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The Role of Human Factors in Transport Accident Investigation

Mark S. Young

Transportation Research Group, University of Southampton, U.K.

ABSTRACT

In the immediate aftermath of major transport accidents, there are often calls for blame and accusations of 'human error'. From the perspective of human factors and ergonomics (HF/E), though, any such errors are the starting point – not the conclusion – of a safety investigation into the deeper, sociotechnical system factors that created the context for the accident to occur. This paper aims to challenge both investigators and HF/E practitioners regarding both the integration and boundaries of HF/E in transport accident investigations. The systems model aligns with the approaches taken by the major transport accident investigation bodies around the world. But there remain barriers in integrating HF/E within investigations, not least around the validity and usability of causal analysis methods. Similarly, although techniques for interviewing witnesses are well served in the literature, there is a gap in the HF/E knowledge base concerning guidance for collecting and analysing evidence relating to human factors in a safety investigation, due to the variable nature of human performance. Such variability can also be at the heart of many positive outcomes aside from accidents and incidents which, whilst seemingly contrary to the very approach of investigating accidents, can also be integrated into a safety investigation. This paper concludes by considering how the HF/E perspective applies to the ultimate output of safety investigations in the form of recommendations.

Keywords: Accident investigation, Human error, Human performance, Methods, Safety, Transport

THE ROLE OF ACCIDENT INVESTIGATION

Shortly before midnight on 28 February 2023, a passenger train carrying over 350 people from Athens to Thessaloniki, Greece, collided head-on with a freight train after being signalled onto the same track. The accident killed 57 people and has become the worst rail disaster in Greek history.

In the immediate aftermath, news media around the world[1] reported that the Greek prime minister declared the cause to be 'tragic human error', while the Greek transport minister resigned his post. Several members of railway staff faced criminal charges amid public protests and calls for justice.

This kind of reaction is not uncommon following a major incident, as those who have been directly affected understandably seek answers. But, as proponents of human factors and ergonomics (HF/E) have known for decades (see

[1] e.g., https://www.bbc.co.uk/news/world-europe-64817894

e.g., Reason, 1990), labels of ‘human error’ and blaming those on the front line do little to help us learn from these tragic accidents. Such thinking represents the ‘old view’, in which rogue operators are either re-trained or blamed out of the system (cf. Dekker, 2006). When it comes to preventing recurrence, we need to move beyond the so-called ‘error’, seeing it as the consequence, rather than the cause. Human actions and decisions take place in the context of a complex sociotechnical system; those actions should therefore be the starting point for an investigation into that system.

Even in situations that, at first glance, appear to be the direct result of individual behaviours, there are always systemic underlying factors. A near miss involving a group of track workers in north-west England on 22 September 2014 was, on the face of it, caused by a lookout who did not provide a warning of the oncoming train to the group. However, the investigation (RAIB, 2015) revealed fundamental issues associated with the task and equipment design that influenced the lookout’s performance; these factors were the focus of actions and recommendations following the incident, not the performance of the individual lookout.

A safety investigation, then, is distinct from a judicial or regulatory investigation, in that it seeks to learn from what has happened without considering blame or liability. Around the world, there are numerous organisations dedicated to such investigations in transport, such as the National Transportation Safety Board in the US, the UK’s Air, Marine and Rail Accident Investigation Branches (AAIB / MAIB / RAIB), and the Australian Transport Safety Bureau (ATSB). With comparatively high levels of time and resource available, these bodies leave no stone unturned in examining all of the factors leading up to the accident, from front-line actions, through local management, procedures and training, to organisational culture and the regulatory context. In doing so, recommendations can be targeted at these upstream factors, thereby having a much wider impact across the system than training and blaming an individual.

Practitioners in HF/E will recognise these levels of analysis as reflecting the levels of a sociotechnical system exemplified in models such as Rasmussen’s (1997) risk management framework. As such, HF/E is naturally embedded in these large-scale safety investigations. However, the extent to which HF/E is formally and explicitly integrated can vary. We might therefore ask whether, why and how HF/E should be integrated into safety investigations. In the following sections, this paper considers good practice for adopting HF/E in investigations from both sides of the fence (i.e., investigator and HF/E practitioner). It sets out two key areas of challenge: the validity of HF/E methods for investigations, and the nature of HF/E evidence in investigations. Finally, the paper concludes with a discussion around the nascent ‘Safety-II’ perspective on safety management (Hollnagel, 2014) and how this relates to accident investigation.

THE ROLE OF HUMAN FACTORS

The UK’s Chartered Institute of Ergonomics and Human Factors (CIEHF) has published a white paper on ‘learning from adverse events’ (CIEHF, 2020) – or, essentially, integrating HF/E into safety investigations. The motivation for the white paper was founded in moving investigators away from blaming individuals, in overcoming hindsight bias, and in advocating systems thinking in the investigation. It could be argued, though, that these principles reflect wider good practice in investigation, rather than being specifically about HF/E.

