

Aurizon's Keystone – the Future of Asset Management

J. Petty & J. Chiesa

Aurizon, Brisbane, Queensland, Australia

ABSTRACT: Aurizon is the largest heavy-haul rail company in Australia, with ownership and operation of materials handling and rail assets, and over 3,000 miles of rail network. Aurizon was government-owned, became publicly listed in 2010, and is now expanding. With upwards of 30% of the company value and costs attributed to the physical assets, in 2020 Aurizon initiated a holistic asset management modernisation program. The objective was to lower cost of maintenance, improve fleet reliability, and increase productivity through an initiative labelled *Keystone*.

Keystone distinguishes itself by solving recurring challenges of typical maintenance programs using technology. Central to Keystone's success is the deployment of "IronMan®", an advanced asset management tool which applies machine learning, seamlessly integrated with the operations, transforming systems and data of variable quality into intelligent maintenance decisions for all levels of the organisation.

Through Keystone and IronMan®, Aurizon has already achieved over 15% reduction in maintenance costs, while improving operational performance. This paper presents detailed case studies highlighting what is possible through leveraging technology within maintenance. It provides insights into how Keystone is setting new standards for asset management in the heavy-haul rail industry, ensuring Aurizon remains competitive, while maintaining their assets as fit-for-purpose, cost effective, and future-ready.

1 INTRODUCTION

Aurizon is Australia's largest heavy haul rail company, with a network spanning over 3,000 miles, handling the transport of commodities, freight, and materials across Australia. In 2010 Aurizon successfully floated as a publicly listed company and now features as one of the top 100 companies on the Australian Stock Exchange.

Acknowledging the high competition, risk, complexity and low margin nature of its business, Aurizon initiated a comprehensive asset management overhaul to future-proof its operations in the early 2020s. The *Keystone* Program was designed with a primary goal of modernizing and standardizing the asset management practices at Aurizon. The aim was to reduce operational costs and ensure higher levels of fleet performance with the use of advanced technologies. By

leveraging innovative tools and processes, the program systematically improved maintenance routines, decreased downtime, and optimized asset utilization.

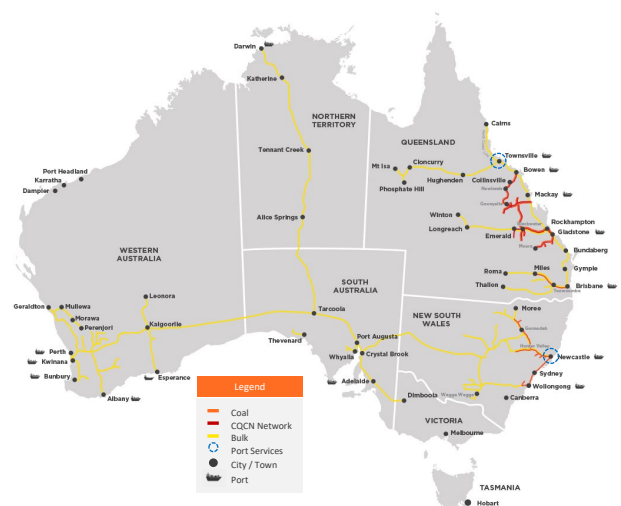


Figure 1. Aurizon's Rail Operations

At the core of the Keystone program lies *IronMan®*, an advanced asset management tool developed by *Ox Mountain (OXMT)*. Through the integration of machine learning and intelligent data analytics, the Keystone principles (with *IronMan®*) have transformed the maturity of the Aurizon maintenance approach, moving from reactive to predictive and into proactive states. With Keystone Aurizon has not only reduced maintenance costs by over 15%, but also significantly improved the operational performance of its fleet.

This paper presents an in-depth look at the methods that underpin the success of the Keystone program and how it has driven a step-change in maintenance at Aurizon. It also explores how *IronMan®* was applied in the rail environment and how it became a key enabler for Keystone at Aurizon. Practical examples will be shared along with valuable insights into how the company has raised the bar for asset management and established a new standard for the future of asset management.

