

## To SPAD or not to SPAD: that is the question...

By Anjum Naweed

The rail industry harbours a very strange and powerful acronym - the 'SPAD': to the general public, it is a front-page newspaper headline that strikes the imagination and conjures up doubts over railway safety; to the knowing passenger, it is an event to file away to the back of the mind in order to make room for more pressing day-to-day concerns; to the General Manager, it is long hours spent deliberating over their rail network, entertaining hope but bracing for inevitability; and to the train driver, it is an emotional response beyond words. All this in a four-letter acronym that means a signal has been passed at danger.

The reputation is well deserved. A SPAD is the single biggest failure mode possible in the railway. It straddles the fine line between accident and disaster, and there's almost a sense that one should not say the acronym out loud, lest fate be tempted. The rail industry is emblazoned with it – stickers on the driver-cab dash or posters on the mess-hall notice board, such that it has taken on a life of its own, and firmly rooted itself into the organisational mind. Technically, the SPAD failure mode simply describes the event of a train or locomotive encroaching into a section of unauthorised track. In practice however, this can be with or without the drivers' knowledge and through an error of omission or commission, which gives rise to a plethora of human factors issues. Let's think through some of these for a moment.

Say that a train driver is distracted by a pedestrian at a crossing, delays braking and passes a stop signal; in this example, they would apply the brake later than intended, and in doing so, perform an error of omission. On the other hand, say that a loco driver goes unwittingly through a red signal when departing a yard; that would be an error of commission. Some SPADs are more ambiguous; say that a driver is approaching a stop signal, brakes by the book, but then suddenly encounters a soiree of fearless millipedes dancing on the railhead – they apply the brake as best they can, but ultimately, don't regain control and slide straight past the stop signal. What kind of error is that? Does it fit in the human factors category or the technical one? Tricky. By far the worst kind of SPADs are those where the driver sails straight past a stop signal having mistaken it for a proceed aspect. Of course, this is a simplistic way of looking at what is a very complex failure mode, but the essence is there - for one reason or another the signal and the driver have become disconnected.

Nowadays, safety technology has been woven into the fabric of the railway to help mitigate SPAD risk. Most rail networks in Australia use mechanical trip-arm devices, which work to stop a train if it passes a danger signal. Then there are the more intricate systems, which communicate with devices aboard the train to stop it automatically, but by and large, these methods serve only to dampen the effect of a SPAD - they arrest the speed of the train once the SPAD is performed, therefore do not address the cause itself. Thus, rail networks also use systems to mitigate risk at the driver-processing level. Some of these are set/reset devices that force the driver to acknowledge cautionary zones, while others supervise train movement and prompt remedial braking for excessive speeds.

Most of these initiatives have been adopted in rail networks across Australia, albeit in a piece-meal fashion. Some clearly attempt to address the latent human factors issues born from operating in a heightened and sustained state of attention for so long (e.g., situation awareness, distraction, physical and mental fatigue), either from the high-event rate and

infrastructure density, or conversely, the monotony and lack of changing information. The problem is that whilst forced-response systems may work to mitigate an element of risk, they can also exploit other human factors issues, such as automaticity and habituation.

To SPAD or not to SPAD: that is indeed the question. Is it nobler to rely on technology and still find yourself suffering the slings and arrows of a SPAD, or should we take arms against the danger signal, and by stopping in front of it in good time, end them? The topic of SPADs has been the subject of much research (and contention). We know to a certain extent that the signal-driver disconnect arises from issues associated with signal sighting, poor driving conditions and inattention, but less clear are the SPADs that result from signals being misread, misjudged, and from the driver getting distracted by their own 'head-space.' We know that a whole host of human factors play a part, but what we don't know much about is how drivers cope and condition themselves to mitigate the problem at an individual level. To help answer these questions, the CRC for Rail Innovation has commenced a SPAD Risk Mitigation project that aims to go beyond the confines of existing safety systems in order to learn more about the strategies that drivers adopt to manage and mitigate SPAD risk, and generally govern driving behaviour.

The project intends to take a qualitative approach, which means we're talking directly to train drivers in both passenger and heavy haul operations - those strapped into training nappies as well as the experts. The hope is we might learn a little more about the way that drivers traverse SPAD risk in different operations, and the way this interacts with expertise. The first phase of the project hopes to achieve this by engaging drivers in focus groups. We'll ask them about their experiences, use generative tools (a posh way of saying that drivers get to draw with felt-tip pens) to examine different types of SPAD scenarios, and identify what strategies they're adopting to mitigate the risk. We aim to conduct at least one focus group in a wide range of organisations to garner full industry representation until the data reaches saturation.

A similar process has received an excellent response from train drivers participating in other projects with the CRC for Rail Innovation, such as Capturing Driving Strategies and Route Knowledge Acquisition. These projects form part of the simulator project suite in the CRC's Safety and Security Theme and aim to derive a better understanding of the dynamics of route knowledge and driving strategy, so that this information may be captured and delivered more effectively. Clearly, a focus group incorporating generative tools that reveal how routes are encoded, may elicit data that go some way to illustrating how train drivers perceive different categories of SPAD, how they internalise distraction and make sense of the SPAD causal pathway, and more importantly, how they manage strategies to mitigate a SPAD from ever occurring.

We've decided to think outside the box a little too and compliment the focus groups with a second phase of data collection that includes a 'Future Inquiry Workshop.' This is best coined as a branch of participative ergonomics, but think of it like a structured daylong think-tank that uses mind maps and other dynamic methods to enrich the dataset, but also provides some pragmatic outcomes for participating organisations. We intend to rustle up a good cross-representation of the key stakeholders groups and experts that interface with the SPAD failure mode or have some part to play in its technical make-up. Important individuals include train drivers, signallers, controllers, supervisors, engineers, ops managers, regulators, union reps and so on. Sounds like a recipe for a lively gladiatorial debate doesn't it. You see, the process explores the past, the present, and the future of the problem, and in doing so, moves the group in and out of different time periods, working to

both stimulate and simulate different perspectives, and ultimately, speaks a universal language that cultivates astonishing harmony. The Future Inquiry Workshop has been run in a number of organisations participating on other Rail CRC projects, such as Keeping Rail On Track, again with excellent response.

So why are we excited about this project? Well first off, most passenger groups in Australia and New Zealand have already signed up. So far these include V/Line, RailCorp, The Department of Planning, Transport & Infrastructure-SA, Public Transport Authority-WA, Queensland Rail, Metro Trains Melbourne, KiwiRail, Veolia Transport Auckland, and Rio Tinto, which gives us an excellent representation of the Australian rail industry. Second, Australia's own Rail Industry Safety and Standards Board is also involved, and there's some very real potential to use the outcomes of this project to embark on the road towards a national standard for SPAD-risk mitigation and management.

We've almost finished the focus groups, which have been received very well. Train drivers are seemingly learning just as much about each other's roles and experiences as we are about their knowledge and expertise. The data have provided some compelling insights into the relationships that drivers share with signals, and we've started to understand more about the sort of SPADs that organisations are concerned about, given the design of individual rail networks and the type of safety systems on their lines. Unsurprisingly, reliance on route knowledge keeps cropping up, which shows how important this information is to the driver for mitigating risk, and how constant risk evaluation seems to be an important subset of driving activity. Lastly, the drivers' workload, and how this plays on their perception of job pressure, and by extension, their driving behaviour, is likely to be an important theme. We're on the cusp of some very exciting research, which should vastly enhance safety on the Australian rail network, and also go some way towards improving train driver welfare. After all, where would we be without them?

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