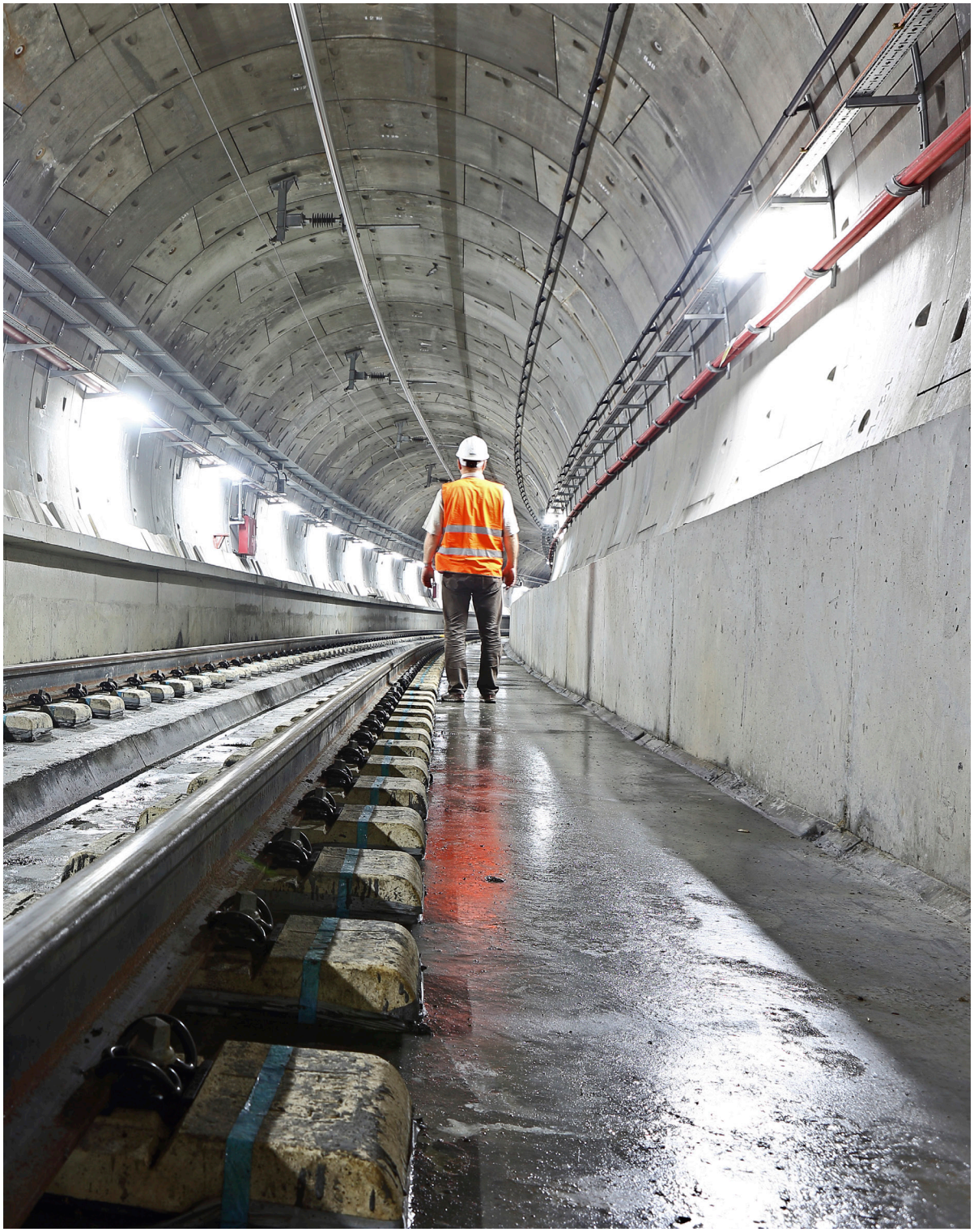
Arup workshop

November 2020

Track Worker Safety Workshop Summary



national rail safety regulator

RISSB

ACRI

ARUP

This report summarises the findings from the Track Worker Safety stakeholder engagement workshop held on 6th November 2020 for online participants across the globe. The workshop explored the topic of track worker safety, including what makes a track worker safety options suitable, an exploration of the options available, and challenges for adopting track worker safety systems. The workshop was designed and facilitated by Arup's Foresight and Innovation team. This report gives an overview of the discussions and key findings.

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Overview of the workshop

The Office of the National Rail Safety Regulator (ONRSR) and the Rail Industry Safety and Standards Board (RISSB) have commissioned the Australasian Centre for Rail Innovation to investigate world standard safety technology to improve Track Worker Safety (TWS) in Australia. Arup are the delivery partner on this project.

On Friday 6th November 2020, Arup hosted a workshop with RISSB, ONRSR, ACRI and rail industry stakeholders to discuss the topic track worker safety. The workshop participants explored the most important characteristics of track worker safety options as well as took a detailed look at available options and how to overcome barriers
to implementation.

