2019 Five-Day Seminar

Motor Vehicle **A**ccident **R**econstruction and **C**ause Analysis

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Text: ***Motor Vehicle Accident Reconstruction and Cause Analysis, 7th Ed., L****exisNexis;*
Software: ***MARC1 – 2019;*** Book either in paper or e-version
Book and Software free to law enforcement participant
$500 to non-lawenforcement.

Overall Seminar Teaching Objectives:

1. Understand and apply fundamentals of accident reconstruction.
2. Identify and properly document critical accident scene and vehicle data.
3. Identify common and unique elements in crashes
4. Understand energy balance and impulse in impact speed calculations.
5. Crush energy: Analysis of vehicle crash test data and their use in crash reconstruction.
6. In-line crash reconstruction: Head-on, rear-end and side swipe accident.
7. Intersection two-vehicle crashes with linear momentum.
8. Combined linear and rotational momentum
9. Accident causation and avoidance analysis.
10. Velocity diagram: Motion analysis made simple
11. Driver response: Reaction time and difference between real and ideal test drivers.
12. Fundamentals of slide-out and rollover accident reconstruction.
13. Hands-on training in reconstructing actual vehicle crashes.

The unique and extremely user-friendly MARC1 software is a companion tool to the *Text* and will make the reconstruction of more complicated crashes a relatively easy task. Beginning in the early 90s, MARC1 was developed with many helpful inputs and hints from law enforcement and experts.

Introduction
Class Overview
What to Expect, Why Officers and Ph.D.s Learn from this Class.

Day 1: **Motion Analysis**

1. Velocity, Distance, Time and Acceleration/Deceleration
   - 1.1. The Velocity – Time Diagram
   - 1.2. Deriving Simple Motion Equations (MARC1 – A, E, S)
     - 1.2.1. Decelerating to a Complete Stop
     - 1.2.2. Decelerating to a Final Velocity (Impact Speed)
     - 1.2.3. Angular Velocity and Angle Rotated
   - 1.3. Braking to Avoid Crash (MARC1 – R)

1.3.1. Driver Reaction Time
1.3.2. Avoid Crash by Stopping at POI.
1.3.3. Avoid Crash by Delaying Arrival Time at POI.

1.4. Time to Avoid Crash (MARC1 – B)
1.4.1. Constant Speed
1.4.2. One or Both Vehicles Braking

1.5. Combined Speeds (MARC1 – J)
1.5.1. Using Energy Balance
1.5.2. Standard Method

1.6. Driver View Obstruction – Time to Crash (MARC1 – G)
1.6.1. Two Vehicle Approaching
1.6.1.1. Constant Velocities
1.6.1.2. One Vehicle Braking

1.7. Speed from Spin Marks (MARC1 – Q)

1.8. Maximum Speed from Engine Data (MARC1 – M)

1.9. Vehicle Hill Climbing (MARC1 – N)

1.10. Vehicle Deceleration from Newton's Second Law (MARC1 – E4)
1.10.1. Give the Road a Name-Tire-Road Friction Coefficient and Drag Boot
1.10.2. Two-Axle Vehicle Deceleration

2. Vehicle Braking Dynamics (MARC1 – V)

2.1. Braking Fundamentals of Two-Axle Vehicle

2.2. The Braking Forces Diagram

2.3. Braking Deceleration – Post Crash Drag Factor (MARC1 – E4)

2.4. Braking of Air Brake Tractor-Trailer Combination (MARC1 Software)

2.5. Pre-Crash Brake Failure

3. Vehicle Directional Control

3.1. Curve Radius Calculation (MARC1 – U)

3.2. Simplified Turning Analysis (MARC1 – U)

3.3. Maximum Speed in a Turn while Braking (MARC1 – U)

3.4. Rollover Speed Including Lateral Load Transfer (MARC1 – P)

3.5. Lane Changing Maneuver (MARC1 – C)

3.6. Steering to Avoid (MARC1 – D)

3.7. Vehicle Rollover
3.7.1. Two-Axle Vehicle – Simple Analysis (MARC1 – U)
3.7.2. Two-Axle Vehicle – Tripping Analysis Using Impulse (MARC1 – O)
3.7.3. Truck-Trailer Rollover (MARC1 – P)

Day 2 and Day 3: **In-Line Collisions**

4. Impulse Analysis (MARC1 – W)

4.1. General Impulse Equation

4.2. Energy balance

5. In-Line Collision

5.1. Fundamental Impact Physics (MARC1 – W)

5.1.1. Elastic Impact
5.1.2. Plastic Impact
5.1.3. Real Impact
5.1.4. Delta-V and Crush Energy

5.2. Wall Crash Tests
5.2.1. Stiffness Coefficients (MARC1 – Z)
5.2.1.1. NHTSA Test Data
5.2.1.2. Neptune Engineering
5.2.1.3. Other Data Sources
5.2.2. Crush Energy (MARC1 – X)

5.3. Mobile Barrier Crash Test
5.4. Car-Pole Impact (MARC1 – W)
5.5. Vehicle-to-Vehicle Crash Test (MARC1 – X8)

6. Frontal Collision
6.1. Head-on Crash (MARC1 – X1)
6.2. Frontal Side Swipe (MARC1 – X2)

7. Rear Collision
7.1. Rear-end Crash (MARC1 – X3)
7.2. Rear Side Swipe (MARC1 – X4)
7.3. Low Speed Impact (MARC1 – W)

8. Measuring Crush and Crush Energy (MARC1-Z)
8.1. A and B-Stiffness Coefficients
8.2. NHTSA-Crash Test Data

9. Car-Pedestrian Accidents
9.1. Crash Test Data
9.2. Scene Data and Empirical Speed Equations (MARC1-T)

Day 4 and Day 5: **Oblique Collisions**

10. Guard Rail Side Swipe Crash (MARC1 – W)
11. Trailer Under-Ride Crash (MARC1 – Y)
12. Polar Coordinate System
13. Linear Momentum (LM) (MARC1 – X5)
13.1. Limitations of LM
13.2. LM Sensitivity
13.3. Delta-V Computation with LM

14. Linear and Rotational Momentum (LRM)
14.1. Fundamental Considerations
14.2. Vehicle Contact Diagram (MARC1 – Z)
14.3. Crash Test on Paper – Checking Reconstruction Accuracy (MARC1 – X8)
14.5. Crash Test Evaluation (MARC 1 – W, X8)
14.6. Special Cases
14.6.1. Post-Crash Data of One Vehicle Missing (MARC1 – X6)
14.6.2. Only Rotation Data after Impact Are Known (MARC1 – X7)

15. Special Applications of Linear and Rotational Momentum with Coefficient of Restitution
15.1. Car-Pole Impact (MARC1 – W1)

15.2. Car-Car Impact (MARC1 – W3)

16. **Actual Crash Reconstruction Applications and Actual Case Discussions**

Concluding Remarks