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TORRENCE D.J. WELCH, PH.D.
SENIOR MANAGING CONSULTANT

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Dr. Torrence Welch is a Senior Managing Consultant at ESi. Dr. Welch holds a Ph.D. in Biomedical Engineering awarded jointly by the Georgia Institute of Technology (Georgia Tech) School of Engineering and the Emory University School of Medicine in Atlanta, GA. His areas of expertise include the biomechanics of human injury, vehicle accident reconstruction, slip-and-fall events, occupational injury, reactive muscle activity, and human balance control and stability. Dr. Welch has offered expert testimony in the fields of accident reconstruction and injury biomechanics in Federal, State, and local Courts throughout the United States.

Dr. Welch has over 20 years of biomechanics research experience, studying human movement on multiple levels.

- *Injury* – the forces present on the body during automotive collisions;
- *Mechanics* – the effects of forces on the bony and soft tissues underlying human movement;
- *Coordination* – the activation of muscles in functional groups called muscle synergies;
- *Control* – the mechanisms used by the nervous system to control standing balance and to learn new balance tasks;
- *Performance* – the effects of supplements on sport and exercise performance

Dr. Welch also has experience in human motion and gait analysis; electromyography (EMG); the computer modeling of biomechanical systems; the mechanical, biochemical, and ultrasound characterization of biological soft tissue; biomedical ultrasound imaging; and statistical and wavelet analysis. Dr. Welch performs biomechanical analyses for litigated matters involving automotive collisions, slip/trip and fall events, falling objects, occupational injury, and other incidents leading to human injury. Dr. Welch is published in numerous publications on topics related to automotive collision-related injury and human standing balance control, and actively maintains collaborative research relationships with several academic institutions.

Areas of Specialization

Human Injury Analysis
Injury Causation/Consistency
Injury Mechanisms
Injury Tolerance
Occupant Kinematics
Restraints and Safety Equipment
Rollover Biomechanics
Vehicle Driver Identification
Vehicle-Pedestrian Accidents
Impact Biomechanics
Occupational Injury/Workers' Compensation
Product Safety
Sports and Fitness Equipment
Slip/Trip and Falls
Human Balance Control and Recovery
Surface Electromyography (EMG)
Anthropomorphic Test Device (ATD) Testing
Computer Modeling

Education

Georgia Institute of Technology & Emory University School of Medicine, Atlanta, GA

- Doctor of Philosophy in Biomedical Engineering, 2008

Tulane University, School of Engineering, New Orleans, LA

- Master of Science in Biomedical Engineering, 2003
- Bachelor of Science in Biomedical Engineering, 2003 (*Summa Cum Laude)*

Professional Licenses

ACTAR #2773

Additional Training

Traffic Accident Reconstruction 1, Northwestern University Center for Public Safety, 2008

Traffic Accident Reconstruction 2, Northwestern University Center for Public Safety, 2008

Business Development for Engineering Consultants, Harry Keshet, PhD, 2008

Marketing for Litigation Consultants, Harry Keshet, PhD, 2012

Using the 3DSSPP Program, University of Michigan Center for Ergonomics, 2012

Traffic Accident Reconstruction 3, Northwestern University Center for Public Safety, 2013

Bosch Crash Data Retrieval Technician, University of North Florida Institute for Police Technology and Management, 2013

HVE Forum, Engineering Dynamics Company, 2016

Injuries, Anatomy, Biomechanics & Federal Regulation, Society of Automotive Engineers, 2017

Advanced Crash Reconstruction Utilizing Human Factors Research, Northwestern University Center for Public Safety, 2018

Energy Methods and Damage Analysis in Traffic Crash Reconstruction, University of North Florida Institute for Police Technology and Management, 2019

Traffic Signal Timing Records Interpretation and Analysis, University of Tennessee Knoxville Center for Transportation Research, 2020

Accident Reconstruction Digital Summit, Society of Automotive Engineers, 2022

Photogrammetry and the Analysis of Digital Media, Society of Automotive Engineers, 2022

Positions Held

Rimkus Consulting Group, Inc., Atlanta, GA
- Principal Consultant, Biomechanics Division, January 2013 – March 2020

Exponent, Inc., Phoenix, AZ
- Senior Associate, Biomechanics Practice, September 2008 – December 2012

Publications

Welch TDJ, Ting LH. A feedback model predicts muscle activity during human postural responses to support surface translations. *Journal of Neurophysiology* **99**: 1032-1038, 2008.

Welch TDJ, Ting LH. A feedback model explains the differential scaling of human postural responses to perturbation acceleration and velocity. *Journal of Neurophysiology* **101**: 3294–3309, 2009.

Ting LH, van Antwerp KW, Scrivens JE, McKay JL, **Welch TDJ**, Bingham JT, DeWeerth SP. Neuromechanical tuning of nonlinear postural control dynamics. *Chaos* **19**: 026111, 2009.

Welch TDJ, Bridges AW, Gates DH, Heller MF, Stillman D, Raasch CC, Carhart MR. An evaluation of the BioRID II and Hybrid III during low- and moderate-speed rear impact. SAE Technical Paper 2010-01-1031.

