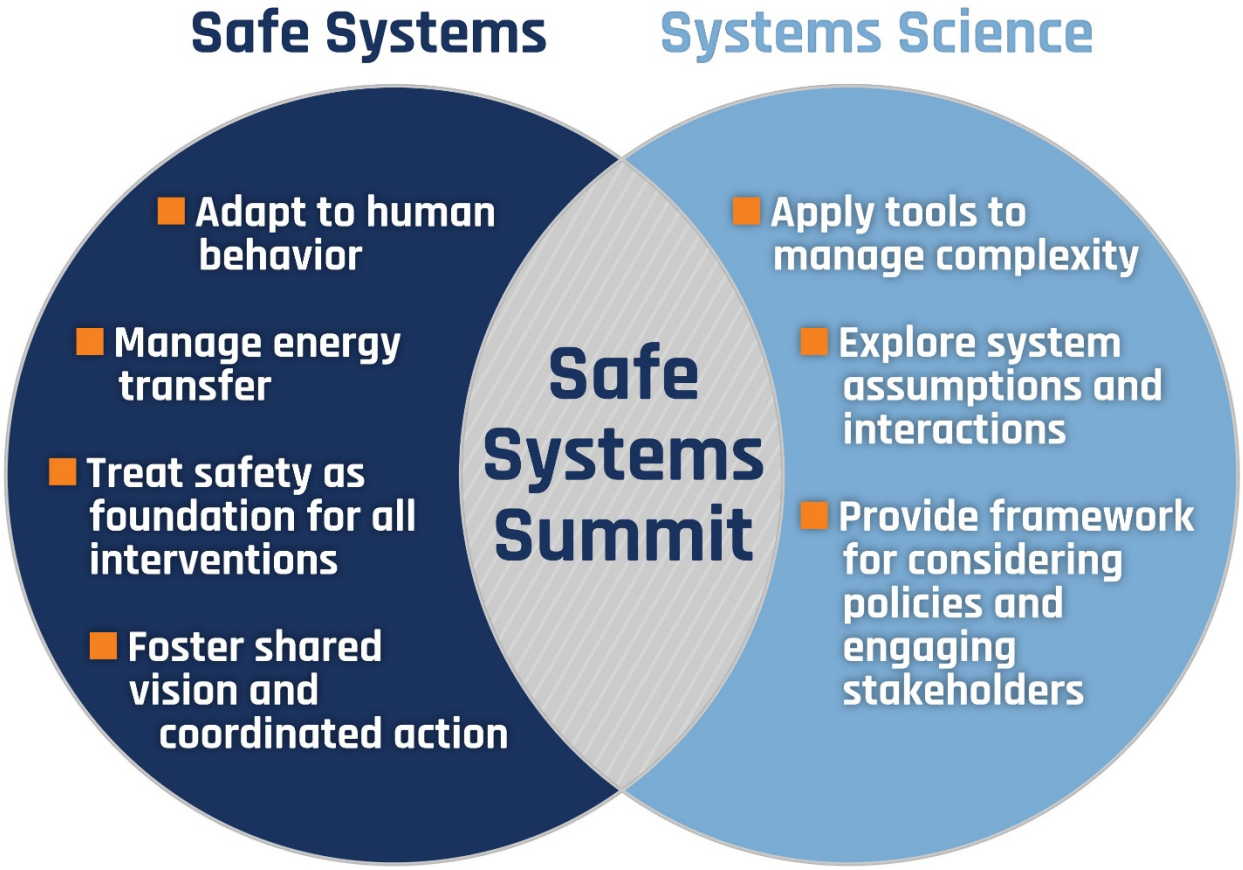
Safe Systems and the role of systems science

Welcome to the Safe Systems Summit! Part of the work here—and that of the Collaborative Sciences Center for Road Safety (CSCRS) at large—is to share and develop a stronger understanding of principles of **Safe Systems** and **systems science** that can be applied to our collective work in reducing traffic injuries and fatalities. This piece provides a brief introduction to core elements of these two guiding frameworks, shown in the figure below, which are open to expansion and further refinement.



What is a Safe Systems approach?

Safe Systems refers to a transportation safety paradigm that fosters a holistic perspective and strives to create a transportation system that ensures that no crash results in death or serious injury. Several countries have formally adopted versions of this approach, including Sweden, the Netherlands, Australia, and New Zealand. Many other transportation agencies, within and outside the US, have applied the principles of Safe Systems without referencing this term. Through CSCRS-sponsored research, we have identified several core principles that underpin, to varying degrees, the Safe Systems approach used in different locations. Safe Systems:

1. **Adapt the structure and function of the system to the complexities of human behavior:** Many factors influence human behavior, including social environments (e.g., laws and social norms), physical environments, as well as habits, expectations, and time affluence. A better understanding of human learning, decision-making, state awareness, and behavior in different environments is central to designing Safe Systems. Roadway, vehicle, and other transportation-related systems can be designed to reduce the likelihood of human mistakes, mitigate the consequences of such mistakes, and adapt to changing human behaviors. If the transportation system is designed to work only for alert, compliant, and expert road users, then the system will fail. Further, as the role of humans in controlling vehicles fundamentally changes with new automated technologies, consideration of human behavior adaptation to new systems will be critical.

