

Sagar Umale, B.E., M. Tech, PhD, ACTAR

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Forensic Expert – Biomechanics & Accident Reconstruction

EDUCATION

B.Sc.	Bachelor of Mechanical Engineering Nagpur University, India, 2004 Internship: TATA Motors India Projects: Designing machining workflow at Mahindra and Mahindra Tractors India
M. Tech	Master of Technology in Mechanical Engineering Indian Institute of Technology, New Delhi, India, 2007 Projects: Development of a Virtual Environment of Drilling a bone in Wrist Surgery
PhD	Doctor of Philosophy in Biomechanics University of Strasbourg, France, 2012 Projects: Characterization and FE Modeling of Abdominal Organs I developed and validated the abdominal organ finite element models using experimental data during my PhD. This was performed for Daimler AG for the development of a thoracic model.

EMPLOYMENT HISTORY

June 2022 - Present — Aperture, LLC – Long Beach, CA
Forensic Expert – Biomechanics & Accident Reconstruction

Responsible for the investigation and analysis of injury-causing events, which includes vehicle and site inspections, accident reconstruction, and necessary biomechanical engineering calculations. Conduct ongoing research to evaluate the biomechanics, human kinematic response, and injury potential of vehicular accidents and other activities. Perform fully instrumented tests utilizing human subjects and/or human surrogates. Data collected and analyzed include accelerations, velocities, displacements, forces, high speed film/video, and vehicle crush and dynamics. I have received training on the retrieval and analysis of data from automobile event data recorders (EDR). I conduct biomechanical and accident reconstruction analyses and consultations for automobile accidents and various events for purposes of litigation, including accident reconstruction, occupant kinematics, occupant force exposure, and injury potential.

Jan. 2019 - May 2022 — Medical College of Wisconsin – Milwaukee, WI
Senior Research Scientist

As a Senior Research Scientist, I was a co-principal investigator for the 'Automated Vehicle Occupant Kinematics' project funded by National Highway Traffic Safety Administration (NHTSA), which aimed to understand human kinematics in automated vehicles. I designed novel techniques to develop subject-specific full-scale and isolated human body models. I investigated subject-specific kinematics and injury mechanisms of out-of-position occupants using those models. I was also a co-investigator of a grant which allowed MCW to be a potential partner in all future NHTSA FEM projects. I investigated injury mechanisms in far-side crashes and factors affecting the injuries and provided countermeasures for other NHTSA funded projects. I worked to reconstruct lumbar spine injuries in crashes using full-scale vehicles and occupant models in high-speed frontal impacts. I have worked to investigate the effects of different lumbar spine fusion techniques and compare it to the mechanics of a healthy lumbar spine.

Feb. 2014 - Dec 2018 — Medical College of Wisconsin – Milwaukee, WI
Post Doctoral Fellow

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As a post-doctoral fellow, I was responsible for conducting various research projects, analyzing - presenting results to funding agencies and writing papers. Followings were my projects and responsibilities:

- Conducting experiments on cervical spine and analysis of the experimental data
- Develop a cervical spine finite element model
  - Develop, validate and optimize a material model using cyclic experimental data
  - Implement the developed material model in finite element model
  - Predict injury in cervical spine intervertebral disc using fatigue analyses
- Validation of full-scale Global Human Body Models Consortium's (GHBMC) Human Boyd Model (HBM) under far-side impacts
  - Development of far-side buck and simulating 60-deg and 90-deg far side orientations
  - Comparing response with PMHS experiments by performing correlation (CORA) analysis
- Evaluation of kinematics and injuries in far-side accidents
  - Assembling Ford Taurus 2001 car model with GHBMC human body model
  - Simulating far-side accidents with pole and MDB at varying speeds
  - Performing analysis on chest-band deformations, occupant excursions, soft tissue injuries etc.
- Far-side Impact Injury Scenario Replication
  - Assembling Toyota Yaris 2010 car model with GHBMC human body model
  - Analyzing accident database for most frequent cases
  - Performing FE analysis for buck and car model, and evaluate input parameters for experiments
- Far-side Impact Shoulder Belt Retention
  - Development and validation of far side buck with GHBMC human body model
  - Improve the model iteratively by performing parametric analysis
- Most biofedelic ATD evaluation under far-side
  - Validation of THOR, World SID and Hybrid III ATD under far-side
  - Comparison of ATD far-side response with PMHS sled data
- Development of 50th percentile 75-year-old GHBMC (In progress)
  - Morphing current 50th percentile adult GHBMC model to elderly 50th percentile
  - Modifying material properties for elderly
  - Validation of the elderly model based on experimental data

