APPENDIX A:
U.S. DOT SBIR Proposed Fiscal Year 2025
Phase I Research Topics

Contents

Federal Highway Administration (FHWA)

About Us: FHWA's Research, Technology, and Education (RT&E) Program strives to generate new solutions, build more effective partnerships, and provide better information and tools for decision making, which will enable the nation to enhance and make the best investments in the U.S. transportation system.

FHWA's RT&E program supports research and development (R&D) to improve safety; the mobility of people and goods; stimulate growth, productiveness, and competitiveness; reduce congestion; improve durability and extend the life of transportation infrastructure, accelerate project delivery, and the transition to a transportation system that provides an equitable approach that serves all road users, including those in social and demographic communities that are underserved in access to mobility options and disproportionately represented in preventable and fatal injury.

The program accelerates the adoption of proven innovative practices and technologies as standard practices to significantly improve: safety, system efficiency, infrastructure health, reliability and performance, and a balanced approach to provide livable/sustainable communities across the Nation.

25-FH1: Open Standards-based 3D-Model Viewer for Highway Construction

The FHWA Building Information Management (BIM) program supports the intelligent 3D model-based approach that gives engineering and construction professionals the insight and tools to more efficiently plan, design, and build highways and bridges. The FHWA Advanced Digital Construction Management Systems (ADCMS) strategic program objectives and grant funding supports digital technologies and processes for management of construction and engineering activities. Through these programs, including activities outlined in the *Advancing BIM for Infrastructure National Strategic Roadmap*[1], owner agencies have identified a gap and need to fully leverage and deploy 3D design models into construction and inspection.

One challenge that faces the adoption of ADCMS and digital delivery is the lack of a simple 3D model viewer that can be used by construction staff in the field on consumer grade portable electronics and doesn't require advanced understanding of modeling, design, and associated authoring tools and software. Such model viewer capabilities in the field would assist owners and contractors with digital project delivery and usage of 3D design models and information during construction, inspection, and acceptance activities. The model viewer would help to ensure the design requirements, standards, specifications, and intent are met.

This research topic supports FHWA's Annual Modal Research Plan (AMRP) by accelerating the implementation and delivery of new innovations and technologies that support the goals of ADCMS. The primary goal of the ADCMS activity is to transform State DOTs and local planning agencies (LPAs) adoption of ADCMS technologies by promoting, implementing, deploying, demonstrating, showcasing, supporting, and documenting the application of ADCMS practices, performance, and benefits. ADCMS systems are generally defined as commercially proven digital technologies and processes for managing

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[1] Advancing BIM for Infrastructure: National Strategic Roadmap, June 2021 - FHWA-HRT-21-064, https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/21064/21064.pdf

construction and engineering activities. ADCMS also includes developing and supporting systems to enhance and share data across an asset's lifecycle and between organizational silos, maximizing interoperability across the agency.

Accelerated implementation and deployment of ADCMS is a priority for the U.S. DOT and FHWA and will ensure that highway construction is using best practices and leveraging advanced digital techniques to accelerate project delivery and increase the safety and efficiency of highway construction. The implementation will support digital transformation in the highway construction and engineering sectors and the advancement and implementation of BIM for Infrastructure, which is an open standards–based collaborative work method for structuring, managing, and using data about transportation assets and networks throughout their lifecycles. It liberates data from siloed systems, which is a repository of data that's controlled by one department or business unit and isolated from the rest of an organization and makes it easier for automated processes to generate asset information and distribute it to anyone within a State DOT when they need it.

Topic Objectives

To that end, the solution being sought aims to facilitate the use of 3D design models during construction by field staff without requiring modeling expertise or advanced skills to view and understand the design models and information to support construction operations and digital project delivery.

The solution shall be devised to provide functionalities to view and utilize 3D design models during construction without requiring the end user to be a modeling expert and not requiring expertise with 3D design authoring tools. The solution shall be capable of viewing model files that are compliant with Industry Foundation Classes (IFC) format and data requirements and be agnostic to any specific authoring tool or 3D model format.[2].

The solution will assist agencies in equipping their field staff with a simple method to access and view 3D design models, properties, and information during construction and inspection activities and ensure the as-constructed asset meets design requirements, materials properties, location, and dimensional requirements for acceptance and payment.

The solution can be either a stand-alone solution or a web-based solution. Stand-alone solutions must function on Microsoft, Android, and Apple iOS operating systems compatible with tablets and smart phones. Web-based solutions must work seamlessly in Safari, Edge, and Chrome browsers. The solution shall be designed with stakeholder needs in mind and undergo beta-testing through a FHWA approved group of personnel with a wide range of understanding of the subjects addressed by the solution and across different areas of responsibility.

The opportunity for commercialization in the United States is high. There are many State agencies that started the transition to digital delivery, utilizing 3D models as the legal document (MALD), and need capabilities for their construction and inspection staff to have access to the design model and information during construction, development of digital as-builts and hand off to asset management and

[2] Refer to buildingSMART International technical information at https://technical.buildingsmart.org/standards/ifc/

maintenance.[3] Using the model viewer, design and construction teams can connect remotely to visualize design data, features, location, orientation, and specification requirements throughout construction. Intricate design features and details can be viewed geospatially, in three dimensions, from multiple perspectives, and used during construction to build and inspect the project. This solution would provide a simple way to implement and advance digital project delivery, utilize 3D design models during construction, and ensure the capabilities and use by field staff during construction. Highway construction contractors would also significantly benefit from the solution with an easy to use and affordable solution that is compatible with various design authoring software in order to bid on MALD and other digital projects. Companies involved in private infrastructure projects can use the solution to optimize digital workflows and ensure compliance with owner specifications. Consulting firms can use the solution to provide specialized design and compliance services to various clients. Designers and authoring software companies can use the solution to improve their products and demonstrate the IFC compliance to potential buyers and owners. Academic institutions can use the solution for educating and training the next generation of engineers and construction project managers. In the future, an effective solution could make its way into other markets such as airfield/airport markets, ports or trucking distribution markets, railway, and other commercial construction markets, or international markets where digital project delivery is deemed critical to project success, facility operations, and economic viability. Specific stakeholders that could be involved in the evaluation and testing phase include the FHWA, one or more State Highway Agencies (SHA) using design models for construction and inspection in the field, academic institutions, and contractors that are interested in implementing the technology and solution.

Expected Phase I Outcomes

The Phase I project is expected to result in a proof-of-concept report that:

- Describes the development of the proposed solution and its architecture;
- Provides preliminary design and layout, and proposed requirements; and
- Discusses how to achieve the most effective implementation within agencies and contractor operations.

