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

Personal Duress Alarm

Rail staff are exposed to a range of security and personal safety risks. Whilst crime on the rail network continues to fall, the reality is customer- facing members of staff have a greater exposure to incidents such as assault and anti-social behaviour than members of the community generally. Moreover, as rail provider's increases its emphasis on providing quality customer service, and the amount of time staff are exposed to customers, there is a corresponding increase in this risk.

Sydney Trains had an existing Duress Alarm system which was infrastructure heavy, obsolescent capability and reliant on an alarm management system for reporting and notification. The existing Duress Alarm system could do no more than report an incident (when activated) – it did not identify the person activating the Duress Alarm, nor the exact location.

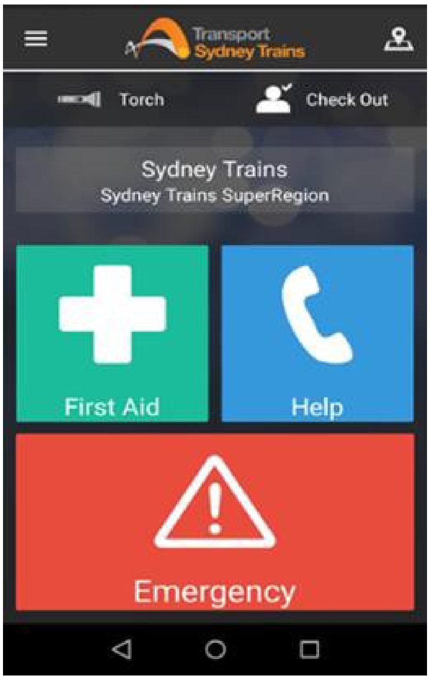


Figure 1 – Duress Alarm Application Interface

A proposal to implement a new Duress Alarm system was put forward based around the mobile telephone products currently used by Sydney Trains staff and to effectively remove the dependence on outdated infrastructure and limitations currently observed. The intention of this initiative was not to replace the procedures included in the Customer Initiated Violence and Anti-Social Behaviour Policies but to provide an efficient response during an emergency situation. A number of options were identified and analysed during the pilot phase, which included a market search of over 200 products, closer inspection of four products and testing of two products. This final analysis resulted in a shortlist of three options which were then subject to a more detailed evaluation of economic and financial costs and benefits, and associated risks.
Subsequently, procurement of a Duress Alarm application which could be deployed to both iPhone an android platforms.

The Duress Alarm application chosen was the most effective option for addressing the existing issues and realising the benefits as it allows:

- Rapid deployment - this option will allow to acquire and rapidly deploy a fit for purpose commercial off-the-shelf (COTS) solution, with minimal staff training.
- Extremely rapid identification of location and identification of staff (and customers) in duress, as well as nearby staff
- The retirement of the existing infrastructure and associated obsolescent hardware
- A significant expansion in staff access to Duress Alarm services, including the potential to include infrastructure and operational staff as and when required
- Additional “man down” functionality, such as presence in the rail corridor.

Sydney Trains has provided over 2,500 staff with the capacity to use their existing smartphones as a Duress Alarm in the event of an emergency situation.

Turnout Installation Method Comparison

The required efficiency and quality in installation of new turnouts or crossovers for new railway lines and replacement or upgrade of turnouts in existing railway lines creates unique challenges. Challenges arise due to restricted working space, restrictions on vibration and noise, past uses of the land, services within the area and constraints of the geology.

There are a number of existing methods in use and more will develop in time as the restraints and challenges change. It is an area where further innovation and automation will be of benefit. The PEM & LEMs (telescopic handling gantries and trolleys) are developed and suited to this specific application and similar styles of machinery. Similar advances in machinery will assist in improving the safety and efficiency of these specialised activities. The existing methods can include;

Built In Situ:

The turnout is built its final position in track. Plant is used to move the materials into position and the team constructs the turnout.

Pros	Cons
Good accuracy in alignment of turnout Limited large machinery required Minimal space required Quick set up	Requires long track possession times which is a critical issue for existing railway tracks Requires machinery access to install location

Figure 1 - Turnout built in-situ

Crane:

For existing railway tracks a new turnout is built adjacent to the location where it will be installed. It is then lifted in segments or as a full unit in to the placement location once the old turnout is removed.

Pros	Cons
Can lift full length of turnout Useful in removal of existing infrastructure Average accuracy in placement for alignment	Large area required for crane Longer set up time Preparation of ground for bearing pressures May impact services in the area (overhead & underground)

Figure 2 - Turnout installation with cranes

Geismar PEMs & LEMs

For existing or new railway tracks a new turnout is built in a suitable location some distance away or adjacent to the install location. It is then lifted and loaded onto the LEMs trolleys using the PEMs (telescopic handling gantries) and motorized trolley in to the install location utilizing already built track and dummy rails.

