

Exponent®
Engineering & Scientific Consulting

Amy Courtney, Ph.D., CAISS

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Professional Profile

Amy Courtney, Ph.D., CAISS, provides technical expertise in areas including injury biomechanics, premises liability, ballistics, and blast injury. She delivers expert analysis and consulting related to traumatic injury events and product liability assessments for clients in automotive, industrial, and firearms-related product manufacturing, transportation, construction, and infrastructure.

Dr. Courtney specializes in combining principles of physics, engineering, and the mechanical properties of the human body to answer complex questions related to injury risk, causation, mitigation, and prevention. Her ballistics expertise includes the safe operation of firearms; the internal physics, trajectories, and terminal behavior of ammunition; and shooting incident reconstruction. She has more than 40 years of experience evaluating the mechanical response of musculoskeletal tissues in normal, aging, disease, and injury conditions.

Dr. Courtney's work addresses issues including mechanisms and timing of injuries in complex events. She evaluates whether and how the severity of an event, product safety features such as seat belts, airbags, and ADAS features, or proper use versus misuse affect injury risk from a scientific perspective as well as how injury risk during an event is affected by anthropometry, age, and history.

In addition to her engineering training and expertise, her doctoral studies in the Harvard/MIT Division of Health Sciences and Technology, Medical Engineering and Medical Physics program, included medical coursework and clinical training at Harvard Medical School. She is also a Certified Abbreviated Injury Scale Specialist (CAISS), which is an established method for categorizing the severity of acute injuries for scientific analysis and research.

In applying her training and experience, Dr. Courtney's consulting approach integrates principles of physics and engineering, anatomy, biomechanics, scholarly research, field inspections, product evaluations, computational analyses, and testing as needed to deliver rigorous, scientifically supported conclusions.

Before joining Exponent, Dr. Courtney was a researcher in the Department of Biomedical Engineering at The Cleveland Clinic Foundation and the Orthopedic Biomechanics Laboratory of Beth Israel Hospital and Harvard Medical School. She also held an appointment as an assistant professor teaching physics at the U.S. Military Academy at West Point. Her research is documented in more than 80 publications in the medical and scientific literature.

Academic Credentials & Professional Honors

Ph.D., Engineering Sciences, Harvard University, 1994

M.S., Engineering Sciences, Harvard University, 1991

B.S., Engineering Mechanics, Michigan State University, 1989

Department of the Army, Commander's Award for Public Service

International Society of Biomechanics Promising Scientist Award

National Science Foundation Graduate Fellow

MSU Alumni Distinguished Scholar

Licenses and Certifications

IDPA Safety Officer Certification

High Master Classification, High Power Rifle Competition

Certified Abbreviated Injury Scale Specialist (CAISS)

Professional Affiliations

American Society for Bone and Mineral Research

Association for the Advancement of Automotive Medicine (AAAM), Scientific Program Committee

International Ballistics Society, Senior Member

International Defensive Pistol Association

Publications

Biomechanics and Injury Mechanisms

Courtney A, Crosby C, Miller B, Osterhout A, Walker J, Gondek J. "Effects of anthropometry and passive restraint deployment timing on occupant metrics in moderate-severity offset frontal collisions," SAE Technical Paper 2024-01-2749.

Sharpe S, Grijalva S, Allin L, Courtney A, et al. "Evaluation of occupant kinematics and kinetics during moderate severity simulated frontal impacts with and without frontal airbag deployment," SAE Technical Paper 2023-01-0559.

Parenteau C, Courtney A, Campbell I, and Lau E. "An update on front-seat occupant injury rates in frontal crashes: focus on modern vehicles," IRCOBI, September 8-10, 2021; Paper No. IRC-21-50.

Kirschman J, Pokutta-Paskaleva A, Courtney A, Courtney M. "Blast pressures and waveforms of consumer firecrackers," Shock Waves 2021; 31:301-306.

Parenteau C, Lau E, Campbell I, Courtney A. "Prevalence of spine degeneration diagnosis by type, age, gender, and obesity using Medicare data," Nature: Scientific Reports 2021; DOI 10.1038/s41598-021-84724-6.

Pasquesi SA, Bruno A, Courtney A, Imler SM et al. "Risk of concussion in low- to moderate-speed frontal and rear end motor vehicle collisions evaluated using head acceleration-based metrics," SAE Technical Paper 2019-01-1218, 2019.

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Courtney A, Courtney M. "A thoracic mechanism of mild traumatic brain injury due to blast pressure waves," Medical Hypotheses 2009; 72(1):76-83.

Courtney A, Courtney M. "Links between traumatic brain injury and ballistic pressure waves originating in the thoracic cavity and extremities," Brain Injury 2007; 21:657-662.

Courtney M, Courtney A. "Apparent measurement errors in "Development of biomechanical response corridors in the thorax to blunt ballistic impacts."" Journal of Biomechanics 2007; 41:486-487.

Perusek G, Davis B, Courtney A, D'Andrea S. "An extensometer for global measurement of bone strain suitable for use in vivo in humans," Journal of Biomechanics 2001; 34:385-391.

