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The Virginia Tech Transportation Institute (VTTI) conducts research to save lives, time, and money and protect the environment. Researchers and students from multiple fields are continuously developing the techniques and technologies to solve transportation challenges from vehicular, driver, infrastructure, and environmental perspectives.

As one of six premier research institutes created by Virginia Tech to answer national challenges, VTTI has effected significant change in public policies for driver, passenger, and pedestrian safety and is advancing the design of vehicles and infrastructure to increase safety and reduce environmental impacts.
MESSAGE FROM THE DIRECTOR

TOM DINGUS
PH.D., CHFP
Director of VTTI
President of VTT, LLC
Endowed Professor of Engineering at Virginia Tech

Driving through adversity

As is true with virtually all of our constituents, partners, and sponsors, COVID-19 has continued to impact our ability to conduct research throughout the 2021 fiscal year. In true VTTI fashion, however, we have turned controversy into opportunity. We are opening up our research, we have written many new proposals and publications, and we have received many exciting new awards. Perhaps more than any time in our past, we are poised to grow rapidly (as of this writing, we have many new job openings across all levels of the organization) in the coming year. I am particularly proud that VTTI has continued to advance and has achieved multiple milestone accomplishments despite these challenging times that will help to shape the future of transportation.

Some of these accomplishments will be described in this report in detail. I did, however, want to highlight a couple of major advancements at VTTI for the 2021 fiscal year.

Opening of the Virginia Smart Roads Rural Roadway Expansion:
The fourth expansion to the Virginia Smart Roads, the Rural Roadway Expansion, opened in November 2020. The Rural Roadway is designed to recreate the challenges of driving on rural roads and will be the first test bed of its kind built with automation and other advanced testing in mind. This expansion is crucial to the advancement of transportation research as the majority of roads across the United States reflect the challenging features that are incorporated into the Rural Roadway expansion. The complete Smart Roads expansion is expected to have an overall economic impact of more than $285 million on the local area during its first decade and create 156 jobs in the region by 2026.

Collaboration with the City of Falls Church:
VTTI and the City of Falls Church partnered together on a Smart Cities test bed which is set to bring cutting-edge transportation technologies to the Falls Church area. The test bed is located near the Virginia Tech Falls Church campus and will connect Virginia Route 7 to the West Falls Church Washington Metro Area Transit Authority site. The $10 million project will assist in testing and developing transportation technologies that will benefit the citizens through improvements in efficiency, safety, and response.

Reorganization into Divisions:
During the 2021 fiscal year, VTTI restructured 12 research centers into five research divisions with two centers. The new divisions are:

- The Division of Data & Analytics, led by Michelle Chaka
- The Division of Freight, Transit, & Heavy Vehicle Safety, led by Rich Hanowski
- The Division of Technology Development & Deployment, led by Zeb Bowden
- The Division of Technology Implementation, led by Mike Mollenhauer
- The Division of Vehicle, Driver, & System Safety, led by Zac Doerzaph (which also houses the Center for Injury Biomechanics, a partnership with the Institute for Critical Technology and Applied Science and Department of Biomedical Engineering and Mechanics)
- The Center for Sustainable and Resilient Transportation Infrastructure, led by Gerardo Flintsch (a partnership with Civil and Environmental Engineering [CEE])
- The Center for Sustainable Mobility, led by Hesham Rakha (a partnership with CEE)

Looking to the future, VTTI recognizes that modern transportation challenges need modern transportation solutions. The new divisions and leadership will increase the Institute’s agility to address current and future transportation needs.

VTTI Responding to Safety Needs:
VTTI researchers responded to safety needs in a variety of ways during the 2021 fiscal year. These life changing responses included air control systems for public transit to increase air quality and air flow, rear seat reminder technologies to eliminate pediatric deaths in hot vehicles, and the transition to virtual learning to continue to educate new drivers on sharing the road with freight, transit, and heavy vehicles.

Despite facing multiple challenges during the 2021 fiscal year, VTTI was still able to drive through adversity and assist in saving time, lives, money, and protecting the environment.

As I look back across my time here at VTTI in preparation for my retirement as Director, I am honored to have participated in the incredible growth and impact of our world-class institute, and I excitingly wait to see what VTTI does next to make the world a better place.
VTTI has an infrastructure worth more than $120 million that includes multiple test beds used extensively for real-world, impactful transportation research across both broad and edge-and-corner scenarios; more than 120,000 square feet of building space in Blacksburg and Alton, Va.; and more than 100 owned and leased instrumented vehicles, including connected-automated light and heavy vehicles. VTTI also owns an autonomous micro-transit shuttle that has been instrumented and deployed for a variety of automation research projects.
Test Beds
Headquartered at VTTI, the Virginia Smart Road is a controlled-access facility managed by the institute and owned and maintained by the Virginia Department of Transportation (VDOT). The road is built to Federal Highway Administration specifications and features seven roadside equipment (RSE) units and two mobile RSE sites that facilitate connected-vehicle communications; an optical fiber communications system; Ethernet fiber transceivers and Ethernet switches; a connected-vehicle-compatible intersection controller model; varying pavement sections and in-pavement sensors; 88 weather-making towers capable of producing snow, rain, and fog; a differential GPS base station for precise vehicle locating; a signalized intersection with complete signal phase and timing control; a wireless mesh network variable control system; and variable pole spacing designed to replicate more than 90% of national highway lighting systems.

In 2017, the institute held a ribbon cutting/groundbreaking ceremony with partners VDOT and Virginia Tech to unveil four unique expansion projects, each building upon the Smart Road testing capabilities and now collectively known as the Virginia Smart Roads: 1) The Surface Street, which features a residential/urban layout with real and reconfigurable buildings, roundabout/stop-controlled intersections, automation-compatible pavement markings, and connectivity to the Smart Road; 2) The Live Roadway Connector, providing a seamless transition between live traffic and the closed test tracks of the Smart Roads while bringing the total length of the highway section to 2.5 miles; 3) The Rural Roadway, which is the first of its kind and will facilitate advanced-vehicle testing on a controlled rural roadway environment, with hilly, winding roads; short site distances; and infrastructure built to 1965 standards; and 4) The Automation Hub, located on-site at the Virginia Smart Roads, which facilitates short turnaround projects focused on advanced-vehicle testing in collaboration with VTTI researchers, industry leaders, and Virginia Tech students, among others. All four of these facilities are now open and being fully utilized.

The Virginia Smart Roads are designed to complement the public testing capabilities offered by the Virginia Connected and Automated Corridors. In 2014, VTTI partnered with VDOT to unveil the Virginia Connected Corridors (VCC), which comprise the Smart Road and Interstates 66 and 495, as well as U.S. 29 and U.S. 50 (one of the most congested corridors in the U.S.). The VCC is facilitating the real-world development and deployment of connected-vehicle technology via dedicated short-range communications and cellular technology. Using more than 60 RSEs located along the corridors, VDOT and researchers from multiple institutes across the Commonwealth are implementing connected applications that include traveler information, lane closure alerts, and work zone and incident management.

In 2015, VTTI partnered with VDOT, Transurban, the Virginia Department of Motor Vehicles, and HERE (a high-definition mapping business) to unveil the Virginia Automated Corridors (VAC). This initiative provides an automation-friendly environment that government agencies, auto manufacturers, and suppliers can use to test and certify their systems, providing a system migration path from test-track to real-world operating environments. The VAC leverages extensive experience in on-road safety research to provide efficient solutions to automated-vehicle testing. The VAC was developed to answer the Virginia governor’s 2015 proclamation that Virginia is “open for business” in the realm of automated vehicles. The proclamation allows the testing of any automated vehicle on Virginia roads under the guidance of VTTI. The Virginia Department of Motor Vehicles supports research efforts performed by VTTI in accordance with the proclamation. With assistance from the Commonwealth of Virginia, the VAC will advance the development, testing, and deployment of automated-vehicle technology, with the ultimate goal of helping stakeholders create robust advanced driver assistance systems and automated driving system-equipped vehicles.

Faculty and students associated with the U.S. Department of Transportation-awarded Safety through Disruption National UTC—a consortium led by VTTI with partners Texas A&M Transportation Institute and San Diego State University—have access to the Virginia Smart Roads and the VAC/VCC to perform research into disruptive technologies, such as automated and connected vehicles, big data analytics, and transportation as a service. Current UTC projects include assessing the impacts of connected-vehicle technology on automated-vehicle safety, developing a connected smart vest for improved roadside work zone safety, using disruptive technologies to support safety analyses, modeling driver responses during automated-vehicle failures, and determining the safety perceptions of transportation network companies by the blind and visually impaired.
FACILITIES

Blacksburg Facilities

The traditional laboratories at VTTI are housed in four buildings totaling more than 90,000 square feet. Building I is 30,000 square feet and houses offices, laboratories, and garage facilities. Low-service laboratories include facilities dedicated to driver interface development, eye-glance data reduction, lighting research, accident analysis, accident database analysis, pavement research, and traffic simulation. The National Surface Transportation Safety Center for Excellence building comprises 22,000 square feet of office and laboratory space. VTTI expanded its on-site capacity by 7,000 square feet of warehouse space and housing for a paint booth facility and a lighting lab. An additional 24,400 square-foot annex opened in 2013. Most recently, VTTI constructed its newest building, the Automation Hub, adding nearly 15,000 square feet of office and laboratory space adjacent to the Virginia Smart Roads. To supplement and support the research endeavors of the institute, facilities feature a fully staffed garage and machine shop to instrument experimental vehicles. Technicians and engineers use full-scale machine and welding shops, electronics laboratories, and garage facilities to customize transportation hardware and software designed to collect large amounts of data. These facilities are also used to support the maintenance and expansion of the Virginia Smart Roads systems and capabilities. Additionally, VTTI occupies an adjacent seven-bay, 12,600-square-foot garage. This facility is used to store the VTTI instrumented vehicle fleet and the equipment necessary for research and Virginia Smart Roads operations.

Information Technology (IT) at VTTI provides end-to-end systems development and support that enables and enhances the institute’s research mission and vision. Services provided include support for daily information technologies, comprehensive computational and data analytics systems engineering, advanced application development, computational systems and database administration, and information security expertise. VTTI IT experts continually work with research groups to develop and optimize solutions that support ongoing projects and research, establish data analysis pipelines for production-level research, and create custom solutions for special projects. IT is the core of the data-intensive research program at VTTI, with “Big Data” computational and storage infrastructure leveraging four data center facilities. The main VTTI facility houses systems to support institute operations and provides network segmentation to secure data reduction labs and a secure data enclave. A second data center located at the Virginia Tech Andrews Information Systems Building houses the bulk of the VTTI high-performance computational, database, and storage operations. Computational systems in the Andrews facility can also be dynamically configured to virtually reside within the VTTI secure network, creating an “Algorithmic Enclave.” Additional data centers at Steger Hall on the Virginia Tech campus and at the Fralin Biomedical Research Institute in Roanoke, Va., provide redundancy and operate to ensure data retention and resiliency. Continually growing capacities include a 4.2 PB database and associated storage, 10.2 PB Network Attached Storage (NAS), and 7 PB archive storage. Compute processing is driven by 1,920 cores and 37 Graphical Processing Units (GPUs).

Southern Virginia Facilities

The Global Center for Automotive Performance Simulation (GCAPS) located in Alton, Virginia, operates in many areas of the mobility eco-system to support tool and technology development. The services provided by GCAPS include tire test characterization, tire modeling, vehicle dynamics modeling, scenario development, environment and event modeling, sensor modeling, control algorithm development, simulation support, and research and performance analysis. GCAPS has a global sponsor base that includes vehicle manufacturers, technology companies, tire manufacturers, and motorsport teams. GCAPS is engaged with a wide spectrum of mobility thought leaders from around the globe and exists to advance mobility technologies, enable job creation, and promote economic development in Southern Virginia. We are an organization built on core values.