Gates D, Bridges A, **Welch TDJ**, Lam T, Scher I, Yamaguchi G. Lumbar loads in low to moderate speed rear impacts. SAE Technical Paper 2010-01-0141.

Welch TDJ, Bridges AW, Gates DH, Heller MF, Stillman D, Raasch CC, Carhart MR. An evaluation of the BioRID II and Hybrid III during low- and moderate-speed rear impact. *SAE International Journal of Passenger Cars – Mechanical Systems* **3**: 704–733, 2010.

McKay J, **Welch TDJ**, Vidakovic B, Ting L. Statistically-significant contrasts between EMG waveforms revealed using wavelet-based functional ANOVA. *Journal of Neurophysiology* 109: 591-602, 2012.

Welch, TDJ, Ting LH. Mechanisms of motor adaptation in reactive balance control. *PLoS ONE* 9(5): e96440, 2014.

Fortenbaugh DM, Shibata PA, Meza-Arroyo M, Thobe K, **Welch TDJ**. Flip-Flops: A survey of risk perception and acceptance. *Proceedings of the 66th International Annual Meeting of the Human Factors and Ergonomics Society* (in press).

Invited Articles

Imler SM, Bridges AW, **Welch TDJ**. The Science of Slipped Discs. *Georgia Defense Lawyer*, Winter 2012.

Welch TDJ. Beyond Causation: When to Use a Biomechanics Expert. *The Verdict*, Spring 2019.

Welch TDJ. Beyond Causation: When to Use a Biomechanics Expert. *The Prairie Barrister*, Summer 2020.

Academic Conference Presentations

Overstreet J, Herb RA, Ludwig S, **Welch TDJ**. Clenbuterol treatment impairs maximal exercise performance in adult mice. 1997 Southwest American College of Sports Medicine Conference, Las Vegas, NV.

Maas H, Prilutsky BI, **Welch TDJ**, Gregor RJ. Reinnervation of the gastrocnemius muscle in the cat: immediate and long-term effects in interjoint coordination. 2004 Society for Neuroscience Conference. San Diego, CA.

Torres-Oviedo G, Lockhart DB, **Welch TDJ**, Ting LH. Dimensional reduction of spatial and temporal patterns of muscle activity for postural control. 2005 Progress in Motor Control V, State College, PA.

Welch TDJ, Ting LH. The initial burst of the human automatic postural response scales with the perturbation acceleration and velocity during quiet stance. 2005 Society for Neuroscience Conference. Washington, DC.

Welch TDJ, Ting LH. Adaptation of muscle activity can be represented as gain changes in a feedback model of human postural control. 2006 Society for Neuroscience Conference. Atlanta, GA.

Welch TDJ, Ting LH. Mechanisms characterizing adaptation of human postural responses to reversing perturbations. 2007 Neural Control of Movement Meeting. Seville, Spain.

Welch TDJ, Ting LH. Adaptive modification of feedback gains revealed through a model of human postural control. 2008 Neural Control of Movement Meeting. Naples, FL.

Ting LH, Chvatal SA, **Welch TDJ**. To step or not to step: Common mechanisms underlying postural response strategies. 2009 International Society for Posture and Gait Research Satellite Symposium, Pavia, Italy.

Welch TDJ, Bridges AW, Gates DH, Heller MF, Stillman D, Raasch CC, Carhart MR. An evaluation of the BioRID II and Hybrid III during low- and moderate-speed rear impact. 2010 SAE World Congress, Detroit, MI.

Gates D, Bridges A, **Welch TDJ**, Lam T, Scher I, Yamaguchi G. Lumbar loads in low to moderate speed rear impacts. 2010 SAE World Congress, Detroit, MI.

McKay JL, **Welch TDJ**, Vidakovic B, Ting LH. A method to determine statistically-significant differences between EMG waveforms in the time domain using wavelet-based functional-ANOVA. 2011 Society for Neuroscience Conference, Washington, DC.

Welch TDJ. The biomechanics of lumbar discs in low- to moderate-speed rear-end collisions. 2014 National Association of Subrogation Professionals Annual Conference, Orlando, FL.

McKay JL, **Welch TDJ**, Vidakovic B, Ting LH. Wavelet-based functional ANOVA to reveal statistically-significant contrasts between EMG waveforms recorded in different experimental conditions. 2016 World Congress of the International Society of Electrophysiology and Kinesiology (ISEK), Chicago, IL.

McKay JL, **Welch TDJ**, Vidakovic B, Ting LH. Statistically-significant contrasts between EMG waveforms revealed using wavelet-based functional ANOVA. 2016 Fifth Annual Symposium on Regenerative Rehabilitation, Atlanta, GA.

Fortenbaugh DM, Shibata PA, Meza-Arroyo M, Thobe K, **Welch TDJ**. Flip-Flops: A survey of risk perception and acceptance. 2022 International Annual Meeting of the Human Factors and Ergonomics Society, Atlanta, GA.

In addition to those listed here, Dr. Welch has presented as an invited speaker at conferences for a variety of esteemed organizations. Dr. Welch is also an approved instructor offering a suite of courses for CE and CLE credits, covering topics related to injury biomechanics and traffic accident reconstruction. A list of available courses and past presentations can be provided upon request.