San Bernardino County Sheriff's Department
Traffic Collision Reconstruction Course
Course Outline

I. Introduction and Orientation
   A. Registration
      1. Sign-in
      2. Payments
   B. Orientation
      1. Restrooms
      2. Breaks
   C. Introduction
      1. Instructor introductions
   D. Equipment
      1. Scientific Calculator
      2. Drafting Equipment
         a. Traffic template
         b. Flex curve
         c. Engineers ruler
         d. Protractor
         e. Compass
         f. Pencil
         g. Eraser
         h. Parallel rulers
   E. Recommended txt
      1. Traffic Accident Reconstruction Manual (Volume 2, The Traffic Accident Investigation Manual), Lynn B. Fricke, Northwestern University Traffic Institute.
   F. Course goals
      1. To provide a means of gaining the knowledge, skill, and experience necessary to interpret the evidence available in a traffic collision.
      2. To enhance the level of understanding and cultivate the ability to express complex concepts in a clear and concise language.
      3. To become familiar with the current trends in Traffic Collision Reconstruction and experiment with these techniques and methodologies in a controlled environment.

II. Mathematics and Physics Review
   A. Mathematics
      1. Basic mathematics (hierarchy)
      2. Review of algebra and right-angle trigonometry
      3. Trigonometry
   B. Physics
      1. Newton's Laws of Motion
         a. First law of motion
         b. Second law of motion
         c. Third law of motion
      2. Physics definition of acceleration and velocity
      3. Mass and weight

a. Definition of relationships
b. Concept of center of gravity

4. Work – Kinetic energy relationship
5. Impulse and momentum
    a. Derived
    b. Definition
    c. Examples of application to vehicle collisions
6. Friction
    a. Physics definition
    b. Coefficient of friction, acceleration factors and G's
    c. Review of resultant drag factors
7. Forces
    a. Types of forces
    b. Point of application
    c. Force lines
    d. Magnitude of the force

III. Vehicle Dynamics

A. Location of the Center of Mass
    1. General concepts
    2. Three dimensional
        a. Longitudinal
        b. Lateral
        c. Vertical

B. Collision Types
    1. Central Collisions
        a. Definition
        b. Translation vs. rotation
    2. Non-central collisions
        a. Definition
        b. Eccentric impacts
        c. Rotation with translation
        d. Flips and vaults
    3. Complete collisions
        a. Definition
        b. Concept of speed match-up
    4. Incomplete collisions
        a. Definition
        b. Sideswipes

C. Impact Sequence and Times
    1. Initial contact
    2. Maximum engagement
    3. Separation

D. Secondary Collisions
    1. Exterior collisions
    2. Interior collisions
        a. Occupant kinematics

E. Inferred Motion (Collision Placement)
    1. Matching of physical damage and force lines
    2. Matching vehicle wheels and contact points with the physical evidence
    3. Development of dynamics diagram from inferred motion

IV. Conservation of Momentum Analysis

A. Momentum Analysis – General Application
    1. Momentum defined
    2. Laws of Conservation of Momentum
        a. Equation
    3. Derivation of the Law of Conservation of Momentum
    4. Application of the Law of Conservation of Momentum
        a. Approach angles
            i. Skidmarks
            ii. Tire prints
            iii. Damage analysis
            iv. Dynamics diagrams
        b. Departure angles
            i. Skidmarks
            ii. Tireprints
            iii. Gouges
            iv. Liquid dribble path
            v. Final rest positions
            vi. Dynamics diagrams
        c. Weights
            i. Weight scales
            ii. Published data
        d. Post-impact speeds
            i. Post-impact collision analysis
            ii. Vehicle dynamic equations

B. Methods for Solving Momentum Problems
    1. Parallelogram method (Vector diagramming)
        a. Parallelogram defined
        b. Vectors
        c. Resultants
        d. Scale
        e. Calculation
    2. Mathematical method
        a. Equations and symbols
        b. Coordinate system
            i. X-axis
            ii. Y-axis
    3. Collinear collision velocity analysis
        a. With known pre-impact speeds
        b. Unknown pre-impact speeds
        c. Solution process and examples

i. Head-on collisions
ii. Rear-end collisions

4. Intersection collision velocity analysis
    a. Coordinate system orientation
    b. Application of X & Y axis conservation of momentum equations
    c. Example problems

C. Momentum Analysis – Special Applications
1. Shallow entry angle and collinear collisions – unknown pre-impact speeds
    a. Shallow entry angle collision defined
    b. Discussion of problems associated with speed analysis
2. Large vehicle versus small vehicle collisions
    a. Discussion of problems associated with speed analysis

D. Discussion of Angular (Rotational) Momentum

V. Auto Collisions involving Pedestrians/Bicyclists

A. Automobile vs. Pedestrians
1. Relative vehicle codes
2. Visibility & conspicuity of pedestrians
3. Evidence in automobile vs. pedestrian collisions
4. Quadratic equations
5. Pedestrian trajectories
    a. Wrap trajectory
    b. Forward projection
    c. Fender vault
    d. Roof vault
    e. Somersault
    f. Restricted fender vault
    g. Partial impact

