Designing Out Flaws Within Road Transportation Systems

Continuous crash review and response is essential to aligning intelligent transport systems with the Safe System approach toward achieving the goal of Vision Zero—zero deaths and serious injuries within the worldwide road transport system.

Article No. 5 in the six-part series addressing how intelligent transport systems can become part of the Vision Zero road safety solution. A link to the all the articles is provided at the end of this article.

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Road transportation systems that work safely result from designs which safely manage the interdependencies and interfaces within them. When severe crashes occur, system designers must revisit the problematic points within the system, understand why and how they occurred, and review the system as a whole before taking corrective action with evidence-based measures. Understanding why and how severe crashes have happened is vital in preventing more deaths and serious injuries on roads—and thus integral to making zero deaths and serious injuries a reality.

With the Safe System approach, designers seek to resolve the issues everywhere within the system, not just at the locations where the crashes have occurred. This approach differs from improving "crash hot spots," as it considers the road transport system holistically, looking at cause and effect in a system-wide context as a progression to achieve the goal of Vision Zero. Vision Zero is rooted in the position that death and serious injury are not acceptable consequences of mobility and strives to establish optimal safety for all users in road transport systems around the world.

Road Safety Urgency

Worldwide, more than 1.35 million people die on roads each year; another 20 million to 50 million people are seriously injured.

More than half of road traffic deaths involve vulnerable road users—pedestrians, cyclists and motorcyclists.

Source: World Health Organization

Overview of Crash Review and Response

When a crash occurs within a road transport system, carrying out an objective review of what happened, why and how enables the system designers[1] to make the changes that have the greatest potential to prevent similar severe crashes from occurring within the system.

Crash review must consider the interdependencies and interfaces between people, vehicles and space so that the response

[1] System designers–according to the Vision Zero approach–include policymakers, politicians/government officials, infrastructure owners and operators, planners, engineers and road designers, vehicle manufacturers, trauma and hospital care providers, enforcers, plus any others who provide for the road transport system. Each contributes important knowledge and expertise to help make and keep roads safe.

focuses attention on correcting the flawed aspect(s), with an eye toward amending that aspect throughout the system, not just at the location where a fatal crash occurred.

The Safe System approach can also be applied to isolated features such as intersections. Where a road network includes a series of similar intersections, all, not just those with the worst crash history, will be subject to the treatment for improvement. The approach can also be adopted for specific locations, treating all the issues at the location of a crash. Knowledge of what happens at other similar locations will inform this process.

Crash review and response comprises two key areas—the immediate response that protects and saves lives, and the analysis of why and how the crash happened in order to prevent further occurrences. The immediate response very much depends on the local situation. In the United Kingdom, for example, the emergency services are available to respond quickly, and their response is mature and effective, based on many years of experience and training. Evaluating what happened and understanding why and how relies on data and the application of objective techniques such as root-cause analysis; the actual causes are not always obvious, and, to effect positive change, it is important to treat the causes rather than the symptoms. To that end, system designers consider the road transport system holistically when undertaking crash review and response—the individual parts must work well independently and in relation to the other parts for the system to work safely.

A fundamental tool in designing safe road systems is speed management—managing the speed of vehicles according to what is appropriate for the environment. Lower speeds dramatically reduce the likelihood that a crash will occur as well as the severity of the injuries that result from crashes.[2] Speed management is a shared consideration across the elements presented in Figure 1. Post-crash care is also essential to creating safe road systems; response to crashes, from trauma care providers and other system designers, is a vital function in the "chain" of considerations/actions addressed by Vision Zero.

