SAFETY TECHNOLOGY DEVELOPMENT AND ASSESSMENT

Safety technology development and assessment are crucial in today's fast-paced and technology-driven world. With the accelerating pace of innovation in communications and networking, autonomy, artificial intelligence (AI,) and real-time alerting, the focus on safety technology is intensifying.

Human-Machine Teaming

Human-machine teaming (HMT)—essentially the effective interaction of human and technology—plays a crucial role in ensuring safety and efficiency in various systems. Designing technology to be a good teammate is complex, however. To support that process, MITRE's engineers wrote the book on human-machine teaming systems engineering and organized a framework and methodology for automation developers and AI technologies.

HMT includes interactions with touchscreens, voice recognition systems, and augmented reality applications, which enable users to access and control machines and systems seamlessly.

MITRE's Digital Copilot™, for example, employs these technologies to provide pilots with automated support in the cockpit, and is enabled by automatic speech recognition and location awareness. These cockpit safety enhancements

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focus on creating interfaces that are user-friendly, intuitive, and responsive, enabling operators to monitor and control machines and systems with ease.

Originally developed to give solo pilots a digital second pair of eyes in the cockpit, researchers are now exploring how this suite of capabilities could be applied to airline pilots. And they continue to expand on those capabilities. Recent additions include an application to prevent pilots from accidentally taxiing onto the wrong runway and an array of rotorcraft-specific applications to detect and mitigate some of the most common safety issues helicopter pilots encounter. To advance their adoption, all digital cockpit capabilities are being made available via license to industry for integration into existing or future products.

No job regarding safety would be complete without a thorough evaluation of the effectiveness of human-machine interfaces in reducing human error, improving system performance, and enhancing overall safety. Our Integration, Demonstration, and Experimentation for Aeronautics (IDEA) Lab accelerates our ability to explore new technologies, procedures, and human-machine interactions designed to improve aviation safety and efficiency in real-world or future scenarios.

It's also vital that software keep pace with the rapid pace of technological change in the aviation arena. To address that need, we've prototyped a framework to deliver new traffic management software in a fraction of the time traditional approaches take.

Communications and Networking

Effective communication and networking technologies—like encryption protocols, mesh networks, and redundancy strategies—and their integration are essential for safe and efficient transportation operations, whether on the surface or in the air.

MITRE's work aims to enhance the speed, reliability, and security of data transmission and communication between devices (like cars or airplanes), systems (like a city's infrastructure), and users. Air, sea, and land vehicles are more connected than ever, and enabling them to interact safely and securely with each other and the surrounding environment requires complex solutions. Part of our assessment of these solutions focuses on evaluating their robustness and resilience against potential threats, such as cyberattacks, signal interference, and equipment failure.

Autonomy

Autonomous systems, such as self-driving vehicles, drones, and robots, rely on advanced safety technologies to operate effectively and securely with minimal human intervention. The building blocks of autonomy in these systems involve the integration of various technologies, such as sensors, cameras, and software algorithms, to enable the accurate perception and interpretation of the surrounding environment. We're using our Driver Research for Intelligent Vehicles and Environments (DRIVE) Lab, Mobile Autonomous Systems Experimentation (MASE) Lab, and our Drone Range to explore how autonomous and highly automated systems will interact with their complex environment. Our assessments focus on evaluating their ability to make safe and appropriate decisions in various scenarios, as well as their resilience against potential failures or malfunctions to ensure autonomous systems can navigate and operate safely.

We're also working with partners at the state level to test drone technology and conduct safety risk analyses in a variety of scenarios. That work will help accelerate the maturation of drone technology as well as inform national policy and FAA rulemaking governing drone operations.

Artificial Intelligence (AI)

AI plays a significant role in enhancing safety technology by enabling machines and systems to learn, adapt, and make decisions based on data and real-time inputs. One way MITRE has deployed AI is in airport traffic flow management, the first human-AI teaming effort conducted for this purpose. Our tool focuses on creating algorithms and models that can analyze vast amounts of data, identify patterns, and predict potential safety and security risks or issues. As with any emerging technology, being able to assess its use is critical. AI and machine learning are inherently linked, and security is paramount, so MITRE developed Adversarial Threat Landscape for Artificial-Intelligence Systems (ATLAS™) to assess and evaluate the accuracy, reliability, and transparency of algorithms and models in making safety-critical decisions. Used by a variety of industries, MITRE has partnered with industry and academia to help organizations assess supply chain risk.

Real-time Alerting (Collision Avoidance)

Real-time alerting and collision avoidance systems are essential safety technologies that help prevent accidents and reduce the potential for human error. These systems use various sensors, cameras, and software algorithms to monitor the environment, detect potential hazards, and provide timely alerts or interventions to prevent collisions. Our work includes the Traffic Collision Avoidance System (TCAS), a nationally implemented onboard system that alerts commercial airline pilots about the presence of aircraft in the vicinity and provides guidance for avoiding a collision. More recently, MITRE partnered with MIT Lincoln Laboratory and Johns Hopkins University Applied Physics Laboratory to develop an award-winning technology called the Advanced Collision Avoidance System (ACAS), which will enable a drone to detect other nearby aircraft and either maneuver out of the way or communicate the threat to a remote operator on the ground.

To further develop and assess real-time alerting systems, we focus on improving their accuracy, responsiveness, and reliability in various conditions and scenarios using all of MITRE's laboratory, modeling and simulation, data analytics, and system performance capabilities. Examples of safety technology we're evaluating in the surface transportation domain include adaptive cruise control, lane departure warning systems, and automatic emergency braking systems. Our recent study of these advanced driver assistance systems explored their effectiveness at preventing collisions and improving overall safety on the road, research that will inform future vehicle safety design.

transportation@mitre.org

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