B. Automobile vs. Bicyclists
1. Relative vehicle codes
2. Bicycle component failure
3. Bicycle helmets
4. Gear-inch formulae
5. Evidence in automobile vs. pedestrian collisions
6. Bicycle lean angles
7. Bicycle braking distance formulae
    a. Dry conditions
    b. Wet conditions
8. Misc. bicycle formulae

VI. Reconstruction Methodology

A. Introduction
1. Step-by-step walk through of a collision reconstruction
2. Designed to put entire course in perspective

B. Scale Diagramming
1. Necessity of scaling

2. Use of scale diagram in the reconstruction process
3. Scale models

C. Damage Analysis
   1. Identification of contact versus induced damage
   2. Detailed measurements
   3. Preparation of scale diagrams/models of damage and undamaged vehicles
      a. Use of the diagram/model in the reconstruction process
   4. Force line determination
   5. Inspection for mechanical defects and/or malfunctions

D. Position Analysis
   1. Establishing locations of vehicles on the diagram based on physical evidence
   2. Significance of vehicle fluid trails
   3. Gouges and other evidence
   4. Overlapping areas of contact damage
   5. Aligning force lines
   6. Plotting vehicle positions

E. Motion Analysis
   1. Vehicle movements with respect to the scene and each other
   2. Motion relative to the centers of mass
   3. Motion analysis should identify
      a. Area of impact
      b. Positions of rest
      c. Other significant positions/events
   4. Motions analysis should examine the effects of vehicle motion on the occupants
      a. Injury mechanisms
      b. Seating position
      c. Mode of ejection
      d. Restraint systems

F. Velocity Reconstruction
   1. Post-impact velocity analysis
      a. Evaluate how each vehicle moved from the area of impact to the point of rest
      b. Determine vehicle deceleration factors
      c. Calculate post-impact speeds
   2. Impact velocity analysis
      a. Determination of approach and departure angles from dynamics diagram and motion analysis
      b. Determination of weights of vehicles
      c. Unusual loading conditions
      d. Momentum analysis
      e. Calculations of impact speeds
   3. Pre-impact velocity analysis
      a. Pre-impact acceleration

b. Combining velocities

4. Speed changes
    a. Vector speed changes
    b. Comparisons with other known information to ensure consistency of calculated speeds

VII. Vehicle Inspection
- A. Reasons for inspections
    1. Fatal collisions
    2. Liability
    3. Rule out or find mechanical reasons for collision
- B. Photography
    1. Reasons
    2. 8 points
    3. Specific components
    4. Documentation
- C. Components to inspect
    1. Tires and wheels
    2. Speedometers
    3. Brake systems
    4. Steering systems
    5. Seatbelts
    6. Suspension systems
    7. Throttle systems
    8. Computers
- D. How to inspect
    1. Methods
    2. Documentation
- E. Report Writing/Court Room Testimony
    1. Document deficiencies
    2. Use photos in report
- F. Courtroom Testimony
    1. Only testify to what you know
    2. Don't guess
    3. Know expertise
    4. Review report
    5. Be professional

VIII. Speed from Crush
- A. Introduction
    1. Explanation of speed change vs. initial speed
    2. Obtain more than one opinion when estimating speed from damage
    3. Record estimates for comparison
    4. Reliability of speed estimates from damage
- B. Factors Affecting Vehicle Deformation
    1. Available energy
    2. Vehicle stiffness

3. Energy partition

C. Methods
   1. Visual estimates (Closing-in-Method)
   2. Chart comparisons
   3. Linear regression equations

IX. Heavy Vehicle Collisions

A. Introduction
   1. Definition of vehicle types
   2. Terminology

B. Special Considerations and Handling Characteristics
   1. Center of mass positions and effects of loading
   2. Commercial vehicle tires and drag factors
   3. Brakes and loading considerations
      a. Types and adjustments
      b. Effects of load versus proper adjustment
   4. Roll-over threshold and critical speed scuffs

C. Resultant Drag Factors
   1. Loading
   2. Braking efficiency
   3. Tire composition and roadway conditions

D. Jackknifing Characteristics and Impacts
   1. Case studies

X. Case Studies/Course Review

A. To illustrate to the students the application of various analytic techniques to "real world" accidents and how accidents occur
   1. To determine if the students have a good grasp of the techniques presented
   2. Each case study is reviewed in order to provide the student with an opportunity to discuss their findings and how they relate to the actual situation

XI. Final Examination and Critique

A. A combination of no more than a one hour written test and no less than three hours of case studies for skills demonstrations
   1. Number of cases will be based on case complexity
   2. Student will have to utilize skills learned to complete case studies which will show knowledge and understanding