Contemporary Ergonomics and Human Factors 2020. Eds. Rebecca Charles and Dave Golightly. CIEHF.

Actor Map and AcciMap: Analysis of the Uber collision with a pedestrian in Arizona, USA

Neville A Stanton[1] & Paul M Salmon[2]

[1]University of Southampton, UK, [2]University of the Sunshine Coast, Australia

ABSTRACT

The aim of this paper is to explore the Actor Map and AcciMap methods as applied to the Uber collision with a pedestrian. These methods have been applied in a wide range of settings, but collisions between automated vehicles and a pedestrian is a new area. The Actor Map presents the major actors in the system that could have created the conditions within which the collision occurred. The AcciMap identifies the events, decisions and actions taken by those actors. This approach moves the foci of study away from the immediate events surrounding the driver and pedestrian, to consider broader system influences that were necessary for the collision to occur. The AcciMap is presented together with recommendations for systems-based interventions.

KEYWORDS

Sociotechnical systems, Actor Map, AcciMap

Case Study of the Uber Collision

The concept of 'distributed decision-making', whereby the decision-making process is distributed across geographically and temporarily separated people in a complex system, is explored in this paper. One important aspect of this research lies in understanding the nature of distributed decision-making so that maladaptive systems can be improved. This paper presents a case study based on the Uber vehicle collision with a pedestrian wheeling a bicycle, which occurred at approximately 21.58 on 18 March 2018 in Arizona, USA. Although the full report by NHTSA (the US National Highway Traffic Safety Administration) was not available at the time of this study, there was sufficient information available to undertake analysis with the methods selected for review (a short preliminary report was available: NTSB, 2018, although the full report is now online: NTSB, 2019).

The background to this collision began with Uber deciding to test its automated vehicles in Arizona after being denied testing in California (owing to the requirement for testing permits, a ruling which Uber disputed). The Arizona State governor made it known that he would allow testing to start without special vehicle permits – and the governor may have been swayed by potential investment opportunities associated with the development and manufacture of automated vehicles. Prior to the vehicle testing, Uber recruited and trained vehicle operators to work eight-hour shifts in its vehicles. The role of the vehicle operators was to observe the vehicle and to note events of interest on a central tablet. They were also supposed to monitor the environment for hazards and to regain control of the vehicle in the event of an emergency. In order for the testing to proceed, Uber disabled Volvo's Autonomous Emergency Braking (AEB) and City Safety system. These systems were removed in order to avoid an erratic ride in the vehicle, such as vehicle braking in the event that objects in the vehicles path were falsely detected. Following the collision of the Uber vehicle with the pedestrian, the testing programme was suspended. There was an ongoing investigation into the collision (NTSB, 2018) which is now concluded (NTSB, 2019). Analysis of the accident was undertaken using eight accident analysis methods in order to highlight the differences between the approaches (Stanton, 2019; Stanton et al, 2019). The AcciMap analysis (Rasmussen, 1997; Svedung and Rasmussen, 2002) was been chosen to be presented here because it offers the most comprehensive description of the collision and was found to be superior in comparisons of methods (Salmon et al, 2012; Salmon et al, 2017; Stanton et al, 2019).

AcciMap of the Uber Collision

The AcciMap process begins with an Actor Map to identify the main parties that are potentially involved in influencing the collision (unfortunately there is not enough room to display this in the paper). It is the contention of this paper, that the 'actors' across the levels of the system made decisions that enabled the conditions for the collision to happen. In contrast to the 'old view' of human error (Reason, 1990), it is not just decisions at the sharp end of systems that cause accidents (Flin, 1996), rather the decisions from the blunt end of system that have a broader influence on performance. The events, failures, decisions and actions are shown in the boxes with relationships between them indicated by the arrows in Figure 1.