Pros	Cons
Can lift full length of turnout Good accuracy in placement for alignment Space efficient	Large area required for crane Longer set up time Rollingstock must be registered Machinery needs to be maintained

Figure 3 - Turnout moved into place by PEMs & LEMs

Introduction to Algorithm Evaluation for Decision Makers

Two tech-savvy engineers walk into a bar. Both have coded an algorithm to predict an (unspecified) mechanical failure. The first claims his algorithm is correct 85% of the time, but returns many false positives. The other claims that hers is correct 92% of the time, but returns a few false negatives. Which one is best? Turns out, this is not a joke, and there is no punch line. As luck would have it, they are members of your team. How do you figure out if either of their algorithms are worth using?

Why it matters

Over the next decade [there will be increasing pressure]for organisations to not only use, but to be more transparent in their use of AI. A basic understanding of how it all works will become increasingly advantageous for decision makers. There are many places to start, but my suggestion is evaluation. Why? Because this is where it becomes obvious if business context and risk has been fully considered. Data science tools and methods are also becoming more accessible, and my opening scenario will only become more common as smart people, who are not data science professionals, begin exploring the vast potential in this space.

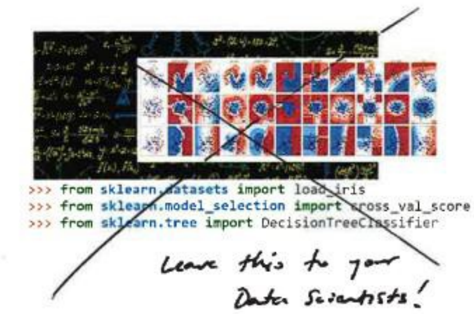
Managing risk

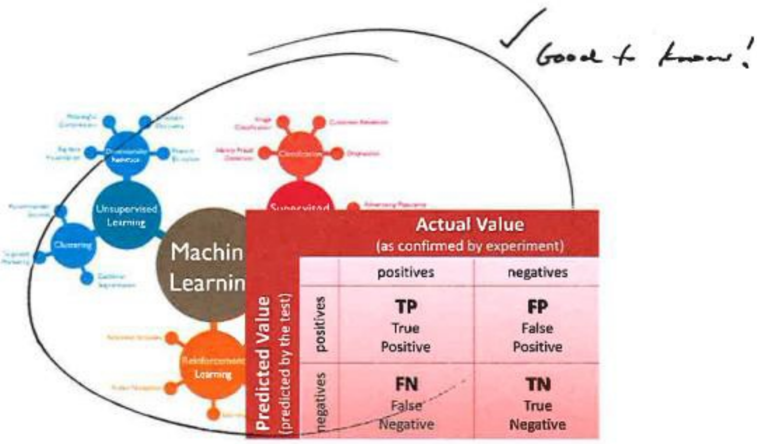
Evaluation, of course, brings us back to the “which-algorithm-is-best” dilemma. Let’s forget about predicting machine failure for a moment and talk about humans. Specifically, predicting any kind of cancer re-occurrence. What would we prefer? A doctor who falsely tells us we’re fine when actually, we’re not? How about the reverse? The latter is surely, mighty inconvenient, but the former? Quite literally - fatal.

Algorithm performance then, is often about getting accurate results for the value(s) which matters most. In fault detection or health diagnosis, both values are important, but the positive value is *more important* than the negative. Thus, the importance of nuanced business knowledge and awareness of risk, for anyone in your business building ML models, should not be underestimated. In high risk scenarios, who cares if you can predict 98% of true negatives, when you can’t pick out the 0.05% of true (potentially fatal) positives? It doesn’t matter at all, does it?

Key metrics

That’s where knowing some of the specific evaluative metrics of machine learning models can come in handy. A few important ones are Accuracy, Recall and Precision. The over-all correct prediction percentage, our two (fictional) engineers were discussing was effectively, Accuracy. In the cancer scenario, Precision would tell us the proportion of positive diagnosis which were correct. Recall, however, tells us the proportion of actual positive cancer cases which were correctly identified – and this is a critical value. From recall you can figure out how many were not picked up and slipped through the radar. Is that a risk you can live with? Is that better than a human could come up with?





Conversation starters

Easy, right? Actually, it's not too difficult. The harder part is figuring out how to adjust a model when it's not quite hitting the mark. Below are some other important considerations in machine learning evaluation with some with some links to further reading for those who are keen.