This involves creating detailed documentation and diagrams that describe how each capability and workflow will be implemented and function. Flowcharts and diagrams must show the overall structure and organization of function with more specific diagrams showing the interactions between different components and modules. It should also involve creating mockups and visualizations of the solution to help stakeholders and other members of the development team visualize and understand the design. Demonstrating a successful proof-of-concept would include an initial build or prototype of the solution to demonstrate initial functionality.

A market analysis is also expected within Phase I to gather information about available systems and software that state highway agencies and contractors across the United States use for digital delivery and use of 3D models by construction staff.

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[3] To view a list of States who have received grants through the ADCMS Program visit the "Grant Applications" section of https://www.fhwa.dot.gov/construction/adcms/grants.cfm.

Expected Phase II Outcomes

Phase II will include the development and demonstration of a market-ready solution for user testing and commercialization. Phase II shall perform further refinement of the Phase I concept and design to develop the final solution(s); and conduct analytical and experimental verification and testing. At the end of Phase II, the awardee will have developed a user-friendly solution that was tested in an operational environment with SHAs and contractors.

25-FH2: Modular Construction of Protected Intersection and Turbo Roundabout

In 2022, 7,522 pedestrians[4] and 1,084 bicyclists[5] were killed in traffic crashes, representing increases of 77 percent and 75 percent to the pedestrian and bicyclist fatalities in 2010, while all other traffic fatalities increased by 22%.[6] About two out of three pedestrian fatalities happened at locations with no sidewalk; about three out of four bicycle fatalities occurred in urban areas with poor bicycle infrastructure and lack of protected lane/space for cyclists. Meanwhile, the need to rely on walking and biking to school and work and other short-distance trips has been on a steady rise in major cities across the country. There is an urgent need to improve the safety for pedestrians and cyclists on the roadway network. Vision Zero is now embraced and officially adopted by most states and large cities; a key element of the Vision Zero policy is to drastically reduce pedestrian and cyclist fatalities by installing safe pedestrian and cyclist facilities along the roadway network.

Protected intersection is an innovative intersection design that uses corner islands and raised curbs to provide separate travel paths for motor vehicles, pedestrians, and cyclists. This design considers all modes of traffic but puts more emphasis on protecting and accommodating pedestrians and cyclists. FHWA has conducted a limited field evaluation which found that a protected intersection instills a higher sense of security to vulnerable road users and encourages people to use micromobility, such as walking, biking, and rolling, rather than cars for short-distance trips. According to the latest daily trip surveys, in the United States, 11 percent was done by walking and 1 percent was done by biking[7]; in the Netherlands, 35 percent was done by walking and 26 percent was done by biking[8]; in Europe, 25 to 30 percent of daily trips was done by walking and biking[9]. Successful examples from other countries indicate that network level implementation of protected intersection design can induce a change in traffic modes, which could replace 10 percent (5,6) or more short-distance single occupant vehicle trips with micromobility trips, leading to reduced congestion and pollution, reduced need for parking spaces, and a more livable and enjoyable environment.

One approach to a protected intersection is a turbo roundabout. A turbo roundabout is an innovative intersection design that uses raised lane dividers to separate vehicle lanes within the roundabout, eliminating weaving and angle conflicts near multi-lane exits. This design drastically reduces traffic crashes inside multi-lane roundabouts while providing better protection to pedestrians and cyclists.

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[4] Insurance Institute for Highway Safety (IIHS): Fatality Facts 2022: Pedestrians. https://www.iihs.org/topics/fatality-statistics/detail/pedestrians

[5] Insurance Institute for Highway Safety (IIHS): Fatality Facts 2022: Bicyclists. https://www.iihs.org/topics/fatality-statistics/detail/bicyclists.

[6] Governors Highway Safety Association (GHSA): Pedestrian Traffic Deaths Fall for First Time Since Pandemic. https://www.ghsa.org/resources/news-releases/pedestrians24.

[7] League of American Bicyclists®. n.d. "National: Rates of Biking and Walking" (web page). https://data.bikeleague.org/data/national-rates-of-biking-and-walking.

[8] Ministry of Transport, Public Works and Water Management. 2007. Cycling in the Netherlands. The Hague, Netherlands: Ministry of Transport, Public Works and Water Management. https://bicycleinfrastructuremanuals.com/wp-content/uploads/2019/02/Cycling_in_the_Netherlands_Netherlands.pdf.

[9] Buehler, Ralph and John Pucher, "Walking and Cycling in Western Europe and the United States." TR News, Number 280, May-June 2012. https://onlinepubs.trb.org/onlinepubs/trnews/trnews280westerneurope.pdf.

Topic Objectives

Traditional methods of constructing protected intersections typically involve cutting and removing existing pavements, which can be expensive. This SBIR project seeks to develop a modular construction approach for converting existing intersections into protected intersections using methods that do not require cutting and removing existing pavement. To ensure long service life, the modular construction material shall be able to be assembled and expand horizontally to form the shapes of typically corner islands and longitudinal curbs; the assembled units shall form one integrated structure with well-conceived ductile design to absorb and distribute vehicle impact loads, while functioning as lane dividers or vulnerable road user refuge areas.

The traditional method of constructing turbo roundabout lane dividers uses the key-in approach, which also involves cutting and removing existing pavements. Lane dividers are slender elements that are prone to fail under repeated lateral vehicle impact loads. So far, there is no reliable product that can be installed directly on top of pavement and survive more than five years of repeated vehicle impacts.

This SBIR research topic seeks the development of a product that is modular, strong, durable, and capable of withstanding repeated heavy vehicle loads. The ultimate objective of this topic is to achieve a final product which can be used for constructing raised islands to convert an existing intersection into a protected intersection, or raised lane dividers to convert a multi-lane roundabout into a turbo roundabout.

This SBIR topic aligns with the following FHWA AMRP Goals:

- Improving Highway Safety for All Users;
- Improving Infrastructure Integrity, Sustainability, and Practices;
- Promoting Equity, and Enhancing Environmental Decision-making;
- Reducing Congestion, Improving Operations
- Accelerating the Implementation and Delivery of New Innovations and Technologies
- Accelerating the Discovery of Transformational Solutions; and Crosscutting.

Proposed solutions must be a product which:

- Can be installed on existing pavement surface.
- Can be produced in different colors and surface textures to resemble conventional construction material such as concrete, brick, and stone.
- When assembled, will form an integrated structure and uses a ductile design mechanism to absorb and distribute vehicle impact loads.