2 THE KEYSTONE PROGRAM

2.1 *Keystone*

The Keystone Program was launched by Aurizon as an initiative to modernize its asset management practices and ensure the long-term reliability and efficiency of its fleet. With over 30% of the company's value and costs attributed to the physical assets, maintaining a high level of reliability while keeping costs to a minimum is mission critical.

Enterprise Resource Planning (ERP) tools such as SAP, Maximo and others are necessary to our operations. They provide a high level of standardization and flexibility but can have downsides in the absence of aligned structures, disciplined application, and rigorous compliance. Maintenance mastery can compensate for this to an extent, as is typically displayed in the North American Rolling Stock maintenance space, where generational maintainers have been able to consistently and effectively manage the assets. In the Australian maintenance environment, management tenure, maintainer tenure, and training standards have encouraged reliance on the use of systems and processes for asset management success.

The Aurizon asset management leadership team has diverse backgrounds from rail, mining, manufacturing and other heavy industries. During the genesis of Keystone, their observation was that asset management challenges, and improvement opportunities, are consistent across many industries. A subtle difference is the rail industry, with low margins and geographically diverse Rolling Stock and maintenance facilities, magnifies maintenance or system inefficiencies.

Aurizon's risk exposure and competitive landscape obviously required the company to optimize maintenance performance at the lowest possible cost. Hence Aurizon recognized that traditional improvement programs were not sufficient and opted to flex to meet the demands of an increasingly complex and data-driven operational environment.

Keystone integrated modern maintenance approaches and technology into the company's established processes and routines. This enabled smarter, more informed decision-making, and focused efforts on the effectiveness of the maintenance processes. The Keystone program systemically addressed:

2.1.1 *Waste*

- Components being replaced too early, consuming valuable labor, asset availability and inventory while forfeiting the optimizing useful life.
- Missed warranty claims.
- Wasted efforts in the planning cycle.
- Wasted capital on unnecessary inventory.
- Excess fleets to deal with added downtime.

2.1.2 *Maintenance tactics*

Reliance on OEM recommendations and regulator obligations as the foundations of maintenance tactics. This significantly increased the cost-base, reduced fleet availability and impacted reliability.

The Aurizon observations were that the rail industry historically had been slow to change due to generational traditions, perceived regulatory constraints, risk-adverse OEM recommendations, low reliance on systems, poor data quality, insufficient imperative to change, perceived risks of change, and operational consequences of failures.

2.1.3 *Defect Elimination*

With the constraints of large and geographically disbursed fleets, disbursed workforce, poorly constructed systems, and incomplete data, identifying defects and eliminating them can be a significant challenge. The Aurizon ERP (SAP) allows for capturing massive quantities of data, but ensuring the quality of the data, interrogating this data and extracting intelligent information from the data can be elusive.

2.1.4 *Reliability findings*

The reliability of assets or fleets stems from the inherent asset design and the applied maintenance tactics. When failures occur reliability investigations typically tend to be a low priority item due to resource constraints, urgency to repair the failure, lack of visibility of the number or frequency of failures, and variability of data. Additionally, without clear accountability and variable workforce expertise, often

“obvious” corrective actions are either not identified, identified by the wrong people, put on the “to-do list”, or ignored.

2.1.5 Predictive maintenance

Transitioning to a predictive maintenance state has been the aspiration of many in the heavy industries. There is obvious value in anticipating and preparing for maintenance events, reducing the frequency or severity of in-service failures, being able to better plan work and allocate workforce, and developing the confidence to extend component life further.

While transitioning to the predictive maintenance domain is the aspiration, in most cases getting the maintenance basics right delivers a much greater return on investment. But it is hard work, outcomes can be variable, and unless systems and processes are applied, the changes or improvements may not be sustained.

The case studies presented in this paper explore how Aurizon addressed the challenges of waste, maintenance tactics, defect elimination, reliability, and predictive maintenance. This was done with a clear focus on immediate return on investment and ultimately total cost of ownership. The paper shares how maintenance was approached, the reliability challenges, early adoption lessons, and pitfalls Aurizon observed.