Figure 1 – Interconnected elements considered when designing and maintaining safe road systems

The speed and quality of the response can make a significant difference in the severity of injury caused by a crash—a severe injury, for example, could prove fatal without proper and timely treatment. In the United Kingdom, a crash is recorded as fatal when a death occurs within 30 days of it happening. Until severe crashes have been eradicated from the worldwide road transport system, it is important that their impact, in terms of human pain and suffering, is minimized. Analysing data about how the crash happened, where it happened, and the consequences—will enable the outcomes of the interventions to be maximised. The right response carried out swiftly will also

[2] World Health Organization, Managing Speed, October 10, 2017

enable training, expertise, equipment and facilities to reduce the impacts on health, the healthcare system and the overall economy.[3]

Holistic View Enables Crucial Understanding

Worldwide, more than 1.35 million people die on roads each year, and another 20 million to 50 million people are seriously injured. Vision Zero is rooted in the position that death and serious injury are not acceptable consequences of mobility and strives to achieve optimal safety for all users in road transport systems worldwide; similarly, the intelligent transport system (ITS) whole-system approach, as established and applied in the United Kingdom, uses a formal assessment framework[4] that focuses attention on those areas which fundamentally advance safety for everyone who uses the road transport system.

With the Vision Zero approach, road users and system designers share the responsibility for achieving safe outcomes. System designers apply their knowledge and expertise to make and keep roads safe for all users. Road users are responsible for following the rules. If users fail to comply with road rules—due to a lack of knowledge, acceptance or ability—system designers must take the necessary further steps to counteract people being killed or seriously injured. The ITS whole-system approach[5] aligns with this Vision Zero principle of shared responsibility—in the integration of people, processes, infrastructure, vehicles, technology and associated data, to form safe and efficient environments.

Both approaches accept that people make mistakes; therefore, the system must be designed so that human error does not result in fatalities or serious injuries. Using post-crash data and analysis, targeted changes can be made to systems to design out the flawed aspects that lead to death and serious injury. Using the data from severe crashes is a "lagging" methodology that is critical in the prevention of serious crashes; supplementing with a "leading" methodology, such as collating and reviewing near misses and analyzing crashes which have caused slight or no injuries, can be useful to identify where crashes may occur and also to identify why death or serious injury did not occur. Crash causation models consider the whole system, including human error, organisation failure and design failure, in order to understand the causes, and potential causes, of system failure—to design out the flaws leading to that failure. It is important that the system designers understand how to use the analysis and methodology to focus on designing out those factors that will most likely result in death or serious injury. Continuous monitoring of system operation with comparisons to expected levels of performance and outcomes allows the system operators to intervene before failure occurs—being alerted to potentially dangerous situations in time to intervene. This process can take many forms, with a monitoring and evaluation plan being one of the most common approaches.

Create a Forgiving Environment

Plan-Do-Check-Act

The Plan-Do-Check-Act process (Figure 2) provides system designers with a disciplined methodology that includes essential steps—crash review (Check) and response (Act)—to achieving Vision Zero. System designers rely on access to a rich source of data to enable them to understand the root causes of the most severe crashes and where to focus attention when

[3] World Health Organization, Road traffic injuries

[4] This assessment framework is explored in "On the 'ITS' Road Toward Vision Zero," article No. 2 in the WSP ITS-Vision Zero series.

[5] The ITS whole-system approach is explored in "Intelligent Transport Systems Advance Vision Zero Road Safety," article No. 1. in the WSP ITS-Vision Zero series.

changing/refining the system (Act). As this is a continuous, cyclical, process, more data is gathered after changes have been implemented (Plan and Do) so that the impact of the change can be monitored and reviewed; where necessary, further changes are made, and the system becomes progressively safer.