2. **Manage the kinetic energy transferred among road users:** There are many ways to effectively reduce the energy forces that get transferred in a crash between two or more road users. In many countries, regulation and testing of vehicles has led to safer vehicle designs, both for vehicle occupants and, increasingly, non-occupants. Roadway design can also affect travel speeds and speed or angle at impact, which relate to energy transfer. The Dutch Safe Systems approach emphasizes homogeneity of road user mass and/or speed, or increased separation of travel mode when this cannot be achieved. Managing exposure to high kinetic energy forces by shifting the population to safer, more sustainable methods of travel (through transit investment, transportation demand management programs, pricing policies, etc.) is another approach. Enforcement, automated or otherwise, has also been tested and may be appropriate in some situations, but can also be challenging if not in alignment with other Safe Systems principles.

3. **Treat road user safety as the foundation of all system interventions**: Road safety for all humans is a fundamental necessity, and it travels hand-in-hand with mobility, access, equity, and other transportation values. In the U.S., we often still view safety and mobility as a tradeoff, inherently in conflict. We even structure our organizations to work separately on these issues. For example,

departments of transportation often have safety divisions separate from mobility and transit divisions, with separate processes and funding structures even when goals and interests overlap. Places taking a Safe Systems approach have figured out how to provide multiple mobility options while ensuring safety for users of every option. These places recognize that if the safest choice isn't the most convenient, people may not choose it, and if the most convenient choice isn't safe for everyone, then fatalities will occur. A Safe Systems approach must acknowledge the tension and interrelation between safety, mobility, and other traveler needs, and define a hierarchy that is aligned with community values. This often requires greater investment in safety and the evidence-based interventions that provide lasting safety effectiveness.

4. **Foster the creation of a shared vision and coordinated action:** Too often, roadway or safety decisions are made in siloed environments, with little consideration for consequences in other areas of the system. For example, a safety target may be met by one stakeholder of the road safety system, at the expense of the safety of another. There is a need for greater vertical and horizontal integration of the systems that influence safety, and a need to work holistically and proactively to prevent unintended consequences and to recognize the implications of policy making in other areas of the transportation system.

In short, the Safe Systems approach offers a transportation injury prevention framework based upon established, evidence-based principles to develop a transportation system that is focused on the needs of the road user.

What is systems science?

Systems science is a multidisciplinary approach to solving persistent problems in health, transportation, and other areas. It is a field of study that originated outside of the transportation discipline and has been used in many areas, including ecology and cybernetics. It offers a wide spectrum of tools that can complement and enrich the Safe Systems approach, or any other transportation safety approach. Systems science methods can be used to:

1. **Apply standardized methods to understand and manage complexity:** Systems science offers formal tools, both qualitative and quantitative, to help recognize the complexity of persistent challenges as well as to identify solutions. These tools are particularly useful in contexts that require collaborative problem-solving and orienting new partners to a shared vision, such as Safe Systems and how it can be applied to address the complex issue of roadway fatalities.

2. **Explore systems assumptions and interactions**: Systems science fosters thinking about the underlying structures of systems that are driving problems, and offers ways to explore assumptions and interactions between system elements. In the transportation context, this approach is needed to help shape a more refined approach to Safe Systems, prompting thinking about the underlying transportation system structures that lead to traffic fatalities, surfacing assumptions and values, and clarifying the relationships between the components of the system and how they can or should interact. It can also help agencies think through how changes to one area of the transportation system can impact other areas or silos.

3. **Provide a framework for considering policies and engaging stakeholders:** System science approaches can help develop shared approaches for policy and intervention, using effective tools to foster multidisciplinary engagement. They can support strategic planning by offering insights into how to leverage system dynamics to maximize policy impact and/or sustainability, enrich policy discussions around Safe Systems, offer ways to examine the unintended consequences of Safe Systems policies and practices, and simulate the synergistic effects of different scenarios. Systems science methods can also be used to improve public engagement around Safe Systems through group consensus building and systems modeling as a communication tool. This can promote agency coordination to get buy-in from all jurisdictions responsible for the safety of the system.

The Path Forward

There is much to learn about the Safe Systems approach, and how systems science tools and methods can be introduced and applied to transportation safety in different contexts. Combined, they offer a promising new paradigm for advancing road safety, presenting a vision for inherently safe road systems that are capable of leveraging interconnected, resilient parts of the system that adapt to change together.

We hope that the Safe Systems Summit provides a space to refine our collective understanding of these approaches, tools, methods, and applications, and to foster a learning community that can integrate new research and theories into well-established injury prevention approaches. Using data and evaluation as guides, road safety professionals and other stakeholders can come together to bolster effective, systems-oriented practices across all disciplines while spurring collaboration and innovation.