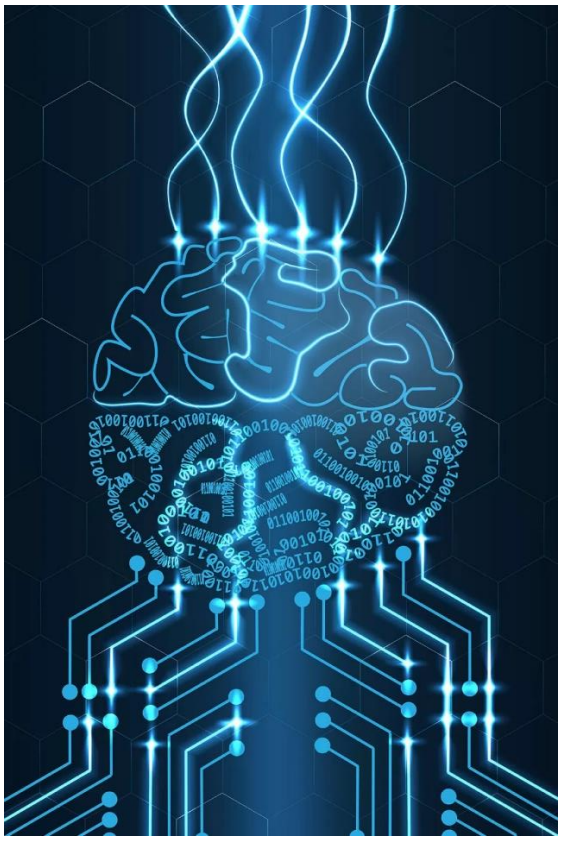
RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

FASTTRACK

THE NEWSLETTER OF THE HORIZONS PROGRAM I JULY 2022

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

In the spirit of reconciliation, the participants of the Rail Industry Safety Standard Board Horizon's 4.0 Program acknowledge the Traditional Custodians of country throughout Australia and their connections to land, sea and community.
We pay our respect to their Elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples today.



TRUST ME, I'M A ROBOT

Are we heading towards the world which Arnold Schwarzenegger warned us of in 1984 or can we really harness the power of AI and work in harmony with it within the Rail industry?

We all remember the line; "Come with me if you want to live". Since the dawn of the idea of AI it has always been the morality question of "would I trust this AI/robot with my life, or the life of anyone else?" The major blocking point for many is the element of intelligence of an entity that has no sense of empathy. Every major advancement in technology however requires a leap of faith and we are fast approaching the jumping platform. AI is inevitable; the reason, because human minds will never be satisfied; we are not wired that way. Therefore, if we wish to be a part of functioning society, we must embrace AI and even trust it as much as we trust every other human invention we use every day. I will leave you with a final though, In the words of the AI compute HAL9000 from 2001: A Space Odyssey "This mission is too important for me to allow you (humans) to jeopardize it"

IS AI LIMITLESS IN RAIL?

The first ever automated train was opened in London in 1967 on the underground Victoria line. Over the past century (yes that's right, a century) we have also been developing driverless cars. Radio controlled cars, vision following cars, magnetic interaction cars, cars that interact with a magnetic field generated by underground circuitry. For all our advancements in autonomy however, we haven't really unleashed the full potential of 'intelligence'. The basic definition of intelligence is:

"The ability to acquire and use knowledge and skills."

It's what makes us human. With intelligence we have achieved some astonishing feats of genius. Moon landings, nuclear fission, the internet, photography of a black hole. So, if we introduce an AI to autonomous trains, where does the limit lie for an entity that can surpass our own intelligence. Will we see optimized headways between multimodal train lines without human interaction? Will we need signals anymore? Will we need train protection systems? Will we need any human interaction at all?

These are the questions presenting themselves to us at this point in our technological age. It is entirely possible to automate almost everything regarding running a train. Driving, scheduling, PA systems, refueling, maintenance, HVAC, platform monitoring. The freight company ARTC have even implemented a system to tell the driver where the rear of the train is located in real time. Where does the limit of AI end though? Is there a limit to something that can acquire and use the same knowledge and skills as a human? Quite honestly no, the only limiting factor is providing the physical coordination ability to the AI and at that point anything is possible.

Could we begin to see smart railways with no infrastructure other than the track elements? Could we begin to see 100% timetable adherence with zero annual casualties.

Could we see a train with the ability to visually recognize dangers and stop safely well in advance?

Whatever happens, it is an extremely exciting time to be in the rail industry.