Talk me through your training methods - Training an algorithm, in a complex environment, sometimes with limited data, requires careful consideration to training methods**.** What options were considered? Why? What challenges did they experience in the training process? How did they get around them?

What made you choose this model? The type of machine learning method used depends on the type of problem, and the type of data. Not all models are equal for the situation at hand. A neural network, known as the 'black box' of AI, for example, is not going to be great if you have a line-up of stakeholders who require a simple and brief explanation of your decision making methodology. On that note, "Explainable" machine learning is worth reading up on.

Unless you're already well and truly on the machine learning/AI track, this is likely enough information for now. There are loads of great resources available. I hope you can see that data science is very much an accessible body of knowledge, and it is becoming increasingly essential for leaders to grasp. Just a little reading, every so often, will provide a great ROI, keep your team on their toes, and see better results for your team. Best of luck!

Design Visualisation and Digital Twins in the Rail Industry

Internet of Things. Big Data. Virtual Reality. Digital Twins. Digital Engineering. These terms are becoming increasingly common in the rail industry. However, the question being asked by many is: “How do we utilise these technologies to benefit all stakeholders across rail projects in the most efficient manner?” The answer to this question lies within a process that connects all these aforementioned terms: Design Visualisation.

So, what is Design Visualisation?
Design Visualisation is any aide that helps engineers, project managers, stakeholders and the wider community understand the decisions made during the design process. For engineers and construction workers, it also allows rapid understanding of progress and any issues arising from the current design. For example, efficient design visualisation allows for an accelerated design process across projects, simulates on-site risks and hazards to minimise chances of them occurring during construction and allows stakeholders to appreciate and interact with the final product before construction even begins.

What does Design Visualisation involve?
In a fast-paced world where engineering designs of rail projects are constantly changing, a dynamic and real-time visualisation tool must be utilised to capture changes and design decisions. This model is known as a digital twin. At its optimum, any information that could be obtained from inspecting a physical product can be obtained from its Digital Twin.1
Design Visualisation of infrastructure projects has evolved from being drawings on a piece of paper that can be seen, to realistic but expensive real-life scale models that can be felt, to static digital models that can be understood, and finally to interactive and dynamic digital twins that can be experienced. Clients and end-users prefer an immersive and realistic visualisation tool. Hence, design visualisation is a key factor for whether a project will be a success or not.
Looking at things from a sustainability point of view, the concept of design visualisation has evolved significantly as well. Only a couple of decades ago, rail project designs were carried out on dozens of renditions printed on pieces of paper. With the advent of the digital twin, only one rendition is required, and can be updated in real-time, hence minimising the carbon footprint.

In order to build a digital twin, inputs must first be captured. A primary tool of data capture is the use of point cloud models. Point clouds are essentially sets of data points in space, which can be captured by 3D scanners through drones or other means. Other types of information can be captured and added, such as GIS, Aerial Photos, photogrammetry, track data and utility information.

Innovation in Design Visualisation

Innovation has become a keyword for Design Visualisation in recent years and this has been further propelled by the move to digital. For example, companies such as Unsigned Studios have utilised game engines to create bespoke tools to create digital twins to meet endless opportunities. Such tools enable a sense or interactivity from stakeholders and enables the use of Virtual Reality to easily give an experience of the final product to the end-user.

During the early stages of a project, design automation and generative design could be used to efficiently and quickly create a digital twin. Such design can be implemented on, for example, rail tracks, overhead wiring gantries and roof structures.

Capabilities of Design Visualisation using Digital Twins in the Rail Industry

In the longer term, Digital Twins can provide the following capabilities which can significantly improve the outcomes of a rail project. They include:

- Understanding how clients and the community will interact with a new project, for example, a station, before it is constructed. VR technology in a digital twin can assist people with wayfinding as well as provide human-centred feedback and allow designers to improve the design based on that feedback.
- Exploring methods to optimise the design of project. For example, by simulating camera placement and recognition distances, the number of CCTV cameras at a station can be minimised, therefore reducing capital and maintenance costs.
- Safety can be enhanced with digital twins: For example, signal sighting at a complex junction can be simulated from the train drivers' view at different times of day to ensure there is minimal obstruction and glare. This allows a easy visualisation of risks and hazards before workers go on site.