Participants undertook the workshop activities on an online Miro board in several breakout groups facilitated on Microsoft Teams.

This report summarises the workshop findings and will inform the development of the final report for this research project.

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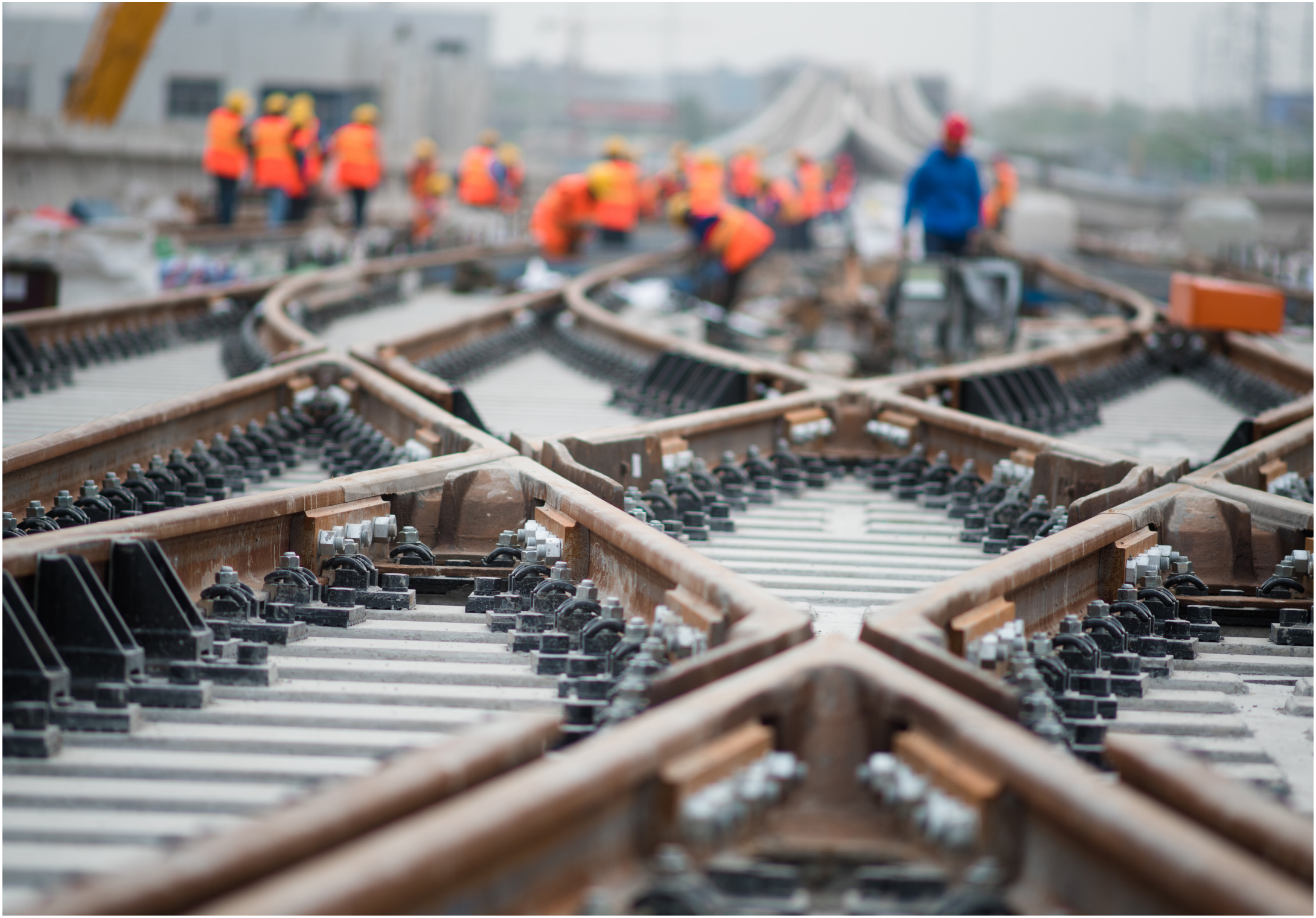


Workshop Activities

The online workshop was opened by Sue McCarrey from ONRSR and Deborah Spring from RISSB. David Bainbridge from the Australian Rail Track Corporation and Graham Bradshaw from Transport for NSW presented on their experiences with track worker safety solutions and the challenges for adoption.

The remainder of the workshop consisted of three main activities:

1. Exploration of the characteristics that make a track worker safety option suitable.

2. Exploration of the track worker safety solution options that are available.

3. Exploration of the challenges for adopting these track worker safety options and potential solutions to these challenges.

For the first activity, participants separated into their breakout groups to discuss what qualities, attributes and features make a track worker safety option suitable. Participants were encouraged to consider the bigger picture as well as for their specific contexts.

