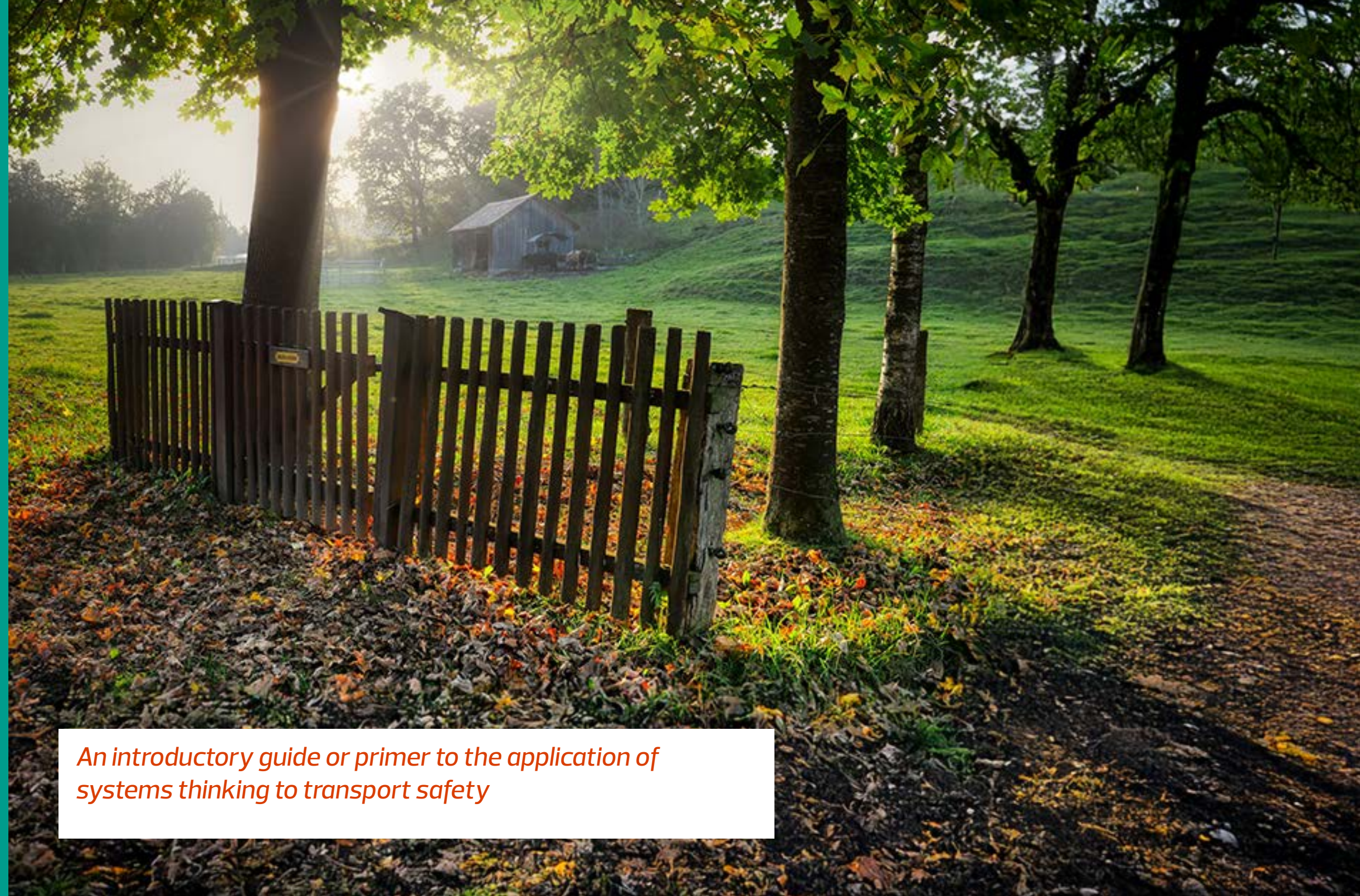# Systems Thinking in Transport Safety

Cross Modal Safety Change Programme

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An introductory guide or primer to the application of systems thinking to transport safety

