Effective Intelligent Transport Systems Integrate Human Factors

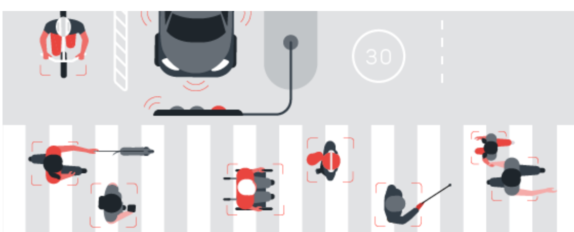
This article—the third in a series examining how intelligent transport systems can become part of the Vision Zero road-safety solution—explores how the interdisciplinary human factors specialism contributes to designing safe road systems.

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



The complexity of road transport systems can be understood in terms of the people who interact within them. As humans, we acquire information from the world around us; we interpret and make sense of it and then respond in our own unique ways. Within road systems, the factors that affect individuals, cognitively and emotionally, causing them to respond the way they do, are varied; and people act in unexpected and sometimes irrational ways. Transport system engineers and related system providers deal with materials and components that tend to perform in predictable, rational and repeatable ways. The human factors specialism brings an understanding of why people do what they do, offering those who design and operate road systems deeper insight to encourage user compliance and reduce human error.

Worldwide, more than 1.35 million people die on roads each year, and another 20 million to 50 people are seriously injured. Vision Zero is rooted in the position that serious injury and death are not acceptable consequences of mobility, and strives to achieve optimal safety for all users on roads worldwide; similarly, the intelligent transport system (ITS) whole-system approach, as established and applied in the United Kingdom (UK), uses a formal assessment framework[1] that focuses attention on those areas that fundamentally advance safety for everyone who uses the transport system.

In the Vision Zero approach, road users and system designers[2] 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 aligns

[1] This assessment framework is explored in article No. 2 of the ITS-Vision Zero series

[2] 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, plus any other provider and enforcer of the road transport system. Each contributes important knowledge and expertise to help make and keep roads safe.

with the 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 of these Safe System approaches consider that people make mistakes and misjudgements; therefore, road systems must be designed so that human error does not result in fatalities or serious injuries. Serious injury and death can be prevented through a collaborative, whole-system approach to road safety that considers the interdependencies and interactions within each road network.

Figure 1 - Responsibility for safety is shared in the Vision Zero approach.
(adapted from the Swedish Transport Administration)

Factoring in the Human

Any activity, improvement, development or change that involves a human requires empathy and understanding to create the right perspective for the right solution. It is essential that system designers have the capability to understand how the system they have designed will be used. Hence, considering and understanding human interaction must be an integral part of the design of every system.

By incorporating the human factors interdisciplinary behavioural science into the design process, system designers can shape transport systems with a deeper understanding of the factors that influence human behaviour; this insight keeps people at the centre of the design process, informs the process with an empathetic approach to comprehending the *why* in road-user behaviour—and offers greater potential for incident/crash prevention.

HUMAN FACTORS

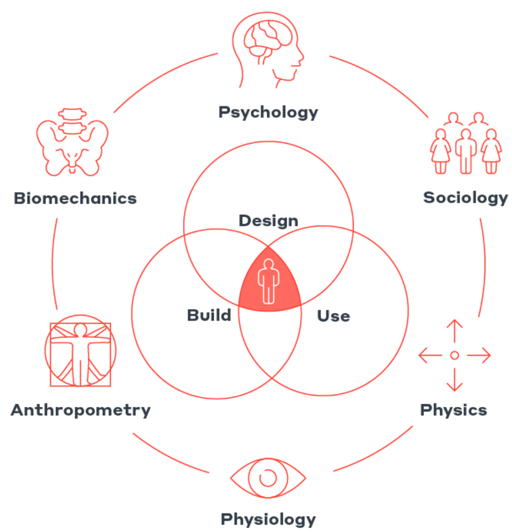


Figure 2 – Human factors is an interdisciplinary behavioural science that keeps people at the centre of the design process.