FRONTLINE WORKFORCES *FIT FOR THE FUTURE*

The COVID-19 pandemic has permanently transformed the way economies and communities live and work. Organisations, with the help of technology, are now expected to explore their corporate operating models resulting in increased flexible working from home opportunities, which will no doubt change the heavy rail customer journey patterns. The pandemic has proven the ability of people and economies to adapt quickly to changes with the help of technology. With this knowledge, technological and digital capabilities will be harnessed, not just by private entities, but also by the governments and their organisations across the world. Network and fleet operations simplified through digital railway systems will require workforce skills and capabilities to change accordingly. With the benefits of work-life balance proven through flexible working for corporate employees, the demand by operations staff for flexible working is expected to get stronger.

The demographic changes in the workforce will further strengthen the demand for digital solutions, not only to manage their daily work but also to provide meaningful work and career opportunities.
Introducing new technology on an operational railway, particularly heavy rail, has its own specific challenges. Leaders tend to be so focused on running the railway that often change programmes aren't engaged until the last minute. Introducing new technology creates an environment of fear, so its pivotal that organisations start the myth busting early on.

Ensuring active involvement of the workforce during both the design stage and creation of learning materials, through to transition to business as usual will ensure buy in from the end user. Ultimately gaining endorsement from those involved in the early stages and encouraging them to become ambassadors for change to their peers.

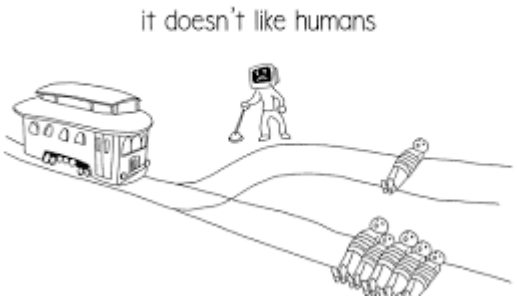
"The demand by operations staff for flexible working is expected to get stronger."

In order to future proof their workforce, organisations need to transform the way they work through harnessing agile technology solutions to deliver customer benefits and operational efficiencies. Early adoption of technological solutions by frontline workers will ensure they are set up for success in the digital railways of the future. If we take Train Crew as an example of frontline workers the "what's in it for me" question is at the forefront of their mind, so digital solutions need to be developed with making life easier as the goal to ensure buy in. Some examples of these solutions include online roster view, qualifications view and shift swapping capability. A large portion of this workforce would not have grown up with an iPhone in their hand, so taking baby steps introducing applications that will benefit their work experience will ensure they are fit for the future, and ready for bigger technological changes coming to the nature of their work.

The space to transform particularly how Train Crew operates through technology is exponential. Solutions to change how they work and the customer experience of the railways, like turn up and go timetables, flexible rosters, electronic safety critical documentation, digital attestation and payroll, advice of altered working, crew association to fleet and real-time tracking of crew movements, are just a few of the ways organisations can both improve the employee experience whilst also creating efficiencies in operations. But with these technological changes comes the question of what are the key capabilities required for the future workforce and how does the recruitment strategy need to change? For many organisations this will mean a review and redefinition of the profile, classification, and core competency requirements of new recruits.

Gone are the days where a young adult will enter the workforce into a role they will stay in for their entire working life, as we see with a large number of older generations of qualified train crew. Millennials are more likely to have a number of different career paths through their working life, yet these digitally enabled individuals are the next generation we need to attract to enter the railways. They are early adopters of technology and less resistant to change, however flexibility is something they place high value on when looking for a job.

So, moving to a digital future must come hand in hand with simplification of network operations to enable flexibility in rostering. Of course, when it comes to impacting crew working conditions, organisations must tread carefully and with utmost empathy, partnering with Union bodies along the way to ensure the voice of their employees is heard.



THE MODERN AI TROLLEY PROBLEM

We have all been subjected to this dilemma of which route you would allow the train to transverse. But what happens when the one in control of the points lever has a different agenda to human empathy?

There is a train heading down a rail line. There is a set of points which can be controlled by pulling a lever to make the train take one of two routes. Down one route we have one human being of unknown background; down the other we have five humans of unknown background. If you are in control of the lever, which lives do you choose to take given you know nothing of their personal lives. If the problem was to change however to say that the five humans on the second route were actually criminals, would this change the decision that is made.

These are the dilemmas that come with our human ability of empathy as well as the priceless nature of the value we put on a human life.

So, what happens when we put the decision in the hands of an artificial intelligent non-sentient entity. How is the decision made and what justification is used to reach that decision? There would be no guilt, no value placed on the sanctity of human life, no empathy based around the backgrounds of the unfortunately positioned humans. The answer: algorithmic reasoning.

