MITRE | SOLVING PROBLEMS FOR A SAFER WORLD®

TRANSFORMING ROAD AND RAIL SAFETY

A DIGITAL PATHWAY TO THE NEXT LEVEL OF TRANSPORTATION SAFETY

May 2023

A strong push for improvements in railroad safety has emerged since the calamitous derailment of a cargo train in East Palestine, Ohio in February, which leaked toxic chemicals into the air and water and resulted in mandatory evacuations.

The reactions to such serious accidents—on both our rails and roadways—are swift, with investigations to determine their causes and calls for changes in policy, procedure, and technology to prevent similar incidents in the future.

However, because of their narrow scope, post-accident investigations are limited in their ability to effect change. To advance overall safety in our transportation systems, a new paradigm is needed.

MITRE, operator of the Federal Aviation Administration's (FAA) federal R&D center and a partner to the U.S. Department of Transportation (DOT) on numerous surface transportation initiatives, proposes a way forward with its "Next Level of Safety" approach.

"With our world becoming more complex and dynamic, safety needs to evolve to proactively identify hazards before they manifest into accidents," says Greg Tennille, managing director of transportation safety at MITRE. "Traditional safety practices, such as spot checking and ad-hoc coordination, must be augmented by new approaches to ensure public safety in this rapidly changing environment. We believe adoption of our Next Level of Safety approach can shift the paradigm of transportation safety."

Evolving Safety in the Digital Age

Society's digital transformation is at the heart of MITRE's approach. Billions of devices around the globe are producing immense volumes of data. These devices are part of a collaborative ecosystem, exchanging data in real time with each other and the broader environment.

MITRE proposes tapping the power of that data—combined with advanced technologies such as artificial intelligence/machine learning (AI/ML)—to enable transportation safety to take an evolutionary leap forward.

Four principles define the Next Level of Safety: a system-of-systems approach, proactive monitoring and analysis, the sharing of safety information across stakeholders, and smart policies focused on safety outcomes.

The Next Level of Safety
Principles

Systems Level Approach
"Holistic 360-degree view"

Proactive Monitoring and Analysis
"Right information at the right time"

Data Democratization
"Incentivize data and information sharing"

Smart Policy
"Focus on safety outcomes"

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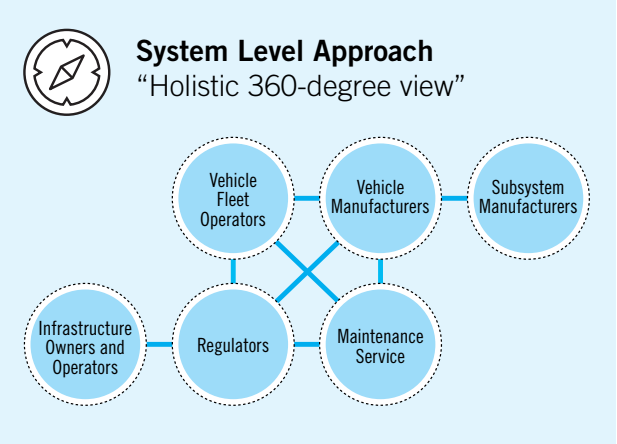
>
> Greg Tennille, MITRE

A Systems Level Approach: Gaining a Holistic View

All modes of transportation are systems of systems in that they are enabled by interdependent components that work together to provide a service. For example, bus transit services require vehicles, bus drivers, road infrastructure, traffic control devices, and traffic and operating procedures to work together to provide safety and timely service to their communities.

Transportation safety in any mode is a byproduct of the risks inherent in each component, as well as risks arising from their interaction. In fact, research indicates that the predominant cause of accidents in some transportation sectors is lack of information exchange between organizations responsible for managing safety.



In light of these system-of-systems realities, the Next Level of Safety requires that the entire system (people, process, and technology) be accounted for when considering safety, including the increasing role of human-machine teams. Adopting a system-of-systems perspective encourages a shared, comprehensive understanding of the environment.

To achieve this common understanding, stakeholders can use safety management system principles to engage in proactive risk management.

Under the Next Level of Safety, safety management systems (SMS) shift from the traditional single-organization focus to a 360-degree safety review that incorporates all stakeholders. This allows multiple organizations to analyze and manage their common risks, share discoveries before accidents or incidents occur, and understand the effectiveness of mitigations.

Additionally, systems level safety management enables the community to discover better solutions and offer faster feedback than any one organization operating independently.

Working separately, one organization might find and make a correction that masks a safety issue for a time. That correction may address the root cause within one organization but not for the system of systems. If multiple organizations work together to monitor leading indicators, the opportunity to spot new issues before they create significant risk is increased.