Essential Insight for Safe System Design

The human factors approach is increasingly recognised as being fundamental in the design, implementation and operation of transport systems—including the investigation process when crashes or near misses occur. It recognises that people are a fundamental part of the overall system, contributing to its ultimate success or failure. This approach to infrastructure design challenges the traditional metrics and standards that are focused on the asset itself, rather than the users.

Bringing an understanding of the human factors that influence behaviour to the planning, design, operation and maintenance of transport systems can minimise human error and go a long way toward preventing crashes that are likely to result in serious injury and death.

PARADIGM SHIFT

	Traditional/Prevailing	Vision Zero
Issue	Preventing all crashes	Preventing fatalities and serious injuries
Premise	Deaths are inevitable	Deaths are preventable
Focus	Perfecting human behavior	Designing a road system that accounts for human error
Responsibility	Individual road users	Shared: road users and system designers*

Figure 3 – Principles of Vision Zero
*From the ITS perspective, the interdependent areas of any mobility system are physical space; users; vehicles; designers and implementers; and operators and maintainers. As noted in footnote 2, system designers, according to Vision Zero, include designers & implementers and operators & maintainers, among other contributors to the safety of road systems.

Adding to the Science Behind ITS and Vision Zero

The users of the road system are diverse and complex—including drivers and passengers, road workers, pedestrians, cyclists, people using emerging micromobility options such as electric scooters, and, in some contexts, horse riders—each with their own needs and vulnerabilities[3] that need to be taken into consideration. Competition exists between modes and users; the interfaces and interdependencies within the system—involving the physical space, vehicles and road users—often lie at the heart of any safety issue. The whole system therefore needs to be designed and operated using a human-centric perspective to achieve the required outcomes—with the evidenced-based Safe System approach guiding the process.

Behavioural science seeks to identify the factors that influence people's thinking, emotional reaction and ultimately their physical response in any given situation or environment. Fundamentally, it seeks to understand why people do what they do and to predict responses in each context. Without this intelligence, any attempt to change human behaviours and interactions—and create a safe system—will likely fail. Developing safe transport systems therefore relies on understanding how to incorporate a proper consideration of the human factors involved.

Behavioural science will enable/assist system designers to:

- recognise that people are fallible. This means accepting that human error can, does and will occur
- understand why people do certain things – recognise the mix of societal norms and learned behaviours and how to encourage (nudge) shifts
- understand the root causes that led to the human error
- understand how and why people respond to/modify their behaviour in response to mitigations – particularly when these may not align with what designers assumed people would do
- identify and understand the parts of the system that failed
- go back to the beginning of the development of any solution, then identify and examine all the factors that influenced the outcome.

When transport system safety specialists can adequately respond to all these considerations, they are then equipped with better evidence and understanding, enabling the delivery of effective, intelligence-led solutions. These solutions result in safer outcomes as a result of an enhanced multi-dimensional approach to understanding and improving human interactions within road systems.

[3] While "vulnerabilities" exist in relation to all road users, Vision Zero characterizes "vulnerable" users as those most at risk in traffic, as they do not have an outside shield to protect them from the force of impact in a crash. *See Vision Zero: Setting a Higher Standard for Road Safety, WSP, p. 9*

Getting to the Root Cause
When presented with an issue, it is important to look beyond the surface and get to the root cause—why did this happen and what factors led to it—before starting to think about a solution. Otherwise, there is a risk of solving the wrong issue, and the problem ultimately persists. Road transport safety professionals carry out incident/crash investigations to gain a full understanding of what caused each one, and then design and target mitigations. Then they need to communicate effectively, explaining why the mitigation is necessary and how it makes a difference in order to influence behaviour and responses, and to achieve the intended outcomes.