Department for Transport

TRL THE FUTURE OF TRANSPORT

Systems thinking in transport safety

How did a shallow spot in a river ten thousand years ago affect pedestrian safety today? What do lifts have to teach us about the safety of roll-on-roll-off ferries? What does Stanley Kubrick have to say about aviation safety and what does that mean for the future of automated vehicles? What does any of this have to do with the arrangement of gates and fences and the effect these things have on the lives of sheep?
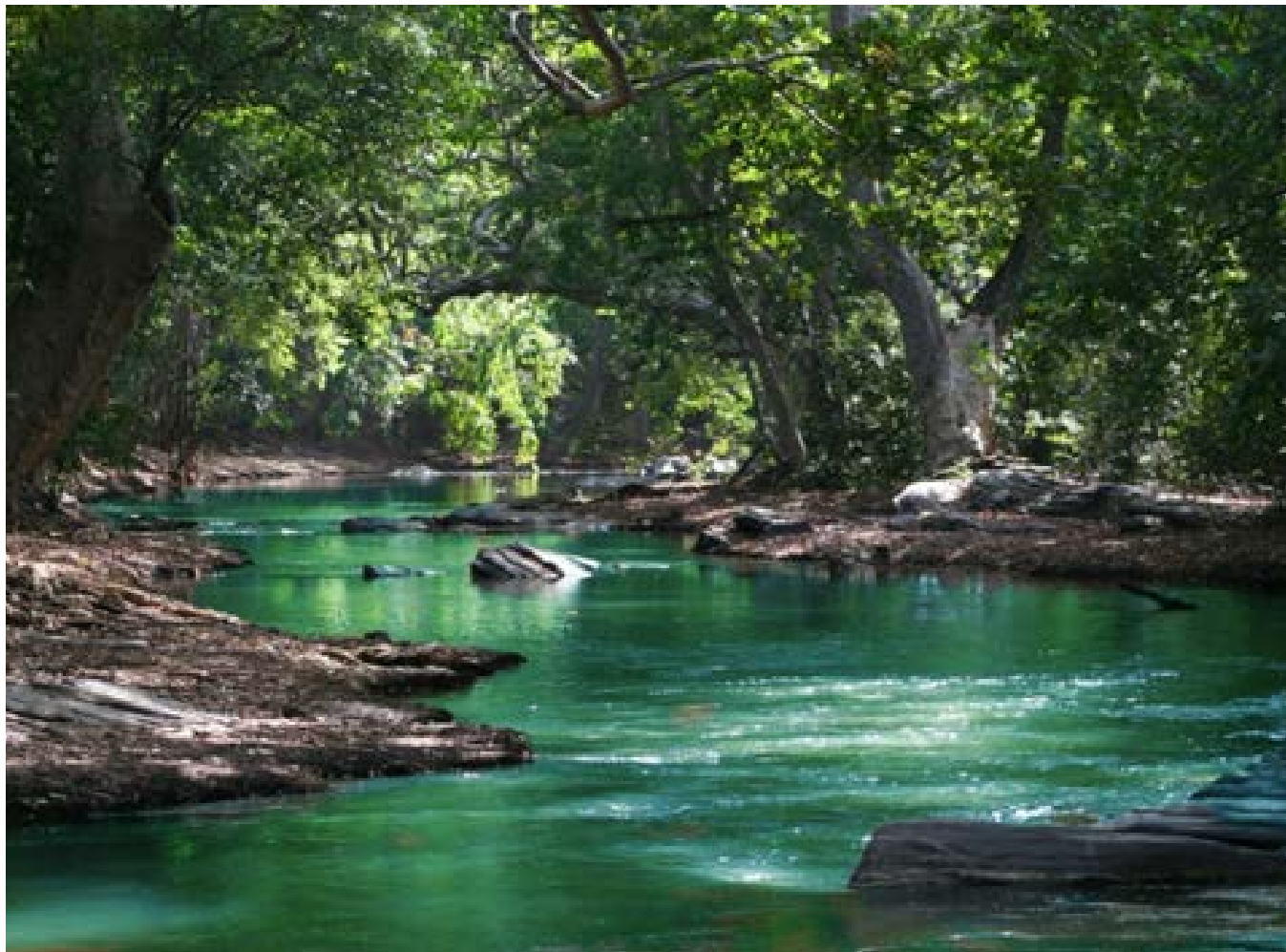
''Systems Thinking'' is becoming a buzzword in transport safety, but what does it actually mean and how should you start applying systems thinking techniques to make transport safer? Systems thinking has useful lessons for transport practitioners of all disciplines and in all modes, whether you are an engineer designing instrument panels for oil tankers or a policy officer promoting active travel for a local authority.