Accelerated Pavement Testing

VDOT and VTTI launched an accelerated pavement testing program in 2015, which uses a heavy-vehicle simulator that continuously applies a weighted load to test pavements over several months. This testing simulates the natural wear and tear caused by heavy trucks on road surfaces. The program is expected to result in cost savings in road maintenance and will enable VDOT to determine how different pavement designs and materials respond to load testing prior to integration on the road. Since its inception in 2015, the program has resulted in nearly $3.3 million in expenditures.

VTTI Vehicle Fleet

The VTTI vehicle fleet is uniquely instrumented for specific experiments. Researchers use the vehicle fleet for Smart Roads tests, and experimental test vehicles are used to develop new instrumentation packages and complement research endeavors. Several vehicles are long-term loaners from vehicle manufacturers, VDOT, and other partnering organizations. All vehicles are maintained in-house, when possible, with fully functional garages and a machine shop. Loaned vehicles are maintained in cooperation with the organization that provided the vehicle.
PROJECT HIGHLIGHTS
VTTI and the University of Massachusetts Traffic Safety Research Program (UMassSafe), a division of the UMass Transportation Center (UMTC) completed An Examination of Emergency Response Scenarios for Automated Driving Systems (ADSs) funded by the Automation and Public Safety Common Solutions (APSCS) Consortium organized through Collision Avoidance and Metrics Partners (CAMP, LLC). This work considered the interactions of vehicles equipped with public safety officials (e.g., law enforcement, fire, and rescue). The research analyzed common scenarios where public safety officials must engage in several different interactions and interaction types with a broad spectrum of public and private vehicles, protocols used during those scenarios and the different interactions and interaction types, and how the current operations may change due to the introduction of ADS-equipped vehicles in driverless operation (DO).

Many Federal Motor Vehicle Safety Standards (FMVSS) were created with the underlying assumption that vehicles include standard equipment such as a steering wheel, brake pedal, and driver’s seat. However, innovative vehicle designs may appear in vehicles equipped with ADS that lack a physical steering wheel, brake pedal, or have a designated driver’s seat. In this project sponsored by the National Highway Traffic Safety Administration (NHTSA), the Division of Data and Analytics is leading a team of experts from the automotive, legal, and research sectors to examine the current FMVSS to develop technical translation options and associated testing procedures for emerging innovative vehicles designed to be operated exclusively by ADS. This ongoing project has produced two reports thus far: Volume 1: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/ads-dv_fmvs_vol1-042320-v8-tag.pdf and Volume 2: https://rosap.ntl.bts.gov/view/dot/54442.

The VTTI-affiliated Center for Injury Biomechanics (CIB) continued to conduct groundbreaking research into injury biomechanics, injury modeling, and transportation-related injury biomechanics. This includes the NHTSA-funded FMVSS Considerations for Vehicles with Automated Driving Systems project (VTTI serves as the PI) for which the CIB is examining safety performance for occupants seated behind the first row Sled tests are being performed using the THOR-SOM and Hybrid III 50th percentile male Anthropomorphic Test Devices (ATDs), and postmortem human surrogates (PMHS) positioned in the rear seats of vehicle bucks. Finite element modeling of the ATD and PMHS tests is being performed. Crashworthiness is being compared to vehicle characteristics. Comparison to like vehicles in the fleet is being used to estimate potential real-world exposure and risk.

VTTI was awarded NHTSA’s Vehicle Electronic Systems Safety Indefinite Delivery, Indefinite Quantity contract. VTTI has teamed with vehicle manufacturers, suppliers, ADS-developers, universities, and research organizations to respond the seven research areas covering a range of emerging issues related to advanced driver assistance systems (ADAS), ADS, cybersecurity, connected technologies, and functional safety.

VTTI continued to propose task orders released under a contract from the Transportation Research Board (TRB) of the National Academy of Sciences potentially worth an initial $2 million, with the possibility of additional funds. The task orders are designed to: 1) Identify critical issues associated with connected and automated vehicles that state and local transportation agencies and the American Association of State Highway and Transportation Officials (AASHTO) will face, 2) Conduct research to address those issues, and 3) Conduct related technology transfer and information exchange activities. VTTI is completing work on the National Cooperative Highway Research Program (NCHRP) 20-102(07) Implications of Automation for Highway Research Program (NCHRP) 20-102(07) Implications of Automation for Motor Vehicle Codes, which explored the impact of ADS on motor vehicle codes and other related domains.

The VTTI Automated Mobility Partnership (AMP) program was officially launched in 2019 and AMP Period 3 continues to build on this work. This program is a precompetitive, private collaboration led by VTTI and directed by the industry Steering Committee members (Vehicle Manufacturers, Tier 1 Suppliers and Tech Companies). AMP provides members with access to a variety of real-world driving data and a suite of support tools focused on the development and evaluation of automated driving technologies. A library of crashes, near-crashes, and driving cases have been developed, enabling the discovery of rare cases. Interactive analytics have been created, providing prevalence of events, norms, and outliers and quantification of the range of cases that ADSs will experience. Lastly, the cases have been reconstructed in simulation, facilitating the testing of many more case variations.

VTTI and partners Texas A&M Transportation Institute and San Diego State University – with support from the Virginia Department of Transportation (VDOT) – continued to conduct cutting-edge research via the Safety through Disruption National University Transportation Center (Safe-D UTC). The Safe-D UTC grant totals approximately $32 million across a 6-year span, funding the study of how best to maximize the safety benefits of integrating technologies such as automation and connectivity into the transportation system. Motivated by an overall desire to promote safety on U.S. roadways, the Safe-D UTC focuses on three key areas: 1) Performing innovative research that is led by the largest consortium of transportation safety researchers in the nation and is largely focused on advanced-vehicle technologies, transportation as a service, and “big data” analytics; 2) Education and workforce development; and 3) Sharing research findings with the broader
transportation community through a robust technical transfer process. The Safe-D UTC award is representative of the hard work and dedication VTTI researchers have collectively put into studying the future of transportation. It provides a continued opportunity to work toward the safe and efficient development and deployment of the next generation of vehicles and technologies, inform national discourse about how best to mitigate rapidly growing transportation challenges, offer students unique hands-on experience in the field of transportation research, and provide more opportunities in the workforce.

8 VTTI continued to serve an integral role in the Virginia Tech Intelligent Infrastructure initiative, particularly in the area of advanced-vehicle research and development. In partnership with VDOT, the institute is expanding its Smart Road testing capabilities. The Rural Roadway Expansion, the fourth test bed created at VTTI, opened in November of 2020. Collectively, the expansions are dubbed the Virginia Smart Roads and will facilitate cutting-edge collaborations focused on advanced-vehicle research and development. The Automation Hub also serves as home to the InternHUB program. The InternHUB fosters collaboration between industry partners, VTTI researchers, and leading students from Virginia Tech. Student interns work for industry partners while in Blacksburg through collaborative sponsored research with VTTI faculty. Each summer, the interns leave Blacksburg for positions at their industry employer for a direct integration into the company’s business and engineering processes.

9 The Virginia Smart Roads also includes the Automation Hub, located adjacent to the Surface Street expansion. The building houses advanced-vehicle initiatives to facilitate cutting-edge collaborations focused on advanced-vehicle research and development. The Automation Hub also serves as home to the InternHUB program. The InternHUB fosters collaboration between industry partners, VTTI researchers, and leading students from Virginia Tech. Student interns work for industry partners while in Blacksburg through collaborative sponsored research with VTTI faculty. Each summer, the interns leave Blacksburg for positions at their industry employer for a direct integration into the company’s business and engineering processes.

10 VTTI continued to develop relationships with both public and private sponsors. This year, VTTI initiated several new relationships with proprietary sponsors, which are likely to result in continued funding in future years.

11 In conjunction with VDOT, VTTI continued its connected and automated vehicle development initiatives on the Virginia Connected and Automated Corridors (VCC/VAC), with expenditures during FY21 of more than $503,000, which includes VTTI’s contribution ($6.2 million from inception to date). VTTI extended the VCC architecture to support a predictive real-time model that helps determine when traffic lights will change on actuated traffic signals. The system is used to broadcast predicted signal phasing and timing data for 30 intersections on the Route 7, US 29, and US 50 corridors in Arlington County, VA.

12 In partnership with VDOT, VTTI created a prototype work zone builder (WZB) application. The WZB is a tablet application that allows VDOT maintenance contractors, work zone inspectors and construction contractors to lay out their work zone designs over a photo map while suggesting placement of various work zone features based on the requirements of the Virginia Work Area Protection manual. WZB compiles the completed work zone design into a data package that is published to the VCC Cloud, where it can be made available to connected and automated vehicles and will fulfill the requirements for VDOT work zone management. The prototype has matured significantly and WZB is being pilot tested in VDOT operations in the Salem District.

13 VTTI continues work on a $7.5M Federal Highway Administration (FHWA) grant to demonstrate Safely Operating Automated Driving System in Dynamic Scenarios on an Optimized Corridor (SOADS) with partners CAMP, LLC, Transurban, LLC, and the Global Center for Automotive Performance and Simulation (GCAPS). The project will result in the development of a Level 4 ADS that can safely interact with police, fire, EMS, work zones, and cooperative driving scenarios.

14 VTTI worked with Qualcomm, Audi, American Towers, and VDOT to develop Cellular Vehicle to Everything (C-V2X) applications for several use cases including work zone interactions between vehicles and workers in work zones and Traffic Light Information (TLI). TLI applications include Red Light Violation Warning and Green Light Optimized Speed Advisory. The concepts were developed on the Smart Roads and will be migrated to the Virginia Connected Corridor in Northern Virginia. C-V2X is a precursor to 5G communications technologies.

15 In 2019-2021, VTTI worked with Spin, LLC, and Ford Motor Company to conduct the first of its kind naturalistic driving study (NDS) for shared e-scooters on the Virginia Tech campus. VTTI developed a data acquisition system that was deployed on 50 e-scooters that were part of the e-scooter fleet deployed by Spin on the Virginia Tech campus. This deployment was ended early due to COVID-19. VTTI is finalizing data analysis and reporting on the impacts of mobility and safety that resulted from this e-scooter deployment and preparing to continue this research project and NDS during the 2021-2022 academic year.

16 VTTI continued work on a project funded by Ford Motor Company to evaluate and compare the performance and safety of various e-scooter designs and features through benchmark testing which will incorporate riding tasks and conditions that are representative of real-
world use. The overall objectives of the benchmark testing include understanding rider specific factors (age, gender, anthropometrics, approach/strategy, posture, etc.) that may contribute to performance and safety when completing the tests, understanding which e-scooter designs and features are most useful at performing specific tasks and conditions that are representative of real-world use, evaluating the accuracy of e-scooter geofencing and rider perceptions of its functionality, and collecting data that can be used to develop and validate algorithms for event detection (fall-overs, impacts, trick riding, etc.).

VTTI partnered with VDOT, Fairfax County, and the NTSCE to collect naturalistic driving data (NDD) from an EasyMile Gen 3 low speed shuttle that is being deployed in Fairfax County between the Dunn-Loring Metro Station and the Mosaic District. VTTI developed a data reduction protocol, analyzed safety data, and made recommendations about the safety of operations during this program.