In the future, much of the cross-organizational sharing will move beyond raw data to include AI-generated findings regarding "what to look for"—in essence, patterns for leading indicators of safety issues. The organizations can then work together to improve the depth of the analysis and determine the best solution.

Systems level approaches also enable decision making about safety to be integrated with decision making about efficient operations.

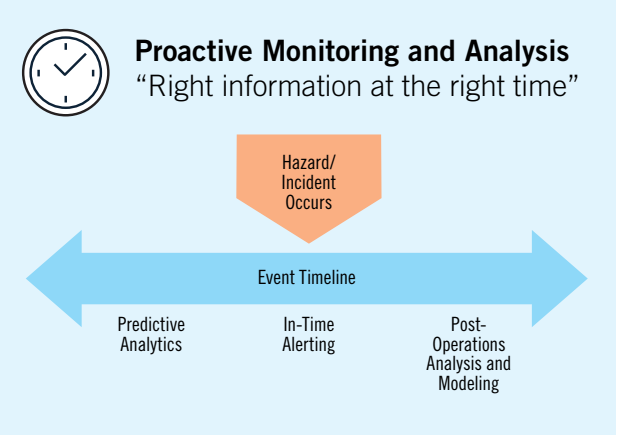
The nation's ports are a microcosm of the kinds of diverse stakeholder engagements that occur in the transportation domain. Local, state, and national regulatory bodies are involved in the oversight of port operations. Trucking companies use these locations to drop off and receive cargo, and ships carrying both people and goods are frequent users of these national entry points. As we invest in improved infrastructure for these critical hubs in our supply chain, a question we must ask is: How do we safely introduce changes and coordinate them among all affected parties? Without such coordination, the interests of some parties may be emphasized while those of others are overlooked.

Proactive Monitoring and Analysis: Delivering In-Time Mitigations

Today's increasingly data-rich environment is enabling the shift from a retrospective to a predictive safety mindset. Proactive monitoring and analysis that employs advanced technologies can detect anomalous events and emerging hazards, provide insights and predictions, and allow for appropriate actions to be taken before they manifest as accidents or incidents.

Under the Next Level of Safety, stakeholders combine a sophisticated network of fused operational, systems, and environmental data with AI/ML-based technologies to generate timely safety intelligence in both strategic and tactical timeframes. Human decision makers and autonomous systems working together as a team use this information to automatically monitor system performance, understand operational impacts, and identify unanticipated system interactions. Long-range forecasts of accident risk inform strategic safety investment priorities. Near-term forecasts provide tactical support to operational actions.

An example of this principle in action is the Virtual Open Innovation Collaborative Environment for Safety (VOICES) test platform.



Initially developed by the Federal Highway Administration, VOICES is a DOT Highly Automated Systems Safety Center of Excellence initiative that is being further developed by MITRE in partnership with transportation stakeholders and innovators from the VOICES community. The goal is to collaboratively research and test safety solutions in a simulated environment before deployment on the nation's highways.

VOICES will provide secure data sharing while enabling interoperability between research and testing tools, environments, and systems. The platform will serve as a proving ground to participants from across the surface transportation industry—including original equipment manufacturers, infrastructure owners and operators, and technology developers and suppliers—as well as from government and academia. The collaboration of these diverse partners will accelerate crucial innovation in transportation safety. The next iteration of the VOICES platform will be tested in late 2023.

MITRE is separately working to create a virtual representation of the transportation system to test the capabilities of new vehicle technologies—and their interactions with system users—before deployment. This sort of capability will be vital as automakers introduce increasingly automated safety features on their vehicles, and as the transportation environment becomes increasingly complex.

Data Democratization: Expanding Sources and Perspectives

A key element of the Next Level of Safety is data democratization, the process of ensuring that data and information are accessible to as many stakeholders as possible. Shared data enables stakeholders to produce more robust predictive analyses and safety intelligence insights, coordinate their mitigations, and understand how to recover from unforeseen hazards.

To maximize the benefits of a systems perspective, members of the community must be incentivized to share safety data, from local to global levels. As a foundational step, issues related to data security, governance, trust, and standards need to be addressed. For example, a set of common frameworks and data standards would facilitate the broad adoption of interoperable solutions and accelerate the impact of data sharing.

Government regulators can serve as a catalyst in fostering information sharing among industry stakeholders. This includes sharing insights from regulatory monitoring activities as feedback to assure the effectiveness of safety controls. Trusted third parties can assist in building trust between government and industry stakeholders.

