Protecting Rear-Seat Passengers

UMTRI researchers develop and test a suite of advanced restraint systems for rear-seat occupants

Riding in the rear seat of a vehicle is generally safer than riding in the front seat, but the advantage isn't as big as it once was, according to UMTRI Biosciences researchers. Associate research scientist Jingwen Hu says that the rear seat of a vehicle accommodates a more diverse range of passengers than the front seat—everyone from infants, toddlers and young teens to seniors. Optimizing occupant crash protection for this wide range of ages and body sizes is a bigger challenge than protecting the adult-sized occupants in front seating positions. Hu explains why.

"Based on the crash injury data for rear-seat occupants, the head is the most commonly injured body region for young children, while abdominal injury is disproportionally high for 6–8 year-old children, and the chest is most vulnerable in older adults," says Hu. "These injury trends indicate different injury mechanisms for the wide range of rear-seated occupants."

And different injury mechanisms require different types of protection. With funding from the National Highway Traffic Safety Administration (NHTSA), Hu and UMTRI colleagues Jonathan Rupp and Matt Reed collaborated with ZF TRW to develop and test a suite of advanced restraint systems for rear-seat occupants.

Advanced Restraint Systems

Advanced restraint systems include such devices as three-point seat belts with pre-tensioners (which pull the seat belt at the beginning of a crash to remove belt slack) and load limiters (which release webbing gradually during a crash to prevent excessive loading to an occupant’s chest). Load limiters have been widely used in vehicle front seats but are rarely available for rear seats due to the lower occupancy rates. Other advanced restraint systems include four-point seat belts, inflatable belts, roof airbags, and self-conforming rear-seat air bags (SCaRAB), all of which are designs currently focusing on rear-seat occupants.

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In the UMTRI/TRW study, researchers conducted a series of three sled crash tests to establish the baseline performance of the current rear-seat restraint system. The tests also allowed researchers to investigate a variety of advanced restraints and to test the final optimal restraints.

For the sled tests, Hu and his team used four different crash-test dummies—representing a 6-year-old child, small female, medium-sized male, and large male—and subjected them to two crash pulses (soft and severe), selected based on standard NHTSA 35-mph frontal crash tests from 25 small cars. Two impact angles (0° and 15°) were varied in each series of crash tests.

The physical tests in the first two series were used to calibrate sophisticated computational models of the occupants and vehicle. Hu says that once good correlations between the tests and simulations were achieved, he used the validated models to perform design optimizations, or strategies to improve protection for rear-seat occupants of all sizes.

"Computational models can be rapidly ‘crashed’ thousands of times with many different restraint configurations to find the best way to protect occupants," explains Hu.

Adaptability is Key Factor

The UMTRI/TRW researchers found that advanced restraints have to adapt to occupant size and crash severity to achieve the best occupant protection. For instance, because field data show that the chest is the most commonly injured body region for rear-seated adult occupants, the researchers attempted to reduce the amount of force impacting the chest while keeping the head from pitching too far forward and impacting the front seat.

Children 6-12 years old, however, have a different problem. Their smaller body size and often slouched posture in vehicle seats can result in poor seatbelt fit and the risk of submarining, or sliding under the seatbelt in the event of a crash.

In addressing these various injury situations, the UMTRI/TRW researchers found that under the soft crash pulse, an optimal advanced belt-only design (three-point belt with pretensioner and load limiter) met all of the injury criteria; under the severe crash pulse, the advanced seatbelt must be combined with the SCaRAB airbag to meet all of the injury criteria.

Final results of the crash tests show that the advanced restraints, especially those with SCaRAB airbag, can significantly reduce the injury risks to the head, neck and chest to the rear-seat occupants with different sizes and under different crash severity.

Still, the UMTRI study demonstrates that properly optimized seatbelts and airbags can significantly improve protection for rear-seat vehicle occupants.

These results are very promising, says Hu, and they come at the right time.

“With the recent popularity of services such as Uber and Lyft, the growing attraction of self-driving vehicles, and the steady increase in the older population in the U.S., rear-seats may become more important than ever before,” says Hu. “Now is a good time to improve rear-seat occupant protection.”
James Sayer Begins Term as UMTRI Director

James R. Sayer began his five-year term as the director of the University of Michigan Transportation Research Institute on March 1. Sayer replaces Carol Flannagan, who has served as UMTRI interim director during the search for a permanent director.

In addition to his position as director, Sayer is a research scientist at UMTRI as well as adjunct professor of civil and environmental engineering in the U-M College of Engineering. He is an internationally recognized leader in the conduct and evaluation of field operational tests of motor-vehicle safety systems and the study of naturalistic driving behavior. Recently, he led the design and development of Mcity, U-M’s unique 32-acre full-scale simulated urban environment for rigorously testing the performance and safety of connected, automated, and autonomous vehicles under realistic, controlled conditions.

“Jim has shown exemplary vision in conceiving innovative interdisciplinary research projects that show the commitment of UMTRI to its mission, and strong leadership in building the relationships with faculty, industry, and government required to make them happen,” said S. Jack Hu, U-M vice president for research.