What is systems thinking?

Systems thinking is a discipline that seeks to analyse situations and solve problems by developing a holistic understanding of the structure of a system and the agents and actions that are influencing its behaviour.

The ''system'' can be any interconnected set of elements coherently organised in a way that achieves something, whether deliberately or otherwise.

In transport, a system could be a machine, like a bicycle or a petrol pump, but could also be less tangible things like a bus service, or the routes that children take to get to school, or the system of regulations approvals and inspections that govern the design and subsequent roadworthiness of cars.

While we tend to easily recognise machines as being systems, and automatically investigate the interconnections within that system when it doesn't behave as we expect – the car won't start, is the battery flat, is there fuel in the tank etc. We often don't recognise that less tangible systems are systems at all.

Systems Thinking in Transport Safety

How is systems thinking helpful in improving transport safety?

The professional world is increasingly divided into specialist silos – vehicle engineering separate from infrastructure engineering, psychology separate from economics, town planning separate from law enforcement and so on. But our lives are a rich soup of the consequences of decisions made in isolation by specialists whose only concern is their individual area of interest. Viewed from a mechanical perspective alone, the door that was intended to keep the sea from flooding onto the car deck of the Herald of Free Enterprise, was absolutely fine, electronically the system that should have prevented the pilot of Flight 447 from holding the aircraft at an attitude that caused it to stall and fall into the Atlantic, fully functional.

Systems thinking encourages us to ask questions like – who are the people that will use this system? How will their culture and experience affect their expectations of how the system will behave? What will happen if they use the system in a way we don't expect? When something goes wrong, will they understand what the system is trying to tell them?

Systems behave in ways that are different to the sum of the behaviour of their individual parts. The fundamental difference is :
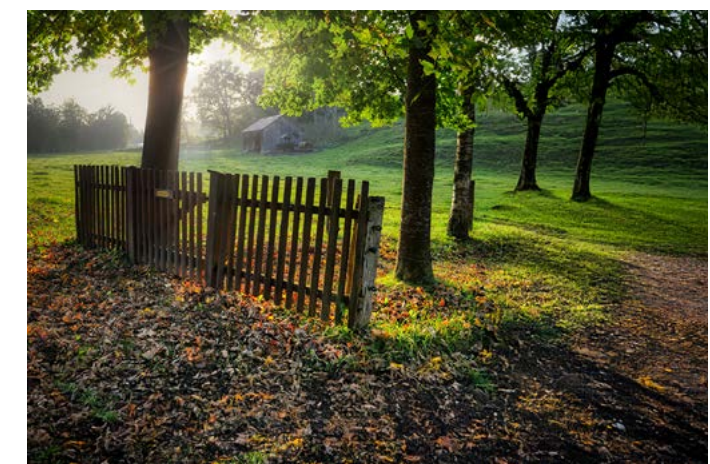
Traditional reductionist methods
Seek to isolate individual elements in order to determine their intrinsic properties.

Systems thinkers
Seek to build a holistic understanding of the ways in which the multiple elements within systems interact to influence the behaviour of the system as a whole.