Meanwhile, investigators seeking HF/E input to an investigation might revert to a focus on individual human performance, or what Shorrock (2017) referred to as 'factors of humans' rather than human factors. Examples of such thinking can be found in investigations of level crossing incidents involving signaller decision making (RAIB, 2017a; 2017b), in which parallels were drawn between human reliability and engineering reliability. Whilst such approaches are valid and, indeed, represent a relatively long-standing effort in the HF/E community to quantify human error probabilities (e.g., Gibson et al., 2013), they do also rather overlook the systems view that we are striving for. What is needed, then, is a way of formally integrating HF/E within the investigation process.

There is a surfeit of methods in the HF/E literature (see e.g., Salmon et al., 2011) aimed at structuring the causal analysis of an investigation around the sociotechnical systems perspective. Methods such as the Accimap (Svedung and Rasmussen, 2002), FRAM (Hollnagel, 2012) and SAFRAN (Accou and Carpinelli, 2022) are directly informed by HF/E thinking. However, anecdotal evidence suggests that, with few exceptions (e.g., RAIB, 2020a), it has proved difficult to make headway in embedding these methods within accident investigations. Instead, investigators prefer to rely on a limited number of familiar methods for their analyses, such as fault trees (Kirwan and Ainsworth, 1992) or STEP (Hendrick and Benner, 1987). At the time of writing, we are carrying out research to understand the facilitators and barriers to the use of these methods among accident investigators.

Moreover, question marks remain over the validity of these methods – and, indeed, what we mean by validity in this context. Various studies have demonstrated the application of, for instance, Accimaps retrospectively to an existing investigation (e.g., Salmon et al., 2013), but this is often self-fulfilling, being based on the original investigation report. The true test for a causal analysis method is actually during the investigation itself. That is, does the use of a given method steer the investigation towards 'better' evidence or findings (again, we need to understand what we mean by 'better'; ultimately, it is about making recommendations to prevent recurrence).

So, evidence is (self-evidently) key to an investigation, but here lies an area where HF/E methods are lacking: there is little to guide the investigator 'in the rubble' (cf. Dekker, 2006) about collecting evidence relating to HF/E. It is worth considering this in a little more focus.

THE SEARCH FOR EVIDENCE

Accident investigators are well-trained in collecting evidence at the scene of an accident in its immediate aftermath. Physical evidence, photographic evidence, documentary evidence etc. are all relatively clearly defined for the on-site investigator. But what about evidence relating to human factors?

What are the perishable or vulnerable aspects that must be collected to ensure the later investigation and analysis phases are properly supported?

These questions are less clear-cut and, in the absence of a structured methodology, are largely down to the experience or 'mindset' of the investigator to determine. For instance, an accident that occurred in the early hours of the morning might point towards fatigue being a factor, so it would be important to collect evidence relating to the shift and sleep patterns of those involved (see e.g., Basacik et al., 2023). Similarly, in a case where visual perception may be a key factor, a record of the environmental conditions and context of the stimuli concerned would be essential, before those conditions drastically changed. But it behoves the investigator to be aware of the potential factors and to know what relevant evidence to collect, in amongst their other duties on site. In all likelihood, part of the reason that there is no such method is that it is difficult to create deterministic guidance for any potential circumstance. An alternative approach, favoured by some organisations, is to provide foundation training in HF/E so that investigators are better able to identify potential human factors lines of inquiry and collect the relevant evidence accordingly. However, it is worth adopting a note of caution with this, since misapplied human factors may be more of a hindrance than none at all; it is all too easy to apply a label such as 'loss of situation awareness', but that does not necessarily offer an explanation (cf. Dekker, 2006; Miranda, 2019).

Although there are some categories of 'objective' HF/E evidence (such as those alluded to above), in reality much of what pertains to the people involved will be collected from those people; that is, through witness interviews. Witness evidence can be considered as vulnerable evidence, in that memory may be subject to alteration or decay with the passage of time. It is therefore paramount that an early account is taken from key witnesses, and preferably this is the first account, before the memories have a chance to be overwritten by recounting them (bearing in mind that other agencies, such as the police or regulatory bodies, will also have an interest in interviewing the same witnesses). Accident witnesses might also be traumatised by their involvement, so must be treated with appropriate care and compassion – not just for their own welfare, but also to increase the chances of obtaining best evidence (which, of course, is the ultimate goal of the interview).