VTTI continues to serve as a subcontractor to Morgan State University on its Tier 1 UTC, Urban Mobility & Equity Center (UMEC). UMEC is federally funded as a Tier 1 Mobility & Equity Center (UMEC). University on its Tier 1 UTC, Urban Mobility & Equity Center (UMEC). This project demonstrated how an Automated Driving System (ADS) Automation Grant: Trucking Fleet Concept of Operations (CONOPS) for Managing Mixed Fleets. This is a comprehensive ($7.5M) research study investigating issues related to the deployment of ADS within the trucking industry. In addition to investigating ADS deployment issues, this project will also include a series of ADS truck demonstrations—including a Port Queuing demonstration. After considerable planning and outreach with federal and state partners VTTI/Pronto conducted an ADS Truck Queuing Demonstration at the Port of Oakland. This project demonstrated how an ADS equipped truck could drive itself while waiting to pick up or deliver shipping containers. VTTI/Pronto recorded video and collected safety data for five days. The Pronto system operated flawlessly when negotiating heavy traffic, intersections, and aggressive cut-in behavior. Pronto provided a live streaming of in-cab and dashcam footage via Zoom for all interested stakeholders.

VTTI was awarded a contract by National Advanced Mobility Consortium (NAMC) to conduct a market research demonstration of existing Unmanned Aerial Systems (UAS), prototype systems, and subsystems that enable a tethered or tether-capable UAS to be integrated to a ground vehicle. VTTI/NAMC executed the market demonstration of five different UAS on three different courses on the VTTI Smart Road.

VTTI continued work on two competitive projects as part of UMEC; the first project focuses on devising eco-driving and traffic signal optimization strategies while the second project focuses on the modeling of bicycle longitudinal motion.

VTTI was awarded three competitive projects as part of UMEC.

VTTI completed its work with the Ford Motor Company to develop tools to evaluate the mutual interdependencies and interactions of transportation and communication systems.

VTTI completed its work on a U.S. Department of Energy project to develop a novel Eco-Cooperative Automated Control (Eco-CAC) system that integrates vehicle dynamics control with connected- and automated-vehicle applications. The approach is revolutionary in that it develops a next-generation, vehicle dynamics-controlled connected- and automated-vehicle system that builds on existing connected- and automated-vehicle technologies to reduce the energy/fuel consumption of internal combustion engine vehicles (ICEVs), battery-only electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs). The development of the Eco-CAC system will involve the following key steps and components: 1) Develop a connected-vehicle eco-routing controller that can be used with the above vehicle types. This unique eco-router will compute vehicle routes optimized for the individual user and entire system. 2) Develop a speed harmonization controller that regulates the flow of traffic approaching bottlenecks in the network. This controller will be fully integrated with the vehicle router, resulting in a unique strategic controller that can route traffic away from congested areas and regulate the flow of traffic entering congested areas. 3) Develop a multi-modal (ICEVs, BEVs, PHEVs, and HEVs) Eco-Cooperative Adaptive Cruise Control-I (Eco-CACC-I) controller that computes and implements optimum vehicle trajectories along multi-intersection roadways in consideration of dynamic vehicle queue predictions. 4) Develop an Eco-CACC-U controller that provides local longitudinal energy-optimal control in consideration of the homogenous and non-homogeneous vehicle platooning of ICEVs, BEVs, PHEVs, and HEVs.

VTTI is part of a team led by North Carolina State University that was awarded an ARPA-E project. The project objectives are to: 1) Identify, quantify, and compare decarbonization options for U.S.
PROJECT HIGHLIGHTS

RESEARCH PROJECTS

Class 1 freight rail over multiple spatial scales and a multi-decadal time scale; 2) identify and characterize infrastructure requirements and decarbonization pathways needed for freight rail deep decarbonization; 3) quantify key sources of variability and uncertainty in decarbonization pathways and their interactive effects on infrastructure, energy supply, and cost; and 4) assess and evaluate techno-economic feasibility of alternative pathways. The proposed work is allocated to eight tasks, including: (1) development of a single train performance model; (2) development of a multi-train network model; (3) quantification of infrastructure requirements; (4) quantification of energy decarbonization pathways; (5) probabilistic cost estimation; (6) development of freight demand scenarios; (7) technology transfer & outreach (TTO); and (8) integrated assessment. The key product of this work will be Achieving Sustainable Train Energy Pathways (A-STEP), an open-source software tool to account for train dynamics, propulsion, energy storage, multi-train interactions, energy delivery and storage infrastructure, substitutions, and capacity expansion in the upstream energy system, levelized cost, and freight safety is expected. As these projects move into the implementation phase, deployment of research-driven countermeasures to improve traffic safety is expected.

27 VTTI continued to work with FHWA to provide data sets to several research teams working in the second phase of the FHWA Broad Agency Announcement related to traffic safety countermeasures. These efforts have transitioned from a pilot research phase into full investigations and continue to leverage the VTTI NDD to decrease risks across all roadway users.

28 As part of its role as operator of the Second Strategic Highway Research Program Naturalistic Driving Study (SHRP 2 NDS) data set, VTTI provided data to support dozens of research projects, primarily geared toward advancing transportation safety, as sponsored, and performed by academic institutions, state departments of transportation, the federal government, research organizations, and private industry partners. VTTI is currently in Phase II in the operation of this data set, and in the first year of a 3-year contract funded at $2.1 million. The Phase I contract with the National Academies, funded at over $17M over 5 years, was successfully completed in 2020. During that period, VTTI has supported the research of hundreds of researchers and students around the world.

29 VTTI continued to operate its own Dataverse repository, providing indexing, citation, and storage for transportation data sets generated within the initiatives of the Institute. The repository provides direct access to dozens of data sets, along with metadata for over 100 SHRP 2 data sets that can be accessed with a data use license.

30 Institute researchers continued work with the FHWA to provide support and expand the capabilities of a secure data enclave at the Safety Training and Analysis Center, which allows secure access to the SHRP 2 NDS data for federal employees, state departments of transportation, and their research partners. Work undertaken during FY20 expanded access within the center to include the National Institutes of Health (NIH)-funded Supervised Practice Driving study.

31 The ISO Road Vehicle Ergonomics subcommittee—on which several VTTI researchers serve as contributing members—continued to work on developing a standard vocabulary for coding characteristics of safety-critical events and is currently preparing an updated technical report to add a vocabulary for the assessment of driver behaviors and conditions.

32 VDOT and VTTI continued the accelerated pavement testing program, which uses a heavy-vehicle simulator that continuously applies a weighted load to test pavements for several months. This testing simulates the natural wear and tear caused by heavy trucks on road surfaces. The program is expected to result in cost savings in road maintenance and will enable VDOT to determine how different pavement designs and materials respond to load testing prior to integration on the road. This cycle, the program is supporting the statewide effort to implement an advanced asphalt mix design methodology.

33 In partnership with VDOT, VTTI has continued to lead a $5 million pooled-fund project that is supporting the implementation of traffic speed deflectometers (TSDDs) across the United States. To facilitate effective implementation of TSDDs and incorporation of the TSDD data into pavement management decision making, the research team is developing guidance on 1) Data collection protocols, 2) Data interpretation guidelines for network- and project-level applications, and 3) Development of a framework to implement continuous deflection measurements as part of the agency's
pavement management system and pavement rehabilitation design practices.

VTTI has initiated the third phase of the Pavement Surface Consortium - Managing the Pavement Properties for Improved Safety pooled-funds, a $4.2 million collaborative effort to conduct applied research focused on enhancing the level of service provided by the roadway transportation system by optimizing pavement surface characteristics. The ongoing second and third phases focus on adopting emerging friction technologies and integrating the measurements into the next generation of pavement asset management systems.

VTTI initiated an FHWA project to incorporate pavement friction as part of the standard safety toolkit. The project goals include: (1) Developing and advancing new, improved approaches to measuring road friction, (2) Establishing new best practices for PFM that explicitly address safety performance, (3) Providing assistance toward implementation, and (4) Developing marketing products to support institutionalization on a national level.

VTTI has partnered with the Virginia Transportation Research Council (VTRC) to instrument and monitor two sections on Interstate 64 to quantify the response of recycled pavement sections subjected to known loadings and to monitor the performance for one year. This will facilitate a better understanding of the behavior of the recycled materials and facilitate their use throughout the state.

VTTI completed a VDOT project to document the early functional and structural performances of various pavement recycling projects in Virginia and to quantify the life-cycle cost and environmental benefits of different treatments in comparison with traditional rehabilitation approaches.

VTTI developed a pilot pavement friction management program for the North Dakota Department of Transportation under the pooled-fund Pavement Surface Properties Consortium - Managing the Pavement Properties for Improved Safety.

VTTI completed two projects funded by the National Academies, that developed Protocols for Network-Level Macrotexture Measurement and Guidance to Predict and Mitigate Dynamic Hydroplaning on Roadways.

VTTI researchers, in collaboration with colleagues at the Carilion Institute for Orthopaedics and Neurosciences, engaged in a study, funded by iTHRIV, to examine the functional progression of driving after Rotator Cuff Tear Repair. The goal of the project is to provide guidance to physicians that need to provide indications to their patients related to the resumption of driving post-surgery.

VTTI researchers completed a project, funded by the National Science Foundation, to establish a group of local stakeholders to foment research on the use of advanced assistance systems (including automation) in order to prolong the time before senior drivers are required to cease driving based on diminished physical and cognitive capabilities. The project features collaborators from Nagoya University in Japan.

VTTI continued as a subcontractor to North Carolina A&T State University on its Tier1 Center for Advanced Transportation Mobility (CATM) UTC. CATM is a consortium consisting of three higher education institutions: North Carolina Agricultural and Technical State University (lead), Virginia Tech, and Embry-Riddle Aeronautical University - Daytona Beach. These institutions collaborate on projects focused on identifying solutions to mobility concerns within two primary areas: 1) Enabling safe and efficient mobility for vulnerable road users and 2) Optimizing mobility in emergencies. The center conducts research, outreach, and educational activities to address the transportation needs of an extremely broad spectrum of the U.S. population, thereby helping the nation maintain its competitive advantage in the global economy. VTTI continues to work with the University of Alabama at Birmingham (UAB) and the NIH-National Eye Institute on an NDS assessing vision impairment among older drivers. Driving is a highly visual task, and older adults have a high prevalence of vision impairment compared to other ages. Most studies addressing visual risk factors for motor vehicle crashes (MVCs) by older drivers use vehicle accident reports as the primary outcome, an approach that has several methodological limitations. Naturalistic driving research methods overcome these challenges and involve installing a high-tech yet unobtrusive data acquisition system (DAS) in an older driver’s own vehicle, operating whenever the vehicle is turned on. The DAS continuously records multi-channel video of driver and roadway, sensor-based kinematics, GPS location, and presence of nearby objects in front of the vehicle, providing an objective measure of driving exposure (miles driven), which are all recorded onto a data drive in the DAS. In this NDS, the purpose is to examine the relationship between seniors’ vision and crashes and near-crashes, lane-keeping, turning at intersections, driving performance during secondary task demands, and the role of front-seat passengers. Results of the on-road driving evaluation are compared to objective indicators of driving safety derived from the naturalistic data. Data collection for this project was completed in November 2018; analysis efforts are ongoing.

VTTI collaborated with researchers from the Texas A&M Transportation
Institute and partners in the rideshare industry to identify factors that affect when parents of young children use or do not use child safety seats in rideshare vehicles. This information is being used to create an informational website designed to educate both parents and rideshare drivers about existing laws and regulations across the country, as well as the benefits and guidelines for usage of child safety seats. The final report is currently under revision, and a journal article is in preparation. Additionally, the research team conducted significant media outreach for the project.

45 VTII worked with researchers at the University of Virginia to investigate the driving performance of newly licensed teen drivers with autism compared to newly licensed drivers without autism and experienced adult drivers. This study uses a unique dual-methodology interface, where the same participants drive in a driving simulator followed by driving an instrumented vehicle on a similar course on real roads. Results have been analyzed, and multiple journal articles have been submitted or are in preparation.

46 VTII researchers worked with the Transportation Association of Canada and the Canadian Council of Deputy Ministers of Transport to develop a website for the Canada Naturalistic Driving Study. This website provides a public portal to allow researchers and interested safety professionals a method to assess what type of data are available within this public data set, as well as a query tool to assess not only the type of data but also the quantity of data available within this naturalistic driving data set.