Proposed solutions shall include material intended for use under high traffic environment, where the vehicle impact load may be any combination of compression, bending, and shearing, and where application sites may be located in extreme hot, cold, or wet environment. The installed product shall have service life of at least five years under the above conditions.

Potential customers include state DOTs, County and City Public Works Departments, and any other agency responsible for constructing and maintaining the roadway system. The links below show the types of intersections that the developed product may be used for:

- https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-23-052.pdf
- https://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa19027.pdf

Expected Phase I Outcomes

The Phase I effort will lead to a proof-of-concept report that includes:

- The development of at least three sample products, each of which will have color and surface texture resembling concrete, brick, and stone. The sample products should have compressive strength of 4,000 psi or above, and a minimum flexural strength of 500 psi, which is the typical strength for roadway concrete.
- Design details of how the modular material will be assembled or connected with each other to form an integrated structure; how the ductile design principle is implemented to absorb and distribute vehicle impact loads; and how the integrated structure is installed onto the pavement surface.
- Design features that enable slender structures such as lane dividers that are up to one foot in width to survive long term under vehicle impact load.

Expected Phase II Outcomes

Phase II outcome will include the construction of three intersections as demonstration projects: 1) two protected intersections with six lanes on a major road and 2) one turbo roundabout. The final report shall document the modular design, installation details, and lessons learned during the field implementation process.

25-FH3: Concrete Shrinkage Measurement Device

Sustainability initiatives domestically and globally have led to an increasing number of novel materials emerging in the cementitious materials market. With this increase, the ability to evaluate materials' performance is more important than ever before. Volume stability is a critical aspect of concrete pavement performance to reduce unwanted slab warping and cracking from shrinkage.

AASHTO R 101[10] identifies various shrinkage tests that can be performed targeting different types of shrinkage that cementitious materials may experience. Plastic, drying, chemical, autogenous, and carbonation shrinkage are all different types of shrinkage that can affect volume stability of cementitious materials. However, these different types of shrinkage are typically tested separately, with a different test method for each type of shrinkage.

Existing test methods do not sufficiently determine the total shrinkage from the time of initial stress development. Shrinkage test setups most commonly use length comparators to test shrinkage 24 hours after casting samples and immediately after demolding. However, much of the chemical and autogenous shrinkage occurs during that first 24-hour period. The lack of volume stability measurements during the first 24 hours of concrete curing would also fail to capture expansion that may have occurred during the first 24 hours[11]. AASHTO R 101 identifies the AASHTO T 363 test[12] which can be performed to measure shrinkage and expansion of cementitious materials and allows for estimation of cracking potential. However, the test is not commonly conducted (there are only three devices for performing AASHTO T 363 in the United States) because the development of the device and test setup is labor intensive and is not available commercially.

This research topic and potential solution(s) will contribute to the Department's strategic objective of designing for the future by investing in purpose-driven research. Additionally, this work supports the FHWA strategic objective of enhancing the performance of the nation's transportation system through research and accelerated development and deployment of innovative technologies by enhancing the ability of the concrete industry to accurately measure total shrinkage and expansion in concrete infrastructure mixtures.

Topic Objectives

Overall, this SBIR topic seeks to develop a device to measure total shrinkage and expansion of cementitious materials immediately upon initial stress development. Furthermore, the solution will reduce the amount of testing needed to measure the volume change expected for novel and traditional cementitious materials. The solution may include test equipment for 1) performing AASHTO T 363, 2) measuring volume change from drying, chemical, and autogenous means concurrently, or 3) another type of test equipment suited for this purpose.

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[10] AASHTO. 2022. Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures. AASHTO R 101-22. Washington, DC: American Association of State Highway and Transportation Officials.

[11] De la Varga, I., R.P. Spragg, J.F. Munoz, M.A. Helsel, and B.A. Graybeal. 2018. "Cracking, bond, and durability performance of internally cured cementitious grouts for prefabricated bridge element connections." Sustainability, Vol. 10, Issue 3881, DOI: 10.3390/su10113881.

[12] AASHTO. 2017. Standard Method of Test for Evaluating Stress Development and Cracking Potential due to Restrained Volume Change Using a Dual Ring Test. AASHTO T 363. Washington, DC: American Association of State Highway and Transportation Officials.

The solution to this challenge is creating test equipment that State Highway Agencies, industry professionals, and researchers can use to measure total shrinkage and expansion of mortar or concrete beginning immediately upon initial stress development.

Proposed solutions should:

- Identify the types of shrinkage (e.g., drying, chemical, carbonation, plastic, autogenous) that the proposed device can measure.
- Develop a device that should be useable in laboratory or field settings. The device should also be applicable for mortar or concretes, and should consider the effects of sample size, sample shape, edge effects, and temperature.
- Identify the amount of restraint associated with the test setup (i.e., the amount of friction from contact surfaces, whether the materials will allow for unrestrained movement, etc.).

Specific stakeholders that might participate in the evaluation and testing phase include the FHWA Office of Infrastructure R&D, one or more state highway agencies, building and transportation materials consultants, and academic institutions that are interested in implementing this technology to facilitate the comprehensive evaluation of novel materials emerging on the market. The combined autogenous and drying shrinkage and potential early-age expansion are important avenues to exploring the construction materials industry's increasing interest in low carbon materials.

Commercialization potential might include potential buyers in the construction materials industry, State DOTs, and research laboratories across the cement and concrete industries. Commercialization should also include long-term support and necessary updates to the technology to meet standards changes and to facilitate the device's use with other emerging materials. For example, there might be different needs for measuring alkali-activated materials compared to traditional hydraulic materials.

Expected Phase I Outcomes

The Phase I project is expected to result in a proof-of-concept report that (1) describes the conceptual design and requirements of the proposed device for cementitious materials volume stability, (2) provides a detailed scientific basis for the operation of the device, and (3) shares a comprehensive description of the proposed prototype(s).

The report should:

- Include an estimated timeline for the prototype(s) production, evaluation, and accuracy verification;
- Discuss critical opportunities and obstacles to implementation;
- Provide schematics and/or shop drawings of the equipment and/or device;
- Identify if any current test methods would allow use of the proposed device;
- Identify how setting time will be accounted when determining stress development;
- Evaluate the mechanism for measuring shrinkage and expansion;
- Provide example outputs that the device will generate, such as an excel spreadsheet providing volume change and time measurements, a graph displaying volume over time, or a net shrinkage measurement at one or more ages;
- Identify any necessary additional post-processing of the measurements or inputs;

- Illustrate a practical and tentative plan for conducting verification and demonstration in Phase II.