2.2 Keystone strategic objectives

Keystone’s primary objectives are to deliver:

1. **Lower Maintenance Costs:** By optimizing maintenance schedules and predicting failures before they occur.
the Keystone program reduced the frequency and severity of unplanned maintenance events, resulting in significant cost savings.
2. **Improve Fleet Reliability:** Through a more precise understanding of component and asset health.
Keystone helped ensure that Aurizon’s fleet operates more efficiently and with fewer disruptions. This led to better on-time performance and ability to expand the business with existing assets.
3. **Increase Productivity:** By focusing people on insights, managing data and improving the way the ERP was applied.
Aurizon achieved more with the same resources and secured a pathway for future-proofing the assets, with the changing workforce demographic.

The Keystone processes and objectives are outlined in Figure 2. and focus on:

- Data and quality of asset management systems
- Core asset management processes
- Systems and tools for executing maintenance
- Increasing people capability

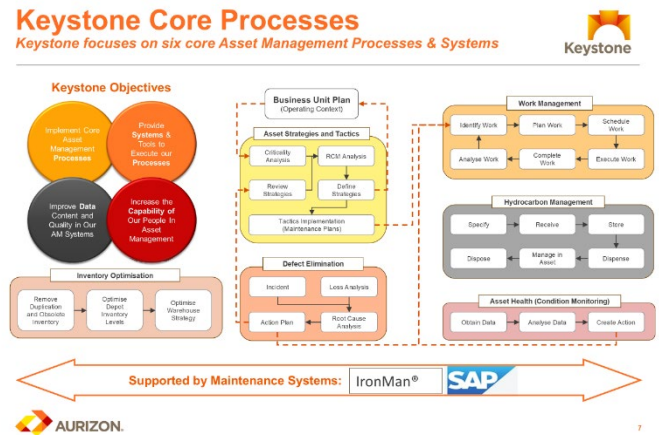


Figure 2. Keystone Core Processes

2.3 Keystone Framework

The Keystone Framework is not unique and is consistent with the asset management frameworks used across many industries, and for many years. The core processes as outlined in the chart above are:

- Business Unit Plan – the operating context
- Asset Strategies and Tactics – the maintenance plans and target component lives
- Defect Elimination – finding root causes of failures and eliminating them
- Asset Health – condition monitoring and actions
- Hydrocarbon Management – managing and monitoring hydrocarbons (fuel and oil)
- Work Management – how the work is planned, executed and analysed
- Inventory Optimization – managing inventory and warehouses

Holistic approach

Unlike traditional asset management programs, Keystone takes a holistic view of the organisation’s asset management needs, including integrating technology seamlessly into the day-to-day maintenance processes. Notably it includes monitoring and intervening in the maintenance execution at the depots.

Leadership and organizational support

The success of Keystone is largely a function of the strong support and leadership from the top levels of the organisation. Led by the CEO, the initiative was recognised as a critical component of the Aurizon growth strategy. Senior leaders at every depot championed and supported the program, helping to foster a

culture of engagement and ensuring alignment between the technology, operations, and the organisational goals. This alignment drove rapid adoption across all levels of the business, and the ultimate success of the program.

2.4 Role of IronMan®

At the core of Keystone is IronMan®: an intelligent, AI-driven asset management system, designed to work seamlessly with an organisation's existing maintenance management systems and data sources. The tool collects, analyses, and transforms vast quantities of data from disparate systems into actionable insights. It uses intelligent algorithms to anticipate and predict potential asset failures, identify trends, and provide recommendations that inform decision-making.

The intent is to arm each person involved with making maintenance decisions with AI, making them the equivalent of 10-20 times more capable of delivering value than previous.

IronMan® was developed by a company with its DNA in Formula 1, Aerospace, Mining, and Rolling Stock Maintenance. This unique blend working together with machine learning and software engineers from Oxford University created the software a decade ago and have been evolving it since.

Aurizon elected to trial IronMan® after observing great successes in mining. After a year of value extraction, the realised and potential value of IronMan® convinced Aurizon to invest in the company. Aurizon now has a shareholding of over 70% in OXMT.

2.5 Why is IronMan® different?

One of the key features of IronMan® is its ability to access and integrate with multiple systems simultaneously, and handle data that is incomplete or of variable quality. The Aurizon data, like many other companies, is incomplete and of variable quality. IronMan® aggregates and standardizes this data and displays it in a form that enables rapid analysis and decision-making. It delivers information and insights in a logical format, that is discernible at all maintenance levels, from the practitioner to the manager.