The second activity had participants in their breakout groups exploring the range of options identified from the literature review and engagement survey. The five typologies considered were:

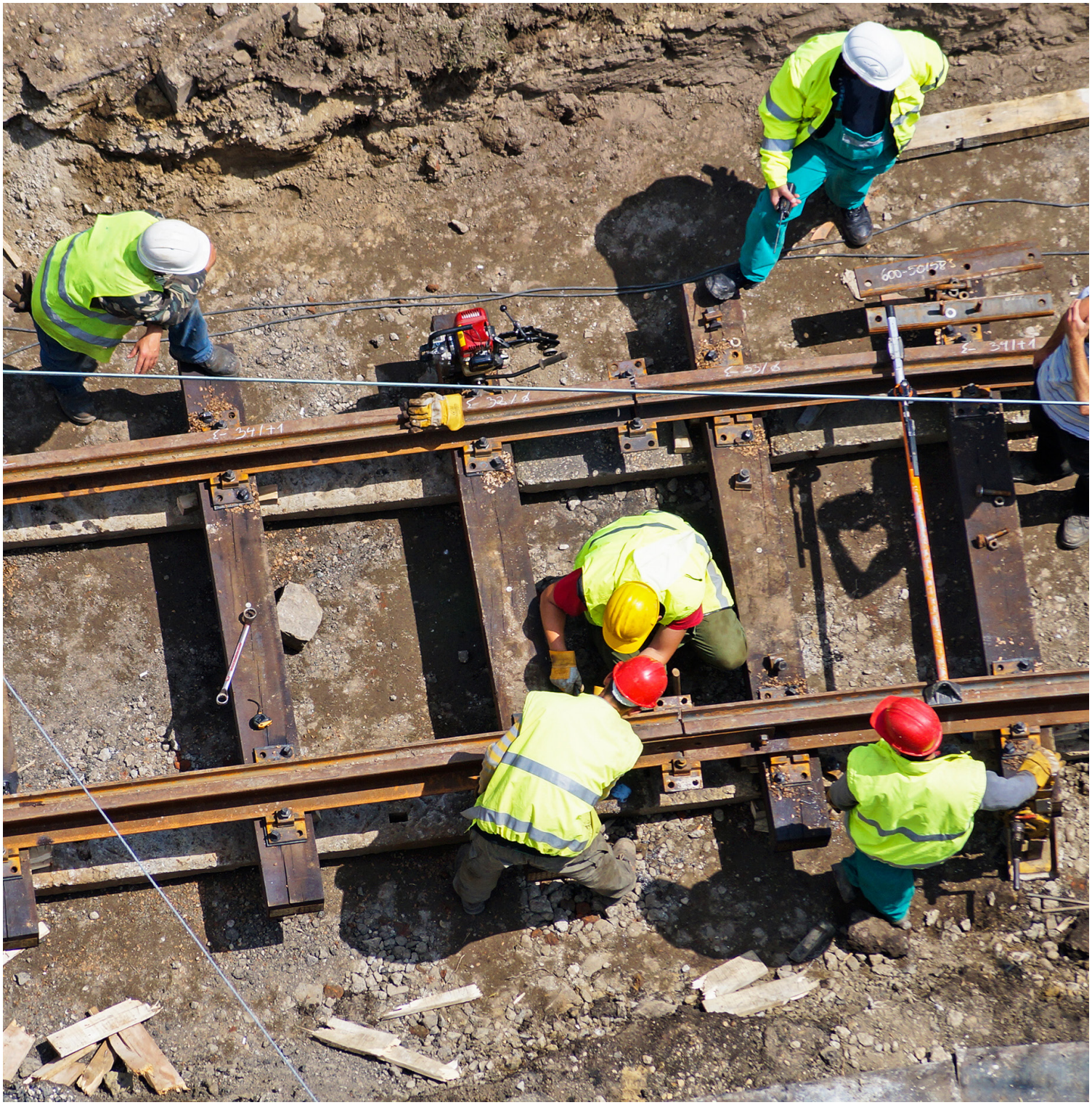
1. Vehicle installed devices that give warning to train crew.

2. Work-site installed devices that give warnings to track workers.

3. Sensors and devices that give targeted alerts to both train crew and track workers.

4. Systems and methods that remove the need for workers on tracks to undertake work.

5. Infrastructure systems and devices that automatically prevent trains from entering a work-site.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Activity 1

Defining track worker safety option suitability

In the first activity, the workshop participants broke into five groups to discuss the qualities, features and attributes that make track worker safety options suitable. The teams brainstormed over forty unique responses.

All participants then had three votes to allocate to the responses they believed were most important for option suitability. From the voting, we identified the top ten responses.

The highest voted response, with eight votes, was “fail to safety” meaning that if a device fails it will not indicate a state that is safer than actually exists. It is a device or system that is designed to remain safe in the event of a failure.