Expected Phase II Outcomes

Phase II will include the development and demonstration of a market-ready prototype device for user testing and possible commercialization with the ability to demonstrate the technology in a laboratory. Phase II shall perform further refinement of the concept, design, and fabrication of the prototype(s) and conduct analytical and experimental verification. In order to increase the likelihood of effective implementation, the experimental verification will include experimentation with:

- A wide range of concrete mixture types (e.g., paving, structural bridge deck, pre-cast).
- A wide range of cementitious materials (e.g., non-shrinkage grouts, ultra-high-performance concrete, PLC, natural pozzolan).

In Phase II, FHWA will also evaluate a delivered final prototype device(s).

Federal Motor Carrier Safety Administration (FMCSA)

About us: The mission of FMCSA's Office of Analysis, Research, and Technology is to reduce the number and severity of commercial motor vehicle (CMV) crashes and enhance the efficiency of CMV operation by: 1) providing data, producing statistics, and conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding, and 2) identifying, testing, and supporting technology transfer activities and deployment of CMV safety technologies.

25-FM1: Lidar-Based Tire Inspection

Tire inspections for commercial motor vehicles can be challenging for drivers and maintenance shops without the training and skills to perform an accurate inspection. Drivers typically kick tires or use a small bat to determine if the tires on the vehicle are below recommended pressure or flat. In addition, tires may be mismatched or damaged from a previous trip, making them apt to have a tire-related failure. Drivers and maintainers do not have access to tools that can provide a hands-off and accurate status of the vehicle’s tires in the immediate state and over time.

While more and more devices are being equipped with Light Detecting and Ranging (LiDAR), there are few applications for it beyond photography. LiDAR represents a powerful tool for characterizing the environment and objects, including the application for tire inspection.

Topic Objectives

The overall solution to the challenges of tire inspections includes using an existing LiDAR device to evaluate tires on a commercial motor vehicle while maintaining a wear and damage record of the tires on the vehicle. The record must be able to associate a specific tire with the vehicle as well as the tire’s position on the vehicle. When the vehicle is a combination unit, the solution must be able to recognize the trailer and the truck both as two different vehicles and as a matched set while in transit.

The solution should be able to detect abnormalities in the tire that indicate abnormal wear. Additionally, tires develop wear patterns or fingerprints over time that indicate the unique wear and damage they have experienced.

The user of the LiDAR enabled device should be able to analyze, document, and associate the scan to a power unit and a trailer prior to starting the inspection. The user should be able to perform a tire inspection of the vehicle by scanning each tire with the LiDAR enabled device. The user should be able to scan a large area of each tire (approximately 24 - 36 inches), depending on the visibility and body type of the vehicle, and obtain an analysis of each tire. The analysis should be able to tell the user if there is a problem with a tire that would prevent operation of the vehicle, such as a flat tire, and if there is a developing problem in the tire, such as misalignment, tire size issues, etc. The system must also be able to associate a tire with its position on the vehicle. When tires are rotated, the system shall be able to update quickly.

All data for the vehicle shall be stored on the device and transferrable by cellular to a web-based server for analysis. The web-based server shall associate every tire scan to its respective tire, vehicle, and tire position. The web-based server shall be able to analyze tire wear and wear patterns that indicate issues with the tire or vehicle.

The scanner must be a handheld device with built-in LiDAR. The advantage of using an existing LiDAR device is that more people can quickly adopt the technology with an application and a service subscription. The market for this device is large and could include both military and civilian privately owned vehicles. FMCSA is most interested in Motor Carriers with Commercial Motor Vehicles.

Expected Phase I Outcomes

The proof-of-concept report should include:

- A description of a successful demonstration of using LiDAR to evaluate tires with several typical issues.
- A framework for the intended web service to be developed in Phase II. The proposed solution can also be the “bones” of a web service.
- A report and presentation of lessons learned.

Expected Phase II Outcomes

A successful Phase II outcome is a substantially working system with vehicle and tire location association. The Phase II final report and presentation should include some tire analysis, a well-defined procedure for the tire inspection process, lessons learned, and future research opportunities.

25-FM2: Weight Equalization Smart Automatic Tire Inflation System for Commercial Motor Vehicles

Commercial Motor Vehicles (CMVs), contrary to common knowledge, do not equally share the weight of loads across all tires on the vehicle. In adjacent research, we find that when tires in a dual pair are equally inflated to the same air pressure, the load is not borne equally between the two tires. In addition, the adjacent research shows that collections of 8 tires on the drive axles of the power unit and the trailer axles on the trailer carry the weight quite differently. The result of an imbalance in the load on the tires reduces stopping power, decreases maneuverability, and increases the risk to the driver for crashes.

Since tires, even adjacent tires, respond differently to weather and road conditions, it makes sense that a single tire inflation figure for all tires on the vehicle is not improving the drivability of the vehicle. Often equal inflation pressures decrease the drivability. Given this, developing a new technology that can sense the load on each tire and adapt the inflation of the tires automatically will create a significantly safer road environment for all drivers. In addition, today drivers cannot change the tire pressures manually to mimic or prepare for changing conditions. For instance, a truck leaves Minnesota in January at -40F and drives to Miami, FL where the temperature is +80F. The change in temperature alone will dramatically increase the tire pressure as the truck moves south. Conversely, as the truck moves north, the pressures will decrease. Drivers cannot accurately stay ahead of this change while they drive. Also, drivers today perform per-trip inspections and rely on hammers and small bats to assess tire pressures, which is also inadequate.

Topic Objectives

A Weight Equalization Smart Automatic Tire Inflation System (WESATIS) for CMVs will automatically adapt for conditions while the truck is in motion creating a dynamic and accurate weight distribution on all tires in a group. These groups of tires on the trailer and drive axles of the truck will be more fuel efficient, wear the tires more evenly, provide significantly better stopping power, and improve maneuverability when the driver needs to make evasive movements to avoid accidents. This system would be expected to dramatically reduce CMV crashes, injuries and fatalities**.**

The system would have several components:

- A tire sensor that can wirelessly broadcast tire weight or strain information to an on-vehicle receiver.
- The receiver will notify the processor of the weight bearing on each tire.
- The processor will command the tire inflation system to inflate or deflate tires – within the safety parameters of the tire – to load balance the vehicle for optimal performance.
- The automatic tire inflation system will increase or decrease inflation on each tire.
- The microprocessor will continuously monitor the tire inflation and tire weight and make adjustments as conditions change.