Courtney A, Davis B, Manning T, Kambic H. "Effects of age, density and geometry on the bending strength of human metatarsals," Foot & Ankle International 1997; 18(4):216-221.

Hayes W, Myers E, Robinovitch S, Van Den Kroonenberg A, Courtney A, McMahon T. "Etiology and prevention of age-related hip fractures," Bone 1996; 18(1) Supplement.

Courtney A, Hayes W, Gibson L. "Age related differences in post-yield damage in human cortical bone—Experiment and model," Journal of Biomechanics 1996; 29(11):1463-1471.

Courtney A, Wachtel E, Myers E, Hayes W. "Age-related reductions in the strength of the femur tested in a fall-loading configuration," Journal of Bone and Joint Surgery 1995; 77-A(3):387-396.

Bouxsein M, Courtney A, Hayes W. "Ultrasound and densitometry of the calcaneus correlate with the failure loads of cadaveric femurs," Calcified Tissue International 1995; 56(2):99-103.

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Haut RC, [Courtney] Powlison AC. "The effects of test environment and cyclic stretching on the failure

properties of human patellar tendons," Journal of Orthopaedic Research 1990; 8(4):532-540.

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[Courtney] Powlison, AC, Haut, RC. Effects of testing environment and cyclic loading on mechanical properties of human patellar tendon. 13th Annual Mtg. Amer. Soc. Biomech. August 23-25, 1989.

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Ballistics and Blast

Streifel B, Courtney A, Courtney M. (2025). "Thermochemical analysis and field performance of small arms propellants from 1953 (30-06 M2 AP) and 2012 (M855A1) ammunition," Defence Technology. https://doi.org/10.1016/j.dt.2025.02.009

Courtney E, Andrusiv L, Courtney A, Courtney M. "Quantifying handgun recoil with high-speed video," Proceedings of the 32nd International Symposium on Ballistics, pp. 670-678, May 2022.

Courtney E, Courtney A, Courtney M. "Comparing lead-based (CCI 41) and lead-free (Ruag SINTOX) primer performance in 5.56 mm NATO," Proceedings of the 32nd International Symposium on Ballistics, pp. 441-445, May 2022.

Courtney J, Courtney A, and Courtney M. "Laboratory simulation of underwater blast waves by high speed water entry," Proceedings of the 32nd International Symposium on Ballistics, pp. 63-68, May 2022.

Courtney E, Courtney A, Andrusiv L, Courtney M. "Clear Ballistics Gel®: Retarding force analysis of paraffin-based alternative to gelatin-based lead-free bullet testing," Proceedings of the 30th International Symposium on Ballistics, September 2017.

Courtney ER, Courtney A, Courtney M. "External ballistics and accuracy of lead free bullets in 5.56 x 45 mm NATO," Proceedings of the 30th International Symposium on Ballistics, September 2017.

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Kabu S, Jaffer H, Petro M, Dudzinski D, Stewart D, Courtney A, Courtney M, Labhasetwar V. "Blast-associated shock waves result in increased brain vascular leakage and elevated ROS levels in a rat model of traumatic brain injury," PLoS ONE 2015; 10(5):e0127971.

Courtney E, Courtney A, Courtney M. "Shock tube design for high intensity blast waves for laboratory testing of armor and combat materiel," Defence Technology 2014; 10(2):245-250.

Courtney M, Courtney ER, Courtney A, Summer PD. "Performance testing of lead free primers: Blast

waves, velocity variations, and environmental testing," Paper #160, 28th International Symposium on Ballistics, Atlanta, GA, September 22-26, 2014.

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Gaylord S, Blair R, Courtney M, Courtney A. "Bullet retarding forces in ballistic gelatin by analysis of high speed video," Cornell University Library, Medical Physics, 2013.

Sherrill M, Powers R, Courtney A, Courtney M. "Relative armor penetration of jacketed lead, solid copper, solid brass and steel core bullets," Defense Technology Information Center 2012; ADA567525.

Courtney M, Courtney A. "Ballistics of the 30-06 rifle cartridge," Defense Technology Information Center 2012; ADA570469.

Courtney ER, Courtney A, Courtney W. "Detecting pitch and yaw and in-flight damping with optical chronographs," Defense Technology Information Center 2012; ADA570911.

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Courtney M, Courtney A. "Using sound of target impact for acoustic reconstructions of shooting events," Medicine, Science, and the Law 2012; 52(2):89-92.

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Courtney M, Courtney A. "A method for testing bullets at reduced velocity," Cornell University Library, Medical Physics, 2008.

STEM (Science, Technology, Engineering and Mathematics) Education

Courtney J, Courtney A, Courtney M. "Do rainbow trout and their hybrids outcompete cutthroat trout in a lentic ecosystem?" Fisheries and Aquaculture Journal 2013; FAJ-78.

Courtney J, Courtney A, Courtney M. "Nutrient loading increases red snapper population in the western Gulf of Mexico," Hypotheses in the Life Sciences 2013; 1:7-14.

