INSIDE THIS ISSUE – WHAT IS SHAPING THE RAIL INDUSTRY TODAY AND INTO THE FUTURE

1500 Volt Traction Power Energy Storage System

Background

The modern electric trains are capable of regenerative brakings. The energy generated by the braking trains, called regenerative brakings, can be up to 40% of the rollingstock traction power. The regenerative braking energy was generally converted to heat and burnt in the braking resistors if there was not another train behind to pick this up. It has resulted in energy waste and carbon emission waste.

There is a proven technology around the world that uses high-efficiency energy converters to capture and store the regenerative braking energy during train braking and release it when the train is taking off.

Metro Trains Melbourne has engaged ABB to design and install the Australian first 1500Volt DC application railway trackside energy storage system at Diamond Creek on the Hurstbridge Line. The system is used to capture, store and release the regenerative braking energy from the trains back to the trains. This has led up to a 15% reduction in the estimated carbon emissions.

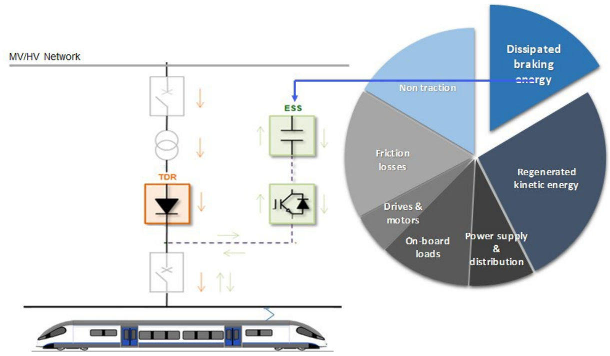


Figure -1 typical concept of the energy storage system

Figure 2 - Energy Storage System installed at Diamond Creek Substation

Benefits

There are many benefits to contributing to a more sustainable outcome by adopting the Energy Storage System for the electrified railway.

1. Energy Saving and demand charge reductions
2. Reduced environmental impact due to less carbon emissions and less global warming potential (GWP)
3. CAPEX saving from not investing in a traction power substation due to:
    a. functional as a short-term substation to boost the line voltages
    b. longer distance between substations to reduce the system cost
    c. smaller ratings of adjacent substations are required
    d. cost saving by not connecting to the HV grid

Safeworking Electronic Protection Forms

Rio Tinto recently introduced a safety improvement within their Train Control team to reduce human error within safety processes. Prior to the improvement Train Control utilised paper-based safe working forms to issue rail authorities to teams in the field. This included managing track access protections, degraded rail movements and system overrides. It was identified they were not fully effective, some forms were lost during the process and it allowed numerous administrative non-conformances, which could then lead to possible safety incidents and breaches in ONRSR data storage requirements. In 2019 there were 129 non-conformances within a 10-month period. An online powerapps solution standardizes data entry using built-in business rules and smarts (pre-populations, dependencies etc.) in order to reduce administrative non-conformances. The app validates user input and stops users from proceeding unless certain requirements within the form are met. The permanent records are automatically stored in three different locations allowing ease of access for audits, incident investigation and business continuity.

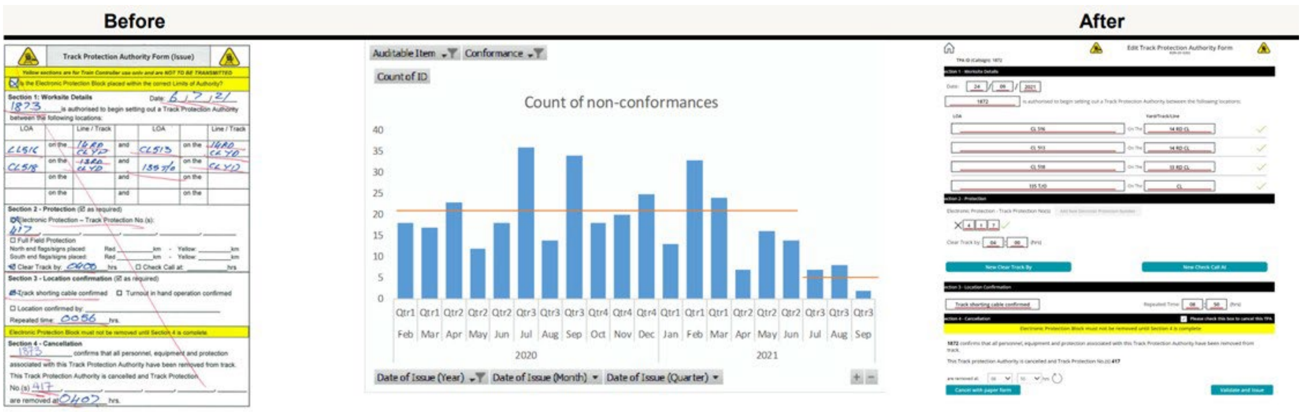
Benefits

1. Since the roll out of the Powerapps Electronic Protection Forms an average reduction of 72% of non-conformances has occurred. By reducing non-conformances, this application helps to reduce potential safety incidents.