Sayer also served as the principal investigator of the U.S. Department of Transportation’s Connected Vehicle Safety Pilot Model Deployment Program, a $31 million program to demonstrate connected-vehicle technologies on the streets of Ann Arbor. The results of the Safety Pilot Model Deployment are being used by the U.S. DOT to determine driver acceptance for, and evaluate the feasibility, scalability, security and device interoperability of connected-vehicle technologies. Overall, Sayer has conducted more than $70 million in basic and translational research in such areas as connected vehicle technology, advanced vehicle safety systems, driving behavior, and driver distraction since 1993. His work in connected vehicles and the development of Mcity earned Sayer a 2015 White House Transportation Champion of Change award. In the same year, UMTRI observed its fiftieth anniversary.

“UMTRI just celebrated its fiftieth year,” said Hu. “I am confident that Jim has the right knowledge, experience, and abilities to lead the organization into its next fifty.”

Associate Directors Named

Sayer recently announced that effective April 1, 2016, Lisa Molnar and Kathy Klinich will serve as associate directors at UMTRI for an initial term of two years.

Associate research scientist Lisa Molnar, Ph.D., who has been with UMTRI since 1986, will be working with, and engaging, schools and colleges on U-M central campus with interests related to UMTRI’s. The focus of her effort will be on increasing faculty, undergraduate and graduate student collaborations.

Associate research scientist Kathy Klinich, Ph.D., who has been with UMTRI since 1996, will be working with, and engaging, schools and colleges on U-M north campus with interests related to UMTRI’s. The focus of this effort is on increasing faculty, undergraduate and graduate student collaborations. In addition, Klinich will continue to lead UMTRI’s initiative on Diversity, Equity, and Inclusion.

Molnar and Klinich replace Lawrence Schneider, whose term as UMTRI associate director ended March 31.
Advancing Sustainable Supply Chains

UMTRI-SMART conference highlights new-mobility strategies and technologies

UMTRI Automotive Futures and U-M SMART (Sustainable Mobility and Accessibility Research and Transformation) teamed up February 17 to host a one-day conference on sustainable supply chains. The event highlighted new-mobility strategies and technologies and how they’re changing goods movement.

SMART’s managing director Susan Zielinski said the movement of goods affects our daily lives—impacting not only the economy, but also the environment and people’s quality of life—and yet most people don’t think much about it.

“For most of us, goods movement is under the radar,” said Zielinski. “We only think of it when it’s not working.”

But lately, plenty of people associated with the supply-chain and freight-movement industries are thinking a lot about innovative solutions, policies, and business models that will make goods movement more efficient, reduce its environmental and social impacts, and offer new business opportunities.

UMTRI’s Bruce Belzowski, managing director of the Automotive Futures group, moderated the conference and introduced speakers representing startup companies and large automotive and IT companies, as well as state and national government representatives and NGOs.

“When we talk about goods movement,” said Belzowski, “it can include anything from raw materials and manufacturing to services and retail, such as consumer products and food, as well as energy technology and distribution, information technology, and infrastructure. It’s about anything that moves regionally, nationally, and globally every day, and sometimes it’s even about trying to move things less. It involves many modes of transportation including ships, air, rail, trucks, even bicycles and now drones.”

Maximizing Efficiency, Minimizing Impacts

The supply chain network has become increasingly complex, as new technologies emerge and new players enter the game.

Sophie Punte, executive director of the Smart Freight Centre in Amsterdam, discussed some of the global issues related to sustainable freight movement. She works with industry to remove market barriers, take advantage of existing initiatives, and accelerate the uptake of practical solutions. One of the challenges, she said, is to understand the landscape. With so many green freight initiatives currently in existence, it’s difficult for companies to know which ones to join.

Reducing market barriers to sustainable freight movement is also a major challenge. Globally, freight transport practices differ from country to country—such as large trucking fleets in developed countries and small, owner-operated vehicles in less developed countries that operate on very different budgets. By working with leadership companies first to address common barriers (such as universal emission standards), Punte hopes the solutions will eventually reach the smaller companies.

Thomas Kearney, transportation specialist at the Federal Highway Administration, shared maps of freight movement across the country and highlighted some of the inefficiencies, particularly in transferring between modes in hubs such as Chicago. He also talked about the government’s role in public-sector decision-making within the freight industry, which involves building trust and partnering with industry to learn where best to devote public funding.

Cheryl Bynum, who directs the U.S. EPA’s SmartWay Transport Partnership, showed how with expanded population growth in developing countries, freight will mushroom. Freight is present at every point of the lifecycle for everything we use, she said, but the global impacts are different across the world. EPA needs to identify solutions to such problems as greenhouse gases and particulates and to implement policies and strategies that mitigate pollution.

She also highlighted disruptive technologies that may change the nature of freight movement, such as mega ships, 3D printing, and IT advancements. However, she said, everything is connected, which creates opportunities but also poses challenges.