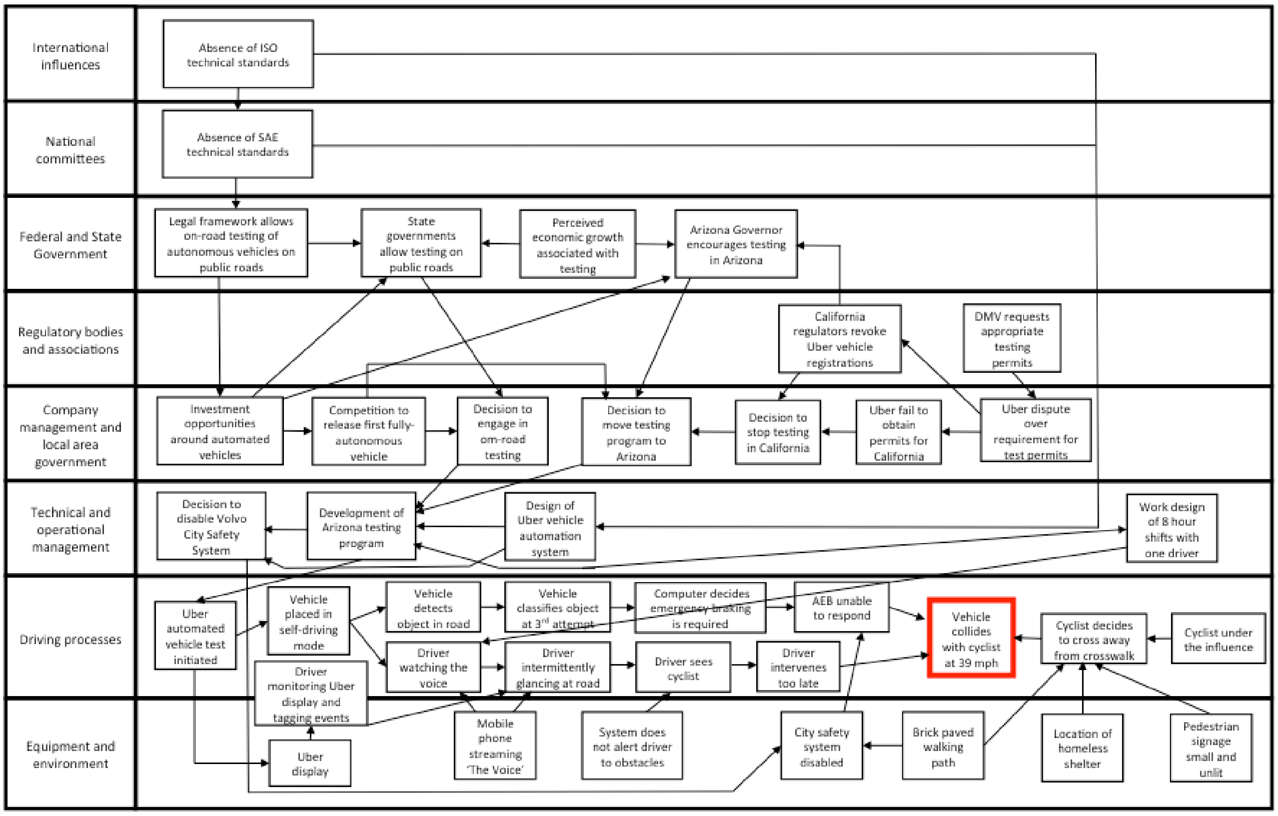

Figure 1: AcciMap of the Uber collision with a pedestrian

At the top of the AcciMap, the lack of international and national standards for automation design and testing meant that Uber had no technical guidance for appropriate interfaces, safety standards or testing regimes. Uber was originally planning to undertake its testing in California but there was a dispute over the need for permits to operate the automated vehicle. Uber argued that as a driver was present, no permit was necessary but the California regulators disagreed and revoked the Uber vehicle registrations. On hearing this, the governor of Arizona encouraged Uber to continue its testing in his state. This decision was based on the perceived economic growth expected to follow investment in the development of autonomous vehicles. Uber set up its testing programme in Arizona with plans to conduct on-road studies (there is considerable competition between companies to have the first on-road fully autonomous vehicle). A decision was taken by the Uber engineers to disable the Volvo City Safety system (including the AEB system) as it can induce an erratic ride experience, if false obstructions are detected. Uber recruited drivers who were trained over three weeks to operate the vehicle.

They were to work eight-hour shifts, driving around a pre-set route, monitoring the automated vehicle's functioning and noting any abnormalities or points of interest on a tablet mounted in the centre console. In addition, they were tasked with monitoring the driving environment for hazards. In summary, the task required them to look at the road scene, evaluate the performance of the vehicle and make notes as required on the tablet. As already noted in figure 1, the driver looked up about half a second before the collision and, on spotting the pedestrian wheeling a bicycle across the road (taking a direct route to a homeless shelter), she grabbed the steering to attempt a swerve. Although the vehicle automation had identified the pedestrian (on its third attempt) and activated the AEB, it did not respond because the Uber engineers had disabled it. The pedestrian was struck at a speed of approximately 39 mph and died in a local hospital. It was also noted that the pedestrian was not crossing the road at the pedestrian crossing. Although the crossing had the appearance of a pedestrian crossing, there were small, unlit, signs stating that the real crossing was further up the road. It is possible that the pedestrian may not have seen the signs (as there was no roadway lighting).

