This short course 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*, Ed 2, published by SAE International in 2011. Additionally attendees will also be given a complete set of class notes.

**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, $\Delta V$, 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 crash reconstructions that combine the use of Event Data Recorder data and impact mechanics
- 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. As convenient prerequisites, attendees should have knowledge of mathematics, physics and mechanics at a level equivalent to a second-year of university. A knowledge of Microsoft Excel is beneficial.
Vehicle Accident Reconstruction Methods Course
Associated educational event with the 26th Annual Congress of the EVU

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

- Analysis of Collisions using EDR Data

- 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
  
  Bicycle model – Understeer/oversteer. Dynamics of a single vehicle or a tow vehicle and semi-trailer, steering and lane-change manoeuvres, locked-wheel braking or tabular steer inputs, dual friction flat surface

- Wrap-up Reconstruction
  
  Crush measurements, energy loss and planar impact mechanics
  
  Post-impact travel and planar impact mechanics

Instructors: 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, USA. He has been practicing and carrying out research in the field of accident reconstruction for over 45 years. Dr. Brach is a fellow member of SAE and a member of ASME, ASA, and INCE. 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-Chicago.

Dr. R. Matthew Brach is a Principal Engineer with ESI, a U.S. professional consulting firm that carries out vehicle accident reconstructions. He was previously a principal of Brach Engineering, 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.