Visualisation in the Rail Industry

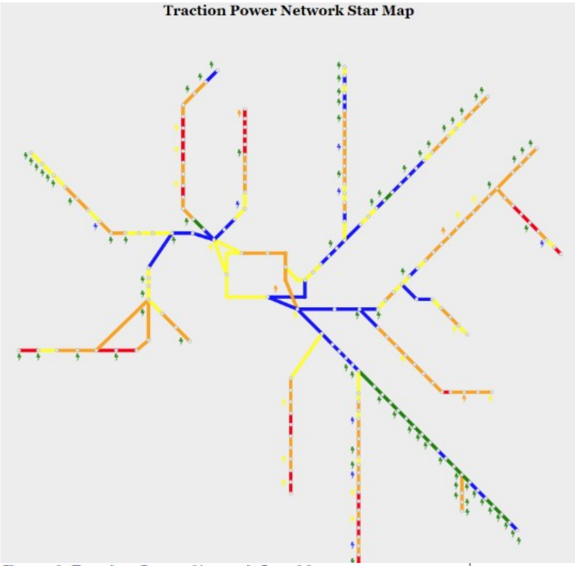


Figure 1: Traction Power Network Star Map

What is visualisation in Rail Industry?

Nowadays, computer-based visualisation technology has developed into a powerful aid for studying a variety of natural phenomena and has become an indispensable desktop technology in professional areas such as medicine, architecture and engineering. Continuous advances in computer technology have made these sophisticated visualisation techniques available and affordable to the transportation industry in general and more specifically to the rail industry.

In the rail industry, visualisation is a science that combines a variety of different applications and technologies such as image, video overlay, animation and Geographic Information System (GIS) to realistically generate and portray existing and proposed project conditions. Effective visualisation significantly improves our ability to assess complex planning scenarios and proposed alternatives. It can be used to identify and solve potential problems early in the project development process, produce and evaluate alternatives faster and facilitate early planning involvement and feedback.

Why do we need visualisation?

Because of the difficulty in communicating the complex nature of rail projects, visual aids are necessary for presentation. The intent of visualisation in presentation is to help understand the context, to add insight to problem solving and to communicate with the wide range of audience. It is used to communicate the effects of future changes and modifications to our transportation system.

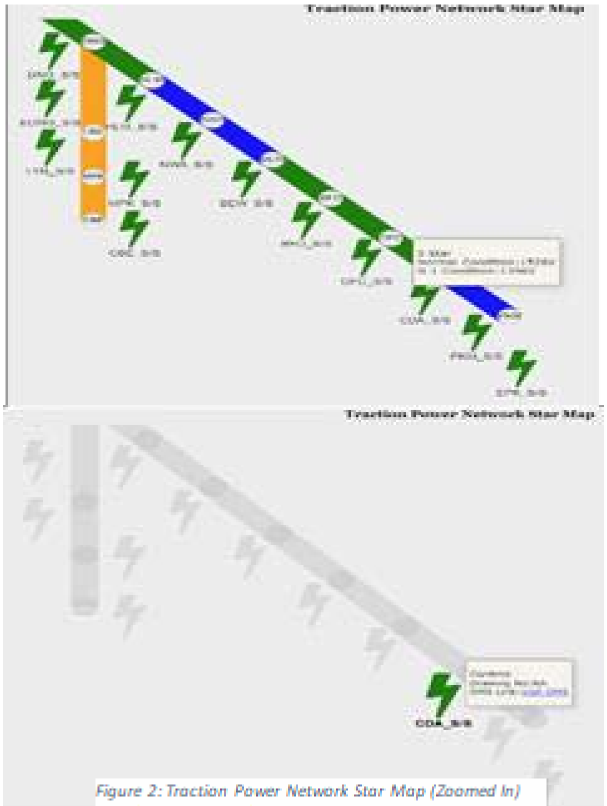


Figure 2: Traction Power Network Star Map (Zoomed In) with full interactive features

An example

Specialized software is utilised to model and simulate the traction power systems of rail networks. Traction power simulation provides engineers a detailed study and broad understandings of the traction power networks such as voltages, currents, power loadings, temperatures of overhead wires, etc. These parameters are critical to assess performances of electrified rail networks and the needs of infrastructure investments. However, it is challenging to convey the technical issues of traction power networks to the wider audience (non-technical experts). Therefore, the need for a visualisation tool to convey important messages is apparent. Figure 1 illustrates a traction power star-rating schematic map which is obtained from traction power simulation study. From the schematic map, users can identify the weak points of the traction power network without the need of understanding technical standards. The map is a powerful tool for rail planners in terms of making decisions about infrastructure investments or services changes in these concerned areas. Moreover, the information of infrastructure can also be incorporated into the map using crosstalk technology. This combination provides a simple, single source of truth for users to quickly understand about the current configuration of the rail network.

AI & Robotics at the Service of Safety;
Example of the Toolbox Spotter

One of the realities that should be considered when analysing the complex question of site safety during track works, is the fact that people are inherently risk takers and do not always follow procedures. While traditional safety procedures and good practice help keep workers and infrastructure free of harm and damage when they are followed, the introduction of new technologies offers opportunities for introducing fail safe mechanisms that will complement these traditional methods.