The second highest voted response, with six votes, was “simple to implement and follow”. It was noted that this simplicity is from a users perspective for operating.

The third highest voted response, with five votes, was “usability and functionality”. It was noted that this included an option being fit for purpose. This response was equally ranked with “Meets SFAIRP (Safety so far as is reasonably practical)” which equally received five votes.

The remaining options that were ranked can be found in figure 1. This collective understanding of the qualities that make options suitable, would be used in activity two when participants ranked track worker safety options.

Rank	Votes	Response	Notes
1 (1)	8	Fail to safety	NA
2 (2)	6	Simple to implement and follow	Simple from a user’s perspective
3 (3)	5	Usability and functionality	An option that is fit for purpose
3 (4)	5	Meets SFAIRP	NA
4 (5)	4	Industry best practice	NA
4 (6)	4	Avoids human fallibility	NA
5 (7)	3	Trust in the system	NA
6 (8)	3	Works on commonly available devices	NA
6 (9)	3	Avoids placing people in dangerous situations	Avoid SWS having to enter the Danger Zone that would require protection to implement these new controls
6 (10)	3	Engineer control	NA
6 (11)	3	Reliability	NA

Figure 1 - Activity 1 response rankings and comments

Activity 2

Exploring the Options

In the second activity, the workshop participants familiarised themselves with the options under the five typologies.

1. Vehicle installed devices that give warning to train crew.

2. Work-site installed devices that give warnings to track workers.

3. Sensors and devices that give targeted alerts to both train crew and track workers.

4. Systems and methods that remove the need for workers on tracks to undertake work.

5. Infrastructure systems and devices that automatically prevent trains from entering a work-site.

The five groups suggested additional track worker safety options that had not already been captured. The groups then each worked through one of the five typologies ranking each of the options and noting some of the strengths and weaknesses for each.

Typology 1 - Vehicle installed devices that give warnings to train crew

This typology had seven options identified, all of which were ranked. The highest-ranked option was "Maintenance vehicle-mounted alert systems". This option had the advantage of an induction system when a train approaches. The issues with this option included a reliance on human skill, not trusted to operate in isolation and requirements for specialist skills in set-up to allow for correct distances.

The option ranked second was "Train mounted alert systems". This option was described as working well for congested construction sites. Its main disadvantages were that it does not specify exactly where a track worker is, they should not be used in isolation and it needs to be self-checking.

The third highest ranked option was "Toolbox Spotter". This option had the key benefit that it is easily fixed but cannot work with longer distance sensing.

The complete rankings for the options in typology 1 as well as their strengths and weaknesses can be found in figure 2.

Rank	Option	Description	Strengths	Weaknesses
1	Maintenance Vehicle Mounted Alert Systems	A device mounted to rail maintenance or heavy machinery vehicles. Used to inform operators of proximity to other machines and sensors.	- Induction system when train approaches	- Human skill reliance - Often fail so not trusted to operate in degraded mode - Requires set up at right distances, specialist skills - Not used in isolation - Needs to be self-checking - defence in depth
2	Train Mounted Alert Systems	A device mounted to a train that will emit a signal when in close proximity to a track worker. Warning the train operator.	- work on congested construction sites quite well	- No info about the workgroup - Needs to be self-checking - defence in depth - Not used in isolation - Doesn't tell you where the track worker is- just that they are there somewhere
3	Toolbox spotter	NA	- Can be fixed	- Only work at short distances
4	Road infrastructure linked warning systems	NA	NA	NA
5	Machine vision on train	Machine vision on train to recognize persons on track and alert driver.	- Might be a future solution - computing power too large	- Technology is not yet suitable. Trains are travelling too fast - can only predict 100m away
6	Lidar Technology on vehicle	Noted that this technology is advancing in cars	- might be a future solution - computing power too large	- Technology is not yet suitable. Trains are travelling too fast - can only predict 100m away
7	Radar technology		- Might be a future solution - computing power too large	- Technology is not yet suitable. Trains are travelling too fast - can only predict 100m away

Figure 2 - Typology 1 option rankings, strengths and weaknesses

Typology 2 - Worksite installed devices that give warnings to track workers

This typology had ten options identified, all of which were ranked. Three of these options shared the top rank which included; “Automatic Train Warning Systems (ATWS)”, “ETCS” and “Smart Wearables”.

The ATWS option had the advantages of fail to safe systems as well as sensors that were highly reliable. The only disadvantages were that these systems can be complex and expensive.

The ETCS system is a new option with track access capability. Its newness to the market is its main disadvantage.

Smart Wearables had no clear advantages, however it was noted that this option is usually only suitable for minor tasks.

The option ranked next highest was “Track worker smart device applications”. The advantages for this option were that they can be affordable and readily available with how common smart devices such as tablets are. Their disadvantages include that they are reliant on communications and can have more information to interpret that not all users may understand.

