1986

Development of a curriculum for a course in advanced accident investigation for field officers: Scene documentation

George William O'Rafferty

Follow this and additional works at: https://scholarworks.lib.csusb.edu/etd-project

Part of the Vocational Education Commons

Recommended Citation

California State University
San Bernardino

DEVELOPMENT OF A CURRICULUM FOR A COURSE IN
ADVANCED ACCIDENT INVESTIGATION FOR FIELD OFFICERS:
SCENE DOCUMENTATION

A Project Submitted to
The Faculty of the School of Education
In Partial Fulfillment of the Requirements of the Degree of

Master of Arts
in
Education: Vocational Education Option

By

George William O'Rafferty, M. A.

San Bernardino, California
1986

APPROVED BY:

Ronald Pendleton, Ph.D.
Advisor

Andrew Schultz, Ph.D.
Committee Member
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>3</td>
</tr>
<tr>
<td>THE PROBLEM</td>
<td>3</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>5</td>
</tr>
<tr>
<td>Purpose of the Project</td>
<td>6</td>
</tr>
<tr>
<td>Definitions</td>
<td>6</td>
</tr>
<tr>
<td>Assumptions</td>
<td>7</td>
</tr>
<tr>
<td>Limitations</td>
<td>7</td>
</tr>
<tr>
<td>Significance of the Project</td>
<td>8</td>
</tr>
<tr>
<td>Organization of the Project</td>
<td>8</td>
</tr>
<tr>
<td>THE LITERATURE REVIEW</td>
<td>9</td>
</tr>
<tr>
<td>METHODOLOGY</td>
<td>12</td>
</tr>
<tr>
<td>EXISTING PROGRAMS</td>
<td>15</td>
</tr>
<tr>
<td>Riverside Community College Course Outline</td>
<td>16</td>
</tr>
<tr>
<td>For Administration of Justice 102</td>
<td>16</td>
</tr>
<tr>
<td>Riverside County Sheriff's Department Course</td>
<td></td>
</tr>
<tr>
<td>Outline Traffic Accident Reconstruction</td>
<td>20</td>
</tr>
<tr>
<td>THE CURRICULUM</td>
<td>44</td>
</tr>
<tr>
<td>Performance Objectives</td>
<td>45</td>
</tr>
<tr>
<td>Course Content</td>
<td>46</td>
</tr>
<tr>
<td>THE BUDGET FOR CURRICULUM IMPLEMENTATION</td>
<td>54</td>
</tr>
<tr>
<td>Traffic Accident Investigation Skidmark Analysis</td>
<td>54</td>
</tr>
<tr>
<td>Traffic Accident Reconstruction</td>
<td>54</td>
</tr>
<tr>
<td>Scene Documentation Course</td>
<td>55</td>
</tr>
<tr>
<td>SUMMARY AND CONCLUSION</td>
<td>56</td>
</tr>
<tr>
<td>FOOTNOTES</td>
<td>57</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>58</td>
</tr>
</tbody>
</table>
INTRODUCTION

The objective of this project was the development of a curriculum for advanced traffic accident investigation, specifically scene documentation. This curriculum will be used as an integral part of the Traffic Accident Investigation Program that is currently taught at the Riverside County Sheriff's Department Training Academy. Field officers at the Riverside County Sheriff's Department, have seen that criminal prosecutors, civil attorneys, law firms, courts, insurance companies, and private individuals rely on law enforcement officers for professional, unbiased accident investigations. Accident investigators must have specialized training in advanced techniques to perform this required service.

THE PROBLEM

Traffic accidents are investigated by law enforcement personnel, insurance companies, and law firms. There are many people with expertise in the mathematical and physical formulas employed in reconstructing the events which occur during traffic accidents. However, the latter two groups must base their investigations almost entirely on the
documentation gathered by law enforcement at the scene of the accident because that scene is completely different by the time they are notified of the accident.

All traffic officers receive instruction in techniques of accident investigation, but this instruction is general. Accident investigation can be complex, and specialized instruction is necessary for the more complicated accidents. Specialized training is available, and currently consists of three weeks of intense training requiring a scientific and mathematical background. This specialized training is very expensive for law enforcement agencies in both tuition (the cost of instruction, materials, travel, etc.), and in the salaries of officers attending the training.

Current training at the Riverside County Sheriff's Department Training Academy includes all forms of collision analysis ranging from the collision scene documentation, through the finished report of cause, to courtroom testimony which may result years after the investigation occurred.

The purpose of this project was to analyze concepts and materials currently being taught and develop a curriculum that would complement the existing curriculum and complete the training that is required for traffic investigations. This training is very high quality, and can adequately prepare an officer with techniques necessary to totally reconstruct the series of events which took place during a collision. Officers who successfully complete this training can be considered advanced traffic investigators.
Statement of the Problem

With the great expense of the current training, and the scientific and mathematical background required of student officers, the number of officers who receive advanced training is very low in comparison to the number of officers who are required to conduct sophisticated investigations. Officers need advanced training to adequately investigate major collisions.

The curriculum presented in this project was designed to outline, define and prescribe a one week (40 hour) course of advanced traffic accident investigation relative to scene documentation. This is the one element of accident investigation which can not be completed at a later time; whereas the physical laws of motion employed in accident reconstruction can be discussed and debated by experts at any time after the initial investigation has been completed.