Jan. 2013 - Dec. 2013 — University of Strasbourg, France, 2012
Application Engineer

- Project: BLASTHOR
  - Understanding mechanics of human thorax under blast conditions
  - Finite element modeling of blast and investigation on a rubber membrane

Sept. 2007 - Dec. 2009 — IBM Global Business Solutions – Gurgaon, India
Case Engineer and Certified Inspector

- Project: Bharti Airtel Telecom (India)
  - Developer in web development projects for mobile services
  - Expertise in Java, DB2 database, ANT scripting and web development

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ACCREDITATIONS AND CERTIFICATIONS

2023 — Accreditation Commission for Traffic Accident Reconstruction (ACTAR)
Traffic Accident Reconstructionist – ACTAR #4735

2023 — Collision Safety Institute, Inc.
Crash Data Retrieval (CDR) System Operator Certification

2024 — Kent Boots and Associates, Inc.
Hyundai-Kia EDR Tool and Tesla EDR Tool Operator/ Technician Certification

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PROFESSIONAL AFFILIATIONS

Society of Automotive Engineers (SAE)
Southwestern Association of Technical Accident Investigators (SATAI)
Biomedical Engineering Society (BMES)

PUBLICATIONS

Alex Kazmierczak, **Sagar Umale**, Alyssa Visalli, Ella Webb, Aryeh Kashdan, Bryan Randles, and Judson Welcher, "*Aggregation of Cervical Loads in Rear Impact Crash Tests and Comparison to Activities of Daily Living*" Submitted to SAE October 2024.

Andrew Phan, Jamie Gross, **Sagar Umale**, Shannon Crowley, and Christopher Furbish, "*The Biomechanical Effects of Neck and Back Cushion/Pillow/Support Devices in Low-Speed Rear Impacts*" Submitted to SAE October 2024.

Aryeh Kashdan, **Sagar Umale**, Alex Kazmierczak, Joseph Kasselik, Bryan Randles, Christopher Furbish, and Judson Welcher, "*Aggregation of Lumbar Loads in Rear Impact Crash Tests*" SAE Technical Paper 2023-01-0647, 2023.

Sagar Umale, Prashant Khandelwal, John R Humm, Narayan Yoganandan. 2022. *"An investigation of Elderly Occupant Injury Risks based on Anthropometric Changes compared to Young Counterparts."* Traffic Inj Prevention. 21 Nov 2022.

Sagar Umale, Prashant Khandelwal, John R Humm, Narayan Yoganandan. 2022. *"Comparison of small female occupant model responses with experimental data in reclined posture."* Traffic Inj Prevention. 12 Oct 2022.

Sagar Umale, John R Humm, Narayan Yoganandan. *"Effects of Personal Protective Equipment on Spinal Column Loads from Underbody Blast Loading."* International Mechanical Engineering Congress and Exposition IMECE2021 November 1-5, 2021.

Sagar Umale, Jaime L. Baisden, Hoon Choi, Narayan Yoganandan, Shekar N. Kurpad. 2022. *"A Biomechanical Investigation of Lumbar Interbody Fusion Techniques."* Journal of Mechanical Behavior of Biomedical Materials, 125, 104961.

Sagar Umale, Prashant Khandelwal, John R Humm, Narayan Yoganandan. 2020. *"Development and validation of an elderly human body model for frontal impacts." Traffic Injury Prevention. 11 Nov 2020.;1-3*

Sagar Umale, Narayan Yoganandan, Shekar N. Kurpad. 2020. *"Development and Validation of Osteoligamentous Lumbar Spine Under Complex Loading Conditions: A first step towards patient-specific modeling."* Journal of Mechanical Behavior of Biomedical Materials, 110, 103898.

Sagar Umale, Hans Hauschild, John Humm, Mike Arun, Klaus Driesslein, Narayan Yoganandan. *"Effectiveness of center-mounted airbag in far-side impacts based on THOR sled tests."* Traffic Injury Prevention 2019, 1-6.

Sagar Umale, Mike W J Arun, Hans Hauschild, John R. Humm, Frank A. Pintar, Narayan Yoganandan. 2018 *"Quantitative Evaluation of THOR, World SID and Hybrid III under far-side impacts: A finite element study."* The International Research Council on Biomechanics of Injury (IRCOBI) Conference 2018, Athens, Greece.

Sagar Umale, Mike Arun, Narayan Yoganandan. 2018. *"Methodology to Calculate Chest-band Compressions in Human Body Finite Element Models."* The International Research Council on Biomechanics of Injury (IRCOBI 2018).