2. The application standardizes the process across all four teams ensuring all data is validated before issuing the forms.

3. It also allows supervisors easy access to view all current active forms and provides a full audit history of any changes train controllers make to theforms.

The Train Control team are now in the next phase of the project looking at further system improvements and replicating this with field teams to remove paper based forms on-site.



Organisational Drift

When railway safety incidents are investigated, a variety of factors are evaluated to determine the underlying causes. Common aspects to consider include:

- The people involved (e.g., Drivers, Train Controllers, Observers).
- The rollingstock (e.g., condition, failures).
- The railway (e.g., broken rail, track grade, turnouts).
- The environmental conditions (e.g., weather, vegetation encroachment).

This results in an investigation report outlining the relevant factors that most likely contributed to the incident and may also include some suggested actions to ensure that a similar incident is prevented in the future.

It is however important to recognise that there are limitations with analysing a rail incident in isolation as there are underlying factors that cannot easily be identified by looking at a single incident. One factor that is often overlooked is Organisational Drift. Every organisation operates under a complex structure of governance, rules & procedures, and management that underpins the operation of the physical system. As these underlying systems evolve over time without any observable increase in risk, the overall system operations start to extend beyond the limits of the original design, increasing the likelihood of a catastrophic incident. Many thorough investigations performed on major accident events (particularly in the aviation industry) uncover organisational issues as the root cause that tend to have come about due to this drift.

One of the most dangerous elements of Organisational Drift is that the risk silently increases in the background and there are few mechanisms that enable an organisation to identify it before an incident occurs. Berman and Ackroyd [1] define Organisational Drift as "the gradual, and apparently imperceptible, degradation of standards that leads to a failure to address shortcomings that are having an adverse impact on performance – and which are theoretically capable of being detected." As this drift is inherent in large, complex organisations, where changes are regularly being made to improve operational efficiency, it can be hard to take a step back and look at the bigger picture, even though the degradation may be apparent.

When an investigation does not consider Organisational Drift (or other organisational factors), what tends to happen is that the root cause is identified as either a component failure or human error, and fixes are "patched on" without asking why the failure was able to occur in the operational context. The failure to identify the true root cause means that it will inevitably happen again.

The most important step to minimise Organisational Drift and the associated negative impacts is to incorporate it into processes and procedures. Often this requires strict change management / governance oversight to ensure that changes are appropriately managed and consider the impacts on the safe operation of the network by integrating systems engineering, safety and human factors. One potential way to start identifying Organisational Drift is to perform regular assessments of changes to ensure that the appropriate subject matter experts (SME) have been consulted and their concerns incorporated. Frequent changes that go against SME input is a good indicator that the system is drifting towards a state of higher risk.

[1] Berman and Ackroyd, 2006, Organisational Drift – A Challenge for Enduring Safety Performance. IChemE Symposium Series No. 151.

Safety Observations

Nearly all construction workers would be familiar with the safety observation. The idea that workers, in particular supervisors and managers, complete a set number of observations of tasks each month which check for compliance and safety risks is hardly new. The main goal of a safety observation is to be a recordable way of getting more people out of the office and looking at task at hand and the risks.

Safety observations are a fantastic tool however one of the main downfalls of them is the same as any other KPI. If they are not managed correctly the focus can move toward quantity, to meet the set target, rather than quality. I have heard that some companies are trying to move away from compliance based safety observations, where a set number are required to be completed per month or week, but the reality for most of us is that safety observations are here to stay.

So how do you approach safety observations the correct way? For Supervisors safety observations should come as a daily part of their job, a supervisor will complete several observations just doing their daily task. However for some more office based positions safety observations must be completed more deliberately and time set aside during the week to complete some. Many sites or companies require workers to do observations outside their department regularly. This is done to ensure that people with fresh eyes are always looking at how the tasks are being approached and hopefully identifying any complacency that is occurring, especially if the task is a repetitive one. So many incidents on site occur during repetitive tasks. An example of this is the death of a tyre fitter during a tyre change on a mine site in the Bowen Basin, a task that occurs daily on every site.