47 VTII researchers conducted additional data coding to better assess parent/teen interactions and secondary task engagement by teen drivers using the Uniform Naturalistic Teenage Driving Database. This additional data coding was performed by VTII researchers in collaboration with researchers at the National Institutes of Child Health and Human Development and EMMES, Corp. Data reduction is complete, with plans to pursue additional funding for analysis.

48 VTII researchers evaluated the prevalence of the engagement of driver assistance systems by drivers and secondary task engagement and errors when using driver assistance systems. This work is sponsored by the State Farm Mutual Automobile Insurance Company. The final report was submitted in October 2019.

49 The impact of driver monitoring and feedback on teen driver secondary task engagement was evaluated for an NSTSCE project. This study used the Driver Coach Study database where case-cohort control segments were identified and coded by trained data coders. Using these newly coded data, the prevalence of secondary task engagement was evaluated as compared to the control study, which indicated a decrease in high-risk secondary tasks in the presence of a monitoring and feedback system. Analysis for the project is complete, and a final report has been submitted to NSTSCE for review.

50 An onboard multimedia training program was developed by VTII researchers to teach drivers about the automated-vehicle systems that are present and available on a vehicle. This multimedia presentation used a tablet display on the center stack and an instrument panel display. This project was conducted for the Safe-D UTC.

51 VTII began launching the Field Study of Newer Generation Heavy Vehicle AEB Systems. While data collection has been delayed due to COVID-19 safety concerns, VTII is applying mitigation procedures for reducing exposure when interacting with participants and their vehicles. The study involves the instrumentation of 150 heavy vehicles equipped with AEB systems during revenue-producing operations. The study will use the data to evaluate real-world performance, understand how drivers interact with the systems, and provide data for modeling the safety benefits of the technology.

52 VTII partnered with the Texas A&M Transportation Institute and San Diego State University on the development of Bayesian and other models for predicting individual crash involvement based on driver characteristics (e.g., driving style, demographics, behavioral history) using NDD. The research team identified enduring personality characteristics and behaviors of drivers to predict the likelihood of future crashes and other high-risk behaviors.

53 VTII collaborated with NSTSCE to investigate truck following distances and car cut-in behavior in naturalistic conditions. Cut-ins are often mentioned as one of the possible hurdles for wide-scale deployment of truck platoons. Even if a platooning application can safely handle cut-ins, they can disrupt the platoon and greatly reduce benefits in terms of fuel savings, safety, and transport efficiency. This project used existing NDD housed at VTII to study car cut-in behavior. A cut-in detection algorithm based on the radar data was developed. A major focus of this study is analyzing the gap between the lead vehicle and the host vehicle (i.e., subject vehicle of the study) before and during cut-in events to quantify the probability of a possible cut-in during real traffic. The project also investigates how a cut-in event changes the behavior of a following vehicle and the potential safety concerns related to such behaviors.
VTTI continued working on FTA-funded research with the New York City Transit (NYCT) Department of Buses designed to enhance pedestrian, bicyclist, and vehicle operator safety by identifying the limitations of current mirror configurations that accommodate a range of operators. During this period, VTTI worked with NYCT to evaluate prototype mirrors that were considered for field demonstration. During this period, VTTI and NYCT launched a field evaluation of the selected mirror design in pre-production parts among 30 buses and implemented on two different bus configurations, i.e., 40-foot and 60-foot articulated buses. VTTI is measuring bus operator survey feedback and bus maintenance and incidents to compare acceptance and performance of the prototype to the standard NYCT mirrors. This project is expected to lead to the development of a uniform set of guidelines for low-floor transit buses and demonstrate a mirror solution set in New York City.

VTTI continued working with the Washington State Transit Insurance Pool, Pierce Transit, and the University of Washington in a project funded by FTA to demonstrate collision avoidance performance on buses in Washington. As a subcontractor, VTTI was tasked to develop and perform a collision warning and AEB protocol including 150 scenarios covering static and dynamic pedestrian (NCAP) and vehicle trials across a range of environments including day/night and dry/rain/fog to characterize the performance of a new crash avoidance warning system (CAWS)/AEB system. Second, VTTI was tasked to measure effects on unrestrained standing and seated passengers in a sample of braking events. During this period, VTTI collected approximately seven months of continuous naturalistic data and collision avoidance event passenger motion data on two separate transit buses during bus revenue operation on routes in the Tacoma, WA region.

VTTI developed a web-based tool to help fleets calculate the return-on-investment (ROI) on advanced safety technologies. This ROI tool is a customizable calculator that allows fleets to enter information about their own operations (or use national averages if they are unsure) to understand the ROI that different technologies may have within a five-year window.

VTTI researchers worked on an NSTSCE-funded project to conduct a literature review of Pediatric Vehicular Heatstroke (PVH) and the current systems available to help counteract this occurrence. Researchers also designed a study to evaluate currently available OEM and aftermarket systems for PVH.

VTTI researchers worked on an NSTSCE-funded project to investigate risky behaviors of pedestrians. Researchers will use previously collected data sets, with the goal of developing new sets of video reduction protocols for future use.

VTTI researchers worked on an NSTSCE-funded project to investigate the rate at which different conditions and maneuvers in automated-vehicle operational design domains occur.

VTTI researchers completed a NSTSCE-funded project to leverage NDD to analyze vehicle kinematic variables toward the evaluation of roadway infrastructure design.

VTTI and the Virginia Center for Coal and Energy Research at Virginia Tech were awarded a subcontract under the University of Kentucky to introduce an autonomous shuttle car into room-and-pillar coal mines. Funding originates from the Alpha Foundation, which was established to improve mine safety and health. VTTI’s involvement includes conducting a cognitive work analysis on the organizational work domain as well as building the human-machine interface for the automated shuttle car controller.

The VTTI-affiliated Global Center for Automotive Performance Simulation (GCAPS) has established many new clients in the India tire and transportation market. GCAPS is also realizing significant growth in China relative to tire testing, tire modeling, and vehicle modeling, thereby providing great upside potential. GCAPS has also completed joint tire test research with UAB.

Through the U.S. Department of Energy project Investigating the Health Impacts of Outdoor Lighting, VTTI has measured the impact of lighting on melatonin levels in realistic outdoor lighting levels. Over a 14-week period, 29 participants were evaluated for melatonin in driving, pedestrian, and sleeping conditions, resulting in the collection of more than 1,800 melatonin samples. The samples are currently being assessed, and the results should provide guidance for decision makers selecting light sources for outdoor spaces and inform the public about the potential health impacts of outdoor lighting. This project is a partnership between VTTI and Thomas Jefferson University.

VTTI was awarded a federal project to consider pedestrian lighting, both to provide visibility of and for pedestrians. The work includes a test on the Smart Road highway section using drivers and on the Surface Street Expansion using both adult and child pedestrians.

VTTI is continuing its U.S. Department of Energy efforts to consider the limitations of the acceptance of solid-state lighting through an investigation of the impact of adaptive lighting in a city environment. Using Cambridge, MA, as an example where adaptive lighting has been implemented in a city, the team is planning to investigate the public acceptance of a lighting system that dims at certain points during the day. The project also considers criteria such as crime and crash statistics. Additional investigations will include factors such as system maintenance and overall cost.

VTTI was awarded an NCHRP project to investigate the impact of LED roadway lighting on driver sleep health and alertness. The objective of
this research is to develop a guidance document for state departments of transportation that: 1) Describes the effects of LED roadway lighting on the sleep health and alertness of drivers, with attention to the illuminance, duration, and spectral power distribution of the LED lighting; 2) Compares these effects to those of high-intensity discharge lighting and the absence of roadway lighting; and 3) Suggests methods to mitigate the effects, if any, of LED roadway lighting on sleep health and alertness.

VTTI was awarded NCHRP 10-109, focusing on Modern Solutions to Safe and Efficient Work Zone Travel. The goal of this project is to identify best practices for leveraging technology to assist the traveling public in navigating roadway maintenance or construction work zones. This project will take advantage of the research team members’ extensive experience with safe work zone (SWZ) technology development, testing, and implementation; work zone data creation and dissemination; stakeholder outreach and engagement; and development of effective guidance materials. The research team will evaluate innovative and adaptive technologies that are attention capturing and enhance work zone safety and mobility; evaluate the use of crowdsourcing applications and data analytics for dynamic work zone devices and in-vehicle notifications for traffic management; and develop a guide for the application and management of innovative work zone technologies.

VTTI was awarded a project by the Illinois Center for Transportation to study the effects of intersection and midblock crosswalk lighting designs on pedestrian visibility. The results will inform the development of new lighting standards for crosswalks at intersections and midblock locations.

VTTI was awarded a small project to investigate the safety benefits of narrow-beam LEDs for lighting crosswalks.

VTTI has completed a project in partnership with WSP, a prominent engineering consulting firm, to develop guidelines for the implementation of solid-state lighting in roadways. This project was funded as NCHRP Project 5-22.

VTTI is investigating the lighting at intersections for VDOT. Twenty-five urban and rural intersections will be investigated using in situ lighting levels and crash statistics to consider the required lighting levels at intersections.

VTTI continued to investigate the impact of lighting on driver behavior through continued studies of measured lighting in Washington and North Carolina, along with California data. This effort is in its third phase and considers a variety of lighting alternatives.

VTTI has been awarded a project considering the possible impact of low-cost delineation systems on curve performance. This will include the nature and frequency of solutions (e.g., bollards and chevrons) relative to drivers and driving performance in a wide variety of applications ranging from interstate roadways to rural applications.

VTTI has been awarded a project by the Illinois Department of Transportation to consider high-mast lighting applications. This effort will include crash assessments, in situ lighting assessments, and alternative design developments.

VTTI completed a project considering how VDOT conveys travel information to truck drivers. VTTI conducted surveys and interviews of truck drivers and other industry personnel to determine how they receive such information, what information is most important, and in what ways dissemination of the information could be improved.

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VTTI provided extensive support for lighting and visibility applications within the Commonwealth of Virginia. The color of light sources, particularly LED,
has been a major topic of discussion. Through this effort, a new policy on lighting and light type was developed and implemented by VDOT.

VTTI continues its work with researchers at North Carolina A&T State University on a CATM project focused on the use of unmanned aerial vehicles for optimizing the routing of emergency vehicles to avoid congestion and obstructions.

VTTI continues its VDOT-funded research on the use of automated placard readers to effectively provide advance notifications to critical facility operators. The project assessed the readiness of automated hazardous material placard readers for their reliable and effective roadside deployment. Findings from the study indicated that several hazmat placard readers were readily available for deployment, and they provided capabilities for installations requiring specific features.

VTTI is working with researchers from the Texas A&M Transportation Institute to study how vehicles in a multimodal environment are managed and prioritized at curb loading and unloading zones between different public and private vehicles and/or use cases. The research will analyze the effectiveness of curb management practices in improving safety through reduced collisions with pedestrians and other vehicles. The research will look at current curb management practices across large and small urban areas in U.S., including use of technology, temporal management, street design and infrastructure, zoning for mode uses and prioritization, traffic monitoring, policies, and regulations, permitting and monetization, and enforcement.

VTTI is working with researchers at Nanosonic Inc. and the Electronic Systems Lab in the VT Hume Center on a Phase 2 SBIR on the use of roadway marking for vehicle-to-infrastructure (V2I) communication.

VTTI is actively working with NASA-Langley to renew a Space Act Agreement Annex on Advanced Sensing and Autonomy for Urban Air Mobility and Intelligent Transportation Systems.

VTTI paused its research with the use of a low-speed autonomous vehicle (LSAV) shuttle for last-mile integration with bus transit for the mobility of VRUs, such as seniors and the disabled due to safety concerns associated with COVID-19.