At the core of the system would be sensors that measure weight. It is expected that the weight of the vehicle would be equally shared amongst all the tires on the drive axles and trailer axles. The accuracy of such a system might be +/- 50 lbs of total vehicle weight (base vehicle weight +cargo weight) on that set of axles. For instance, a truck may be carrying 32,000 lbs on the drive axles and 36,000 lbs on the trailer axles. The system would ensure that the weight bearing of the drive axles is approximately 4000 lbs each. On the trailer, the value would be 4500 lbs. All tires would bear the load equally. The system shall also have notifications to the driver if it is unable to inflate a tire (e.g. a nail in a tire that is letting air escape).

The system must operate with little driver interaction. Drivers should be notified that the vehicle is operational and carrying the load as expected. There must also be a warning system in case the truck's system is unable to keep a tire adequately pressurized.

The market here is quite large and could include military vehicles in addition to civilian privately owned vehicles. FMCSA is most interested in Motor Carriers with Commercial Motor Vehicles.

Expected Phase I Outcomes

The proof-of-concept report should include:

- A design of a prototype with some basic demonstrability of how the issues noted here would be addressed.
- System design and expected equipment and cost.

Market analysis to determine the market and associated cost parameters.

Expected Phase II Outcomes

Phase II should have a demonstrable system that can be shown on a CMV. The system shall be able to inflate and deflate based on a wireless tire-mounted sensor.

Federal Railroad Administration (FRA)

About Us: FRA's research, development, and technology (RD&T) mission is to ensure the safe, efficient, and reliable movement of people and goods by rail through basic and applied research, and development of innovations and solutions. Safety is U.S. DOT's primary strategic goal and the principal driver of FRA's RD&T program. FRA's RD&T program also contributes to other U.S. DOT strategic goals because safety-focused projects typically yield solutions toward state of good repair, economic competitiveness, and environmental sustainability goals. The RD&T program also has an important role to play in workforce development.

FRA's RD&T program is founded on an understanding of safety risks in the industry. Hazard identification and risk analysis allows us to identify opportunities to reduce the likelihood of accidents and incidents, and to limit the consequences of hazardous events, should they occur. Key strategies to these ends include stakeholder engagement, project prioritization, cost-effective research procurement, and partnerships with other researchers such as the Association of American Railroads (AAR), the American Short Line and Regional Railroad Association (ASLRRA), industry, labor, and academia.

25-FR1: Non-Destructive Longitudinal Rail Stress Measurement Device

The U.S. railroad network spans over 140,000 miles consisting of seven Class I railroads, 22 regional, and 584 local/short line railroads.[13] A variety of different rails, ties, fasteners, rail anchors, and other components make up the network. Continuous welded rail (CWR), which has a longitudinal stress-free temperature or rail neutral temperature (RNT), makes up much of the network. When the rail heats up in the summer, significant compressive stresses can build up and cause a sudden track buckle to relieve the stress. These buckles derail trains with disastrous consequences and are one of the costliest forms of track-caused accidents.

To date, there is no robust way to measure or monitor the rail longitudinal stress or RNT without disturbing the railroad track. A device that can be readily used by field personnel to measure the longitudinal stress or RNT could identify locations that might buckle soon, and thus have the potential to prevent track buckle derailments. Such a device would serve the interests of the public and rail operators through enhanced rail safety and operational efficiency, which supports the U.S. DOT's strategic objectives for safety, state of good repair, and transformation.

Topic Objectives

This SBIR topic seeks to develop and demonstrate new technologies that can reliably measure RNT non-destructively and preferably without a zero-reference. Such a technology must be proven in the laboratory before field test to ensure accuracy and repeatability with numerous variables. The only device that effectively estimates internal rail stress without damaging the system is the VERSE(R) system. This system has drawbacks in that it is labor intensive since it requires users to unfasten clips, and it only works when the rail is in tension. This topic seeks a more efficient method and technology that can work with rail in tension and compression states.

The proposed technology should be able to obtain a reliable RNT measurement within 1 hour of track time and within 5 degrees of the actual RNT for various rails and track constructions. The other

[13] https://railroads.dot.gov/rail-network-development/freight-rail-overview

requirements are purposefully flexible as this is a new technology, and the main goal is repeatability and accuracy.

Expected Phase I Outcomes

The Phase I outcome includes a proof-of-concept report which describes:

- The proposed technology
- Preliminary results of the demonstration of the technology in lab
- Plans for future field testing

Expected Phase II Outcomes

The Phase II outcome would be further validation of the prototype and the production of a pre-production prototype suitable for extensive field testing and demonstration with the potential for manufacturing at scale. Phase II should also include field tests on rail in varied track construction configurations (e.g., Wood vs. Concrete Tie, Cut Spike vs. Elastic fastener, etc.).

25-FR2: Development of Next Gen End of Train Device Technology

The U.S. railroad network spans over 140,000 miles consisting of seven Class I railroads, 22 regional, and 584 local/short line railroads.[14] This large and diverse system crosses various terrains, from remote rural areas and mountainous regions to densely populated urban centers. Communication between the front and rear of the train can be particularly difficult in mountainous areas where terrain blocks signals or in urban environments where interference is common.

End of Train (EOT) devices are crucial because they continuously monitor brake pressure and ensure communication between the end and head of the train. These devices communicate with the Head of Train (HOT) device, which can be more than a mile away, and help to maintain safe operations, especially during emergencies. As trains grow longer, with some now exceeding two miles, this communication becomes even more challenging, particularly on curving tracks or in difficult terrain.

EOT devices, developed in the 1980s and updated to two-way communication in the mid-1990s, have seen little technological advancement since. They monitor brake pressure at the rear of the train and trigger emergency braking when necessary. However, these devices have limitations, especially as train lengths increase and communication reliability becomes more critical.

FRA envisions a new generation of EOT devices that will address these limitations by enhancing communication frequency and signal reliability. These new devices could maintain more consistent and frequent communication by leveraging advances in battery life, alternative energy sources like air-driven generators, and modern digital communication systems. Additionally, they can improve safety by incorporating an emergency signal that transmits continuously until braking is confirmed.

Beyond communication, these new EOTs could offer benefits such as data management and cybersecurity features, providing real-time or downloadable data insights and ensuring system security.

Accidents such as the Granite Canyon incident in Wyoming underscore the importance of developing next-generation EOT devices. In that accident, communication between the EOT and the HOT device failed, preventing the activation of the emergency brake at the rear of the train. This communication failure allowed the train to accelerate uncontrollably, resulting in a fatal collision. Investigations revealed that the emergency brake signal from the EOT only transmitted for two minutes before stopping, further exacerbating the accident.