Sagar Umale, Narayan Yoganandan, Frank A. Pintar, Mike W J Arun. 2018. *"Factors Influencing the Effectiveness of Occupant Retention under far-side Impacts: A parametric study*." Journal of Mechanical Behavior of Biomedical Materials, 84, 235-48.

Sagar Umale, Narayan Yoganandan. 2018. *"Mechanisms of Cervical Spine Disc Injury under Cyclic Loading."* Asian Spine Journal, Vol 12(5), 910-918.

Mike W J Arun, **Sagar Umale**, Narayan Yoganandan, Frank A. Pintar. 2017. *"Can 1 –DOF Sled Tests Reproduce Real World Far-Side Crashes? A Finite Element Study."* The International Research Council on Biomechanics of Injury (IRCOBI 2017), Antwerp, Belgium.

Mike W J Arun, **Sagar Umale**, John R. Humm, Narayan Yoganandan, Prasanaah Hadagali, Frank A. Pintar. 2016. *"Evaluation of Kinematics and Injuries to Restrained Occupants in Far-Side Crashes using Full-Scale Car and Human Body Models."* Traffic Injury Prevention, Vol-17, NO. S1, 116-123.

Mike W J Arun, **Sagar Umale**, John R. Humm, Narayan Yoganandan, Frank A. Pintar, Rodney W Rudd. 2016. *"Impact Response Evaluation of a Restrained Whole Human Body Finite Element Model under Far-side 90- and 60-degree Impacts."* The International Research Council on Biomechanics of Injury (IRCOBI), Malaga, Spain.

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Narayan Yoganandan, **Sagar Umale**, Brian Stemper, Brian Snyder. 2017. *"Fatigue responses of human cervical spine intervertebral discs."* Journal of Mechanical Behavior of Biomedical Materials, Vol 69, 30-38.

Sagar Umale, Brian Stemper, Mingxin Zheng, Aidin Masoudi, Daniel Fama, Narayan Yoganandan, Bryan Snyder 2015. *"Methodology to Calibrate Disc Degeneration in the Cervical Spine during Cyclic Fatigue Loading."* Biomedical sciences instrumentation, Vol 51, 222-9.

Sagar Umale, Narayan Yoganandan, William Curry, Brian Stemper, Brian Snyder. *"Responses of the cervical disc under cyclic loading: data for finite element models."* Rocky Mountain Biomechanics Symposium 2016, Denver Colorado. USA.

Sagar Umale, Caroline Deck, Nicolas Bourdet, Michele Diana, Luc Soler, Remy Willinger. 2017. "*Experimental and Finite Element analysis for Prediction of Kidney Injury under blunt impact."* Journal of Biomechanics, Vol 52, 2-10.

Brian D. Stemper, Narayan Yoganandan, Jamie L. Baisden, **Sagar Umale**, Alok S. Shah, Barry S. Shender, Glenn R. Paskoff, 2015. *"Rate-dependent fracture characteristics of lumbar vertebral bodies."* Journal of Mechanical Behavior of Biomedical Materials, 41, 271-279.

Sagar Umale, Caroline Deck, Nicolas Bourdet, Michele Diana, Luc Soler, Remy Willinger. *"Modeling and Validation of the Human Liver and Kidney Models."* The International Research Council on Biomechanics of Injury (IRCOBI) Conference, Sept 2013, Gothenburg Sweden.

Sagar Umale, Caroline Deck, Nicolas Bourdet, Parag Dhumane, Luc Soler, Jacques Marescaux, Remy Willinger, 2013. *"Experimental Mechanical Characterization of Abdominal Organs: Liver, Kidney & Spleen."* Journal of Mechanical Behavior of Biomedical Materials, 17, 22-33.

Sagar Umale, Simon Chatelin, Nicolas Bourdet, Caroline Deck, Michele Diana, Parag Dhumane, Luc Soler, Jacques Marescaux, Remy Willinger, 2011. *"Experimental in vitro mechanical characterization of porcine Glisson's capsule and hepatic veins."* Journal of Biomechanics, Vol-44, Issue-9, 1678-1683.

PRESENTATIONS / ABSTRACTS

Sagar Umale, Prashant Khandelwal, John Humm, Narayan Yoganandan. "*The Influence of Personal Protective Equipment on Male and Female Spinal Loads in Vertical Impact."* Summer Biomechanics, Bioengineering and Biotransport Conference, June 20-23, 2022.

Sagar Umale, Prashant Khandelwal, John Humm, Narayan Yoganandan. *"Effect of Stature and Lordosis on Female Lumbar Spine Loads in Vertical."* Summer Biomechanics, Bioengineering and Biotransport Conference, June 20-23, 2022.