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VTTI is working with a team of other VT researchers on a NIOSH project to develop an Intelligent Wearable Analyzer for Vapor Exposure (iWAVE) that will help protect truck drivers from harmful pollutants encountered during vehicle fueling operations.

VTTI maintains a small data center on its campus and has a much larger university computing infrastructure co-located at the Virginia Tech Andrews Information Systems Building to take advantage of internal and external high-speed networking and the physical space required to house clustered servers, multi-petabyte high performance computing storage systems, and a multi-petabyte (PB) DB2 data analytics system. Continually growing capacities include a 4.2 PB database and associated storage, 10.2 PB Network Attached Storage, and 7 PB archive storage. Compute processing is driven by 1,920 cores and 37 Graphical Processing Units.

VTTI is collaborating with the NHTSA, working on an automated truck-mounted attenuator (TMA) study. The project, which receives support from Safe-D UTC, seeks to develop an automated control system for TMA vehicles using a short following distance, leader-follower control concept which will remove the driver from the at-risk TMA vehicle.

VTTI researchers collaborated with Dunlap and Associates (prime) and Battelle to establish a NHTSA-sponsored NDS of how seniors use Level 2 Automation-equipped vehicles (i.e., those vehicles equipped with autonomous vehicle control features operating simultaneously in the lateral and longitudinal dimensions).

VTTI collaborated with NTSCE Stakeholders on a project evaluating the provision of mobility solutions for rural seniors. The population of older adults is increasing and is expected to represent a larger proportion of the population over the next several decades. Those who live in rural areas face many transportation challenges, including a reliance on personal vehicles, reduced availability of public transportation, fewer friends, and family to rely on for rides, and longer travel distances. This research effort entailed expert interviews and a search to determine what types of programs currently exist in rural or urban environments that might enable rural seniors to retain mobility. Results
illustrated a wide variety of programs, many of which offered multiple types of services. Among these, there were also minute but important differences. Several gaps between users requiring rides and available mobility options for seniors were noted. Suggestions for an implementation to bridge the gap were explored. Researchers discovered that many law enforcement training programs appeared to no longer be functional. Additionally, gaps related to the use of GPS technologies as well as expansions of current implementations were discussed.

96 VTTI completed a project funded by NHTSA entitled “Special ADS/ADAS Implementation Considerations for Heavy Vehicles.” The purpose of this project was to move ADS and ADAS heavy vehicle industry/government/research activities from concept/demonstration to implementation/operations. The objective was to develop a systematic framework of the direct and indirect impacts of ADS/ADAS-equipped heavy vehicles across the implementation stages of development, test/demonstration, deployment, licensure, operation, and maintenance/repair.

97 VTTI continued working on a video analytics project with FHWA that will develop a system that can analyze naturalistic driving videos and automatically produce annotations and descriptors for events, behavior, and driving scenarios that relate to transportation safety. Using state-of-the-art machine-learning techniques to recognize safety-related aspects of the driver (e.g., distraction, secondary tasks), passengers and the outside environment (object, driving condition) Researchers will study the interrelation between events taking place inside and outside of the vehicle (e.g., driver gaze at a pedestrian crossing).

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99 VTTI continued working with FMCSA to study Electronically Controlled Braking Systems (ECBS). A key part of this study is engaging with industry to provide FMCSA with valuable insight into industry concerns about market or regulatory barriers and future integration potential with ADS and ADAS. VTTI provided FMCSA a draft report that surveyed current ECBS technology, how industry got to its current position, and industry’s future plans for development and deployment. VTTI completed another round of industry engagement focusing on the regulatory assessment of ECBS, consideration of possible risks and hazards, and a high-level concept of test procedures that are applicable despite the uncertainty surrounding deployment and integration.

100 VTTI completed work with the University of South Florida and the FTA on a COVID-19 feasibility study for a transit bus operator temporary barrier. The purposes of this project were to investigate (1) reducing bus operators’ exposure to the presence of COVID-19 in airborne droplets and particles, (2) maximizing fresh air for passengers who occupy buses for shorter periods of time than bus operators, and (3) determining feasibility of a temporary barrier to organize air flow and pressure in a transit bus. A barrier design was developed by VTTI prior to testing in this project. The physical bus airflow testing was performed on the Virginia Smart Roads on three different 40-foot transit bus configurations and resulted in recommendations for applying principles of gravity (physical distance) and dilution (fresh air) with existing and novel bus components that can reduce the exposure of bus operators and passengers to COVID-19 on varying transit bus configurations. https://www.vtti.vt.edu/PDFs/Transit%20Bus%20Engineering%20Controls.pdf

101 VTTI supported a non-federal employee on assignment—an Intergovernmental Personnel Assignment (IPA)—for the NIOSH Assistance for Re-opening Industries Safely (COVID-19) program to assist in providing research and communication for occupational safety and health technical assistance for employers, public health officials, and others on how best to decrease the spread of COVID-19 in transportation through the application of engineering controls.

102 VTTI is working with TRB to evaluate transit vehicle brake inspection through ultrasonic emissions analysis. This project proposes a new approach for improving transit safety by analyzing ultrasonic sounds emitted by the brakes to detect problems. Ultrasonic-based brake monitoring systems consist of non-invasive sensors placed roadside near exits of transit vehicle facilities. The sensors can be automated to provide daily analysis of brakes for every vehicle and issues alerts if problems are detected. The study collected transit bus sound emission data and maintenance records in order to try to correlate emissions to known maintenance issues. VTTI is working with BrakeAudit to analyze the data and develop new procedures to improve data collection and apply the technique to new domains.

103 VTTI continued working with Noblis, the American Truck Association, the American Transportation Research Institute, and the Owner-Operator Independent Drivers Association on a project to accelerate the adoption of ADAS. Serving as a subcontractor to Noblis, VTTI helped research technical and market barriers to adoption of ADAS.
and served as a subject matter expert on heavy vehicle ADAS. VTTI will also perform a crash analysis feasibility assessment based on data. VTTI is working with Transport Canada to develop driver training material and fleet management guidelines aimed at mitigating Driver Distraction in the motor carrier industry in Canada. The three main objectives of the project are to 1) Develop commercial vehicle driver training material aimed at addressing driver distraction; 2) Develop fleet management guidelines to help motor carriers mitigate distracted driving, and 3) Develop a strategy to promote and disseminate this material to motor carriers, and a gap analysis of A literature review, survey of Canadian driving, and 3) Develop a strategy to achieve maximum industry penetration. promote and disseminate this material to the project are to 1) Develop commercial the driver motor carriers mitigate distracted based on data. VTTI is working with fleet management guidelines to help ADAS, which and serves as a subject matter expert on relies on advanced perception sensors, by vehicles. The goal is to ensuring their capabilities are retained despite harsh exposure to the elements in the real world.

105 VTTI is examining the role that a supervisor’s coaching has in the relationship between driver and in-vehicle monitoring system. VTTI partnered with an oil and gas fleet operation to collect data and evaluate an industry-recommended practices previously created by the research team from 33 subject matter experts across 16 industries.

106 During FY20, VTTI was awarded two very competitive Automated Driving System grants. The Safe OperatingADS through Complex Dynamic Scenarios is a $10M project focused on development and demonstration of how ADSs can overcome difficult scenarios in which robotic systems must interact with public services such as police, fire, and rescue as well as navigate work zones and respond appropriately to truck operators. This effort is being accomplished in collaboration with major vehicle manufacturers through the Crash Avoidance Partnership LLC as well as Transurban, VDOT, and the public services community. The other project will seek to provide the trucking industry with clear guidelines on how to safely implement and benefit from trucks equipped with automated driving systems. In concert with the development of a fleet concept of operations, demonstrations will occur on public U.S. roadways.

107 VTTI is working with NHTSA on a project to evaluate the impact of sensor degradation over the lifetime of advanced vehicles. The goal is to maximize the performance of ADAS, which rely on advanced perception sensors, by ensuring their capabilities are retained despite harsh exposure to the elements in the real world.

108 This year VTTI expanded our work with Ford and Spin through development of a collaboration with the BEAM (Biomedical Engineering and Mechanics) senior design team. The team, along with support from VTTI faculty and graduate students, is evaluating injuries from collisions on e-scooters and developing countermeasures to improve scooter design.

109 VTTI completed a VDOT-sponsored project that determined that the structural condition information collected with the traffic speed deflectometer on bituminous pavement sections was appropriate to use in the VDOT pavement management system. The project collected data on more than 4,000 miles of interstate and primary roads and the data were used to augment pavement treatment selection in a manner similar to the current VDOT procedure using falling weight deflectometer-based structural condition data on interstate roads.

110 VTTI has continued to support the development and implementation of a statewide pilot pavement friction management program in Virginia. This effort included the measurement of approximately 7000 miles of continuous pavement friction, macrotexture, and other roadway characteristics on the Virginia Corridors of Statewide Significance and the implementation of a methodology to rank friction safety improvements based on benefit-cost analysis.

111 In partnership with VDOT, VTTI initiated and has continued to lead the transportation pooled-fund TPF-5(345) Consortium - Managing the Pavement Properties for Improved Safety, which focuses on optimizing pavement surface texture characteristics. This second phase of the consortium is addressing some of the emerging challenges in the evaluation of pavement surface properties and the changes needed to best support the next generation of pavement and asset management systems, including support for MAP21-related initiatives.

112 VTTI initiated a collaboration with the US Army Corps of Engineers Engineer Research and Development Center (ERDC) and completed a first project that provided support to the ERDC to conduct friction testing using various friction measuring devices at the Virginia Smart Road in collaboration with Applied Research Associates, Inc.

113 VTTI started a collaboration with Fugro to support the verification of their pavement profiling systems at the Virginia Smart Road.

114 VTTI began work on a study entitled “CRISP Type 2:
Collaborative Research: Towards Resilient Smart Cities.” Sponsored by the National Science Foundation, the purpose of this multi-departmental project is to break new ground in the understanding of synergies between multiple cyber-physical infrastructure and resilient resource management, thus catalyzing the global deployment of smart cities. This research will contribute to the fostering of trust between residents and the various technological processes that are fundamental to the operation of a smart city. The VTTI portion of this project explored how individuals reacted to a simulated vehicle hack under manual or SAE J3016 Level 2 driving automation system conditions.

VTTI completed a Safe-D project on driver modeling in collaboration with Texas A & M. The research investigates drivers’ behavior in a takeover scenario during safety critical events. The researchers have presented their work in a webinar and the final report is available on the Safe-D website.

VTTI researchers have worked in a NHTSCE funded project to study the traffic behavior around an automated easy-mile shuttle using cameras mounted on the vehicle. Researchers have used computer vision algorithms to process the videos to identify and track location and trajectories of different roadway objects (car, truck, pedestrian) in perspective to the 3D scene geometry.

VTTI partnered with Deloitte to automate the processing of police accident reports for FMCSA to check for eligibility and preventability of crashes by a fleet driver. Crashes deemed eligible and not preventable by the fleet driver are removed from the Compliance, Safety and Accountability score. A combination of artificial intelligence, decision making, and natural language processing techniques are used to automate the ingestion process.

VTTI was awarded and continues work on a NHTSA-funded project titled “Assessment and Comparison of Advanced Driver Assistance System Safety Testing Procedures.” The purpose of this project is to compare existing and proposed ADAS performance tests and testing procedures conducted and planned by all credible domestic and international ADAS testing programs. With the increasing prevalence of ADAS features across the light vehicle market, these technologies have only recently begun to be incorporated into the safety ratings of vehicles. Currently, there is no single standard when it comes to ADAS and crash avoidance testing procedures, which means that each testing program assessing and rating advanced safety systems may have its own testing and rating process.