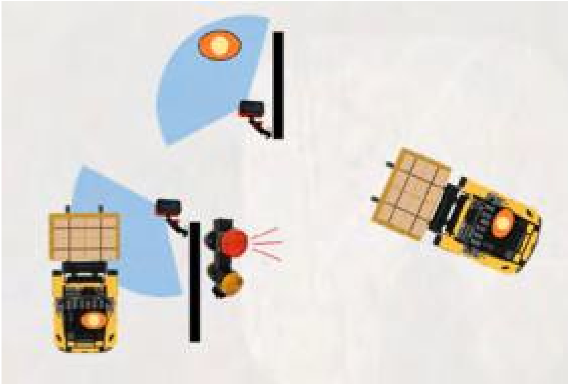
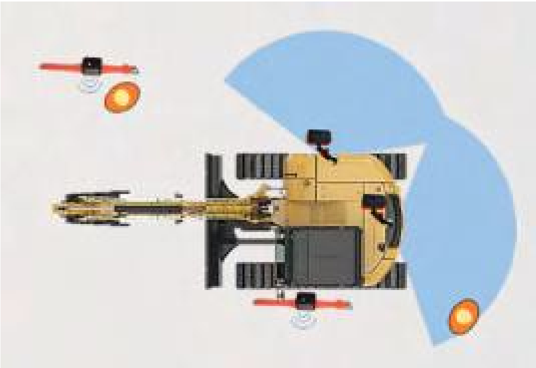
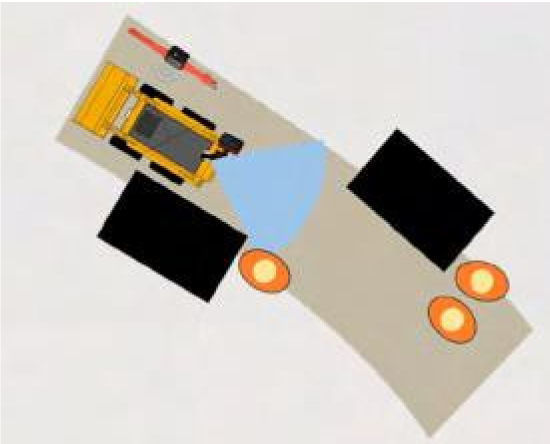
International Engineering Company and Tier 1 Contractor on major rail projects Laing O'Rourke (via its Research and Development branches, the Engineering Excellence Group and PFP Robotics) has been pushing for the development of new systems using AI and Robotics to help workers deliver projects with greater safety and less potential for infrastructure damage.

The result of this innovative drive is the Toolbox Spotter, a device that has received much positive attention since its recent introduction on site, receiving the Master Builders Association's (Queensland) recognition for Excellence in Workplace Health and Safety and cementing Laing O'Rourke as one the Most Innovative Australasian Companies as listed by the Australian Financial Review.
The Toolbox Spotter consists of 3 main parts: a sensor node to capture data (typically a camera) fixed to a moving plant or a fixed object, a processing unit to analyse the data, and a device to alert workers of a danger (this can be a vibrating wristband, a luminous hard hat, a flashing light, etc.).

A typical application in the rail sector would be the protection of track workers working near moving plants: the machine is fitted with the Toolbox Spotter camera and the driver is wearing a wristband. The system's AI is able to identify whether a person, an object or a piece of infrastructure is within reach of the machine (the system can differentiate between these and adapt the response) and sends a vibrating signal to the wristband to inform the operator of the hazard.

Figure 1: Toolbox spotter positioned on pieces of plant to alert the driver of humans or foreign objects in proximity (Photo: Laing O'Rourke)

The Toolbox Spotter is very versatile and can be adapted to various applications

Zone protection: Ideal for installation on plant and infrastructure with little movement, or on the side of the tracks. The spotter will detect vehicle and personnel getting close to the item being monitored and can warn of potential danger.	
Slewing Plant and worker protection: Application mostly adapted to the protection of workers located near a slewing piece of plant. On the example to the right, the Tool Box spotter notices a person behind the machine and sends a vibrating signal to both the driver and the spotter for the machine.	
Collision protection for travelling items of plant: The agility of the system allows it to spot in real time any item of interest located in its travel path. In the example to the right, the toolbox spotter will warn the driver that workers are located behind the machine as it reverses back. The system can differentiate between an individual and an immovable object and would only warn against a potential collision with a person.	

Thanks for reading

FAST TRACK