To me there are three general stages during a safety observation;

- Check the paperwork
- Identify the hazards you can see
- Ask the worker what hazards they can see and discuss

In my experience checking the compliance side is easy. Ensuring that the workers have all the required paperwork completed HITs/SLAMs/Take5, JSA/JSEA and any other permits, Permit to Excavate, Working at Heights, Lift Study etc should be done first and is fairly easy to identify. This will show that the worker is complying with the site procedures and participating in identifying hazards. Keep in mind just because they have completed the paperwork does not mean they have suitably managed or even identified all the hazards.

The next part of a job observation is drawing on your own experience. It is easier for someone who has experience in the field to identify the hazards around a specific task. However you don't need to know the task to see some of the hazards. An example of this is poor housekeeping and cables everywhere through the work area poses a risk for trips and also reduces productivity.

The last part of the Job Observation is the most important. Have a friendly chat to the workers and ask what they are doing and 'What can hurt you while you are completing this task'. It seems like it should be the most obvious question, but so many times I see people being told what the hazards are during an observation rather than being asked and identifying the risks through an active conversation.

Being prompted will make them think harder about the risks involved in the task.

If the use of HITs/SLAMs/TAKE5s is well ingrained and is used correctly as a safety tool rather than just another target to meet at your site hopefully they will have identified these risks already but quite often this is not the case. If they don't identify the areas you thought posed a risk, now is the time to ask them about that specific hazard and have a discussion about it. Some of changes required once a hazard is identified may be easy to implement, a change in the way the job is set up, or not so easy, a change in procedure or extra tooling which require safety actions to be assigned to someone to ensure they are investigated or completed.

The end result is that the workers are thinking more about the risks involved in the task and some areas for improvement may have been improved. At the end of the day this is why safety observations should be completed, rather than just to meet any set target.

ATO over ETCS - Obstacle and Track Intrusion Detection

Introduction

One of the most exciting and challenging ETCS-related projects is the definition of the standard specification for the ATO over ETCS System, which will allow the ETCS-equipped trains to be driven automatically in an interoperable way.

Background

The UNISIG, ERA and Shift2Rail AoE WPs have been working together to develop the ATO over ETCS Standards for the last 10 years, and the GoA2 specification is expected to be released as part of a new TSI during the 3rd quarter of 2022.

One of the key assumptions is that the ATO System is not a safety related system (could be developed as a no-SIL system) and it relies on other systems to assure the safety of the overall supersystem. In GoA2 the ETCS System performs speed and distance supervision, and it still highly relies on the driver for obstacle/intrusion reactions and degraded situations management.

Grade of Automation	Train Operation	Setting train in motion	Driving and stopping train	Door closure	Operation in event of disruption
GoA 1	ATP with Driver	Driver	Driver	Driver	Driver
GoA 2	ATP and ATO with Driver	Driver / Automatic	Automatic	Driver	Driver
GoA 3	Driverless (DTO)	Automatic	Automatic	Attendant / Automatic	Attendant
GoA 4	Unattended (UTO)	Automatic	Automatic	Automatic	Automatic

Transition to GoA3/4

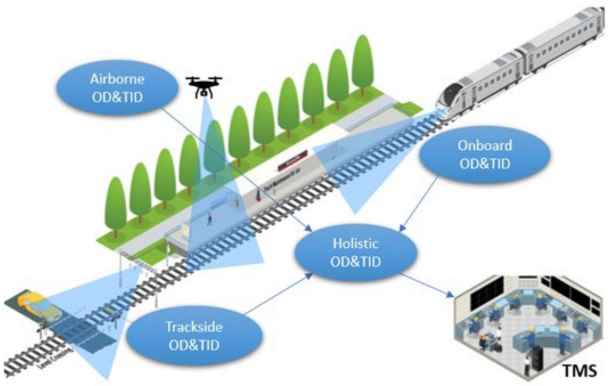
As part of the Shift2Rail program, the Shift2Rail partners, UNISIG and ERA are currently specifying the GoA3 and GoA4 ATO over ETCS System for the near future. To assure the safety of the supersystem, an important challenge to face is the need for an effective Obstacle Detection and Track Intrusion Detection System (OD&TID).