With funding provided by TRB, VTTI initiated and continues work on “Preparing Transportation Agencies for Connected and Automated Vehicles in Work Zones” (NCHRP 20-102Z28). The goal of this project is to help transportation agencies prepare for the impacts that connected and automated vehicle (CAV) technologies will have on work zone environments. Work zones represent temporary interruptions to an otherwise “familiar” environment from the perspective of CAV technologies. Thus, it is important to understand (1) how these technologies will behave when they encounter typical work zone scenarios, and (2) what can be done (from the perspectives of both the CAVs and work zone operations) to ensure ultimate compatibility between all available technologies until conditions return to normal.

Researchers at VTTI and VT continue to investigate ways to increase detectability of electric vehicles (EVs) via a Safe-D UTC-funded project on “A Data Driven Approach to the Development and Evaluation of Acoustic Electric Vehicle Alerting Systems for Vision Impaired Pedestrians.” EVs produce considerably less noise compared to internal combustion engine (ICE) vehicles, especially at low speeds. Although pedestrians across all demographics are at risk, visually impaired pedestrians face significantly greater disadvantages in environments where ambient noise levels are high in relation to EV noise output. This research will build on previous efforts to investigate improved methods of sound dispersion, develop sounds with characteristics that more detectable while meeting regulatory standards, and investigate alternate ways to measure effectiveness in different environments.

Through the Safe-DUTC, VTTI was awarded a project on “Improving Methods to Measure Attentiveness through Driver Monitoring,” building on prior, proprietary research. This project leverages previous research, naturalistic databases, and input from recent literature to develop robust algorithms for assessing when drivers are inattentive to the driving task, while also investigating limitations of different approaches and sources of information. Effectively detecting distraction and inattention can enable automakers to develop countermeasures against this behavior and thereby increase safety for all road users.

VTTI supported Virginia’s Commonwealth Cyber Initiative (CCI) via autonomous system security testing in the context of remote operation through secure communications between ground, aerial, and infrastructure. Establishing and verifying secure communications via Cellular Vehicle-to-Everything (C-V2X) are critical components for safe deployment. Building upon VTTI’s existing Automated Truck Mounted Attenuator (ATMA) platform, CCI funding has provided an opportunity to investigate and develop two useful additions: 1) Remote Operator, providing remote control and a live video feed allowing a remote operator to safely maneuver the ATMA around unexpected hazards, and 2) a paired Unmanned Aerial Vehicle (UAV) that provides operators with a live aerial video feed of the ATMA and mobile work zone environment. VTTI accomplished these tasks, developing and validating real-world applicable approaches that provide additional capabilities to the ATMA platform, while
demonstrating how C-V2X can support secure communications in this context. CCI funding also provided an opportunity for VTTI to expand on existing test bed improvements, with the addition of C-V2X roadside units (RSUs) on top of the pre-existing dedicated short-range communication (DSRC) components, C-V2X on-board units (OBUs), and a video- and radar-based smart intersection system.

123 Under CCI, the VTTI team also worked with the gcaps on evaluating opportunities for misinformation in a connected environment, researching how misinformation could be introduced by affecting sensor technology or sensing mechanisms. Both teams targeted the automation platform sensor set and how they could be affected by external factors. Sensors such as GPS, Lidar, and Radar can be indirectly affected to produce misinformation, and this work covers detection mechanism and workarounds for these situations.

124 The CIB is working with NHTSA on a parametric study of pre-crash vehicle maneuvers and occupant safety performance response. The purpose of this task is to use finite element (FE) human models to investigate how a range of pre-crash occupant kinematics and seat positions impact occupant safety. To perform this investigation, a reduced-factiorial design of experiments (DOE) was implemented, for which the passenger type, seating position, and pre-crash maneuvers and their effect on occupant safety are considered.

125 The CIB is working with the Global Human Body Models Consortium (GHBMC) to develop, validate and improve pedestrian human finite element models. During this project, 4 simplified pedestrian FE models (5th female, 50th male, 95th male, and 6-year-old child) and 3 detailed pedestrian FE models (5th female, 50th male, 95th male) were generated by scaling and morphing from GHBMC occupant models. Then the models were validated at the component level. The final validation was performed in car-to-pedestrian simulations. The stability of pedestrian models was verified in different impact scenarios, and also certified by Euro-NCAP.

126 The CIB is also working with GHBMC to develop, validate, and improve human FE models with active musculature. Human volunteer tests are being conducted with 5th-percentile females and 50th-percentile males to evaluate the effect of pre-impact bracing on occupant kinematics, kinetics, and muscle activation during low-speed speed frontal and frontal-oblique sled tests. Subjects first experience two sled tests (relaxed and braced) with a target peak of 1 g that simulates a pre-crash autonomous braking event, followed by two tests (relaxed and braced) with a target peak of 2.5 g that simulates a low severity frontal crash. These data are being used to quantify the effect of age loading rate, loading mode, and bone mineral density/ossification on the material response. Ultimately, these data will be used to in FE models of the ribs to improve the response and prediction of rib fractures during motor vehicle collisions, which will aid in the design of improved safety restraints.

127 The CIB is working with Autoliv Research and The Ohio State University to improve the understanding of human rib material response, structural response, injury mechanisms, and injury tolerance, as well as to improve the validity of FE models of the ribs and their ability to accurately predict the timing and locations of ribs fractures in both younger and older subjects. For this project, the CIB is conducting numerous material tests to quantify the tensile and compressive material response of human rib cortical bone, trabecular bone, and costal cartilage at two loading rates over a wide range of subject demographics. These data are being used to quantify the effect of age loading rate, loading mode, and bone mineral density/ossification on the material response. Ultimately, these data will be used to in FE models of the ribs to improve the response and prediction of rib fractures during motor vehicle collisions, which will aid in the design of improved safety restraints.

128 The CIB is working with the Geneva Foundation to study injury mechanisms associated with Warfighters exposed to primary blast waves. The performance of protective equipment is being examined to better understand how to mitigate injury risk and potentially improve equipment.

129 VTTI is conducting the NSTSCE-funded evaluation of truck parking needs in a changing regulatory environment project. The purpose of this project is to work with fleet safety partners and/or fleet management system providers to acquire hours-of-service data and geographic location data. The goal of this study is to inform the decisions made by truck parking providers, planners, and other stakeholders.
VTTI houses close to 90% of national and international naturalistic driving data in the world. With onsite data reduction labs and extensive analysis experience, the Institute realized the role it could play in helping others mine and reduce its data to answer subsequent research questions about driver behavior and performance. The labs provide abundant opportunities for undergraduate and graduate students to receive advanced training and participate in data reduction and analysis activities conducted at VTTI.

In collaboration with affiliated faculty in the departments of civil and environmental engineering, industrial and systems engineering, psychology, and statistics, VTTI is offering the Human Factors of Transportation Safety Graduate Certificate Program (HFTS GCP). The certificate program is designed to create and deliver to students in-depth knowledge and marketable skills applied to the research, evaluation, maintenance, improvement, and protection of all ground transportation users and their communities, all from a human factors perspective. Students enrolled in the program will become leaders in the field of transportation safety within the Commonwealth, across the nation, and internationally.

In collaboration with TRB of the National Academy of Sciences, VTTI generated and made available transportation data sets that were delivered free-of-charge to several graduate students around the country, selected through a competitive process, to support their theses and/or dissertation research.

At the request of VDOT, VTTI administered a connected- and automated-vehicle training program for VDOT employees. The program was designed to provide information about connected- and automated-vehicle development relative to VDOT operations.

VTTI maintained a VCC website that describes all aspects of the VCC, including the purpose, goals, technical description, and how interested third parties can become involved. More information is available at https://www.vtti.vt.edu/vcc/

The Safe-D National UTC is dedicated to fostering education and workforce development opportunities. Each research project funded through the Safe-D UTC must include student support at any level (i.e., undergraduate and/or graduate). Safe-D encourages project teams to include students in every aspect of research, such as reviewing literature and methods, assisting with the development of experimental design and study protocols, assisting in executing a research experiment, contributing to project reports and publications, and presenting research results at conferences and seminars. Most research projects funded through Safe-D also contribute to a student’s thesis or dissertation.

Safe-D National UTC researchers were actively engaged in teaching efforts at each of the consortium universities.

At all levels of education, Safe-D UTC activities aim to inspire and educate the next generation of transportation professionals. Safe-D research projects must include an education and workforce development component as an output of each project. This requires project teams to identify specific education and workforce development products from their projects for development and dissemination. These products can include K-12 curriculum modules to be used by teachers at various levels to educate students about the results of project research, full university-level course development, outreach to the public, and educating the public about various aspects of research and transportation safety.

Safe-D National UTC researchers focused on encouraging students to pursue STEM fields and enter the transportation workforce through outreach at events such as the VDOT Northern Virginia District Annual Transportation Career Fair, the Virginia Tech Science Festival, and outreach performed with K-12 teachers and directly with students in their classrooms.

The Safe-D National UTC supported the collaborative summer internship program held at the Texas A&M Transportation Institute during 2020. Through this program, interns are matched with mentors and research projects, including many led by Safe-D faculty, to gain hands-on experience in transportation research.

With support from public and private sponsors and the Safe-D National UTC, the VTTI InternHUB is providing advanced training and practical hands-on experience to students in a variety of transportation-related areas and the opportunity to collaborate with faculty across Safe-D consortium universities.

Safe-D National UTC researchers presented at various science fairs and science nights held at schools across Virginia and in partnering states.

VTTI maintained membership within the ISO Road Vehicle Ergonomics subcommittee and coordinated the development of two technical reports: 1) Automated-vehicle takeovers 2) Methods for evaluating automated-vehicle external communication.

VTTI continued an FMCSA project to provide key information to driver education students on how to safely share the road with commercial motor vehicles. This project involves onsite education and hands-on demonstrations at 25 high school driver education programs.

VTTI will participate in the Global Case Challenge hosted by Virginia Tech Outreach and International Affairs and VT KnowledgeWorks. Student teams and faculty representing 14 institutions from 12 countries will explore new ideas to solve existing company’s problems for $40,000 in cash prizes.

The Driving Healthy website was updated to provide tips and...
information for commercial motor vehicle drivers. The information includes Eating & Living Healthy and Prevention & Screening. The website is useful not only to professional drivers but also to the general public.

17. VTTI continued the development of the FMCSA Data Repository, which, when opened, will host a number of FMCSA data sets that researchers can use to improve traffic safety and operations. These data sets will be available to researchers at no cost.

18. VTTI continued to operate the InSight website, which makes information and data elements of the SHRP 2 NDS available to researchers around the world at no cost.

19. VTTI completed the Data Visualization Portal, which provides several free-access analytics sets for use, along with private credentialed access for sponsors.

20. VTTI hosted several research groups in its secure data enclave, which allows for access to sensitive portions of the naturalistic driving data housed at the institute.

21. The InSight Canada Data Access website continues to be operated. The website makes data elements from the Canada Naturalistic Driving Study available to researchers around the world at no cost.

22. VTTI researchers serve on multiple TRB committees and subcommittees—including the Committees on Statistical Methods; Safety Data, Analysis, and Evaluation; Winter Maintenance; Traffic Flow Theory; and Air Quality and the Subcommittee on Unmanned Aerial Systems—providing valuable input into a broad range of transportation concerns.

23. A VTTI researcher serves on the selection committee for the Alphonse Chapanis award given by the Human Factors and Ergonomics Society. The award recognizes the best student paper submitted to the annual meeting of the society. A VTTI researcher served as the conference chair of the 2019 Quadrennial meeting of the International Commission on Illumination (CIE).

24. VTTI worked the National Safety Council’s Road to Zero program to conduct outreach for the Sharing the Road with Trucks program. This project involved in-person demonstration at 15 high school driver education programs, developing and evaluating a virtual Sharing the Road with Trucks video series, and creating an implementation guide for driver education programs to replicate the program.

25. VTTI researchers conducted the Sharing the Road with Trucks program in 21 high schools in Virginia, West Virginia, and Delaware through the FMCSA High Priority grant program.