If the entity has been programmed to value life, then it will seek the path of least casualties. What if the entity has been programmed to protect infrastructure and by taking the more casualties option, it reduces damage caused to the train and infrastructure by 50%? But AI learns right? Correct, it learns to be more efficient at achieving its goals but who sets those goals; well to begin with, we do. It is imperative that we progress through AI implementation in rail with extreme caution. As we open our industry to more autonomous control we must always be grounded in the safety of human beings as the most important goal.

We are constantly striving to remove the human element from job roles that we have labelled as being "candidates for upgrade" (if you excuse the reference to the cybermen of Doctor Who) but when will we be content with the level of control, we are willing to give away. Moreover, what level of caution makes us feel comfortable when dealing with a safety critical situation. Is there a sacrifice to be made between caution and efficiency?

The current state of AI is approaching the levels only dreamed of in sci-fi stories of the past 50 years. Technology is advancing at an unprecedented rate (adhering the Moore's Law) but we cannot lose sight of our humanity and the role humans play in society. If we do, then the line between artificial intelligence and human intelligence begins to fade.

Are we heading towards a world governed by the AI Machine?

"It seems probable that once the machine thinking method has started, it would not take long to outstrip our feeble powers. They would be able to converse with each other to sharpen their wits. At some stage therefore we should have to expect the machines to take control."
Alan Turing

INNOVATING RAIL HVAC FOR IMPROVED ENERGY EFFICIENCY

Have you ever thought twice before switching on your home air-conditioner? Maybe it's the cost of electricity, or you worry about carbon footprint? Like we are cautious at home, we need to think similarly about our railway networks and take measured steps to reduce unnecessary energy usage.

One of the greatest energy consumers in a train fleet is the Heating, Ventilation, and Air-Conditioning (HVAC) system. A significant amount of energy is required for the "simple" task of blowing hot and cold air. On a hot day with sweating passengers entering the train, the system requires a powerful compressor and a few large fans to keep internal conditions comfortable. For those cold winter days, the system might use heating elements like that of your home electric heater, but much larger and more energy hungry.

How can we revise and innovate existing and future HVAC systems to improve energy efficiency without compromising on passenger comfort?

Well, it turns out there is much to be considered in the careful selection of components and optimising the control software.

Electronically Commutated (EC) fans are becoming increasingly popular in many rail HVAC systems. These types of fans are available for AC and DC power supplies and are more energy efficient due to their unique design using a brushless motor with on-board electronics. They significantly reduce energy usage when compared to a traditional AC fan motor and bring other benefits such as variable speed control and fault diagnostics.

Selecting a more innovative condenser coil can also improve energy savings. Recent advancements in technology have shown that 5mm tubed coils are viable in rail applications. The 5mm coils provide better heat transfer compared to traditional coils, which reduces the power consumption of the compressor motor and condenser fan. Upgrading an existing coil to a 5mm coil is relatively easy since the form factor about the same.

Now, let's be smart about our system control.

Many HVAC systems are fitted with a programmable controller that provides the opportunity for reducing energy usage.

In existing systems, we can revisit old control algorithms. This activity can begin by analysing data logs from revenue service to locate segments of energy wastage, followed by an exercise of adjusting software parameters to achieve an energy reduction at those times. For example, tuning the setpoint calculation to consider the ambient temperature can make the system smarter about its mode of operation.

The addition of traffic hours is also helpful. The aim is to reduce the frequency of heating and cooling during periods when the train is least operated. This can be achieved by implementing a mode where the system can operate to a relaxed setpoint and provide only bare essential temperature regulation. Such improvements can be easily implemented in a minor software update and energy savings measured over a short trial.

Let's make a difference and reduce energy wastage on our networks – it all starts with you.

MANAGING GROWING RAIL PROJECT COMPLEXITY

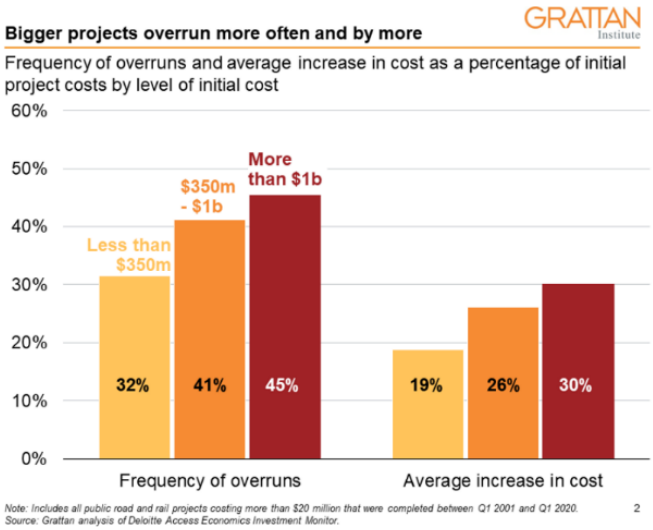
There are currently billions of dollars invested in the delivery of rail projects in Australia, and things do not seem to be slowing down.