IronMan® takes the mystery, frustration, and potential confusion out of interpreting big data. Using the algorithms and AI, IronMan® turns data into information, information into insights, and the insights promote intelligent maintenance decisions.

A strength of employees using and engaging with IronMan® is giving them knowledge of what elements of data are important for future asset management, reliability, maintenance improvement, and critically, and what elements don't matter.

**"In the past having power meant having access to data.
Today having power means knowing what to ignore."**
Yuval Noah Harari (Author of Sapiens & Homo Deus)

3 CASE STUDIES AND RESULTS

3.1 A Data-Driven Breakthrough in Transforming Locomotive Maintenance

The legacy maintenance model for the Progress Rail GT42 locomotive classes was built around OEM-prescribed, time-based overhauls. This strategy is conventional, however it proved increasingly unsustainable for our growing business. This approach resulted in the premature replacement of components, wasting up to 30% of their remaining useful life. Time-based scheduling also failed to account for utilisation differences between locomotives, leading to over-maintenance of low-use units and under-maintenance of high-risk assets.

To address these systemic inefficiencies, Aurizon adopted a usage-based maintenance strategy powered by IronMan® and SAP. This shift enabled component-level planning based on real-world usage data (specifically, megawatt-hours and kilometers travelled) rather than calendar time intervals. IronMan's® analytics identified failure trends and optimized maintenance intervals with ease. Component replacements were set to optimal lives and executed in-house through the Aurizon depots, reducing reliance on external maintenance providers. This approach not only minimized downtime but also cut preventative maintenance costs by approximately 25%.

Fleet availability improved significantly, with a measurable reduction in Mission Critical Failures per Locomotive per Year (MCFLY). This new strategy resulted in significant cost savings for the Aurizon fleet. By redistributing maintenance capacity and aligning interventions with actual asset usage, the organization not only overcame its legacy challenges but also set a new benchmark for locomotive fleet management in the rail industry.

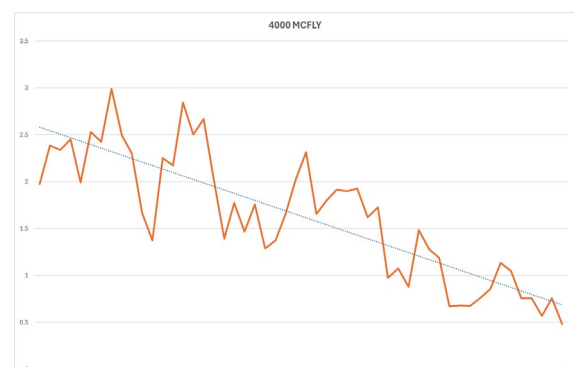


Figure 3. GT42 Mission Critical Failures per Year

3.2 *Cracking the Code on Defect Elimination, Enabled by IronMan®*

Aurizon's nationwide depots, fragmented systems and inconsistent defect elimination (DE) practices were quietly eroding operational performance. Investigations into recurring reliability issues were siloed, with the people at each depot using their own tools, workflows, and standards. The result was disconnected data, inconsistent root cause analysis, and a lack of ownership that allowed systemic issues to persist. Valuable insights were lost on isolated drives, and opportunities for cross-depot learning and continuous improvement were routinely missed.

To break down these silos, Aurizon, with the support of OXMT, enhanced the IronMan® platform with a purpose-built DE module. This enhancement introduced automated investigation triggers, a structured and standardized workflow, and integrated action tracking all housed in a centralized, searchable repository. Investigations are now initiated based on real-time business rules, guided through evidence-based methodologies, and tracked to closure with full accountability. The result is a seamless, organization-wide approach to defect elimination that embeds best practices into daily operations and fosters a culture of transparency and collaboration.

The DE module has now driven a 10% reduction in annual work order spend related to Rolling Stock defects, while improving process consistency across all depots. Real-time visibility into investigations and corrective actions has strengthened accountability and accelerated resolution timelines. Most importantly, the unified system has unlocked cross-depot collaboration, enabling teams to share lessons learned and implement systemic fixes faster than ever before. With the IronMan® DE module, the organization has turned defect elimination from a fragmented afterthought into a strategic engine for operational excellence.