26. VTTI co-organized the 2020 Virtual Automated Vehicles Symposium breakout session on Trucking Automation: Highly Automated and Platooning Cargo Transport. VTTI is coordinating the same session for virtual presentation in 2021. VTTI researchers are involved with the Illuminating Engineering Society Roadway Lighting Committee,
the Vision Science Committee, the Discomfort Glare in Outdoor Nighttime Environment Committee, the Resilient Lighting Committee, and the Outdoor Environmental Lighting Committee.

27 A VTTI researcher was elected as a representative for research faculty to the Virginia Tech Commission on Research.

28 Through the BEAM department, Dr. Zac Doerzaph taught the Advanced Vehicle Safety Systems Research and Development course, a hands-on minds-on class taught at VTTI to provide students with immersive research and development learning experience.

29 VTTI continued working with the TRB to evaluate the efficacy of Predictive Coach’s online driver training program. The purpose of this project is to evaluate the ability of Predictive Coach’s innovative driver training delivery method to reduce transit bus operators’ risky driving behavior. This project is funded through the Transit Innovation Deserving Exploratory Analysis program.

30 VTTI researchers hosted a group of high school students enrolled in the North Carolina A&T Summer Transportation Institute. An overview of VTTI was presented along with detailed insight into teen driving safety.

ADDITIONAL ACCOMPLISHMENTS


VTTI graduate student Ioannis Papakis won best master’s thesis presentation award at the 2021 Paul E. Torgersen Graduate Student Research Excellence Award, Virginia Tech.

Grace Wusk was awarded the 2nd Place Torgersen in the PhD Poster Category in May 2021 (Faculty Advisor: Clay Gabler)

Max Bareiss was awarded the Torgersen Award in the MS Oral Presentation Category in May 2021 (Faculty Advisor: Clay Gabler)

Samantha H. Haus was awarded the 2nd Place Torgersen Award in the PhD Oral Presentation Category in May 2021 (Faculty Advisor: Clay Gabler)

Morgan E. Dean was awarded as a New Horizon Graduate Scholar

The Association for the Advancement of Automotive Medicine created the H. Clay Gabler Scholar’s Program Award in honor of Clay Gabler.

Best Presentation Award, 1st Place, Association for the Advancement of Automotive Medicine Student Symposium, October 12-16, 2020, Virtual Event. First Author: Hana Chan, PhD candidate, Advisor: Dr. Andrew Kemper.
Division of Data & Analytics
Division of Freight, Transit, & Heavy Vehicle Safety
Division of Technology Development & Deployment
Division of Technology Implementation
Division of Vehicle, Driver & System Safety
Center for Injury Biomechanics
Center for Public Policy, Partnerships, and Outreach
Center for Sustainable & Resilient Transportation Infrastructure
Center for Sustainable Mobility
Global Center for Automotive Performance Simulation
Center for Injury Biomechanics
I-81 Corridor Coalition
International Center for Naturalistic Driving Data Analysis at Virginia Tech
National Surface Transportation Safety Center for Excellence
Safety through Disruption (Safe-D)
National University Transportation Center (UTC)
Division of Data & Analytics
Michelle Chaka, Director

The Division of Data & Analytics (DDA) specializes in collaboration with industry, academic, and government partners to translate large-scale data collections into robust and timely guidance and decisions. The division focuses on challenging questions at the intersection of mechanical engineering, physics, computer science, statistics, behavior, performance, safety and policy. DDA projects leverage innovative data fusion approaches, algorithmic labeling processes, and interactive visualizations to translate disparate and highly dimensional data into visible progress and understandable results. The Division’s goals are to provide domain expertise and state-of-the-art data and analytic methods to enable our partners to answer their questions quickly, cost effectively, and with accessible output that is ready to address their most pressing needs.

Division of Freight, Transit, & Heavy Vehicle Safety
Rich Hanowski, Director

The Division of Freight, Transit, & Heavy Vehicle Safety (DHVY) solves complex and meaningful heavy-vehicle problems through deployment, testing, analysis, education, and outreach. With a focus on addressing real-world challenges, this Division follows a research-to-practice philosophy by translating research findings into actionable countermeasures - most recently with a strong focus on cutting-edge driver assistance and automated truck and bus technologies. With a long history of establishing key partnerships across a variety of industry and government stakeholders, DHVY has conducted innovative research-based initiatives that support the safety, health, and well-being of truck and bus drivers and all who share the roads with them.

Division for Technology Development and Deployment
Zeb Bowden, Director

The Division for Technology Development and Deployment specializes in developing, manufacturing, implementing, and maintaining innovative systems for transportation research. The division collaborates with other research programs and groups within VTTI to provide innovative research support. It is continuously developing advanced systems for data collection with the goal of collecting a range of detailed data while remaining unobtrusive to participant drivers. The division’s responsibilities include: a) the technical capability and reliability of VTTI’s current data acquisition systems (DAS), which have been updated to provide for increased data acquisition rates and throughput via updating of communication and processing hardware, b) the implementation, instrumentation, and recovery of data from a vehicle- and infrastructure-based DAS, as well as performance of offsite repairs and initial data quality checks, c) continued development of VTTI’s highly integrated DAS, which offers increased research parameters and reduced unit size that will significantly decrease installation times, provide corrected vehicle dynamics data, and render improved video compression and quality, d) continued development of machine-vision capabilities related to driver, vehicle, and roadway metrics, and (e) the design, development, and testing of vehicle automation and safety systems.
Division for Technology Implementation
Mike Mollenhauer, Director

The Division for Technology Implementation (DTI) participates in the investigation of requirements, selection of vendor solutions, development of hardware and software solution components, systems integration, data collection, data analysis, performance analysis, and cost/benefit estimation. DTI leads outreach activities that join partners into consortia to collaboratively resolve the legal, policy, operational, and technical issues required to conduct an effective implementation. DTI has developed and maintained connected vehicle test bed environments including a cloud computing environment, roadside communications and localization equipment, dashboard applications for performance monitoring, and mobile reference applications. DTI has deployed these capabilities on closed test tracks and live operational environments on public roads. DTI also specializes in the development of customized web and mobile applications that are used for a variety of transportation research purposes.

Division for Vehicle, Driver, & System Safety
Zac Doerzaph, Director

The Division for Vehicle, Driver, & System Safety applies cutting-edge scientific methods to design, develop, refine, and evaluate solutions to complex transportation challenges; focusing on applications to improve the safety and effectiveness of transportation systems for the broad range of users. We support the development and evaluation of advanced technologies and operations using our laboratories, numerical models, test-tracks, field studies and analysis toolchains. The applied nature of our work is intended to support original equipment manufacturers (OEMs), automotive suppliers, policy makers, and infrastructure owner operators in designing and improving the effectiveness of systems by quantifying performance benefits, resilience, unintended consequences, and potential misuse while also characterizing user acceptance, reliance, comprehension, and understanding of advanced vehicle and infrastructure systems.

Center for Sustainable & Resilient Transportation Infrastructure
Gerardo Flintsch, Director

The Center for Sustainable and Resilient Infrastructure (CSRI) is a partnership between VTTI and the Via Department of Civil and Environmental Engineering (CEE) Transportation Infrastructure and Systems Engineering (TISE) Program. The mission of CSRI is to envision, develop and deploy innovative, safe, efficient, sustainable, and resilient solutions for re-inventing, renewing, and managing our infrastructure facilities, networks, and systems, while educating the next generation of transportation professionals to have a solid academic foundation, be creative and resourceful, and appreciate the social, economic, and environmental impacts of our profession.

Center for Sustainable Mobility
Hesham Rakha, Director

The Center for Sustainable Mobility (CSM) conducts research relevant to society’s transportation mobility, energy, environmental, and safety needs. The center translates the results of research into realistic and workable applications, creates and provides tools needed to apply developed knowledge and processes, and educates qualified engineers to meet today’s transportation demands and tomorrow’s transportation challenges in the following areas: transportation network control; large-scale transportation system modeling; traffic state prediction using large data and artificial intelligence techniques; transit bus real-time routing and scheduling; vehicle energy and environmental modeling; connected and automated vehicle control; and eco-transportation applications.
Global Center for Automotive Performance Simulation
Frank Della Pia, Director

The Global Center for Automotive Performance Simulation (GCAPS) is an affiliated company of Virginia Tech that is revolutionizing the automotive industry. GCAPS provides advanced tire research, vehicle simulation, and mathematical modeling for virtual vehicle technology development. The center specializes in independent simulation, testing, research, and assessments to complement or supplement activities performed by global vehicle manufacturers, tire manufacturers, suppliers, and motorsports teams. GCAPS provides and utilizes accurate models to support virtual development for the transportation industry. Their simulation group, which has significant experience ranging from mathematical model development to graphic design to tire mechanics, is an important aspect of the successful model creation. These models—including tire models, vehicle models, and environments—are created from both customer data sources and physical testing performed in their own advanced testing facilities, which feature the world’s most capable indoor flat-belt tire test machine. GCAPS’ physical testing expertise has led to research and new modeling methods for improved products delivered to their customers. Clients use the models and testing services to elevate their performance in vehicle handling, autonomous vehicle technology, and many other aspects of transportation simulation. Collectively, the vast experience in controls development, vehicle simulation, model creation, and physical data interpretation help many companies in the transportation industry excel.

Center for Injury Biomechanics
Warren Hardy, Director

The Center for Injury Biomechanics (CIB) is an interdisciplinary research center that is a partnership between the Virginia Tech College of Engineering and the Wake Forest University School of Medicine. The CIB is part of the Virginia Tech - Wake Forest School of Biomedical Engineering and Sciences joint graduate program. The center investigates injury mechanisms following trauma to develop a greater understanding of human tolerance to injury, to engineer enhanced safety countermeasures, and to mitigate the occurrence of serious injury in society. By using a multidisciplinary approach to solving real-world biomechanics problems, the center combines the biomedical expertise at Wake Forest Baptist Medical Center with Virginia Tech’s top-rated college of Engineering. Applications of this research are far-reaching and include automobile safety, military safety, and sports biomechanics.

I-81 Corridor Coalition
Andy Alden, Executive Director

The I-81 Corridor Coalition is a consortium of stakeholders dedicated to improving the safety, continuity, and efficiency of commercial and personal travel along the I-81 corridor that extends from Tennessee to the Canadian border in New York. This partnership comprises state Departments of Transportation, Metropolitan and Regional Planning Organizations, non-governmental organizations, and private entities from the six corridor states. The focus of the coalition is to study and implement innovative solutions to challenges specific to travel on a freight-intensive highway serving a variety of geopolitical regions and users. Current focus areas include incident management, development planning, and truck parking.
International Center for Naturalistic Driving Data Analysis at Virginia Tech
Zeb Bowden, Director

VTTI’s data center infrastructure is a large, complex, and continually evolving environment supporting the institute’s mission by providing the foundation for VTTI’s data-intensive scientific research programs, including peta-scale studies such as the National Academies of Science - Transportation Research Board’s “Second Strategic Highway Research Program” (SHRP 2) Naturalistic Driving Study. VTTI’s Naturalistic Driving Studies collect immense volumes of data, with current storage requirements for archive and online data exceeding 10 PB (petabytes). Data collected at remote locations is often staged on an off-site server and transferred to VTTI. After arriving at VTTI, the data are processed by an enterprise-class workflow system running on a 48-node High Performance Computing (HPC) cluster. The workflow system archives the raw files to a Hierarchical Storage System and unpacks and processes the individual files for ingestion. Composite video files are processed into their discrete views, re-encoded for analysis, and loaded into a 2.4-PB scale-out Network Attached Storage (NAS) clustered file system. Sensor-derived data is extracted, transformed, and loaded into a 1.2-PB Massively Parallel Processing (MPP) enterprise database platform. Once data is in VTTI’s facilities, processing and analyses are carried out using a 10-gig HPC network to quickly manipulate the data.