“It’s important to look at supply chains as a system,” said Bynum. “You can’t just improve one area.”
New-Mobility Innovations

Komal Anand Doshi, research specialist at SMART and Mobi Platform lead, highlighted some of the disruptive innovations arriving on the freight scene. She gave an overview of several new-mobility companies that employ new business models and technologies to maximize efficiency and minimize environmental impact. They include Trunkbird, Instacart, DoorDash, Bellhops, Shipster, and more.

Other speakers at the Sustainable Supply Chain conference included Mary Wroten of Ford Motor Company; Dave Hoover of Meijer Food Stores; Mike Dargis, president of Zip Xpress, Mike Maceroni and Brian Becker of UPS; and Cherry Burke of Dow Chemical Corporation, all of whom highlighted their company sustainability practices and strategies to maximize freight efficiency and reduce environmental impact.

Names & Faces

TRB 95th Annual Meeting

The Transportation Research Board (TRB) 95th Annual Meeting was held January 10–14, 2016, at the Walter E. Washington Convention Center, in Washington, D.C. A number of UMTRI researchers were among the estimated 12,000 transportation professionals from around the world who attended.

The meeting program covered all transportation modes, with more than 5,000 presentations in nearly 800 sessions and workshops, addressing topics of interest to policy makers, administrators, practitioners, researchers, and representatives of government, industry, and academic institutions.

More than 35 sessions and workshops focused on the spotlight theme for the 2016 meeting, Research Convergence for a Multimodal Future, and more than 75 addressed one or more of three hot topics, including transformation technologies, resilience, and transportation and public health.

UMTRI and the U-M Mobility Transformation Center (MTC) hosted a reception on Sunday, January 10, which was well attended by UMTRI and MTC faculty and staff as well as national and international guests from industry, government, and universities.

Throughout the meeting, UMTRI faculty presented research in sessions on transportation network modeling, signal systems, connected-vehicle applications, parking management, young driver behavior, older driver safety, and overseas data sharing. Among the presenters were research professor Henry Liu, assistant research professor Robert Hampshire, associate research scientist Carol Flannagan, research professor Raymond Bingham, and research professor David W. Eby.

Automotive News World Congress

UMTRI director and research scientist James Sayer participated on a panel addressing connected, autonomous, shared, and electric (CASE) vehicles at the 40th annual Automotive News World Congress, held January 12–13, in Detroit, Michigan.

CASE describes the bundle of technologies and business models companies may need to stay at the forefront of the industry. Because it is difficult to lead in all four categories, investments are significant and incremental. Panelists discussed how the industry is meeting that challenge and the opportunities it creates.

SAE Government/Industry Meeting

Understanding how technology, regulations and legislation affect the design of light- and heavy-duty vehicles in terms of safety, environment, and energy conservation is essential to vehicle development. The SAE Government/Industry Meeting, held January 20–21 in Washington, D.C., provided opportunities for technical leaders from government, industry and academia to address issues influencing future decision-making within the industry.

Technical session topics included vehicle crashworthiness, child safety, telematics, compliance, and much more. UMTRI associate research scientist Kathy Klinich presented “Development of Fit Envelopes to Promote Compatibility between Child Restraints and Vehicles.” UMTRI research professor Matt Reed presented on driver head position in the technical session on protecting occupants within the vehicle compartment. UMTRI associate research scientist Jingwen Hu was scheduled to present on rear-seat occupant protection in the technical session on inflatable restraints.
Recent UMTRI Publications

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UMTRI In The News

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Like millennials, more older Americans steering away from driving

http://www.npr.org/2016/02/11/466178523/like-millennials-more-older-americans-steering-away-from-driving

Fuel-efficient cars: Best way to fight climate change


Oil price plunge is good for drivers, but it’s a big threat to some clean energy technologies


Upcoming Events

Aging in America Conference
March 20–24; Washington, D.C.
http://www.asaging.org/aia

Automotive Cyber Security Summit
March 21–23; Detroit, Michigan
http://www.automotivecybersecurity.com/

Michigan Traffic Safety Summit
March 22–24; East Lansing, Michigan
http://www.michigan.gov/msp

Lifesavers National Conference
April 3–5; Long Beach, California
http://www.lifesaversconference

2016 AASHTO GIS for Transportation Symposium
April 4-7; Raleigh, North Carolina
http://www.gis-t.org/

SAE 2016 World Congress
April 12-14; Detroit, Michigan
https://www.sae.org/congress/

Globalization of the Automotive Industry: The 2016 Update
April 13; Ann Arbor, Michigan
http://umtri.umich.edu/who-we-are/research-groups/automotive-futures

Transportation and Logistics Council Annual Conference
May 2-4; Albuquerque, New Mexico
http://www.tlcouncil.org/

Conference on Electric Roads and Vehicles
May 16-17; Logan, Utah
http://cervconference.org

ITS America 2016
June 12-15; San Jose, California
www.itsa.org
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UMTRI’s Strategic Intent
To be the leader in transportation systems research integrating vehicles, people, and infrastructure to achieve a highway transportation system where:
- Fatalities and injuries are eliminated
- People and goods flow efficiently
- Reliance on nonrenewable energy is reduced

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