In the aviation domain, the Aviation Safety Information Analysis and Sharing (ASIAS) program—a partnership between industry, the FAA, and MITRE—has helped to dramatically improve safety in the airline industry. In recent years, the ASIAS model has spurred the development of similar programs in other domains.

One such program is the Partnership for Analytics Research in Traffic Safety (PARTS), a public-private partnership through which the National Highway Traffic Safety Administration (NHTSA) and automobile manufacturers share safety data with MITRE for analysis to advance traffic safety.

GOVERNMENT REGULATORS CAN SERVE AS A CATALYST IN FOSTERING INFORMATION SHARING AMONG INDUSTRY STAKEHOLDERS.

The strength of PARTS is in its scope. This was evident in a recent, first-of-its-kind, cross-industry study examining the real-world effectiveness of advanced driver assistance systems (ADAS) in passenger vehicles. Eight automakers provided vehicle equipment data for 47 recent model year vehicles, and NHTSA provided 12 million crash reports from 13 states. By fusing those data sources, researchers were able to obtain a clearer understanding of ADAS effectiveness than would have been possible using a single entity's data.

As the PARTS partnership and data set expand, researchers will be able to study increasingly nuanced and emerging research questions.

In the future, PARTS plans to enable partner organizations to analyze the anonymized data sets formed from their contributions. As part of its longer-term strategy, PARTS is considering providing external research organizations with access to analyze its data.

Smart Policy: A Focus on Safety Outcomes

Because traditional safety regulatory approaches are often insufficient in today's increasingly dynamic, unpredictable, and complex digital environment, government regulatory policy is shifting. It's becoming more performance-based and more focused on safety outcomes. It's also promoting industry self-discovery, disclosure, and correction. This approach enables innovation by granting industry flexibility on how to achieve the desired safety outcomes.

From a Next Level of Safety perspective, regulators take an integrated approach, supporting the oversight responsibilities of all organizations in a "shared mission" operational chain (i.e., manufacturers, maintenance organizations, operators, and regulators).

Adoption of a "safety continuum" is an example of this approach. Not all trucking operations, for example, need to be held to the same requirements to maintain consistent safety outcomes. Regulations differ based on vehicle weight, the type of freight being carried, and the extent of the route. This same "continuum" approach could be applied to other aspects of transportation as well. Ideally, a safety continuum would align regulator and industry safety management goals with the public's safety level expectations, while simultaneously granting industry innovation flexibility.

On an operational level, with the smart policy approach, regulators use oversight to promote greater shared understanding of the system level operational environment, potential risks, and associated impacts among stakeholders, in addition to determining regulatory compliance. Oversight attention is focused on the shared discovery of risks and better coordinating the layers of mitigation across stakeholder organizations.

More broadly, smart policy is needed to enable the transportation system's resiliency to a natural or manmade disaster.

In a disaster, a functional transportation system is crucial. It's the backbone for evacuation, search and rescue, and the delivery of emergency services and supplies to the devastated region. With natural disasters increasing in intensity and attacks on infrastructure becoming a greater threat, there is a need for policy that builds in mechanisms for a coordinated response.

For instance, if key roadways are unavailable as evacuation routes, how can stakeholders coordinate to provide evacuation via rail or air? If railways typically used to transport supplies are damaged, what is the Plan B for rerouting supplies to get them to people quickly? How do we strategically invest in our transportation system so that these multi-modal strategies exist ahead of time and can be executed as needed? What communication structures and processes should be enabled in advance so that real-time coordination will be possible during a crisis?

Shared data, analyses, and collaboration will all be critical components to effectively addressing these questions.

Moving Forward as a Community

The Fourth Industrial Revolution is transforming the surface transportation environment by creating more connectedness than ever before between systems and human users. Understanding the safety implications of this greater connectivity requires broad community understanding and engagement with a more diverse set of users to generate new safety insights.

To achieve this vision, members of the transportation safety community must come together and accelerate implementation of the Next Level of Safety principles. By taking a systems perspective, sharing data, proactively monitoring and identifying risks, and implementing smart policy, we can create safer roads and rails.

Read more in the MITRE white paper: The Next Level of Safety: Evolving Safety in the Digital Age.

About The MITRE Corporation

MITRE's mission-driven teams are dedicated to solving problems for a safer world. Through public-private partnerships, as well as the operation of federally funded R&D centers, we work across government to tackle challenges to the safety, stability, and well-being of our nation.

MITRE operates the Center for Advanced Aviation System Development, which has supported the FAA for more than 60 years. In addition, MITRE provides technical expertise to various international civil aviation authorities, airport operators, airlines, and other aviation organizations in air traffic management systems engineering, aviation operations, airspace design, and systems automation and integration.

Learn more at www.mitre.org.

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