Sagar Umale, John R Humm, Narayan Yoganandan. *"Role of Muscle Activation on Lumbar Spine Force in Frontal Impact Loading."* Summer Biomechanics, Bioengineering and Biotransport Conference, June 14-18, 2021.

Jamie Baisden, **Sagar Umale**, Vaibhav Porwal, Prashant Khandelwal, Hoon Choi, Narayan Yoganandan. *Finite Element Model for Spinal Metastatic Disease.* Lumbar Spine research society conference 2021.

Jamie Baisden, **Sagar Umale**, Hoon Choi, Narayan Yoganandan. *Comparison Of Lumbar Fusion Techniques for Spondylolisthesis using Finite Element Analysis.* Lumbar Spine research society conference 2021.

Sagar Umale, Prashant Khandelwal, John Humm, Narayan Yoganandan, Frank Pintar. 2019. *The investigation of pre-crash reclined occupant using GHBMC human body model.* 2019 GHBMC Users' Workshop, Detroit, MI, April 8, 2019.

Hoon Choi, Jamie Baisden, **Sagar Umale**, Vaibhav Porwal, Diane Braza, and Narayan Yoganandan. 2019. *Upright MRI Study of Flexor/Extensor Musculature and Cervical Lordosis in Females after Helmet Wear.* 2019 Military Health System Research Symposium (MHSRS). Aug 19-22, 2019. Kissimmee, FL.

Sagar Umale, Narayan Yoganandan, Mike Arun, Brian Stemper, Brian Snyder: *Mechanisms of cervical spine disc injury under cyclic loading:* Experiments *and finite element analysis.* ASME Summer Biomechanics, Bioengineering, and Bio transport Conference, National Harbor, Maryland, June 29- July 2, 2016.

Sagar Umale, Brian Stemper, Mingxin Zheng, Aidin Masoudi, Daniel Fama, Narayan Yoganandan, Bryan Snyder. *Progressive changes in cervical spine intervertebral disc properties during cyclic compressive fatigue loading.* ASME Summer Biomechanics, Bioengineering, and Bio transport Conference, Snowbird Resort, Utah, June 17-20, 2015. Poster # 235.

Daniel Baumgartner, Alok Shah, **Sagar Umale**, Mathew D Budde, L Ren, Junsheng Yang, Remy Willinger, Brian D Stemper, 2014. *Influence of Head Rotational Acceleration Pulse Shape on Brain Tissue Strains*. Journal of Neurotrauma 31 (12), A121-A121.

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Mingxin Zheng, Aidin Masoudi, **Sagar Umale**, Daniel Buckland, Narayan Yoganandan, Brian Stemper, Thomas Szabo, Brian Snyder. *Dual Ultrasound Can Measure Kinematic Motion and Intervertebral Disc Deformation of Cervical Spine.* ORS 2015 Annual Meeting, Las Vegas, Nevada, March 2015. Poster # 1096.

Sagar Umale, Brian D. Stemper, Narayan Yoganandan, Barry S. Shender. *Integration of Viscoelastic Mathematical Model to Experimental Data to Generate Material Property Data for Finite Element Model*. Aerospace Medical Association, May 2014, San Diago, USA.

Sagar Umale, Nicolas Bourdet, Caroline Deck, Remy Willinger. *Experimental Characterization of Porcine Hepatic Parts.* ISN Workshop IRCOBI, Sept 2012, Dublin Ireland.

Sagar Umale, Nicolas Bourdet, Caroline Deck, Remy Willinger. *Characterization, FE Modeling and Validation of Porcine Liver.* Living Imaging (LIVIM), Dec 2011, Strasbourg France.

Sagar Umale, Nicolas Bourdet, Caroline Deck, Remy Willinger. *Experimental In Vitro Mechanical Characterization of Porcine Glisson's Capsule and Hepatic Veins*. Simulation in Bio-Sciences & Multiphysics International Conference, June 2011, Marseille France.

RESEARCH AND TESTING

May. 2026 — Performed and participated in a series of low-speed crash tests involving a truck tractor–semi-trailer combination and both a Ford F-150 pickup truck and a GMC Acadia SUV. A total of seven crash tests were performed using various impact configurations, including sideswipe collisions between the right side of the tractor–trailer and the left side of the Ford F-150 and GMC Acadia, as well as rear-end collisions involving the front of the tractor and the rear of the Ford F-150. The tractor–trailer was operated by a human volunteer, while the Ford F-150 and GMC Acadia were occupied by a combination of instrumented human volunteers and anthropomorphic test devices (ATDs). Instrumentation was used to measure and record regional body forces and/or accelerations of human volunteers and ATDs throughout the testing program. The tests were recorded using a combination of stationary, aerial, and onboard camera equipment.

