FASTTRACK

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

Onboard Batteries for Metro Trains

As Australia stumbles towards its 2030 and 2050 emissions reductions targets, all industries are looking to reduce emissions and increase sustainability of their systems and processes. It's estimated that the Transport industry contributes 19% of the Australia's CO_2 emissions, which has highlighted an area for potential change and innovation.

Batteries have been the go-to solution for emissions reduction in recent years, being installed in cars, buses, houses, and distribution networks. As Metropolitan Trains are already electrified, why don't we put batteries in them?

One aspect of electrically powered trains that can utilise batteries is the regenerative braking system. This function converts Kinetic Energy from the rotating wheels and converts this to Electrical Energy when the brakes are applied. This function already exists in some Metro Trains, and the converted energy is output into the Overhead Wiring network and consumed by trains nearby, if there is one. If there are no nearby trains, this energy is simply 'wasted' and consumed by losses within the wiring network. If batteries are installed on trains, this converted energy can be redirected into the battery system and stored for when the train is drawing high current, known as "peak lopping". This not only reduces the overall power consumption of the network, but also reduces the peak currents drawn by each train, putting less stress on the overhead wiring systems.

Unfortunately, it's not all sunshine and lollipops for the "Batteries on Trains" argument. There are inherently some negative impacts associated with battery systems that may put the idea to bed. Batteries are expensive, they have a relatively short lifespan, they are known to explode, and they are very heavy. The weight is the main factor that raises question marks over the above-mentioned energy saving claims.

A new fleet of High-Capacity Metro Trains (HCMTs) are soon to rolled out across Melbourne as the next generation of rolling stock. A fully loaded, standard size HCMT can weigh up to 478t. If you want any hope of moving a mass of this scale, a very large battery system will be required, which will further add to the overall mass. As we increase this mass, we increase the energy required to move the train when regenerative braking is not occurring. This additional energy may be greater than the energy saved by the regenerative braking system, in which case the proposal would be a failure. Detailed modelling and analysis must be undertaken to understand how realistic this energy saving claim is. Do the benefits of regenerative braking battery systems outweigh the cons of lugging around all that extra weight?

As time goes on, weight will come off and these systems will become smaller and lighter. It is yet to be confirmed if Batteries on HCMTs are an emissions target hero, or an overly optimistic idea that will ultimately run flat.

Wheeling Robot

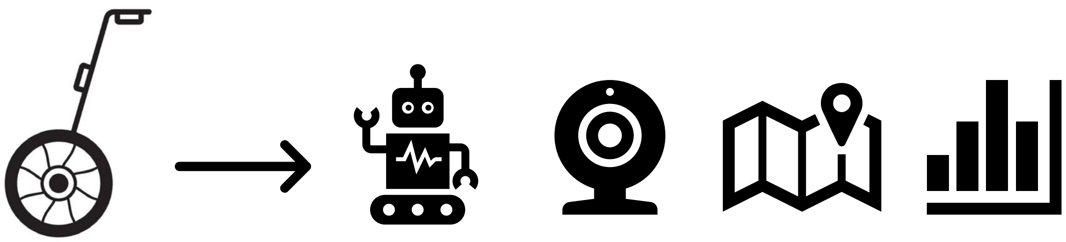
Measuring wheels (known as surveyor's wheels) are widely used within the rail industry as the most effective tool for accurate measuring of rail tracks. In order to measure distance on the rail track, an engineer will be wheeling on even and flat surfaces by holding the handle of the measuring wheels whilst walking. The wheels have metal side plates to ensure the wheel stays on the track.

Integrating this feature into a robot which can move by itself on the rail track by mounting on one side of the rail track could be introduced and will give us many advantages like free hand as we don't need to hold the handle of the measuring wheel. So that, we can prevent from chronic injury for our wrist especially wheeling long track from area to area. Moreover, we can focus more on checking / marking up on the signalling plans such as Signalling Arrangement Plans, Track Circuits, Bonding and Signalling Apparatus Plans independently to make sure that all the track items and their positionings are accurate while the robot is wheeling.