Case studies illustrate key concepts:

1. The intersection between machines, the humans who operate them and the social structures influencing their behaviour.

2. The essential role of feedback loops in systems thinking.

3. Testing the permeability of a system boundary.

4. Being aware of the delayed effects of interventions.

5. Factors needed to create robust systems especially where human error is inevitable.

6. Automated vehicles – the challenges from the interface between the machine and the humans around it.
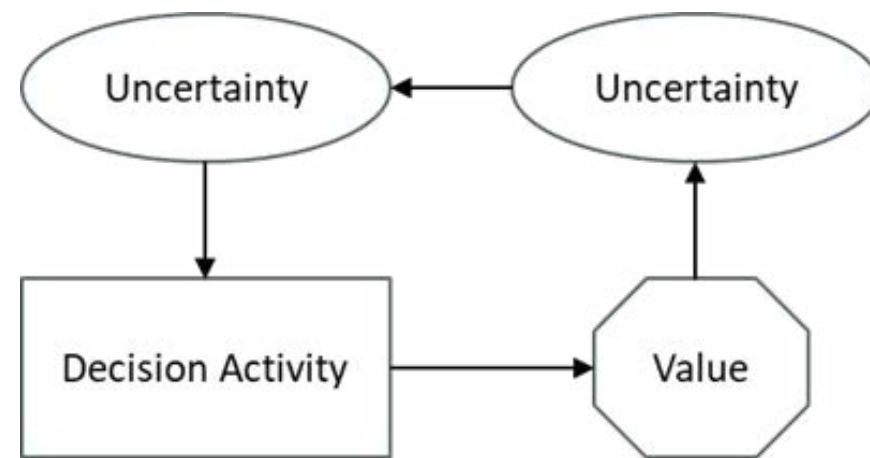

The full report looks in depth at three major transport disasters:
1. The sinking of the Herald of Free Enterprise
2. The crash of Air France flight 447
3. The Selby rail crash
Lessons can also be learned from trials of introducing new mobility modes.

Tools for systems thinking

A wide range of tools and techniques have been developed to support systems thinkers, ranging in complexity from very simple methods for representing systems in diagrammatic form, to complex theoretical frameworks for analysing the interconnections within socio–technical systems.

This study has divided these tools into two groups which broadly indicates whether those tools embody a sophisticated philosophical framework for thinking about systems ,or are more simplistic techniques that may be applied in combination with those more sophisticated methods.