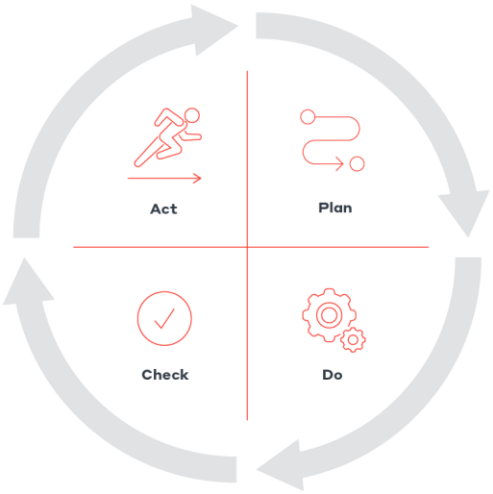

Figure 2 – the Plan-Do-Check-Act cycle used in crash review to improve performance of a system - Crash review and response forms the Check and Act parts of the cycle.

ERIC-PD: 'ERIC Prevents Death'

The Safe System approach seeks to understand the nature of the system failure and what contributed to it, to enable the development of a forgiving environment where the ability for the system to cause harm is ultimately eliminated; zero harm requires the application of the ERIC-PD principles to manage risk (Figure 3).

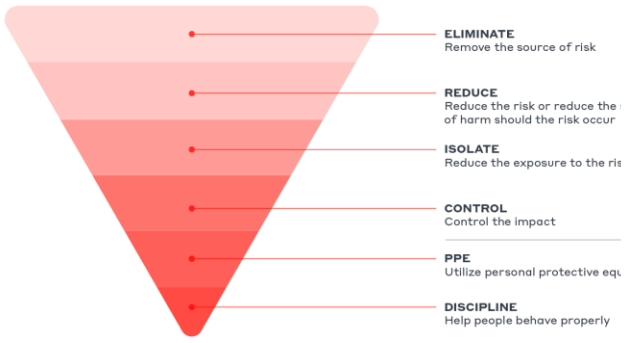

Figure 3 – ERIC-PD principles to manage risk

The evaluation of any crash should lead to responses that align with ERIC, aiming to eliminate the root causes and potential to create harm, wherever practicable. A systematic, evidence-based analysis of crashes will reveal why and how the crashes happened, and will enable the identification of potential mitigations likely to create maximum benefit.

System designers use various tools and techniques, including root-cause analysis and sequence of events. These tools enable the use of evidence-based interventions that support Vision Zero. Continuous review and feedback are essential to refine the system and design out the flawed aspects that lead to severe injury and death.

Broaden and Deepen Understanding

The paradigm shift to shared responsibility requires ongoing collaboration among system designers to create forgiving environments.

Providing guidance for drivers and other occupants of vehicles involved in an incident—enabling them to identify and seek the safest location while waiting for assistance—is an intrinsic part of the Safe System approach. The introduction of automated reporting systems—eCall in Europe and 911 in the United States—enables the road authorities to set signs and signals (where available) to warn oncoming vehicles of the crash or breakdown and to coordinate with emergency services more quickly and effectively.

Educating those who use the transport system—road users and stakeholders such as core responders—is also important in forming forgiving environments. Continual engagement and communication promote meaningful discussion, using the tools and media appropriate to the audience, such as desk-top exercises for emergency services. Designing elements into the system, such as road signs and markings, assist road users to drive as the

system designers intended. Undertaking reviews enables system designers to understand how users respond to what they are expected to do.

The Safe System approach, as represented by Vision Zero and the ITS holistic perspective, expects system designers to allow for road user mistakes. This means that significant attention must be given to how people use the system and the factors that influence their decision-making and behaviour. A widespread attitudinal shift to apply this evolved point of view will go a long way toward creating safe road systems.

Education works in tandem with shifts in design to advance safety and reinforces shared responsibility between users and system designers. As society changes, so do expectations, perceptions and behaviours. Ongoing learning is essential for the safe use of road systems.

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A holistic view of road transport systems, one that considers how the elements of each road system work together, creates the context for effective crash review and response. The application of data and objective analysis then enables crucial understanding of why and how failure occurred, to prevent any similar future occurrence. This approach enables the causes of failure to be designed out of road systems—essential to achieving the Vision Zero goal: zero deaths and serious injuries within the worldwide road transport system.

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