Features of the wheeling robot could be included as followings but not limited to:

1. 360 HD Camera Recorder with built-in GPS
2. Digital Measuring Display with measuring unit
3. Controlled by an app
    - To capture photos with GPS coordinates
    - To download the recorded photos and videos with GPS Coordinates
    - To set the starting chainage
    - To set the measuring distance (if required)
    - To set/convert measuring units (kilometres/metres to yards/feet)
    - To stop/start or forward/reverse wheeling (Adds forward, Subtracts in-reverse)
    - To turn on/off digital measuring display (if required)
4. Controlled by a remote controller (simple easy functions)
    - To capture photos with GPS coordinates
    - To set/convert measuring units (kilometres/metres to yards/feet)
    - To stop/start or forward/reverse wheeling (Adds forward, Subtracts in-reverse)

Additionally, the downloaded Photos and videos with GPS Coordinates data can be uploaded and captured into pass assets management system (e.g., https://pa.apps.ptv.vic.gov.au/ in Victoria).



Unmanned Aerial Vehicle (UAV) use in Railway

How do we currently complete inspections in the rail industry to make sure our track is fit for purpose?

Well, we send our rail workers out on a cyclic basis or in an unplanned manner for emergencies to ensure we have an asset that is fit for purpose, reliable, safe and within our standards. Our workers may have to travel hundreds of kilometres to do these inspections, wait on site for track time and work in a live environment.

A more recent technology that is being used worldwide already may be the answer to reduce the number of people on track and the time required on track. Drones or Unmanned Aerial Vehicles (UAVs) are becoming more commonly used for commercial purposes in recent years and the rail industry is no exception. There are generally two types of drones that are available for the rail industry which are aerial UAVs and rail-bound UAVs.
The aerial UAVs are used more traditionally as eyes in the sky and a broader view of what is happening in the field for scoping, bridge inspections, locations difficult to access and data on features across the whole rail corridor.

Photo source: [The Rise Of The Railway Drone | COPTRZ]

The rail-bound UAV designed by Nordic Unmanned has a range of 200km and can operate for up to 7 hours with an average speed of 20km/hr. The most impressive aspect of this UAV is that it is designed to detect oncoming rail traffic and changes in conditions on track and has the ability to move out of the danger zone to let trains pass. The rail-bound vehicle could be used for track patrols over large distances, track inspections and right of way inspections and this could be done when track access is limited.

Photo Source: [The Drone that Can Drive – The Staaker Railway Drone - Nordic Unmanned]

The benefits of using UAVs on the rail network include:

- Reduced time for people on track
- Remove people from the firing line
- More efficient use of resources
- Monitor progress of projects
- Access difficult locations
- Reduce safe working incidents

- Improve overall safety
- Improve confidence of drivers passing worksites on adjacent lines
- Reduce impact to the network
- Real-time live asset data accessed remotely
- Initial examination of defect to provide information on planning or immediate corrective actions

There are limitations with using UAVs for these inspections such as the detail they provide relating to rail condition, ballast condition, measurements, and general ability to physically experience field conditions.

Beyond the current benefits, with the technology improving and using Lidar, higher quality cameras and thermal technology drones could do a large majority of inspections required on our rail network and related infrastructure. When we can rely on the data to tell us exactly what we would see with having a person on site and even more, this will be the way of the future.

References:

The Drone that Can Drive – The Staaker Railway Drone - Nordic Unmanned
Drones or Unmanned Aircraft Systems (UAS) - Network Rail
How drones will change the future of railways | Thales Group
The Rise Of The Railway Drone | COPTRZ

Small Culvert Inspection Robot

The Pilbara Region of Western Australia is subjected to long periods of significant rainfall during the wet season. These rainfall events typically result in very large flows through defined watercourses or more broadly as overland flows towards the ocean. The construction of a heavy haul railway in this region causes the disruption of these flows and as such provisions are required to allow the flows to cross the rail alignment. This is achieved through the construction of bridges or large culvert banks for large watercourses or single/small banks of culverts to balance water levels between each side of the railway. The typical diameter of the culverts range from 3.6m for large flow sites down to 0.6 m for small balance culverts.

The ongoing inspection of these bridges and culvert assets is typically undertaken by trained inspectors who physically look over the assets to identify areas of deterioration. The inspection of the smaller culverts (1.2 m and smaller such as the example in the Figure 1 below) poses a challenge due to limitations associated with access which results in only a partial inspection undertaken from both culvert ends. This partial inspection leaves a significant portion of the culvert barrel effectively un-inspected and as such any deterioration of the central portion of the culvert is unlikely to be identified. This deterioration may result in a culvert collapse and loss of embankment which poses a significant risk to the above track.


