

Vehicle Accident Reconstruction Methods

Automotive accident reconstruction is a process carried out with the specific purpose of estimating in both a qualitative and quantitative manner how an accident occurred. Reconstructions are based on physical data and physical evidence gathered during an accident investigation. To some extent, testimonial evidence is also used. Whether a crash is between two vehicles, a vehicle and pedestrian or a vehicle and a barrier, specific accident components, classified as pre-impact, impact and post-impact motion often are studied separately. Each of the components is analyzed using established engineering, scientific and mathematical principles and based on the physical evidence. Not only must each method be well established, but it must be selected so its coverage corresponds to the conditions of the physical problem. Three main factors, human, vehicle and environment must also be taken into account during a reconstruction.

This seminar is devoted to the exposition, use and limitations of the engineering, scientific and mathematical principles and methods used to reconstruct vehicular accidents. The primary objective is to help the attendees achieve a high level of understanding of these methods. The course covers a wide range of topics including uncertainty, impact mechanics, Tyre mechanics, vehicle-pedestrian impacts and vehicle dynamics. Most of the calculations can be carried out using commonly available spreadsheet technology suitable for personal computer use.

Attendees will receive a copy of the instructors' book, *Vehicle Accident Analysis and Reconstruction Methods*, published by SAE International. Additionally attendees will also be given a complete set of class notes

This course has been approved by the Accreditation Commission for Traffic Accident Reconstruction (ACTAR) for 13 Continuing Education Units (CEUs). Upon completion of this seminar, accredited reconstructionists should contact ACTAR, 800-809-3818, to request CEUs.

Learning Objectives

By attending this seminar, you will be able to:

- Describe the basic mechanics of collisions, including the differences between normal and tangential contact/interaction effects, restitution, energy loss, ΔV , PDOF, common velocity conditions and other effects
- Articulate the differences between point mass and rigid body impact analysis and when each can be applied, not applied and misapplied
- Determine when conservation of momentum is and is not appropriate and see how it can be checked for consistency
- Recognize the assumptions and limitations of various methods that can be critical in carrying out an accurate reconstruction
- Describe the assumptions behind the methods and know when the methods should not be applied
- Use spreadsheet technology to turn an analysis into a reconstruction
- Formulate and solve impact problems that combine the use of Event Data Recorder data and crash analysis
- Combine accurate pedestrian motion analysis and vehicle motion to reconstruct pedestrian collisions without knowing the point of impact
- Determine unknown points and paths using a photograph and site measurements
- Describe Tyre forces and Tyre mechanics
- Determine the post-impact motion of a vehicle with one or two wheels locked due to damage and other free to rotate, including the effects of dynamic weight shift

Who Should Attend

This course is well suited for persons just beginning to work in the area of accident reconstruction as well as persons already in the field who want to establish a firm foundation in impact mechanics, Tyre mechanics and vehicle dynamics.

Prerequisites

Attendees should have a knowledge of mathematics, physics and mechanics at a level equivalent to a second-year of college.

Seminar Content

DAY ONE

- Uncertainty in Measurements and Calculations
 - Three methods of estimating uncertainty – upper and lower bounds, differential variations and statistics of related variables
- Straight-Line Motion
 - Position, speed and acceleration as functions of time, braking and stopping distance
- Analysis of Collisions, Impulse-Momentum Theory
 - Full and rigorous coverage of point mass impact theory, conservation of momentum and planar impact mechanics
- Crush Energy, ΔV and tangential energy loss
 - Estimation of crush energy using the CRASH3 algorithm and proper estimation of tangential energy loss
- Frontal Vehicle-Pedestrian Collisions
 - Mechanics of pedestrian and vehicle motion

DAY TWO

- Planar Photogrammetry
 - Transformation of points on a photograph to known and unknown points on a flat surface
- Mechanics and Modelling of Tyre Forces
 - Equations of Tyre side force (cornering force), Tyre longitudinal force (braking or accelerating) and combined forces
- Critical Speed From Tyre Yaw Marks
 - Use of the critical speed formula and experimental variations
- Vehicle Dynamics Simulation
 - Dynamics of a single vehicle or a tow vehicle and semi-trailer, sophisticated Tyre model, rigid suspension, specific vehicle physical characteristics, steering and lane-change manoeuvres, locked-wheel braking or tabular steer inputs, dual friction flat surface
- Rollover
 - Presentation of vehicle and site examination as well as the analysis and reconstruction of pre-trip, trip and post-trip phases of rollover accidents
- Wrap-up Reconstruction
- A complete example of the reconstruction of vehicle speeds using:
 - crush measurements, energy loss and planar impact mechanics
 - post-impact travel and planar impact mechanics

Instructor(s):

Raymond M. Brach and R. Matthew Brach

Dr. Raymond Brach is a consultant in the field of accident reconstruction and a professor emeritus of the Department of Aerospace and Mechanical Engineering at the University of Notre Dame. He has been practicing and carrying out research in the field of accident reconstruction for over 35 years. Dr. Brach is a fellow member of SAE and a member of ASME, ASA, INCE, and NAPARS and is a licensed professional engineer in the state of Indiana. In addition to over 100 research papers and numerous invited lectures, he has authored the book *Mechanical Impact Dynamics*, published by Wiley Interscience in 1991 and is a co-author of the book *Uncertainty Analysis for Forensic Science*, published by Lawyers and Judges Publishing Company, 2004. Dr. Brach is also a co-author of *Vehicle Accident Analysis and Reconstruction Methods*, published by SAE International. He was granted a Ph.D. in engineering mechanics from the University of Wisconsin-Madison, and a B.S. and M.S. in mechanical engineering from Illinois Institute of Technology.

Dr. R. Matthew Brach is a principal member of Brach Engineering, a professional consulting firm that carries out vehicle accident reconstructions. He was previously an adjunct professor at Lawrence Technological University and has held engineering positions at Exponent Corporation, Ford Motor Company and MPC Products. Dr. Brach is a co-author of *Vehicle Accident Analysis and Reconstruction Methods*, published by SAE International. He has a B.S. in electrical engineering from the University of Notre Dame, an M.S. in mechanical engineering from the University of Illinois-Chicago, and a Ph.D. in mechanical engineering from Michigan State University.

Testimonial

"This was an excellent course in vehicular accident reconstruction that covered a broad variety of topics and theories."

Alec G. Haugdahl

Senior Project Engineer
Coloney Bell Engineering

Wednesday 23rd and Thursday 24th September 2009

**The Hinckley Island Hotel,
A5 Watling Street, Hinckley,
Leicestershire
LE10 3JA**

Cost: £495

For more **information** on the course please contact:

matt_brach@brachengineering.com

ray_brach@brachengineering.com

To **book** please contact:

conference@itai.org