3.3 *Wagon Coupler Lifecycle Optimisation*

Two depots. One type of fleet. Two very different outcomes. While both depots operated nearly identical bulk wagon fleets, their maintenance strategies for high-risk components (brake cylinders and slack adjusters) were vastly different. Depot A embraced a condition-based maintenance (CBM) model, replacing components only when wear or failure indicators emerged. Depot B used a legacy fixed-time replacement model, exchanging parts on a 6-to-8-year interval, which is significantly more frequent than the OEM-recommended 12-year interval. Depot B experienced a 6.4% failure rate and unnecessary costs, while Depot A experienced a 0.75% failure rate with some components achieving over 14 years of life.

Analytics revealed the root cause: the strategy was triggering infant mortality (components failing after premature replacement) – mirroring the classic “bath-tub curve” of reliability. Instead of preventing breakdowns, fixed-time replacements introduced additional failures. By replacing components too early, the depot was wasting parts and labor, and degrading fleet reliability. With this insight, Aurizon introduced the CBM model across the whole fleet, shifting maintenance decisions from calendar to condition of the asset.

Annual savings exceeded 10% of the maintenance spend, driven by reduced parts usage, labor efficiency, and fewer unplanned outages. Component reliability improved, and depot capacity was released for higher-value tasks.

“This is a case of not just fixing what’s broken but knowing when not to fix what isn’t broken.”

3.4 *Empowering our Teams when it Matters Most with IronMan®*

How many depots have this experience? Nightshift, changing a large Locomotive component, people are tired, and the critical part was not delivered. They check the ERP system, but without the exact part name or number it can’t be found. Precious time is wasted searching the warehouse, only to discover it’s out-of-stock. The parts manual doesn’t help, and it seems the job will stall. However, IronMan® has the answer. IronMan® has visibility of not just the part, but its related components, and its actual warehouse stock location.

The Aurizon depot teams are finding that IronMan® has become an essential maintenance tool and where in the past it was the domain of the Reliability Engineers, now the maintainers and leaders are using it. Beyond parts lookup, the maintainers can now quickly search for similar faults on the same equipment, see how they were resolved, and identify the exact parts used. They can even search other depots with similar fleets.

The intuitive interface of IronMan®, fast response times, and smart search capabilities make it one of the primary tools for frontline teams and their leaders, surpassing the capability of traditional ERP systems in both speed and usability. Below is direct quote from the depot maintenance leader:

“I can't express enough it's the ease of use that makes IronMan® shine for us. As a leader when I receive calls for locomotive failures on track, I enter the fault into IronMan® to see how the fault was previously fixed. Being such an easy and quick process, this has resulted in saving services that would have

been cancelled if not for the quick use and troubleshooting ability of IronMan®.”

4 INSIGHTS AND FUTURE DIRECTION

The success of the Keystone program and integrating IronMan® into Aurizon’s operations have delivered profound outcomes for the business.

While in hindsight the outputs from IronMan®, and outcomes from the case studies, seem obvious and discernible for any seasoned maintainer, in the real-world maintainers are typically too busy to interpret massive volumes of data, let alone make real time decisions based on the data. IronMan® has enabled all the people in the depot who make maintenance decisions to use an intelligent system to make educated decisions in real-time.

Diligent maintainers typically create extensive records describing the work they performed. But if they don’t have a systems-view of how the information is used for asset management, they may miss key pieces of information (e.g. what position was the traction motor that was changed, or what was the fault that caused the engine to fail - oil leak, power assembly failed, valve issue). Through using IronMan® for decision-making, maintainers gain a greater understanding of the value of comprehensive data, and this inspires them to better use the ERP systems.