Intelligent transport systems that are well-designed from a human-centric perspective:

- are intuitive – combining and using features such as road markings, signing, fencing, etc. that take account of how users see and understand the system/network that they are using
- present the right information, in the right place and at the right time
- combine “push and pull” (instruction and encouragement)
- provide the right mix of education, enforcement, encouragement and engineering to achieve the required result

Once a road-transport system has been implemented, system designers then need to monitor how it used and, where necessary, take action to modify the system to accommodate actual behaviours and revised predictions—based on the available evidence—and, where practicable, devise education campaigns that encourage compliant behaviours. Intelligent monitoring of the effectiveness of mitigations and the responses to them from a behavioural point of view is crucial, as is the willingness to learn and change mitigations and solutions as more responses and evidence is gathered/assimilated.

WSP Examples Illustrating the Integration of Human Factors

Human Factors Research, Road Tunnels, 2020—North and Mid Wales Trunk Road Agent
This research provided a detailed understanding of how road users would react in a tunnel emergency that required evacuation. The research explored whether road users in a panicked state would be able to use the existing evacuation equipment to aid their escape, and identified potential issues that require mitigation. It also provided insight into the many factors, both physical and psychological, that influence behaviours. The research concluded the biggest area of improvement required is education. The road users need to understand what to do in the event of an incident in the tunnels in order to prevent human error and promote safe evacuation. It is also important as part of the education to advise road users on how to reduce the risk of incidents in the first place, such as vehicle maintenance to prevent breakdowns/engine fires.

A2M2 Connected Vehicles Trial, 2018 - 2020—Highways England
This project provided insight on how new systems influence driver behaviour in congestion, junction management (traffic lights) and roadworks. The work involved conducting interviews in order to obtain user feedback. Connected vehicles were trialled where participants experienced messages on roadworks, road signs, speed limits, traffic light changes and lane changes. The project also qualitatively analysed the data by examining the interviews with participants and presenting these

results in a report. The A2M2 project won ITS project of the year at the ITS (UK) President's dinner.

Ipswich Connected Vehicle Pilot as part of the Connected and Automated Vehicle Initiative, 2020–Queensland Department of Transport and Main Roads (TMR), Australia
The largest component of TMR's Connected and Automated Vehicle Initiative (CAVI) is the Cooperative Intelligent Transport Systems (C-ITS) Pilot. The pilot takes place on public roads in and around the City of Ipswich. This project provides insight on how new systems, utilising Cooperative Intelligent Transport Systems (C-ITS) can influence driver behaviour.

Testing will assess the value proposition of C-ITS safety use cases, including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) applications. There will be around 500 public and fleet vehicles retro-fitted with C-ITS technologies, and roadside C-ITS devices installed on arterial roads and motorways. These devices allow vehicles and infrastructure to talk to each other to share real-time information about the road and to generate safety-related warning messages for drivers.

The use cases being trialled include in-vehicle speed warning, emergency brake warning, turning warning for bicycle riders and pedestrians, roadworks warning, back-of-queue-warning, and red-light-violator warning, among other hazard warnings in the road environment. Quantitative data analysis will be employed for safety evaluation: analysing driver behavioural response to C-ITS alerts to infer crash reduction potential. The project will also employ surveys to assess user perceptions.

Bruce Highway Interchange Virtual Reality Usability Testing, 2019, Queensland, Australia
WSP led the behavioural evaluation and design of usability testing for the new Bruce Highway Interchange. This is a complex intersection design that has multiple decision points in quick succession, visibility issues and significant safety consequences if a driver makes a wrong decision. We combined virtual reality technology, behavioural science techniques and digital engineering data to simulate driver experience, understand why driver behaviours occurred and provide practical adjustments to the design—allowing the project team to save costs and improve safety outcomes for public road users.

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The ever-growing human factors interdisciplinary specialism contributes to the development of effective intelligent transport systems by keeping people at the centre of the design, build and use of these systems—and thereby fostering safe and efficient interactions on roads. There is a need for the transport sector to go beyond the standards and models in place, to test and design for human behaviours and help standards evolve. Continually gaining insight from human factors studies and channelling that intelligence into projects will strengthen road-safety efforts seeking to make Vision Zero a reality in communities around the world.

Continue to the next page for author and contributor contact information.

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