The National Transportation Safety Board (NTSB) made two key recommendations in response to the incident: (1) increasing the frequency of communication checks between EOT and HOT devices, and (2) ensuring that emergency brake signals continue to transmit until they are received and addressed. While the FRA has not yet updated regulations to reflect these recommendations, developing new EOT technology that addresses these challenges is critical. Implementing these improvements could prevent similar accidents in the future by ensuring more reliable and continuous communication, enhancing both safety and operational efficiency across the rail network. By enhancing both rail safety and operational efficiency, these advancements serve the interests of both the public and rail operators, helping to maintain the reliability of the U.S. railroad network.

[14] https://railroads.dot.gov/rail-network-development/freight-rail-overview

Topic Objectives

This topic seeks the development and demonstration of new technologies that enhance the efficiency and reliability of EOT devices. The topic's goals include increased frequency of communication between the EOT and HOT devices to ensure near-continuous monitoring, even over long distances or in challenging terrains. Additional objectives involve leveraging advancements in battery life and alternative energy sources to extend communication capabilities and developing more effective emergency signal systems that transmit continuously until they receive confirmation from the EOT. These innovations will provide greater safety, data management, and operational efficiency benefits for both rail operators and the public.

The performance requirements for this next generation of EOT devices are such that they must function reliably for all railroads, across all terrains, and without customization for specific routes. These devices must maintain consistent performance whether operating in mountainous, urban, or rural environments to ensure seamless communication over long distances regardless of track conditions or train length.

Expected Phase I Outcomes

The Phase I outcome includes a proof-of-concept report which provides:

- A detailed physical description of the proposed device(s) including renderings, drawings, or photographs.
- Descriptions of the device's communications framework and how they will interface with existing EOT/HOT technology.
- A description of how the device will be powered.
- A description of how the device will be protected against the environmental hazards of the rail environment.
- A description of how the device complies with current Federal regulations, while also improving the technology over current standards.
- An analysis of the proposed device's improvements over existing technology.
- An analysis of the feasibility of production, adoption, and maintenance.

The Phase I effort will produce a prototype, or "beta" version, of a "Next Gen EOT" system. The prototype may work with either existing HOT devices or a new "Next Gen" complementary HOT device. The awardee will collaborate with at least one railroad operator to test or demonstrate the system and collect feedback on the system's performance to prepare plans for Phase II enhancements.

Expected Phase II Outcomes

Phase II objectives include enhancing the Phase I prototype system based on the initial trials to improve the feature set and autonomy of the technology. The contractor will increase the number and type of demonstrations to broaden the application of the tool. FRA expects that a Phase II effort will require the awardee to have an established working relationship with a railroad to demonstrate the feasibility of a prototype.

25-FR3: Railroad Ground Hazard Mitigation Technology

Existing monitoring technologies to assess ground hazards along railroad rights of way such as slope failures, washouts, floods, rockfalls, and landslides tend to be designed for the specific territory and hazard making them site specific. While this supports safety risk management for known hazards, there is a gap in technology to identify and manage emerging hazards. As a result, there is a need for more efficient and effective hazard identification and warning system that serves the interests of the public and rail operators through enhanced rail safety and operational efficiency.

The challenge of this research topic is to develop technology to support an advanced ground hazard alert and notification system using railroad condition assessment data that provides improved technology to identify the hazard, location, and provides initial data to mitigate the operational risk. This research, and intended outcomes, support U.S. Department of Transportation safety, state of good repair, and future transformation strategic objectives.

Topic Objectives

This SBIR topic seeks the development and demonstration of new technologies to improve the efficiency and effectiveness of railroad ground hazard detection, monitoring, and warning systems.

The solution needs to:

- Enable industry assessment of ground hazard risks to locate specific areas of concern;
- Provide remote monitoring of these locations using satellite, weather, or other data generally available to the public;
- Develop effective automated warning algorithm to alert stakeholders of changes in conditions that pose a safety risk; and
- Support or advance implementation of a real-time Railroad Ground Hazard Detection, Monitoring and Warning System in cooperation with an operating railroad.

The commercialization potential has applications within the railroad community, including industry, suppliers, regulatory agencies, academia, and international counterparts.

Expected Phase I Outcomes

Desired Phase I proof-of-concept report and deliverables for this technology development should:

1. Demonstrate an adequate resolution to quantify a ground hazard in engineering terms using data from one or more data sources or sensors.
2. Support or advance implementation of a real-time Railroad Ground Hazard Detection, Monitoring, and Warning System in cooperation with an operating railroad.
3. Enable industry assessment of ground hazard risks to locate specific areas of concern; remote monitoring of these locations using satellite, weather, or other data generally available to the public; and development of effective automated warning algorithm to alert stakeholders of changes in conditions that pose a safety risk.

Expected Phase II Outcomes

Phase II outcomes should align with the level of effort and funding provided for Phase II. Phase II outcomes typically include further demonstration or validation of design/concept and/or prototype development.

Deliverables may include prototype iterations, software capabilities, or test results. Deliverables are typically documented in reports and not physically delivered to the Government.

The expected Phase II outcome is a demonstration of a working prototype that includes the following:

1. An alert system and one or more approaches that compiles and makes accessible the necessary algorithm for consumers.
2. Technology results.
3. A marketing plan.

25-FR4: Human Factors Fatigue Assessment System (HFFAS)

There is a growing need for research that measures levels of fatigue in locomotive engineers as documented in the Bipartisan Infrastructure Law, Transportation Review Board AR070 Committee Research Needs Statements, and FRA Office of Safety. Measuring fatigue of engineers during operation – either in real life or in a simulator – can play an important part in research and development (R&D) and testing and evaluation (T&E). This topic seeks novel approaches to measure fatigue using observational techniques instead of relying on self-reporting methodologies. Other modes have had success using similar systems (NHTSA, FHA, FAA, etc.) to measure types of fatigue.

Topic Objectives

FRA is seeking a system developed specifically to measure fatigue for locomotive engineers during operation on a simulator and actual engine using camera systems and multiple behavioral indicators of fatigue for near-real time assessment of fatigue for testing. This Human Factors Fatigue Assessment System (HFFAS) will be a software and hardware system suite that uses a camera system to measure multiple potential factors (e.g., facial expression analysis, body language assessment, movement statistics such as sway and speed deviations, etc.) to provide human factors analyses to determine the level of fatigue a locomotive engineer is experiencing. The objective of this topic is to develop a system that can measure behavioral indicators and antecedents of fatigue, analyze data, and provide a fatigue level measurement in near-real time. FRA may support system testing and demonstration at DOT's Transportation Technology Center (TTC) in Pueblo, Colorado for Phase II development activities.