Recently, further $billions have already been pledged by the newly elected government for rail projects, with works starting on a fast rail network quite likely – a project that would be very novel for the Australian rail industry.

An ongoing issue with rail megaprojects in Australia (>$1Bn) are frequent cost blowouts and overruns, which are not the greatest outcomes when taxpayers' money is on the line. The Grattan institute found that the average increase in cost for megaprojects is 30% (shown in the figure below). Common causes for these overruns are overlooked requirements early in the project that emerge late in the construction and minimal integration planning, resulting in rework in the design and construction phases.

A further spanner in the works arises from rail projects becoming increasingly more complex. Technology advancements such as condition monitoring, artificial intelligence, IoT, real-time data streams and advanced communications systems becoming increasingly more common to keep up with the customer's growing digital demands.

Managing this growing complexity, and the complex integration of technology with the people and processes involved in delivering and operating a megaproject, requires a pragmatic and 'digitally enabled' approach in itself to decrease the risk of overruns.



Using digital engineering tools and processes, such as model-based systems engineering, applies a pragmatic approach to manage complexity in rail projects from the very start of their lifecycle. Operational concepts are managed and traced right through to the requirements and design of the project to ensure all bases are covered, requirements are not overlooked, and objectives of the project are kept in mind throughout its lifecycle.

This approach, which ties digital engineering and systems engineering fundamentals, can tie closely with the BIM and Digital Twin spaces to ensure that we make the most of technology itself to manage technology application advancements in rail projects and its inherent complexity. This ultimately decreases risk of overruns and cost blowouts, getting optimal value for the taxpayer.

SEPARATING FROM THE PACK

Photo 1: Sleepers being laid with labourers close by

For far too long there has been an expectation in the track construction industry that the close interaction of plant and labour is required I order to get the job done. It is important to note that on well-run sites these interactions are conducted in a highly controlled manner with the operator, spotter and labourer always aware of one another's location. However, no matter how well coordinated these activities are there is always an elevated risk of significant injury. In recent years these interactions are finally being phased out with the addition of new technologies. These technologies both increase efficiency and remove the need for plant and labour interaction.

Machine control has been common practice in civil construction for many years already, however it has taken a little while for the track industry to catch-up. This has largely been due to the more specialised nature of the works and machinery used. The barriers haven now been broken down with machine control being built into hi-rail excavators, individual attachments are being modelled allowing activities such as laying sleepers to be completed without on-site survey and the need for labour on the ground measuring spacings.

Along with the addition of machine control to existing plant and equipment the advent of novel machinery has also changed the game for rail construction. Particularly in the instance of moving long welded rail strings which has traditionally been one of the highest risk activities carried out on a rail construction site.

Photo 2: Sleepers being laid with machine control

Trac Rail Transposers, or TRTs have been a revelation, whereby long lengths of continuously welded rail can be moved safely, efficiently and with millimetre precision from a distance via remote controls. These units ensure that the entire length of a rail string is moved in a completely controlled manner, when in the past this would have been a job for a loader or excavator that can only secure it from one end.

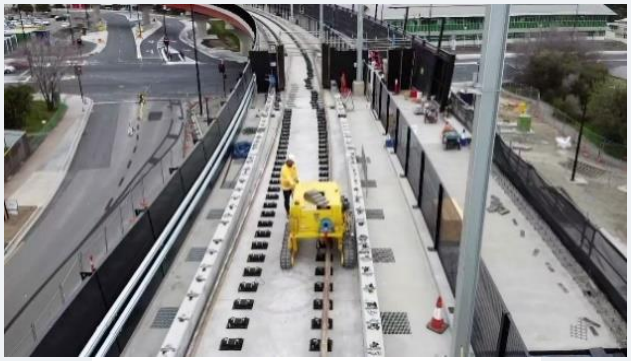


Photo 3: TRTs moving long welded rail

In addition to the technologies mentioned many safety specific technologies are now also being rolled out within the industry. Innovations such as Blindsight and Halo have made their way onto rail plant in recent years, which are both technologies designed to make those necessary close interactions with people and plant much safer and far more controlled. Halo is a very simple piece of technology which projects a ring of light signifying the zone of influence on the ground around an item of plant, this acts a visual cue for those on the ground to ensure they are always maintaining a safe distance. Blindsight on the other hand is a more active piece of technology which notifies an operator in the cabin of an item of plant when a person has entered their blind spot.