The complete rankings for the options in typology 2 as well as their strengths and weaknesses can be found in figure 3.

Rank	Option	Description	Strengths	Weaknesses
1 (1)	Automatic Train Warning Systems (ATWS)	These systems use train detection sensors that, when triggered, will signal to track workers through alarms and flashing lights.	- Fail to safe systems - Reliability of sensors	- Complex and Expensive
1 (2)	ETCS	level 2 system with track access capability - Zoelner	NA	- New system
1 (3)	Smart Wearables	Wearables such as vests that respond to approaching hazards when worn by track side workers.	NA	- Usually only suitable for minor tasks
2 (4)	Track worker smart device applications	Applications used by track workers that can assist in determining the safety of the work site they are entering.	- Affordable, low cost (as app/software) - Readily available – tablets	- Reliant on comms - More info to interpret (user knowledge/understanding)
3 (5)	Laser based sensors on site / wayside at worksite detection limits	NA	- Only requires locally installed equipment - Reliability	- Local work area only
4 (6)	Sensor that tracks based on train GPS transmits to device on work site	NA	- Near real time train approaching information	- GPS is not accurate - Depends on remote communications - Less resolution
5 (7)	Track shorting devices	NA	NA	NA
6 (8)	Live Adjacent track warning systems	NA	- Kiwi Rail Example	NA
7 (9)	Rail transmitted noise sensor system	NA	NA	NA
8 (10)	Detonators	NA	- Loud - Cheap	- Handling and training - Require layer of protection to apply

Figure 3 - Typology 2 option rankings, strengths and weaknesses

Typology 3 - Sensors and devices that give targeted alerts to both train crew and track workers.

This typology had five options identified, all of which were ranked. The top-ranked option was “Blindsight Device”. This option has the advantage of being adaptable to all environments including tunnels and restrictive spaces. Its disadvantages were that it can’t be used on trains and there is limited awareness of this system due to how new it is.

The second-highest ranked option was “Worker sign in/out systems”. This option has the key advantage of recording if workers are in a specific area but has the drawback of being subject to human error.

The third-highest ranked option is the HALO system. This option similarly relies on human intervention and for the device to be actively used by workers.

The complete rankings for the options in typology 3 as well as their strengths and weaknesses can be found in figure 4.

Rank	Option	Description	Strengths	Weaknesses
1	Blindsight device	AI system that provides warning to operators and workers when in close proximity. Distance can be pre-set Updated version replacing toolbox spotter. Not yet suitable for rolling stock at line speed. Suitable for track machines.	- Adaptable to all environments - tunnels or restricted spaces - Plant-infrastructure or plant-public interactions	- Can't be used on trains - Acceptance to cover risk of people-plant interactions - Limited awareness of system
2	Worker Sign in/out Systems	Track workers sign in/out of track areas with systems such as a swipe card terminal. These systems will signal to vehicle operators when travelling near or through work sites.	- Record or workers in an area	- Subject to human error
3	HALO system	NA	NA	- Relies on workers to use the device
4	smart wearables - active	NA	NA	- Relies on workers to use the device
5	Personal Alert Devices	Devices carried by track workers that inform of approaching trains. Simultaneously these devices warn vehicle operators of the track workers position.	NA	- Relies on workers to use the device

Figure 4 - Typology 3 option rankings, strengths and weaknesses

Typology 4 - Systems and methods that remove the need for workers on tracks to undertake work.

This typology had ten options identified, seven of which were ranked. The highest-ranked option was “Relocate equipment out of danger zone”. The key advantage of this option is that it is an elimination control that can potentially remove all risk of danger. The main disadvantage, however, is that it can be costly to relocate equipment from already operating rail infrastructure.

The second-highest ranked option was “Remote overhead Isolation”. The advantages of this option included that it is a fail-safe solution, it can be interlocked with the issue and cancellation of access permits and it also minimises the need for driving between switching locations. This option had no clear weaknesses.

The third highest ranked option was “Segregation of work from the danger zone”. The advantage for this option is that it can be set once and the barrier will always be in place. The main drawbacks can be a high cost for installation and it may not always be entirely preventative.

The complete rankings for the options in typology 4 as well as their strengths and weaknesses can be found in figure 5.