4.1 Lessons learned

The outcomes of the Keystone Program have been impressive. The lessons that best highlight the key takeaways from the program’s implementation are:

- *Data Quality and Integration Are Crucial:*
One of the most significant hurdles was dealing with the variable quality of data across Aurizon. This variability is not unique to Aurizon, and while the temptation was there to “correct the data”, the reality is that it’s a massive and unrealistic task. The benefit of integrating IronMan® in the maintenance processes is its ability to deal with incomplete data. Companies seeking to replicate the success of Keystone must either have complete data or a mechanism to compensate for that, which IronMan® does.
- *Leadership Support is Key to Program Success:*
The buy-in from senior leaders, particularly from the CEO and executive team, was instrumental in overcoming resistance to change and ensuring that the necessary resources were allocated. The commitment from the top down was crucial in driving adoption throughout the organization.
- *Employee Engagement Drives Adoption:*
In parallel, Aurizon ensured that the maintenance employees at all levels were educated, trained,

motivated, and engaged with the program. Providing clear understanding of the program and intent helped foster a culture of engagement. Aurizon focussed on “doing it with them” rather than “doing it to them”.

- *Flexibility and Scalability are Vital:*

The Keystone Program has adapted to the business dynamics, ensuring it remains relevant as maintenance tactics mature and Aurizon’s needs evolve.

4.2 New Standards for Asset Management

Through its commitment to innovation and integrating technology, Aurizon is setting new benchmarks for asset management within the heavy haul rail industry. The success of the Keystone program has demonstrated that integrating advanced technologies like machine learning into traditional asset management practices can significantly reduce costs, improve reliability, and enhance operational efficiency.

As a result, Keystone could become a model for other rail operators, especially those managing large fleets and extensive infrastructure. Aurizon took a holistic approach to asset management, integrating technology and predictive analytics to deliver a better outcome for the business. Aurizon lowered maintenance costs while improving reliability. The Aurizon approach is not unique however it is complex, requires cultural change in the business, and has a requirement for a robust and powerful machine learning tool such as IronMan®.

4.3 Looking ahead

Aurizon’s goal is to continue refining and expanding the Keystone program to ensure that it remains relevant and able to meet future challenges. As the industry moves toward greater automation and further integration of AI, Aurizon will be exploring new ways to incorporate emerging technologies into its asset management practices.

Aurizon is delighted by the Keystone results, and particularly the decision to purchase a stake in OXMT. Aurizon’s investment has provided leverage within OXMT to influence the development of IronMan® and compound the benefit – for Aurizon and other companies that may choose to use IronMan®.

5 CONCLUSION

The Keystone program has proven to be a transformative initiative for Aurizon.

The detailed case studies have demonstrated how Keystone has led to tangible operational benefits, including cost savings and improved asset utilization. Additionally, the Keystone approach has demonstrated a new standard for how advanced technologies can be integrated into business processes, reducing the manual and variable aspects of asset management planning and maintenance execution. It also demonstrated how complex AI tools can be successfully and sustainably used and interpreted by all levels of the business.

As has been demonstrated, the Aurizon Keystone approach works, and can be used as a reference or example for other rail operators. Also demonstrated was how IronMan® is intuitive, scalable, easy to deploy, and delivers immediate value.

The future of Aurizon includes the lessons learned from Keystone continuing to guide the approach to asset management, ensuring technology is integral to the maintenance execution, and providing a template for improving the business. The aim is to ensure Aurizon remains a learning organisation and is increasingly competitive into the future.

6 ACKNOWLEDGMENTS

The content of this paper, learnings, and the success of Keystone are testament to the commitment of the asset management professionals at Aurizon, from the CEO (Andrew Harding) through to the asset management team of William Schuh, Vikram Khosla, Roshan Rodrigo, and Luke Hayes. And the Aurizon maintenance managers and leaders have demonstrated extraordinary commitment to what initially appeared to be a novel maintenance approach but turned out to be common sense and value-adding.

The concept, groundwork, much of the initial content, early business engagement, and the Keystone label should largely be credited to Bianca McAndrew (previously with Aurizon) and Mark Warrenner, Managing Director of *Technology Enhanced Asset Management*.

<https://teampps.com.au/>

Elias Kassas, CEO of *OXMT* and leader of the IronMan® team has been intimately involved with Keystone and shares in the success. Not just through his willing participation, but also through his guidance, and commitment to ensuring IronMan® flexed to meet the needs of Keystone.

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