed unworkable if the projected spare inventory level returned was below zero.

The results

The researchers discovered that the inventory planning tool, when combined with a dynamic rotation strategy, reduced truck downtime by up to 14% by fitting a percentage of new tyres to the rear position. This is compared to a reduction of truck downtime by 7% when new fitments were made only to the front axle. Furthermore, downtime reductions were possible while also reducing spare inventory levels under certain conditions.

The study led to a number of working hypothesis that will be tested in further research planned in the year ahead.

Firstly, that tyre management teams could intentionally install new tyres to the rear axle to generate more used spare tyres, thereby reducing the number of downtime events and extending the time period that tyres remain on front positions. The additional risk of increased tyre damage – with new tyres being fitted to the rear – would be more than covered by the productivity savings by avoiding excess truck downtime.

Figure 4. A Kal Tire team member inspects a tyre on-site.

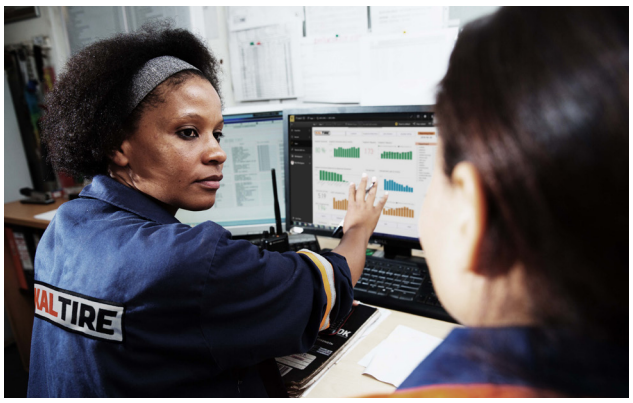


Figure 5. Two Kal Tire team members review the data from TOMS.

Figure 6. Ensuring all necessary tyre maintenance is performed while a haul truck is in the bay.

Secondly, in winter months, more planned tyre rotations could be made to stockpile spares for the higher demand seasons. That way, tyre teams can better accommodate high season demand, spreading out the tyre work and reducing unnecessary truck downtime during summer months.

And thirdly, that there looks to be clear benefit under certain operational conditions of making tyre rotation strategies dynamic, taking into account the changing seasonal demands.

With the continuing drive from its mining customers to maximise fleet productivity while reducing tyre costs, Kal Tire is encouraged by the findings from the case study. The company is continuing to work on refining the research tools with the goal of integrating final results into TOMS as a part of their overall tyre management programme.

Conclusion

Kal Tire's research highlights that for mining operations in regions of high seasonality, the planning of tyre rotations to proactively stockpile spares before they are required can help avoid unnecessary and unplanned truck downtime.

Furthermore, a targeted programme of selective new to rear tyre fitment may have the potential of offering further productivity benefits. It appears well worthwhile to give a little more consideration to the consequences that tyre management strategy can have on driving fleet availability and operational costs.