Figure 1 - Small Diameter Rail Culvert

A number of varying inspection devices have been trialled to allow for a more thorough inspection of these smaller culverts with limited success. The typical vehicle style inspection units are heavy and require a range of supporting hardware (controllers, numerous batteries, tethers etc) which further add to weight and difficulty associated with transport. The culvert sites requiring inspection are regularly a significant distance from an access road meaning all inspection equipment needs to be carried by inspection personnel. Aerial vehicles such as drones have also been trialled given they are very lightweight, however the airflow created by the rotors kicks up a significant amount of dust, obscuring the inspection camera.

A recent development is the development of a wheeled or tracked inspection robot which is specifically designed for this task. An example of such a unit is included in Figure 2 below:


Figure 2 - Inspection Robot

The unit features a fully orbiting inspection camera controlled from a remote control as well as high intensity lighting and high powered motors powering rubber tracks. The units incorporate a number of 3D printed elements to focus on weight reduction by only using material where it is actually required for this specific application.

Figure 3 - Inspection Robot Outputs

Early results from trials currently underway show very promising results such as the example in Figure 3 below. Such views of this particular deteriorated culvert have not been possible using conventional inspection techniques.

The main limitation associated with this style of inspection robot is the communication between the unit and the controller. There are currently two methods in use for this communication link, a fibre optic cable attached as a tether, or a wireless radio transmitter. The fibre optic cable provides significantly better resolution to the inspector using the controller, allowing them to direct the camera to areas of interest. In addition, the cable can be used as recover tether, however care has to be taken not to damage the cabling. The wireless version offers significantly better freedom of movement however there are limitations with the resolution for video feed as well as potential communication loss.

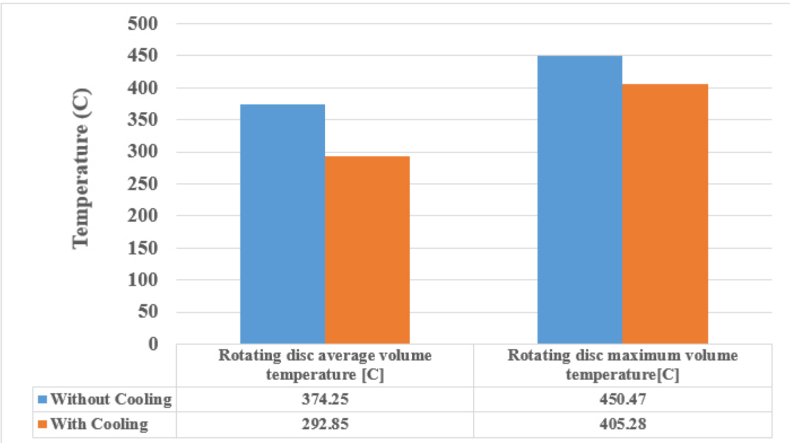
Both a tethered and wireless version of these units are currently being tested.

Sustainable braking

Braking systems are often overlooked when we talk about sustainability in rail. Braking system is one of the most important part of the rolling stock operation and given its consumption of material and resources, there can be real opportunities in designing sustainable braking systems.

The traditional way to achieve braking is by using friction, where the brake pads are pressed under high pressure against the surface of a moving part to make it stop. The fundamental science behind is the conversion of kinetic energy into thermal energy. With the output being the thermal energy, the key parameter is temperature that highly impacts the efficiency of the braking, consumption of material and other performance factors including its life cycle. The simplest idea that had been floating around for a while is to provide some sort of a cooling system to lower down the average temperature of the disc during the braking period.

A UK based company OGAB has done some simulations to study the performance of their proposed cooling system and their theoretical findings have shown positive results. Their study involved the activation of cooling system during the braking period and then for extended period after the brake application to study its performance for the overall reduction of average disc temperature. They find that operating cooling system during the braking period of 62.5s reduces the average temperature of the disc by 21.75% and maximum temperature of the disc by 10%.