The HFFAS shall use multiple behavioral indicators of fatigue to assess an overall fatigue level which users can validate against existing standardized measures of fatigue. Field equipment such as cameras, eye trackers, body trackers, etc. must be able to easily measure behavioral indicators in the HFFAS. The total combined weight of the entire system, including associated computer for analysis and near-real time data analysis and reporting, should not exceed 50lbs.

Expected Phase I Outcomes

Phase I will include a proof-of-concept report describing:

- The solution and components to the system,
- Behavioral and/or psychophysiological measures,
- The method used to combine data into a fatigue score framework,
- Alternative analysis of existing systems,
- User and/or system requirements, and
- The initial prototype design.

Expected Phase II Outcomes

Phase II will include a final report indicating the:

- Results of the field testing and piloting,
- Validation of the system and measures,
- Demonstration of a fully developed system, and
- Identification of gaps in the initial design and recommendations to enhance and/or expand the system.

Federal Transit Administration (FTA)

About Us: The Federal Transit Administration's (FTA) mission is to improve America's communities through public transportation. We envision a better quality of life for all built on public transportation excellence. The Office of Research, Demonstration and Innovation, which directs FTA's research program, provides industry and policy makers with the information and skills to make good business decisions about transit technology, operational, and capital investments. The program uses research results to identify best practices and shares this information with others who can benefit from it. Through its research, FTA shows a range of outcomes that help direct where future transit investments should be made.

25-FT1: Exploring AI-based Predictive Maintenance for Public Transit Fleets

"Predictive maintenance is an approach that tries to prevent catastrophic failure of scheduling maintenance operations and detects the type of failures on the basis of the current condition of the machine. It is also referred to in the literature as condition-based maintenance since it uses actual operating conditions of the equipment to predict the future state of the machine, using a model defined on the basis of historical data where sensors are applied in machinery to continuously monitor signals, or other appropriate indicators, to assess the health of the equipment."[15] Transit agencies can benefit from an intelligent predictive model that analyzes their transportation rolling stocks, determines the current conditions, predicts when they need to be replaced or rehabilitated, and determines the funding needed to replace in a future year to maintain the state of good repair.

Since many transit agencies do not have adequate analytical tools for predicting the service life of their fleets, exploring the use of AI predictive model would be a valuable resource for identifying their state of good repair needs and prioritizing their capital needs for fleet replacement and rehabilitation. This research topic will explore the potential of AI applications for predictive maintenance by harnessing the power of data-driven insights to optimize maintenance schedules, reduce downtime, and improve overall fleet performance improvements and safety.

Topic Objectives

One of the main objectives of the research in Phase I is to conduct a feasibility-study of the potential solutions of AI use for predictive maintenance opportunities in public transportation systems. It also includes a thorough review of relevant information, such as studies, reports, industry publications, and market trends to help establish the foundational knowledge to identify potential risks, challenges, and key success factors for the use of AI approaches in predictive maintenance applications.

As AI technology advances, there are growing benefits and increasingly sophisticated predictive maintenance solutions. This technology has the potentials for:

- Real-time Monitoring: enable real-time monitoring of transit fleet conditions to allow immediate intervention when maintenance issues arise.
- Enhanced Diagnostics: analyze data with even greater precision, pinpointing the root cause of potential problems and enabling more targeted repairs.

[15] Cavalieri S, Salafia MG. A Model for Predictive Maintenance Based on Asset Administration Shell. Sensors (Basel). 2020 Oct 23; https://pmc.ncbi.nlm.nih.gov/articles/PMC7660343/.

- Diagnosing Vehicles: as vehicles become even more intelligent, they will be capable of self-diagnosing problems and communicating maintenance needs directly to fleet managers.
- Integration with Other Technologies: seamlessly integrate AI with other technologies such as autonomous vehicles to further optimize logistics and transportation operations.

The integration of AI innovations in preventive maintenance offers numerous benefits for fleet management, including:

- Reduced Downtime: by predicting potential failures and proactively scheduling maintenance, the AI can reduce vehicle downtime to ensure fleet vehicles are always in optimal operation condition.
- Cost Savings: AI-driven preventive maintenance helps to identify and address issues before they escalate, reducing the need for expensive repairs.
- Improved Operational Efficiency: real-time monitoring and automated maintenance schedules enhance operational efficiency by ensuring prompt and accurate performance of maintenance tasks.
- Enhanced Safety: by ensuring that vehicles remain in optimal condition, AI innovations in preventive maintenance contribute to improved safety for drivers and passengers.

The future of preventive maintenance could be shaped by several emerging trends in AI technology with:

- The integration of AI with the Internet of Things (IoT) devices will further enhance predictive maintenance capabilities. IoT sensors can provide a wealth of data on vehicle performance, which AI algorithms can analyze to predict and prevent failures.
- The development of more advanced machine learning algorithms will enable even more accurate predictions of vehicle failures. These algorithms will be able to analyze vast amounts of data and identify patterns that may not be apparent to human analysts.
- Cloud-based AI solutions will allow fleet managers to easily access and analyze data from anywhere. This will facilitate better decision-making and ensure efficient maintenance activities.

For small businesses, incorporating AI can provide competitive advantages such as the ability to streamline operations, predict market trends, and respond to customer demands with greater agility. The technology can empower these businesses to reduce their operational costs by proactively managing their inventory, enhancing supply chain transparency, and optimizing delivery routes.

The following references provide additional information to help support this topic.

- https://cms.uitp.org/wp/wp-content/uploads/2020/08/UITP-AP-CTE-AI-in-PT-Executive-Summary-Dec-2018_0.pdf
- https://www.researchgate.net/publication/382622809_The_Impact_of_AI_and_Cloud_on_Fleet_Management_and_Financial_Planning_A_Comparative_Analysis/link/66a56b464433ad480e80bee6/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19
- https://papers.phmsociety.org/index.php/ijphm/article/view/3583
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7660343/

Expected Phase I Outcomes

The Phase I proof-of-concept report should define the concept solution with specifications for designing, building, and testing in Phase II.

Expected Phase II Outcomes

Phase II should build on the Phase I concept to develop a working prototype, in the form of a software or tool, that has undergone demonstration and testing at a transit agency. The Phase II awardee must work with at least one transit agency to test and demonstrate how the product will work.

National Highway Traffic Safety Administration (NHTSA)

About us: The National Highway Traffic Safety Administration's (NHSTA) mission is to save lives, prevent injuries and reduce economic costs due to road traffic crashes, through education, research, safety standards and enforcement activity. NHTSA's research offices are the Office of Vehicle Safety Research and the Office of Behavioral Safety Research. The Office of Vehicle Safety Research's mission is to strategize, plan, and implement research programs to continually further the agency's goals in reduction of crashes, fatalities, and injuries. Our research is prioritized based on potential for crash/fatality/injury reductions and is aligned with Congressional Mandates, along with DOT and NHTSA goals. The Office of Behavioral Safety Research studies behaviors and attitudes in highway safety, focusing on drivers, passengers, pedestrians, and motorcyclists, and uses that to develop and refine countermeasures to deter unsafe behaviors and promote safe alternatives.