Rank	Option	Description	Strengths	Weaknesses
1	Relocate equipment out of danger zone	Reducing exposure of workers to strikes from moving rail vehicles by relocating equipment away from the danger zone.	- "Eliminate" type control	- Cost of relocation
2	Remote Overhead Isolation	NA	- Fail Safe - Can be interlocked with issue and cancellation of access permits. - Also minimizes the need for driving between switching locations	NA
3	Segregate work from danger zone	Segregating the associated places where persons must work from the danger zone by means such as a handrail.	- Set and forget -once approved barrier is in place	- Cost of installation - May not be entirely preventative
4	Worker Vehicles	Putting workers in vehicles on track rather than people walking on track. For example, mechanised track patrol vehicles.	- Faster to get to worksite. - Better working conditions.	NA
5	Vehicle mounted and Unmanned Rail Imaging Systems	The use of robotics and machine vision to perform rail line inspection and maintenance to remove the need for workers on tracks.	- Elimination of risk	NA
5 (6)	Unmanned Aerial Systems	The use of UAV or Drone technology to conduct track worker operations on live lines while removing the need for a human worker to be present.	- Elimination of risk	NA
6 (7)	Integrated planning upfront - dedicated maintenance windows	Better planning and consolidating any works together. Also, more predictive maintenance to reduce reactive maintenance.	- Reduce length of time in danger zone - Reduce number of times track work needs to be done	- Difficult to coordinate different groups - Uncertainty of Cost - Trust in predictive models
NA (8)	Fall arrest protection systems	Barriers and other solutions that prevent workers falling into an area of danger as well as protection from harm caused by the fall.	NA	NA
NA (9)	Buffer Stops	Buffer stops within 500m of the limits of protection	NA	NA
NA (10)	Permit to proceed	Procedure for indicating why you haven't adopted measures high up in the hierarchy of safe-working controls	NA	NA

Figure 5 - Typology 4 option rankings, strengths and weaknesses

Typology 5 - Infrastructure systems and devices that automatically prevent trains from entering a work-site.

This typology had eight options identified, six of which were ranked. The highest-ranked option was "Train protection warning systems". The advantage of this option is that it is completely automatic and has been widely proven to be effective in Europe. Its only drawback, which applies to all of the proposed options, is that they are reliant on a level of human compliance and intervention.

The second-highest ranked option was "Absolute signal blocking". This option needs the track to be clipped.

The two options ranked equally third-highest were "Worksite protection keys" and "Geo-fencing". Worksite protection keys need to provide a multi-layered interlocking system. Geo-fencing systems, similarly to other options, relies on a level of compliance and human intervention.

The complete rankings for the options in typology 5 as well as their strengths and weaknesses can be found in figure 6.

Rank	Option	Description	Strengths	Weaknesses
1	Train Protection Warning System	Train Protection Warning Systems will stop a train by initiating a brake demand where the equipment is fitted. This may be triggered by passing a signal without authority or approaching a signal or danger too quickly.	- Completely automatic - network dependant - Proven technology in European	- All of these rely on a level of human compliance and intervention
2	Absolute Signal Blocking	Absolute Signal Blocking excludes rail vehicles from entering a portion of track for a specified period of time.	- Track needs to be clipped	- All of these rely on a level of human compliance and intervention
3 (3)	Worksite Protection Keys	A Worksite Protection Key involves a key switch mounted on an automatic signal. When the key is withdrawn the signal is forced to display a stop aspect and a noticeboard is displayed informing train drivers that the signal must not be passed.	- Need to provide multi-layered interlocking	- All of these rely on a level of human compliance and intervention
3 (4)	Geo- fencing shock collar	Geo Fencing, keeping workers out of the zone - that provides feedback when zone is breached	NA	- All of these rely on a level of human compliance and intervention
4 (5)	Protection by train on track	NA	- Very basic, but effective	- Still impacts train operations and schedules - All of these rely on a level of human compliance and intervention
5 (6)	Authority Based Systems	These systems provide workers Occupancy Authority on the track section they are working within. This would mean that trains are completely restricted from entering the worksite.	NA	- Dependant on compliance - All of these rely on a level of human compliance and intervention
NA (7)	Electronic Train Stops	Speed signalling systems to prevent trains from entering work site - electronic train stops. ETWS linked	NA	NA
NA (8)	TC blocking	TC blocking or track Devices that will prevent ATP equipped trains from entering Track Worker area	NA	NA

Figure 6 - Typology 5 option rankings, strengths and weaknesses

Activity 3

Challenges for Adoption

In the third activity, the workshop participants collectively discussed the challenges of adopting track worker safety systems. The participants suggested nearly forty unique challenges for adopting track worker safety systems.

The participants then had three votes to allocate to the challenges they believed were most difficult to overcome. From the voting, we identified the top five challenges.

The participants then discussed the top three of these challenges and proposed potential ways to overcome them.

The top challenge, with seven votes, was “Resistance to change and organisational change”. Discussion of this challenge focused on taking a people-centred approach to implementation and using focus groups with track workers to gain their input and support for new options early in the process. Allowing track workers to own the changes that are made was suggested as a way to overcome resistance to change and understand what is liked and not liked. Trialling solutions and backing these up with data and evidence of success are other ways to push back against potential resistance.

The other equally highest-ranked challenge, also receiving seven votes, was “Integration with old signalling system”. The discussion for this challenge focused on looking at equivalent functionality for new track worker safety options and simulating the use of other systems for a smoother transition.