The autopsy revealed that the pedestrian was intoxicated with methamphetamine and marijuana. Figure 1 presents an Accimap of the collision that depicts the many underlying influences that led up to the fatal event. From the collision analysis, it is possible to develop recommendations with the aim of preventing this type of event from reoccurring. At the top two levels (international influences and national committees), new standards for vehicle automation and on-road testing are required. Governments and regulatory bodies (the next two levels down) need to develop and enforce new laws for vehicle automation and their on-road testing. At the next level down, the company needs to undertake a comprehensive analysis of human and technical risks, accompanied by task and workload analysis. At the same level, local planners should improve lighting and fence off central reservations where there is a natural crossing point.

Technical and operational management need to better understand the demands made on drivers of automated vehicles and share tasks accordingly. The vehicles should be fitted with dual control and two drivers present. The inbuilt vehicle safety systems should be left intact and should be fully compatible with any advanced automation. Finally, at the bottom level, drivers should place all nomadic devices in the glovebox before the vehicle is put in motion. The point here is that collisions do not result from any single point of failure; rather they are systemic and multi-causal in nature. To reduce collisions, issues need to be addressed at all of the system levels. It is almost meaningless to study decision-making at the sharp end if the systemic influences are not considered. Sociotechnical systems analysis is clearly an important concept as there were decisions across all levels of the system that played a role in the collision.

Conclusions

Beyond the immediate issues that require resolution for automated vehicles, systems are becoming even more complex and connected; technologies more advanced, and the role of technology is both increasing and changing dramatically. There are also new, emerging constructs from other disciplines that can enrich the science of naturalistic decision-making. These include embodied cognition, advances in the brain sciences, as well as ethnographic and prescriptive ontologies. Systems continue to become more complex and technology-driven, which in turn raises important questions around naturalistic decision-making and how best to support our analysis and understanding of it across individuals, teams, organisations and entire systems. The Actor Map and AcciMap methods offer a useful approach for analysing systems that should be explored further.

Acknowledgments

This research was funded by the Royal Automobile Club Foundation in the United Kingdom of Great Britain. Neville A Stanton also received funding from Jaguar Land Rover and the UK-EPSRC grant EP/N011899/1 as part of the jointly funded Towards Autonomy: Smart and Connected Control (TASCC) Programme. Paul Salmon's contribution was funded through his Australian Research Council Future Fellowship (FT140100681).

References

Flin, R. H. (1996). Sitting in the hot seat: Leaders and teams for critical incident management. Chichester, West Sussex: J. Wiley.

NTSB (2018). https://www.ntsb.gov/investigations/AccidentReports/Reports/HWY18MH010-prelim.pdf (Accessed on 22 January 2019).

NTSB (2019). https://www.ntsb.gov/news/press-releases/Pages/NR20191119c.aspx (Accessed on 9 December 2019).

Rasmussen, J. (1997). Risk management in a dynamic society: A modelling problem. Safety Science, 27, 183–213.

Reason, J. (1990). Human Error. Cambridge: Cambridge University Press.

Salmon, P. M., Cornelissen, M. & Trotter, M. J. (2012). Systems-based accident analysis methods: A comparison of Accimap, HFACS, and STAMP. Safety Science, 50, 1158–1170.

Salmon, P. M., Walker, G. H., Read, G. J. M., Goode, N. & Stanton, N. A. (2017). Fitting methods to paradigms: are ergonomics methods fit for systems thinking? Ergonomics, 60:2, 194-205.

Stanton, N. A. (2019). Models and Methods for Collision Analysis: A guide for policymakers and practitioners. RAC Foundation: London, UK.

Stanton, N. A., Salmon, P. M., Walker, G. H and Stanton, M. (2019). Models and Methods for Collision Analysis: A Comparison Study based on the Uber collision with a pedestrian. Safety Science, 120, 117-128.

Svedung, I., & Rasmussen, J. (2002). Graphic representation of accident scenarios: Mapping system structure and the causation of accidents. Safety Science, 40, 397–417.