This technology is currently used in some metro applications around the world and in specific hazardous track locations in some mainline applications, but, to fulfill the expectations of such ambitious project, the Shift2Rail Users Group raised the need for an OD&TID system capable of detecting not only an obstacle or intrusion from a physical point of view but also including models that can differentiate the inputs and learn out of experience to determine what is to be considered an actual safety related obstacle, intrusion, or potential intrusion in a smart way. As examples of discussions taking place in those meetings: one cow may not be considered a safety obstacle while a group of several cows may; an adult running close to the track may not be identified as a potential intrusion but a kid in the same situation may.

This detailed categorisation results in a reaction allocation defining how the system should react to a specific obstacle or intrusion. Those reactions could include: sound the horn, stop a specific train, stop all trains around an area, slow down the train to a safe speed…

To achieve this level of detail in the categorization of obstacles and intrusions, a smart, sophisticated, and holistic OD&TID system capable of taking the required decisions and connected to the TMS is to be developed.

This holistic OD&TID system is expected to include not only the already used Onboard and Trackside sub-systems, but also aerial devices (e.g. drones) flying in front of the train and scanning the track ahead to detect any obstacles and potential intrusions (Airborne OD&TID sub-system).



Acronym reference:

ATO: Automatic Train Operation
AoE WP: ATO over ETCS Work Package
ERA: European Union Agency for Railways
ETCS: European Train Control System
GoA: Grade of Automation
OD&TID: Obstacle Detection and Track Intrusion Detection
SIL: Safety Integrity Level
TMS: Traffic Management System
TSI: Technical Specification for Interoperability
UNISIG : Union of Signalling Industry

Conclusion

There is still a long way until the OD&TID technology to provide the required SIL, efficiency and operational reliability of the supersystem is developed, but Shift2Rail is already funding the "Smart2" Project which aims to provide suitable solutions to cover this need.

Leveraging Existing Organisational Data for Enhanced Asset Management

Ageing and deteriorating infrastructure is a global problem. Effective asset management is essential to ensure the safety of workers and the public, and secure a sustainable future. Advances in data quality and availability have opened new horizons for condition monitoring, root cause analysis, and fault prediction. These tools are key to championing higher safety standards while working within realistic budgets.

Data collection is increasing exponentially, however, data utilisation lags significantly behind. The rail industry is constantly creating new technology and data streams, but rarely identifying where these often-siloed systems can combine to derive extra value. Compared with new data collection, this task can be cost effective and quick to develop, whilst yielding significant rewards. "Integration, Visualisation, Interaction", describes three key steps to realising the value of existing data.

Integration

Datasets must first be integrated such that they can be referenced from a single place. Ideally this would be an enterprise data warehouse, where datasets are automatically loaded and transformed to a consistent referencing system. However, this could be as simple as a manual process using spreadsheets, or a database with some simple scripts to automate parts of the process.

Visualisation

Visualisation – equal parts art and science - is arguably the most important part of data analysis. Good visualisations allow the viewer to rapidly gain an understanding of a system or situation and communicate messages coherently and efficiently. High quality visualisations begin with imagination and teamwork, not a computer. There are tools available that allow you to build almost anything you can imagine, so dream big before applying system constraints.