25-NH1: Automated Police Crash Report Data Collection and Management Software

In support of five DOT innovative principles and the National Highway Traffic Safety Administration's (NHTSA's) Annual Modal Research Plan, this project aims to develop software with automation features and capabilities that integrates into current crash report software of law enforcement agencies (LEAs).

Law enforcement officers are tasked with completing crash reports and submitting crash information to entities overseeing their agency's jurisdiction, such as the state-level Department of Transportation or Department of Motor Vehicles. To help NHTSA gather more robust data, crash reports should be accurate, complete, uniform, timely, accessible to users of data, and in a format that supports data integration with other data and systems, in accordance with NHTSA's Model Performance Measures for State Traffic Record Systems. However, officer exposure to traffic while capturing crash information increases their risk of being involved in a secondary crash. Additionally, forms that officers submit may have issues such as incomplete, missing, or inaccurate data. Data and data quality may not be uniform and may vary widely within and between agencies, creating difficulties in comparisons and missed opportunities for identifying contributing factors. Further, completing the forms may take a significant portion of the officer's time, which may lead to poor quality data as the officer may rush or not have enough time to complete their task. NHTSA is mindful of officer roadway exposure to secondary crashes and inaccuracies in data collection and looks for ways to reduce risk while improving data quality. Discrepancies between reported crash characteristics and actual crash characteristics lead to biases not only in NHTSA's crash fatality and injury data, but also the state's records. As such, findings and results are affected, and the implications supported by the statistics may be invalid. Data-driven programs, policies, and procedures that are implemented as a result are not precise.

For this project, NHTSA will collaborate with small business researchers to explore the use of automation to reduce police officer exposure to secondary crashes and assist in populating police crash reports of LEAs. As such, the automation must fully integrate into various crash report software used by LEAs. This partnership will also assist NHTSA in enabling LEAs to increase accuracy, timeliness, completeness, and uniformity of crash reports through the reduction of missing data and coding errors. This will improve accessibility and integration, thereby improving the quality of the data NHTSA uses for its Fatality Analysis Reporting System (FARS).

The proposed SBIR project also aligns with NHTSA's FY2023 and FY2024 AMRP program areas for the Office of Behavioral Safety Research (OBSR): Highway Safety Research. A key component of highway safety research is the monitoring and measurement of safe and unsafe driving behaviors to track progress and identify emerging safety problems, all of which are captured as elements in crash reports.

Topic Objectives

This SBIR topic seeks the development of software with automation features and capabilities that integrates into various LEAs police crash report software to more efficiently capture and manage crash information and populate the fields on the crash report, limiting exposure of law enforcement to traffic. Information that the automation software collects must align with the Model Minimum Uniform Crash Criteria (MMUCC). MMUCC represents a minimum, standardized set of data variables to describe motor vehicle traffic crashes. This can help to identify traffic safety problems and design countermeasures to improve traffic safety nationally and in each state. Overall, the software must collect data at the crash, vehicle, and person level using a combination of input methods. It must also add officer identification. The software must allow for differences in data collection formats as states and territories vary in how they gather and submit data elements. All Personally Identifiable Information (PII) and Public Health Information (PHI) safeguards must follow the same protocols which LEAs currently use.

The software with automation features and capabilities must employ a variety of collection methods, including:

- Geolocating to determine the location, date, and time;
- Integrating Federal Highway Administration's (FHWA's) Model Inventory of Roadway Elements (MIRE) data to determine roadway characteristics and traffic inventory elements;
- Capturing an image of the scene and drawing inferences from photo contents and positioning of such contents;
- Pulling current location-based weather and lighting conditions; and optical character recognition for scanning capabilities.

Additionally, the software must collect, transcribe, and integrate officer narrative. One example is the ability to perform speech-to-text transcription. The automation software should also be able to create and add a crash diagram to the record. Type ahead, or predictive text, and keywords for text fields must be an incorporated feature. The software must collect and integrate FARS data elements at the crash, vehicle, and person level found on NHTSA's Fatality Injury Reporting System Tool (FIRST). For example:

- Crash Level Data Elements: Time-based data (e.g., date, day of week, weekend, minute), Atmospheric conditions (e.g., snow, cloudy, severe crosswinds), Crash type (e.g., single vehicle), First harmful event (e.g., collision with fixed object)
- Vehicle Level Data Elements: Vehicle type (i.e., make, model, body class), Vehicle identification (VIN, license plate number, registration State and County), Owner and address, Motor carrier or responsible entity (i.e., type and identification)

- Person Level Data Elements: Identity, Ejection, Injury type and severity, Person type (e.g., driver, pedestrian), Related factors – Person level (e.g., overcorrecting, improper lane usage), Demographics (e.g., age)

The proposed project will accept any software and hardware platforms. The performer should, to the extent feasible, describe the potential for, and any challenges with, integration with market-prevalent software and hardware platforms available to consumers.

Commercialization potential is expansive as all police agencies in the United States may adopt the automation software to streamline management operations and data collection. The Federal Bureau of Investigation reports that in 2023, there were 19,156 law enforcement agencies.[16]

The awardee should demonstrate a knowledge of recent publications in automation, especially integrating data of different formats and sources into one record. Knowledge of automation systems that can generate new content, such as text and images, is necessary for project success.

Expected Phase I Outcomes

The Phase I outcomes should include:

1. Collection of data sufficient to address the specifications from the topic description and table above.
2. Prototype design and specification for the Automated Police Crash Report Data Collection and Management Software to address the project's requirements.
3. Proof of Concept paper including a testing plan to determine, at a minimum, the device's sensitivity, validity, and reliability with a sufficient sample size for meaningful analyses. The paper should also discuss the feasibility for LEAs use, and any potential legal issues.

Expected Phase II Outcomes

Phase II outcomes should include a functioning prototype of the Automated Police Crash Report Data Collection and Management Software. The prototype must demonstrate the ability to integrate officer information and crash-level, vehicle-level, and person-level data consistent with MMUCC standards into police crash reports software of LEAs to fully populate the fields and be amendable as agencies require.

The opportunity for subsequent development after Phase II may be possible to expand the functionality of the prototype.

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[16] https://cde.ucr.cjis.gov/LATEST/webapp/#/pages/le/pe