Courtney J, Courtney A, Courtney M. "Estimating interaction strengths with correlations in annual relative

weight: interspecific competition and predation in fishes, Pueblo Reservoir, Colorado," Cornell University Library, Populations and Evolution, 2013.

Courtney A, Courtney M. "Illuminating Fourier series with audacity," Cornell University Library, Physics Education, 2012.

Courtney J, Klinkmann T, Courtney A, Torano J, Courtney M. "Relative condition factors of fish as bioindicators one year after the Deepwater Horizon oil spill," Defense Technology and Information Center 2012; ADA564207.

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Courtney M, Slusher T, Courtney A. "EI Videos," Mathematica Militaris, April 2012.

Courtney M, Courtney A. "Measuring thrust and predicting trajectory in model rocketry," Cornell University Library, Popular Physics, 2009.

Courtney M, Courtney A. "Comments regarding "On the Nature of Science."" Physics in Canada 2008; 64:3.

Courtney M, Courtney A. "Acoustic measurement of potato cannon velocity," The Physics Teacher 2007; 45:496-497.

Courtney M, Althausen N, Courtney A. "Five frequently fatal freshman physics fantasies," Physics Education 2007; 42:116.

Project Experience

Automotive Product Liability

- Determined the kinematics (body movements), timing, and biomechanical mechanisms of injuries for multiple vehicle occupants involved in a severe rear-impact crash and fire. Additional data was gathered via vehicle inspection, surrogate/exemplar evaluation, and vehicle testing. Scientifically supported answers were provided to additional questions including why injury severity and pattern were different among the occupants. This multidisciplinary project engaged experts to address questions related to medical forensics, vehicle structure, and fire cause and origin.
- Determined the forces involved and the biomechanical mechanisms of serious lower extremity injury to a driver in a frontal collision within the severity of standardized testing. Additional data was obtained from standardized vehicle tests and surrogate/exemplar evaluation. Analysis showed that the individual had pre-existing conditions that changed the load distribution and made them substantially more vulnerable to injury in those crash conditions.

Automotive Crash Injury Analysis

- Evaluated biomechanical mechanisms of fatal injuries to an unrestrained driver in a high-speed frontal collision. Additional data were gathered via vehicle inspection, surrogate/exemplar evaluation, and standardized and publicly available research test results. Scientifically supported answers were provided to additional questions including whether and how the injury outcome would likely have been different had the driver been using a seat belt.

Heavy Equipment Injury Analysis

- Analyzed the kinematics of the operator of a tracked heavy construction vehicle involved in a fatal runover incident. Distinguished between voluntary actions and reflexive responses contributing to sudden vehicle movement resulting in the operator dismounting, unsuccessfully attempting to remount, and ultimately being run over. Provided camera-matched, to-scale computer models overlayed on a video recording of the incident to demonstrate the findings.

Premises Liability

- Quantified the loading in an incident involving impact to the head of a guest on a cruise ship. Additional data were gathered at a site inspection. Calculated whether the incident loading would be expected to result in concussion or mild traumatic brain injury (mTBI) utilizing research supported injury risk relationships and considering multiple scenarios to cover uncertainties.

Firearms Product Liability

- Scientifically determined whether discharge of a firearm causing nonfatal facial injuries occurred when the firearm was dropped versus when the trigger was pulled. Considered basic principles of physics, specifications of the firearm and ammunition, scene evidence, physical evidence on the individual, and the wound trajectory. The evidence supported that the individual had operated the trigger of the firearm at close range. Also identified absence of pertinent evidence that would have been expected if a drop-fire had occurred in ruling out that hypothesis.

Shooting Incident Reconstruction

- Determined the positions and body orientations of individuals involved in a shooting at the time a shot was fired. The approach considered basic principles of physics, specifications of the firearm and ammunition, and the wound trajectory in addition to provided incident-related materials.

Additional Education & Training

Blood Detection, Documentation & Collection Techniques

AIS2015 Online Course, AAAM

Forensic Shooting Incident Reconstruction Course

Peer Reviews

Reviewer for AAAM annual meeting, scholarship, and grant programs

Traffic Injury Prevention

SAE International Journal of Transportation Safety

Accident Analysis and Prevention

Reviewer for the US Army Medical Research and Development Command (USAMRDC)

Military Operational Medicine Research Program (MOMRP)

2024 – BBAI-3 [Blast, Blunt, and Accelerative Injury Prevention and Sensory Injury Treatment]

2025 BI [Blast Injury]

2026 TBI-1 [Traumatic Brain Injury]

Combat Casualty Care Research Program (CCCRP)

2025 PM [Pain Management]

Reviewer for the Defense Health Agency

2027 Traumatic Brain Injury, Science & Technology Portfolio Management Division

Journal of Biomechanics

Journal of Neurotrauma

Advances in Life Sciences and Medicine

NeuroImage

Journal of Neuroscience Research

Defence Technology

International Journal of Energetic Materials and Chemical Propulsion

Shock Waves

Journal of Visual Experiments (JoVE)