Comparison of temperature between the case without cooling and case with cooling at t=62.5s

During second simulation the cooling system was kept operative for another 177.5s in addition to the braking period of 62.5s and making the total operating time of 240s, where t=0s is when the brake is applied and t=62.5s is when the brake is released. The results show that the average disk temperature shows an improvement of 78% and maximum disc temperature of 52%. The study notes that the cooling system was implemented on current brake system designs which had limited the performance of the cooling system. The study suggests that the braking systems designed with integrated cooling systems can further enhance the performance.

The reduction in temperature of the disc can improve the braking performance by reducing the stopping distance. The reduced consumption of brake linings (stators or pads) will have a positive impact on the environment. Other improvements include increasing the period of peak performance of the brake pads, lower stop distances mean lower track fatigue, improved disc life and huge improvement on the overall maintenance cost and reliability of the braking system.

Reference

ww.ogab.co.uk

Bringing 1988 into 2022 with TTU

The Tangara is a double-deck electric train capable of running across the entire Sydney Trains network, and sometimes serving the South Coast Line. The 440-carriage fleet was delivered from 1988 to 1996, initially in a suburban trim and capacity, but later as an outer-suburban train with onboard lavatories, more substantial seating, and minor external differences.

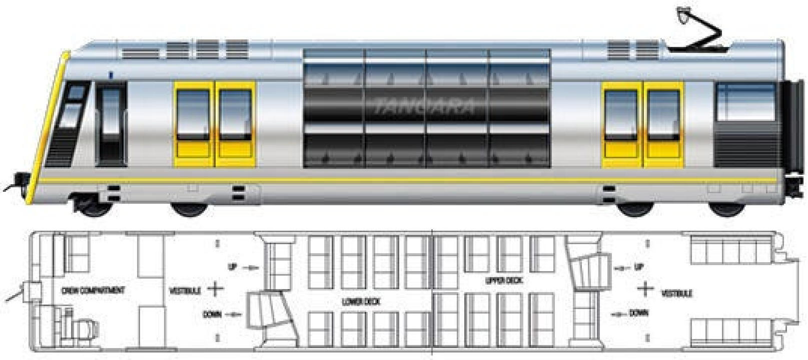
A pioneer of technology to the Sydney network at release, the Tangara is undoubtedly a product of the 1980s. More than a fresh coat of paint is required to make sure the fleet remains in service and continue to meet the transport needs of a growing Sydney.

Enter the Tangara Technology Upgrade (TTU), a long-term investment into the fleet aiming to bring the third-generation train into line with the latest fourth-generation Sydney trains like the Waratah, Millennium and Oscar fleets. The project is complex and phased, comprising of connected and enabling systems, mechanical, and customer information upgrades.

There are challenges in conducting this program, as the fleet was delivered over a period of almost a decade, comprises of two models with five carriage variations, and must remain in service as it it progressively upgraded. The successful delivery of the project will increase the reliability, accessibility, comfort, and ease of operation of the fleet.

One of the larger completely components replaced the original doors across the fleet a with lighter, stronger, easier-to-maintain design. A total of 3568 new doors and supporting door systems have been installed and immediately increased the reliability of the fleet by minimising delays, improved passenger safety, and reduced vandalism.

The new doors have proven over five times more reliable than the original design, going from 6.8 failures to 1.3 failures for every million door cycles. This alone has significantly lessened the likelihood a mechanical train failure will impact network operations and has extended the life of the fleet by ten years.



Modern operating and communication systems are due to be installed, including a new Train Operating System and upgraded crew desks, Train Communication Network, and Automatic Train Protection. Customer-facing improvements include Internal Emergency Door Releases, automatic Digital Voice Announcements, customer information displays and CCTV systems. In addition, new accessible seating, customer touchpoints, lighting, intra-carriage access, and audio systems will complete the upgrades.

For customers, the upgrades provide for a more consistent and connected experience across the wider Transport for NSW network, but for the operator these upgrades represent a leap in capability and integration into the network as modern safety systems continue to come online. The increased dependability of the fleet will be critical in unlocking reliable capacity of the Sydney Trains network into the 2020s as the Tangara enters the second half of its life.

These interconnected enabling systems and technologies combine and enable real-world improvements to create a safer, more reliable train with higher levels of service and facility both for customers and Sydney Trains as an operator. Moreover, this program extends the life of the fleet which represents a huge value to NSW monetarily and as a reliable asset to an ever-growing transport network.

Thanks for reading

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