National Surface Transportation Safety Center for Excellence
Jon Hankey, Director

The National Surface Transportation Safety Center for Excellence was established by the Federal Public Transportation Act of 2005 to develop and disseminate advanced transportation safety techniques and innovations in both rural and urban communities. Center research focuses on four major objectives: 1) To develop and test transportation devices and techniques that enhance driver performance; 2) To evaluate the roadway environment and infrastructure-based safety systems; 3) To address mobility for vulnerable road users; and 4) To examine driver impairment issues.

Safety through Disruption (Safe-D) National University Transportation Center (UTC)
Zac Doerzaph, Director

Fueled by the inevitable changes in our transportation system, the Safety through Disruption (Safe-D) UTC endeavors to maximize the potential safety benefits of disruptive technologies through targeted research that addresses the most pressing transportation safety questions. Safe-D focuses on three key areas: (1) cutting-edge research by leading transportation safety experts and their students; (2) education and workforce development with programs for all levels from grade school through college to continuing education for professionals; and (3) fully supported technology transfer including practitioner training partnerships, social networking, commercialization, and intellectual property management.
The Virginia Tech Transportation Institute works with many sponsors, clients, and partners that support the research that saves lives, time, money, and protects the environment. The continued success of VTTI is due, in large part, to these organizations. Ranging from government agencies to academic institutions, these sponsors, clients, and partners are integral to the completion and awareness of the research conducted at VTTI.
OUTREACH, COMMUNITY ENGAGEMENT, & MEDIA COVERAGE
OUTREACH

COMMUNITY ENGAGEMENT, & MEDIA

During FY21, numerous representatives of current and potential sponsoring/partnering organizations, marketing groups, and conference groups visited VTTI and/or the Virginia Smart Roads, including, but not limited to:

- Aerial Focus Pro
- Delegate David Reid (Virginia 32nd District)
- Nano Sonic
- New River Valley Leadership
- Port Solutions
- Save the Road Group
- Unisys
- Various Virginia high school students
- Virginia Department of Transportation
- WSLS 10

VTTI and its facilities were well represented at several international and national industry conferences, symposia, and meetings, including, but not limited to:

- BAM Forum
- ITSAVA Annual Conference
- Partners for Automated Vehicle Education Workshop
- SAE Government/Industry Meeting
- SAE WCX Digital Summit
- Transportation Research Board 100th Annual Meeting
- Virginia Governor Transportation Conference – Spring Webinar

MEDIA COVERAGE FY21

* Denotes media outlets that covered VTTI more than once during FY21

- 2025AD
- 4Legend
- AARP
- Augusta Free Press*
- Automotive World
- Autotrader.ca
- Baltimore Post-Examiner
- Bankrate*
- Betanews
- Bus & Motorcoach News
- Business Insider France
- Business Insider Mexico
- CCJ
- CDL LIFE*
- Claims Journal
- Commercial Carrier Journal*
- Construction & Demolition Recycling
- Construction Equipment
- Content Review
- Daily Progress
- DesignNews
- Electronics360
- Energy Live News
- EurekAlert
- Falls Church News Press*
- Forbes*
- Fleet Owner*
- Fox13
- FreightWaves*
- Geekzilla.tech
- Government Technology
- Greater Greater Washington
- Green Car Congress
- Heavy Duty Trucking*
- IIHC March Newsletter
- ITBizNews
- ITS International
- Lawyers
- Legacy
- Los Alamos Daily Post
- Markets Insider*
- NBC12
- News Break
- Newswise
- Nova
- NRVN News*
- Patch
- Progressive Railroading
- (Cision) PR Newsire*
- (Cision) PRWeb
- SAE
- Saskatoon Star Phoenix
- SF Gate
- SlashGear*
- StataScoop
- Strade & Autostrade
- Stuttgarter Nachrichten
- The American Prospect
- The BRAKE Report
- The Daily Progress
- The Lee Daily Register
- The Legal Advocate*
- The Richmond Times-Dispatch
- The Roanoke Star*
- The Roanoke Times*
- The Roundup
- The Spokesman-Review
- The Times Hub
- The Washington Post
- Times-Mail
- Transport Rooter*
- Transport Topics
- Troy Daily News
- Tysons Reporter*
- Valenciacars
- Virginia Business Magazine*
- Virginia Economic Review
- VT News
- WalletHub
- Ward’s Auto
- Washington Business Journal
- WBMA
- WDBJ7*
- WDJT
- WDVM
- WXIR*
- WHSV
- WLS*
- WTOP*
- WUSA9
- WWVA
- WZZM
- Yahoo*
- Yahoo Finance*
PRESENTATIONS
HONORS
AWARDS & SERVICES
PRESENTATIONS
Honors, Awards, & Services

FY21 PRESENTATIONS, CONFERENCE PAPERS, AND PROCEEDINGS


Camen, M. C., Osiecki, D., & Garney, S. (2021, May). Proven strategies to increase fleet safety [Invited webinar]. Scopelitis Transportation Consulting LLC.


Doerzaph, Z. (2021). Overview of VTTI activities related to Drive2theFuture topics [Virtual]. Drive2theFuture Workshop Programme


Flintsch, G. W. (2020). Gestión de activas viales en tiempos de vehículos autónomos e infraestructura inteligente (Managing assets in times of autonomous vehicles and intelligent infrastructure) [Invited presentation]; Intelligent Technologies Cycle, ITS Argentina (virtual), July 29.

Flintsch, G. W. (2020). Sistemas modernos de administración de activas viales (Modern road asset management systems) [Invited presentation]; PIARC Seminar; Quito, Ecuador (virtual), December 16.

Flintsch, G. W. (2020). Tendencias en la gestión de activas viales (Trends in road asset management) [Invited presentation]. Unidad de Mantenimiento Vial, Bogota, Colombia (virtual), March 17.


PRESENTATIONS

HONORS, AWARDS, & SERVICES


Klauser, C. (2020, December). DriveSmart VA [Podcast interview].


Layman, C. (2021, May 5). Data introspection in standard export code: Data Analyst Group Meeting. [Location].


McCall, R., McLaughlin, S., Williams, V., & Rainey, C. (2021, May 1). Observed crashes, near crashes, and factors that increase risk in the MSF 100 naturalistic riding study [Invited talk]. 2021 Texas Motorcycle Safety Forum organized by Texas A&M Transportation Institute and the Texas Department of Transportation.


Mollenhauer, M. (2020, October 27). C-V2X work zone and traffic light information use case development and Smart Vest program. SGA Virtual Showcase of C-V2X Deployment. Virtual.


Schaudt, W. A. (2020, August). Transportation in the NRV and beyond [Invited speaker]. Virginia Tech Women’s Club, Blacksburg, VA.


Honors, Awards, & Services

PRESENTATIONS

STUDENT PRESENTATIONS, CONFERENCE PAPERS, AND PROCEEDINGS

INCLUDES THOSE MADE IN COLLABORATION WITH VIRGINIA TECH STUDENT AUTHOR(S)


Dyna Conference (online).


Osteopathy in the cranial field as a method to enhance brain injury recovery: A preliminary study. MHRS Conference.

Preliminary investigation of skull and brain dynamics during blast. 2020 BMES Annual Meeting.

Comparing signal preprocessing techniques for a low-cost EEG system. Biomedical Engineering Society Annual Conference.
**PRESENTATIONS**

**HONORS, AWARDS, & SERVICES**


Riexinger, L. E.* (2021, April). Using real-world crash data to predict the effectiveness of LDW systems. Bucknell University, Biomedical Engineering Department.


Valente, J. T.*, & Perez, M. A. (2020, August). Emergency response to vehicle collisions: Feedback from emergency medical service providers [Virtual presentation]. Student Research Symposium within the Scientific Conference for the Association for the Advancement of Automotive Medicine, Portland, OR.


HONORS, AWARDS, AND SERVICE TO THE PROFESSION

Myra Blanco
- SAE International 2021 Top Contributor

Matt Camden
- Virginia Department of Education’s Driver Education 2021 Standard’s of Learning Reviewer
- Member of Governors Highway Safety Administration (2021-present)
- Member of ITS America (2021-present)
- 2020 Making a Difference Award, Better Agreements, Inc.

Michelle Chaka
- SAE Government Industry Special Sessions Committee
- Recipient of the SAE International 2021 J. Cordell Breed Award for Women Leaders – April 2021

Zac Doerzaph
- Treasurer: Intelligent Transportation Systems, Virginia Chapter (ITSVA)
- Associate Editor: SAE International Journal of Connected and Automated Vehicles
- Member: NOVA Transportation Authority Technology Committee (TCC)
- Member: SAE Crash Causation and Data Analysis Committee

Gerardo Flintsch
- Appointed Dan Pietta Professor of Engineering, College of Engineering, Virginia Tech

Warren Hardy
- Scientific Research Committee- International Research Council on Biomechanics of Injury (IRCOBI)
- Membership Committee- Association for the Advancement of Automotive Medicine (AAAM)
- Scientific Program Committee (SPC)- Association for the Advancement of Automotive Medicine (AAAM)
- Program Chair – ASME IDETC/CIE, 22nd International Conference on Advanced Vehicle Technologies (AVT)
- Symposium Chair- ASME IDETC/CIE, AVT Conference, Ground Vehicle Safety and Ergonomics Symposium
- Secretary, Vehicle Design Committee, ASME
- Journal of Vibration and Acoustics (ASME)
- Associate Editor, Journal of Commercial Vehicles (SAE)
- PLOS One, (Public Library of Science)

Charlie Klauer
- Current chair of the TRB Vehicle User Education, Training, and Licensing Technical Committee (ACH60)
- Board member for DriveSmart Virginia
- Promoted to tenured associate professor in the VT Grado Department of Industrial and Systems Engineering

Justin Owens
- Member: TRB Committee on Human Factors in Vehicles [ACH30]
- Co-Chair: Pedestrians and Autonomous Vehicles Interactions Subcommittee [ACH10(3)]

Miguel Perez
- 2021 Liviu Librescu Faculty Prize for Outstanding Accomplishments
- Leader in teaching, recognized by Department of Biomedical Engineering and Mechanics, Virginia Tech, May 2021
- “Golden Pen” Award (contract award over $5M), recognized by Department of Biomedical Engineering and Mechanics, Virginia Tech, May 2021

Hesham Rakha
- First Place, IEEE ITSC 2020 UAS4T Competition
- Editor, Sensors, Intelligent Sensors Section.
- Associate Editor, Journal of Intelligent Transportation Systems: Technology, Planning and Operations.
- Associate Editor, Journal of Intelligent Transportation Systems.
- Associate Editor, 16th IFAC Symposium on Control in Transportation Systems, Lille, France, June 8-11, 2021.
- Program Committee Member, 21st IEEE International Conference on Autonomous Robot Systems and Competitions (ICARSC2021), Santa Maria da Feira, Portugal, April 28-29, 2021.
- Associate Editor, 23rd IEEE International Conference on Intelligent Transportation Systems Conference, September 20-23, 2020, Rhodes, Greece.
- IEEE Fellow (Class of 2020) for contributions to optimization, modeling and assessment of transportation systems.

Andy Schaudt
- Nominated for membership in Lead Virginia, 2021
- National Distinction and Outstanding Contributor, Virginia Tech, 2021

Tammy Trimble
- University of Minnesota School of Public Health Focus Group Training (completed May 2021)

Jacob Velante
- President of the Biomedical Engineering Society student chapter at Virginia Tech (Aug 2020 – present)
PUBLICATIONS
FY21 PUBLICATIONS INCLUDES TECHNICAL REPORTS AND JOURNAL ARTICLES


Palmer, M., & Gibbons, R. (2020). Recommendations, E: Smart lighting for...


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