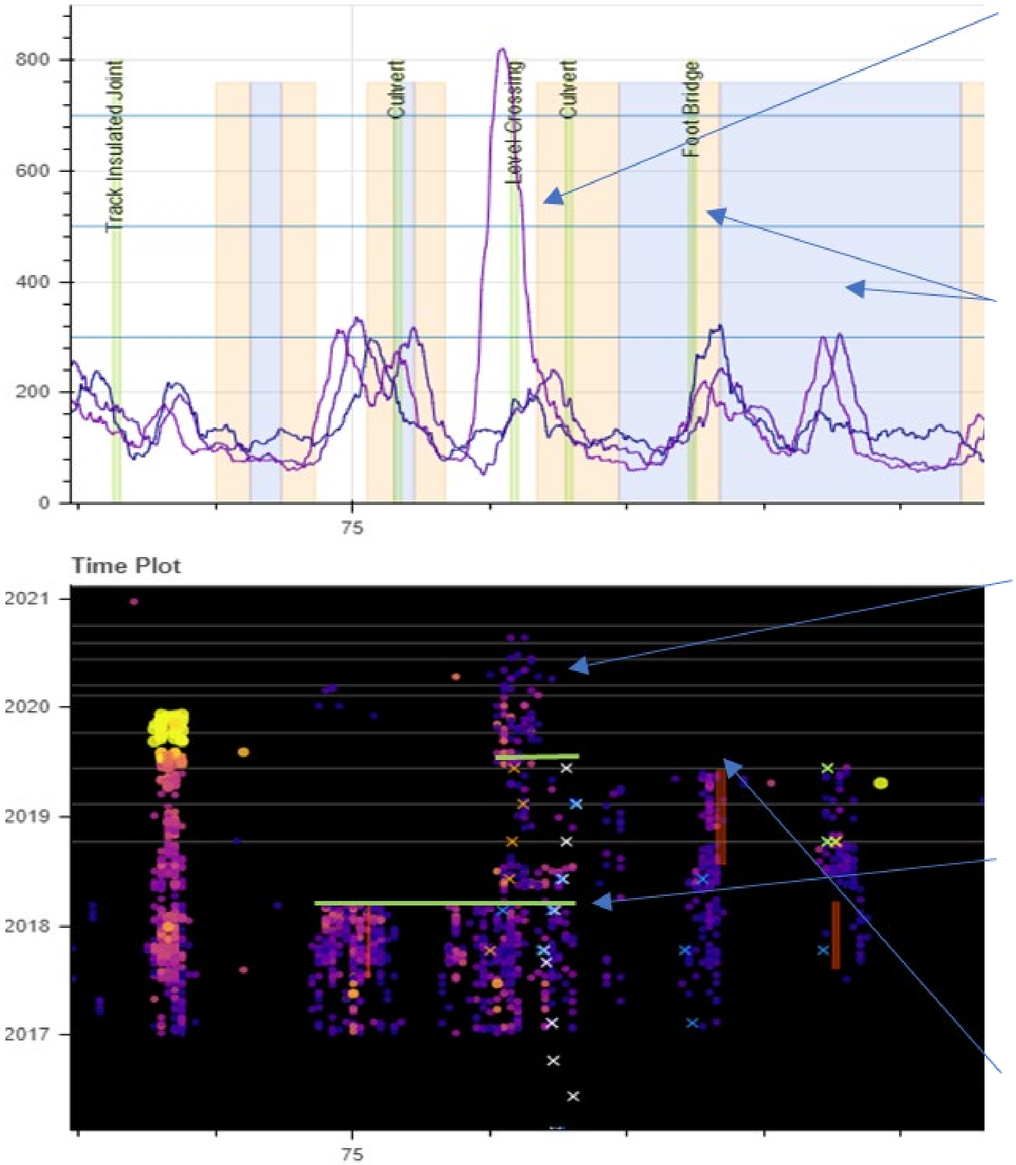
Interaction

Traditional visualisations display a very narrow perspective, owing to the difficulty of representing many dimensions in a single plane, and issues of scale. However, when exploring data, there can be many more variables, and these can yield different insights at different scales. The use of shapes, sizes and colours allow more dimensions to be visualised, however at the cost of becoming unwieldy and confusing. Interactive visualisations may allow datasets to be toggled on and off – which can keep the image uncluttered and is especially useful in time series analysis. The canvas can be navigated around and rescaled to see macro or micro trends. Finally, multiple canvases display different perspectives relevant to a single scale or dataset and can be linked to retain the relationship throughout graphinteractions.

Case Study

An example is the Track History Chart shown below. This chart was the result of an initiative to post-process existing data to model track performance. A track recording car produces traces for geometry parameters (top, twist, line, gauge, etc). Rollingstock mounted accelerometers reported exceedances, of which the highest were investigated. The visualisation was based around these two datasets then incorporated many others, including: assets, speed restrictions, defects, alignment and work history. It was designed such that issues stand out clearly to the viewer, who can then interact with the data, diving deeper to identify likely future incidents or investigate historical ones.

This chart has become invaluable in identifying tamping scope, investigating incidents, and determining corrective actions for poor performing track. This tool was built on free, open-source technology (SQLite, Python and Bokeh), demonstrating that this capacity is not limited to organisations with large R&D budgets.



A derivation of 'Top' geometry is plotted for multiple dates showing a spike at a level crossing that has since been fixed.

Assets (green) and curvature (blue, orange) help paint a picture and explain trends in the data.

The history of accelerometer exceedances show the characteristics of degradation prior to reaching an alarm level and highlight outliers.

The trace shows tamping work (green line) and effectiveness.

Missing work records are also evident.

Figure 1 – 'Track History Chart' visualisation

Data visualisation is a powerful tool which deserves to be thoroughly employed in asset management. Utilisation of existing data through integration, visualisation, and interaction can offer valuable insights, without the cost of new systems or data acquisition. The result of which is enhanced safety and economic outcomes, contributing to a sustainable future for infrastructure.

Thanks for reading

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