Aug. 2024 — Performed and participated in a series of 59 simulated low-speed rear end collisions with a remote-controlled sled. Delta Vs ranged from 4.0 to 7.5 mph. An instrumented BioRID II ATD was utilized with a 2018 Toyota Camry driver's seat to assess biomechanical differences with 10 different neck and low back support and cushion designs and configurations.

Feb. 2022 — SATAI Conference (Feb. 2022)
Glendale, Arizona facilitated by *Southwestern Association of Technical Accident Investigators.*
Participated in the rear impact test. The test data was analyzed and presented at the conference.
Topics included: instrumentation of human volunteers and crash testing vehicles, crash data retrieval and crash data analysis, threshold write events for several vehicle manufacturers, vehicle to barrier impacts, inline rear end vehicle to vehicle collisions, vehicle to scooter impacts, offset rear end impacts, side-swipe snag impacts, angled broadside impacts, idle speed testing and idle speed backing impact, Toyota Safety Sense, Lexus Safety Systems, 3D laser scanning, photogrammetry, 3D data processing, 3D data acquisition systems, Hybrid-III data analysis.

Feb. 2014 - May 2022 — Medical College of Wisconsin, Milwaukee, WI
I was involved in assisting and planning sled test experimental setup for ADT and PMHS for different projects. I had developed a protocol to perform cyclic loading environment experiments on the cervical spine. Over 40 cervical spine segments were tested. The experimental results were analyzed and published in journal papers.

Jan. 2010 – Dec 2013 — University of Strasbourg, France
During PhD research, I dissected and characterize individual components (capsule, parenchyma, and vessels) of abdominal organs such as liver, kidney, and spleen. Over 50 samples were tested for each tissue and mathematical material models were developed which were further used in the finite element models of the organs.

CONTINUING EDUCATION, TRAINING, AND KEY PROJECTS

Mar. 2026 — *HVE Users Forum*
5-day forum sponsored by *Engineering Dynamics Corporation (EDC)* in New Orleans, LA. The forum predicated on *Complicating Issues Involved in Scientific Accident Reconstruction* covering the following topics: Simulating vehicle impact case studies using EDCRASH, EDSMAC, SIMON. The Case studies

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included Advanced Methods for HVE: Part I to IV. The case studies utilized vehicles made from mesh details, tire models and other mechanical details such as stiffness. The case studies utilized different simulation methods to conclude the results for an accident. HVE White Paper Session / Tips, Tricks and Tech Support. Theory Series: that included Advanced Simon, DyMESH theory, and Brake Design.

May 2025 *PhotoModeler Technologies Course – ApertureLLC Signal Hill, CA*

Two-day course on photogrammetric analyses of photos and videos. Topics included an introduction to the PhotoModeler user interface; analyzing scene photographs, placing evidence on scene using photographs; taking vehicle crush measurements from damage photographs; determining vehicle speeds from video; testifying to photogrammetry analysis; and analyzing video of video.

Mar. 2025 *Human Factors and Ergonomics Society Research Conference – Long Beach, CA*

Topics included: vehicle interfaces and screens influence on driving performance, visual impairments, roadway signage and driver propensity to use turn indicators, driver performance during automated driving, driving simulation, effects of cell phones on driver performance and blind spot monitoring, influences in human-automation team performance.

Mar. 2024 *HVE Users Forum*

5-day forum sponsored by *Engineering Dynamics Corporation (EDC)* in Berkely, CA. The forum predicated on *Complicating Issues Involved in Scientific Accident Reconstruction* covering the following topics: Simulating vehicle impact case studies using, EDCash, EDSMAC, SIMON; Building a simulated vehicle; Building advanced environments; Simulating tire blow-outs and rollovers; Vehicle-environment interaction; Multiple vehicle events; Data interpretation.

Sept. 2022 *Simcenter Madymo Introduction – Signal Hill, CA*

Topics included: Madymo user interface, multibody systems and models, joint simulation, seat belt modeling and simulation, vehicle seat material characteristics, ATD positioning, FE modeling, contact definitions, airbag modeling, biomechanical data analysis, data visualization.

Mar. 2022 *Human Factors and Ergonomics Society Research Conference – Long Beach, CA*

Topics included: vehicle interfaces and screens influence on driving performance, visual impairments, roadway signage and drivers propensity to use turn indicators, driver performance during automated driving, driving simulation, effects of cell phones on driver performance and blind spot monitoring, influences in human-automation team performance.

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