Systems thinking approaches and methodologies   *Communication tools used in systems thinking*
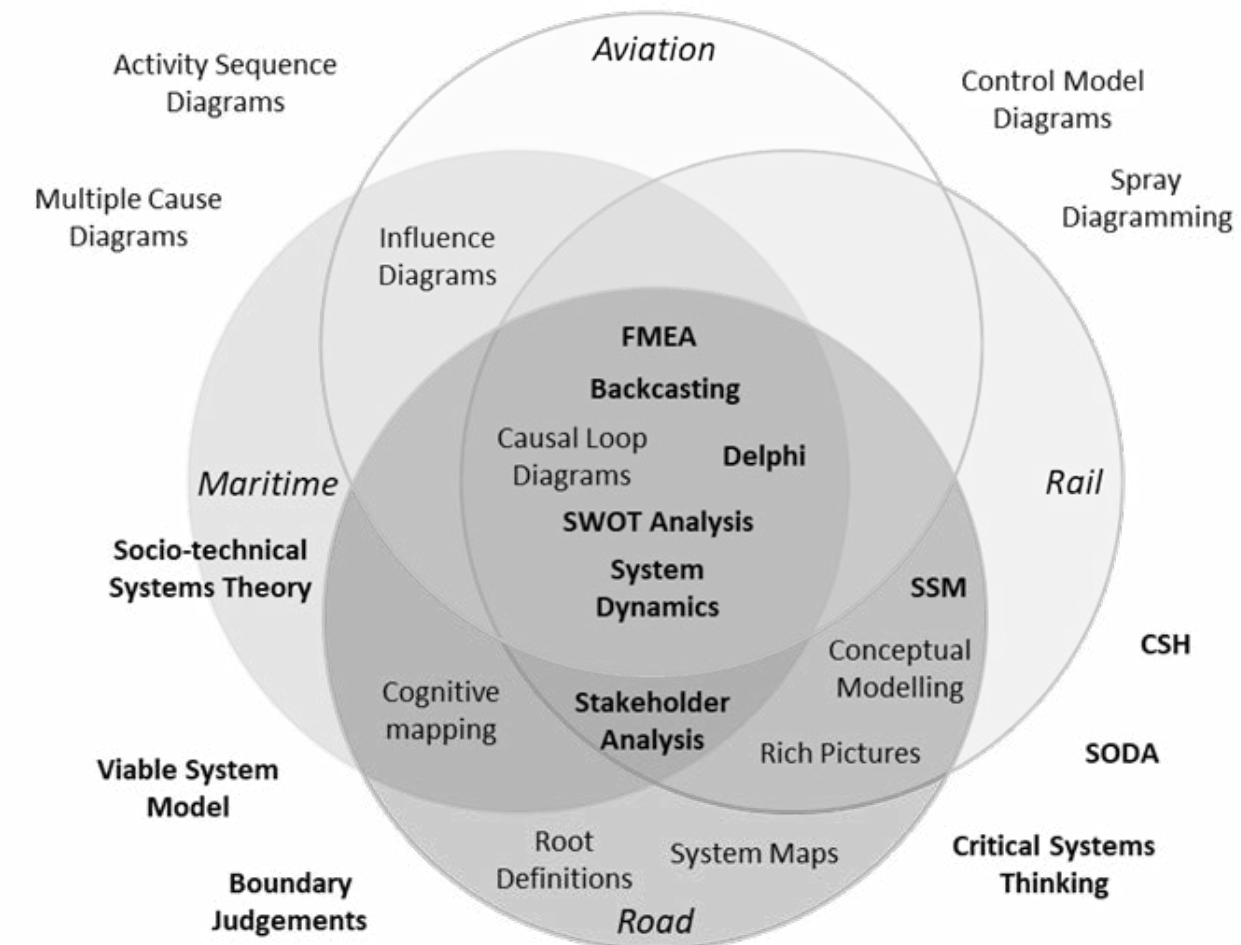

Generalised Influence Diagram

It is important to stress that systems thinking is not primarily a tool–driven discipline; just because you are using a systems thinking tool doesn't mean you are doing systems thinking. Conversely, it is possible to be a systems thinker without any knowledge or use of systems thinking tools.

Engaging with stakeholders is a key element of systems thinking. Seeking the, often opposing, views of different stakeholder groups can often in itself provide useful insights, which may lead to unexpected solutions.

The full report contains details of 22 different tools as a starting point for practitioners who are new to systems thinking, who, when and how to use them. Learn to walk before you run!

Conclusions and Recommendations

The key take-away of our investigation is that systems thinking has far more to do with mindset when approaching a problem than the tools that can be used when solving it.

The aim is for no one to be injured or killed when travelling by any mode. Whether or not this is an achievable target, systems thinking provides a practical mindset from which to approach the solutions.

It is important for practitioners to understand that, just because we have drawn an Activity Sequence Diagram or conducted a Delphi study, this does not mean we are suddenly doing systems thinking.

The discipline of systems thinking requires an approach to situations that takes into account the broader cultural, technical, economic and environmental influences as appropriate, even if the techniques we use to capture and process those insights are of our own devising and have no formal name.

This does not mean that everything has to be quantified, and all interdependencies qualified, before actions or safety interventions or recommendations can be made. Instead, it means consideration must be given to defining and including the important relationships.

Systems thinking should help you to identify impediments and barriers to safety improvements that more reductionist analysis methods might overlook.