Photo 4: Halo on a forklift

Technology is always evolving in the construction industry with the focus on safety always front of mind with new innovations. It is just refreshing to see that the rail industry is finally doing away with some of the old habits and looking to separate plant from the pack.

WHERE IS THE RAIL FREIGHT?

The conversation around environmental sustainability in rail often throws up topics such as hydrogen use, solar power and renewable material use in track infrastructure – all ideas with merit and obvious environmental benefit. The unfortunate reality right now is they are decades away from being commercial, scalable initiatives they can create significant change and move the needle towards net zero carbon.

From a freight perspective, rail is already fundamentally more carbon efficient than the alternative, road transport. Moving freight by rail is four time more fuel efficient than road. Estimates from the Inland Rail project indicate an annual reduction of 750,000 tonnes of carbon per year. However, nationally we don't do a good enough job of leveraging the inherent benefits of rail as a base case for freight haulage, with only around 10-12% of container throughput at Australian ports transported in and out via rail.

The table below illustrates a concerning trend, with only Adelaide achieving any substantial growth in rail freight percentage over the last eight or so years. Compare this to an increasing volume of freight moving through Australia's ports, the result, more trucks on roads and a backwards step in environmental sustainability.

Table 7.2: Freight on rail (%), Australia between 2013–14 and 2020–21[243]

	2013–14 (%)	2020–21 (%)	Percentage point change over the period
Adelaide	4.1	20.3	16.2
Brisbane	5.6	2.1	-3.5
Fremantle	16.8	19.9	3.1
Melbourne	13.9	6.1	-7.8
Sydney	12.0	15.5	3.5
National	11.6	10.5	-1.1

Source: ACCC calculation based on data from BITRE Waterline 68.

(1)

Make no mistake, trucks will continue to play a pivotal role in Australia's growing freight task, particularly in the domestic market. This is rightfully so given the accessibility differences between the two modes. However, more needs to be done to increase the rail mode share across Australia, particularly in and around seaside ports for the export/import market.

There are numerous barriers to increasing rail share, explored recently by the 'Freight Modal Shift' report prepared by GHD Advisory (on behalf of the Australian Railway Association') (2). These barriers range from the physical infrastructure through to the costs borne by the freight owner. To be fair, there continues to be significant private and public investment in various infrastructure projects to increase capacity and capability in rail freight. This includes Inland Rail, on dock rail at various port terminals and a handful of intermodal terminals. Unfortunately, these investments alone, thus far, have failed to deliver meaningful change in the rail freight space. The elephant in the room continues to be the commerciality of freight on rail. Freight owners continue to show reluctance to shift freight due to the cost associated, along with the loss of flexibility in comparison to road transport.

The fact is currently there is enough latent capacity in the rail freight network to significantly increase the share of freight that travels by rail in and out of our ports. This capacity is also increasing given the pending completion of various infrastructure projects. The low hanging fruit that requires attention is making rail freight more commercially attractive to freight owners in the short term, whilst scalability and efficiency slowly develops.

A handful of mode shift incentive scheme/rebates have been attempted in more recent times, to varying degrees of success (Port of Fremantle subsidy, Victorian Mode Shift Incentive Scheme). This author knows that schemes such as the above are often the only reason a customer will even consider rail as a freight option in the first instance. Perhaps it is time for a national scheme, one with extensive exposure, to not only financially incentivise freight owners, but also educate them properly on what the modal shift would mean for sustainability in this country.

Conceptually, modal shift is a realistic means to reduce the carbon footprint in Australia. There is no more testing required, no further investment in innovative technology, no more open hypothesis. It is achievable in the short term, which should make investment from Government in the form of rebates more palatable. History should thus far be telling us that the 'build it and they will come' theory does not apply to modal shift. There is no shortage of intermodal terminals collecting dust, so to speak, and a not-so-subtle risk of an Inland Rail line doing the same thing.

Sources:
(1) Container stevedoring monitoring report 2020-21, Australian Competition and Consumer Commission, October 2021
(2) Freight Modal Shift Mode Shift Impediments and Opportunities, Australian Railway Association & GHD Advisory, March 2022

Thanks for reading

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