Germany train crash—ways in which rail safety systems can fail

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The great train wreck of 1918 in Nashville, Tennessee, that resulted in 101 lives lost. Credit: The Tennessean/Kaldari

Whenever we hear of an accident such as the head on train collision that occurred in Bavaria on Tuesday our first thoughts must be with the victims who were killed or injured, and their friends and families. But as with all accidents an investigation is now underway, which should bring

answers to how such a tragedy can happen.

In recent decades, there has been significant investment in safety systems to prevent incidents occurring, or to mitigate their impact. These include: developing new materials and structures to strengthen rail carriages to make sure that in the case of a crash, the damage is limited; Automatic Train Protection (ATP), which asks drivers to acknowledge that they have seen an oncoming red signal, and automatically applies brakes if a signal has been passed at danger; and physical interlocking which prevents signals allowing two trains to occupy the same section of track, and which maintains distance between them.

The basic principle of signalling which is used in most parts of Europe at present is the "fixed block" system, where trains are kept a number of blocks apart. A signaller will set a route, and the engineering within the rail system will ensure that the signals display the correct instructions to the train driver. So if a route is set for a train, a signal will display as green; once the train has passed that signal, it will revert to red, the next signal behind will be amber, and the one behind that, double amber.

This fixed block system is gradually being replaced in parts by the European Rail Traffic Management System, which operates on a moving block principle, but the idea is still that engineering and technology will maintain a safe distance between trains. In the case of the Bavaria rail crash, it is not yet completely clear exactly which type of technology was implemented on the stretch of track where the accident occurred. The incident occurred on a single track part of the line, which would normally operate using a "token block" system which only allows one train on a particular section of track.

Search for a cause

Modern railways are well-engineered systems that allows many of the

previously human tasks involved in train driving to be supported, or in some cases replaced by technology. Train drivers are expected to be familiar with routes, to enable them to anticipate the performance of the train at particular points in the journey, and apply the brake and throttle at points that deliver the most fuel efficient and comfortable journey.

Reports suggest that the trains in the Bavaria crash not only had ATP technology, but also had technologies which help drivers to manage the speed of the train. It is these systems that some have jumped on in the search for a cause – but which we will have to wait for the investigation to reveal.

However, an "irony of automation", as noted by Lisanne Bainbridge in 1983, is that if we introduce a large amount of technology into a previously manual system, the nature of the work task changes, and there is a danger that drivers can becomes less able to intervene and to problem solve quickly when incidents occur.

We are still in the early days of investigation of the Bavaria incident. But in many cases, after major accidents, the cause of incidents are often reported as "human error". In the case of the Bavaria crash this possibility will certainly form a part of the investigation.

With the exception of deliberate sabotage or acts of aggression such as terrorism, post-incident analyses often highlight not only the human actions that may have contributed to an accident, but also the factors surrounding that human behaviour. As someone who studies human factors, I am interested not only in which actions occurred, but also why and how they could be prevented or mitigated in the future. The factors that cause an incorrect action might be whether a person was distracted or stressed for example. We should also ask whether routine behaviours were practised that were strictly speaking against the rules but were culturally accepted as the standard way to complete a task – perhaps to

ensure that a system is efficient, or to overcome limitations in a system's design. And most importantly, how can we ensure that complete systems, where people and technology work together, are designed in a way that minimises the likelihood of incidents occurring? Working out if any of these questions apply in the German case will take some time.

Human intervention

One of the things that I say when I'm teaching ergonomics, which aims to understand the interactions of humans and systems, is that "humans are fallible, but humans are also brilliant". Humans do get tired and distracted, or make mistakes when they are trying to solve complex problems, and engineers and scientists have made great advances in developing and deploying technologies that do many tasks to a much greater level of performance than humans could ever achieve. But humans are also able to come up with new, innovative solutions to problems quickly and effectively, and a well-designed complex system will take advantage of this knowledge-based behaviour – supporting basic, repetitive tasks with technology, but allowing humans to problem solve.

Sadly, the two drivers of the trains in the Bavaria incident were among those killed. It is likely that the investigations into the crash will be lengthy and detailed. Whatever the cause of this particular incident, it is important to remember that all rail systems are complex, and involve collaboration between humans and technology, whether those humans are active operators, monitors, maintainers or even designers of the system elements. Very rarely are accidents solely caused by a single instance of "human error" but instead are a complex combination of multiple factors and influences.

And for each accident, there are likely to be many occasions when effective human intervention has prevented an incident occurring or

lessened its impact – our jobs as engineers and human factors professionals is to ensure that we take advantage of the brilliance of humans and technologies working together.

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