Many safety problems, which at first sight appear impossible to resolve, may become solvable when viewed through the holistic perspective that Systems Thinking provides.
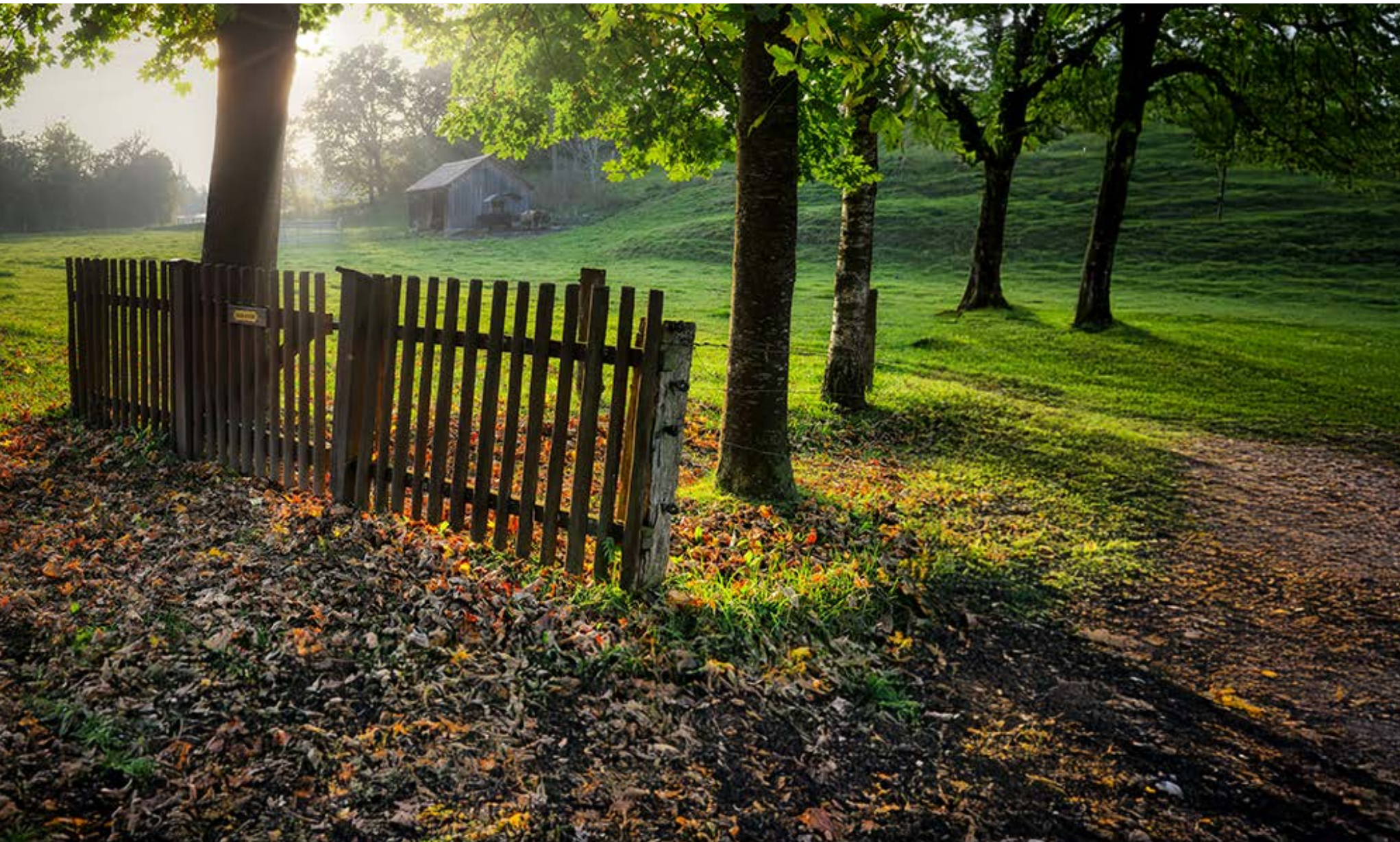
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To download a copy of the full report please visit the TRL website and search for PPR2059 or use the QR code here:

PPR2059

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