The next highest-ranked response, receiving four votes, was “People needing to know what was available to manage the risk to track workers”. Discussion on this challenge focused on having a centralised strategy and consistency in communication of success and failure of track worker safety practice. Sharing resources widely and web-based platforms for sharing were also raised as possible solutions.

The remaining challenges that were ranked can be found in figure 7.

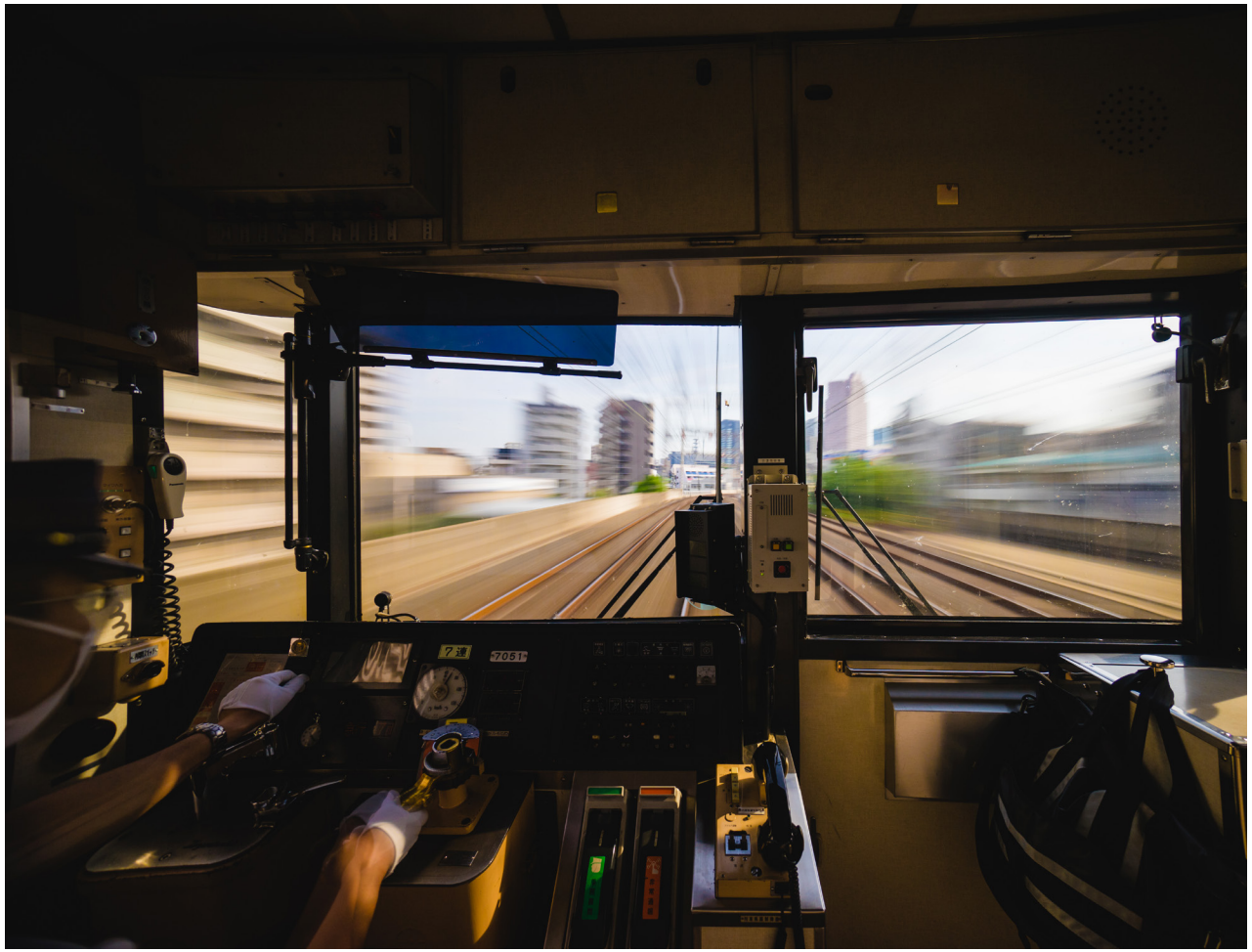
Rank	Votes	Challenge	Challenge discussion and solutions
1 (1)	7	Resistance to change + organisational change	- Change conversation from 'Are we going to do this', to how will we do this' - Engineers good at hard change not soft - People centered implementation - feedback from stakeholders - Ability to try before implementation - Consideration of Organisational Culture - Data/evidence to demonstrate benefits - Need to understand what people don't like – details - Focus groups - what will work for front line - Stakeholder consultation very early in process - Helping the workers to own the change - Identify and then get the influencers on board - Bring people on the journey
1 (2)	7	Integration with old Signalling System	- Equivalent functionality - to simulate "other" systems - Make a worksite look like a train
2 (3)	4	People need to know what is available to manage which risk to trackworkers	- Work like this - and sharing widely - Consistent / unity of messaging - Cobranded centralised strategy - Web based platform to share new tech - If a tested method can be utilised, it may help with issue 1. - Share learnings (including failures) - Admitting to other our problems and challenges
3 (4)	3	Training & Competency	NA
3 (5)	3	Safe Working Rule Changes	NA
3 (6)	3	Significant cost barrier for implementation	NA