Research in cognitive psychology has, over several years, developed and refined the cognitive interview method for this very purpose (see e.g., Memon et al., 2010). The cognitive interview involves several phases, the first – and, arguably, most important – of which is establishing a rapport with the witness. In a safety investigation, this needs to emphasise that there is no search for blame or liability in the process, in order to gain the trust of the witness. The cognitive interview then moves on to use different techniques to try and optimise the recall of the witness. However, the method has been tried and tested primarily in forensic interviewing; whilst it is certainly used in safety investigations, there has been little evaluation of its efficacy for this purpose. Whilst there is no particular reason to doubt its application in this context, research in this area would serve both to provide confidence as well as potentially beneficial adaptations to the method.

Regardless of the source of evidence, investigators have to contend with the challenge that most HF/E evidence is by no means definitive (CIEHF, 2020). In contrast to, say, a fracture surface on a component, or recorded data from a 'black box', evidence pertaining to the human factors is always going to carry a level of uncertainty, due to the inherently variable nature of human performance. To some extent, this is a facet of the well-known research-practice gap in HF/E (Chung et al., 2017), since there will inevitably be some extrapolation when interpreting research data in the context of a specific investigation (it would be a rare find if a paper directly addressed the problem at hand). Consequently, there will be some subjectivity in interpretation and analysis of this evidence which, while perhaps discomfiting for the investigator, only emphasises the importance of rigorous and valid methods for the causal analysis phase.

CONCLUSION AND RECOMMENDATIONS

On the subject of performance variability, some have challenged the very nature of accident investigations in the light of momentum surrounding the 'safety-II' movement for safety management (Hollnagel, 2014). In contrast to safety-I, which investigates what has gone wrong in an accident, safety-II is popularly taken to be about examining what goes right on a day-to-day basis in the context of normal work, and is therefore seen as anathema to accident investigation. The argument in support of this, which is rational and logical, is that the sample size of positive events is far greater than the comparatively rare accidents and incidents. Furthermore, understanding 'work-as-done' can help us to learn how the adaptive behaviours of those on the front-line contribute to overall system resilience; this is where the variability in human performance comes to the fore. Processes and procedures only take an organisation so far, since it is impossible to anticipate (in the 'work-as-imagined') every conceivable scenario when writing them. Mitigating against the safety-II approach is a simple matter of resources: investigating what goes right to the same extent and with the same rigour as a major accident investigation would require unfeasible amounts of time and personnel. Moreover, an accident investigation is, by definition, an analysis of something that has gone wrong, and there are myriad ethical, societal and technical imperatives to understand what exactly did go wrong.

There is, however, room for both approaches in an investigation, since they can readily be viewed as two ends of a continuum. Whilst the adaptive behaviours of front-line workers can indeed compensate for gaps in procedures, they might also lead to 'drift' in the system (cf. Dekker, 2006) which, under other circumstances, could prove to be maladaptive. An investigation which seeks to understand 'work-as-done' can therefore uncover systemic factors associated with procedures, monitoring or assurance underlying the incident (see e.g., RAIB, 2020b). Moreover, it is not outwith the scope of a safety investigation to identify positive lessons arising from the incident; a near miss that was avoided due to the actions of those involved can serve to highlight good practice (e.g., RAIB, 2023). Such learning is just as valuable as that arising from the identification of causal factors, so efforts should be made to extract positive lessons wherever possible.

Furthermore, the safety-II perspective does not necessarily imply that we should no longer investigate accidents and incidents. Indeed, there remain many legal, moral and societal imperatives to carry out safety investigations and learn from what has gone wrong.

To that end, we come full circle in this discussion, since effective safety learning depends on taking a sociotechnical systems perspective, in line with HF/E thinking. It is not enough to identify only the immediate cause, or to attribute that cause to an individual; we must dig deeper into the systemic factors that led the individuals involved to those decisions at that point in time (cf. Dekker, 2006).

Integrating HF/E throughout the investigation process equally applies to writing the report and recommendations. Many human factors labels (such as 'error' or 'violation') may be well understood by HF/E practitioners, but are loaded with judgement when read by those outside the discipline. There is no place for such judgement in a no-blame investigation; it is much better to remain neutral and simply write about the actions and decisions taken in factual terms.

Finally, the ultimate product of a safety investigation is its recommendations, for it is through these that any safety learning is effected. It is therefore important to understand what makes an effective recommendation and, without wanting to stray again into general good practice for investigations, the HF/E approach can offer some advice.

Whilst recommendations should of course be evidence-based and related to the incident under investigation, they should not – as with the causal analysis – be targeted at front line individuals, but should address upstream factors that propagate throughout the system. Nor is it necessarily appropriate to merely recommend new or improved procedures or warnings (which are effectively 'sticking plasters'), or automating the human out of the loop (for reasons expressed at length elsewhere in the HF/E literature; see e.g., Young and Stanton, 2023). Recommendations are our opportunity to justifiably apply the safety learning arising from an investigation – and, therefore, our opportunity to make a real difference by integrating HF/E principles into the system.

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