Figure 7 - Activity 3 challenge rankings, discussions and solutions

Next Steps

The findings from this workshop will be used to develop the final project report and options table. This final report will integrate the findings from this workshop as well as the literature review and engagement surveys that have previously been conducted by Arup Foresight and Innovation.

The final report will explore the identified track worker safety technologies and systems. The report will additionally include potential product options and suppliers.



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Brett King - Downer Group
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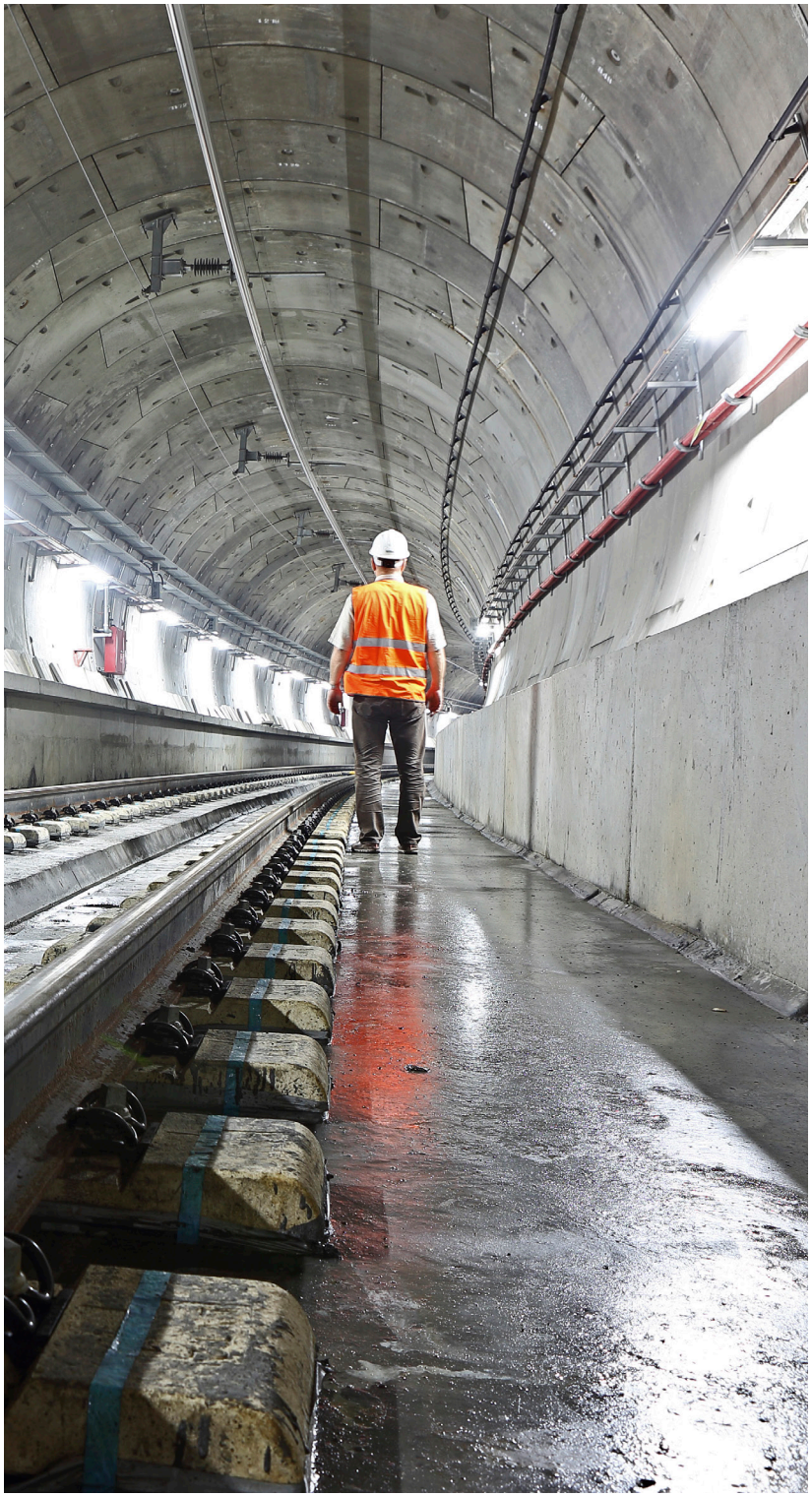

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