Advanced investigators will be able to evaluate data with the investigating officers prior to the completion of the final report of cause, and before courtroom testimony if necessary. These advanced investigators are necessary, but every officer who investigates a major accident does not need the in-depth training advanced investigators receive.
Purpose of the Project

Every officer investigating major traffic accidents needs specialized training in scene documentation. The purpose of this project was to present a curriculum which can supply the advanced training necessary to adequately document a collision scene.

This curriculum was not designed to eliminate or replace the existing courses in accident reconstruction, as that specialized expertise is also needed by law enforcement agencies. This curriculum was designed for those officers who have not or will not receive such advanced training as a result of budget restrictions, manpower limitations, or the absence of the requisite mathematical and scientific background.

Definitions

For the purpose of this study, the terms listed below are defined as follows:

- **Officer** shall refer to any sworn peace officer who investigates traffic collisions.
- **Advanced officer** shall refer to an officer who has expert knowledge and training in the investigation of traffic accidents. The criteria used to establish expertise shall include: successful completion of an On-Scene Accident Investigation course, a course in the
Technical Aspects of Accident Investigation, an Accident Reconstruction course, and a minimum of two years of experience in investigating traffic accidents.

Traffic accident and traffic collision will be used synonymously to refer to collisions which occur involving a vehicle or vehicles.

Assumptions

It is assumed that the Advanced Accident Investigation and Accident Reconstruction Courses offered by the California State Commission on Peace Officer Standards and Training are programs which provide comprehensive instruction in specialized techniques of traffic accident investigation. The curriculum developed for this project consists of specific portions of those programs relative to scene documentation.

Limitations

The course is intended for officers with at least one year of experience in accident investigation, and successful completion of a Basic Accident Investigation course such as required by Section 40600 of the California Vehicle Code.
Significance of the Project

Traffic collisions must be documented because law enforcement agencies are responsible for the protection of life and property. With this responsibility comes the requirement to gather information for the prosecution of persons guilty of any violation which has contributed to the collision. (1)

Traffic officers are not required to document collision scenes to benefit involved persons who may use the officer or his investigation in a subsequent civil suit against other involved parties. (2) However, municipalities and individual officers are sued when persons involved in collisions indicate that the officer did not or could not conduct an adequate criminal investigation. They contend that if other parties were criminally prosecuted, they could have used that evidence in their civil suit. (3) Many of these "deep pocket" law suits have yielded large monetary awards for plaintiffs.

Traffic officers need training in collision scene documentation to fulfill statutory requirements. This will also save their employers the possibility of law suits claiming that legal requirements were not met.

Organization of the Project

The content of this curriculum has been derived from advanced investigation courses which have been approved by
the California State Commission on Peace Officer Standards and Training. It is not a diluted version of what is currently offered, but a program extracted from those in depth courses, relative to scene documentation.

The project consists of a two hour introductory period, four hours of instruction in the identification and measuring of skidmarks, three two hour blocks of instruction on conversions, symbols and charts, one four hour block of instruction in human factors of accident investigation, ten hours of instruction on the roadway environment, four hours of instruction in vehicle damage analysis, and four hours of instruction on the reconstruction process of accident investigation. The last block will be used to introduce students to the advanced investigator's duties, introduce the reconstruction aspect of accident investigation, and explain their role in the reconstruction process.

THE LITERATURE REVIEW

In 1966, the California Legislature enacted the Highway Safety Act. This act mandates the reporting of traffic collisions to the State Department of Transportation. The Department of Transportation initiated the Statewide Integrated Traffic Records System (SWITRS) in 1972, to
establish standards in the recording and reporting of traffic collisions. SWITRS is operated by the California Highway Patrol. The California Highway Patrol publishes the Collision Investigation Manual (CIM) on an annual basis. The CIM states precisely how collision reports are to be completed, but it does not offer training in the investigation of collisions, nor does it regulate the extent to which collisions must be investigated.(4)

Traffic accidents have been documented with the intent to prosecute the responsible parties since the case of People v. Herman in 1939.(5) Herman was the first person to be prosecuted for vehicle code violations as a result of a collision investigation. In Herman, there were no witnesses to support the contentions of law enforcement. The investigating officers used derivations of Newton's laws of gravity to justify their estimate of his speed. The conclusion was, that "speed can be determined from skidmark length."(6) The case is a landmark for law enforcement which has yet to be successfully challenged.

Since 1939, there have been many successful criminal prosecutions as a result of collision investigations. The information which may be proved as a result of traffic investigations, has become greater as technology has progressed. Currently, law enforcement agencies are using advanced techniques to determine: total speeds of vehicles, pre-collision speeds, post-collision speeds, which vehicle
entered the intersection first, whether the vehicle had lights operating at the time of the collision, and the list continues to grow.(7)

With this increased technology, comes increased responsibility for law enforcement agencies. They are required to prosecute violations when such violations can be supported by facts obtained as the result of their investigation.(8) In the years since Herman, we have seen that "many major arrests follow complete investigations."(9)

Law enforcement agencies have also found themselves in the midst of civil suits as a result of their collision investigations. They are not bound to conduct investigations which will build a suit for either party; however, when a collision has been thoroughly investigated as required for the possibility of criminal prosecution, that evidence may be used by either party in a suit. We further find that "In civil cases resulting from accidents, courts rely upon investigating police officers for unbiased testimony."(10)

It is clear fact that accidents need to be investigated thoroughly because it is required by law, and the information is often used in civil cases. A third element involved in collision investigation is the least official, but probably the greatest concern. Law enforcement agencies have been sued because they have not attempted to prosecute responsible parties in the collision. The agencies are protected from suits alleging that they did not give parties enough information for their civil suits. However, the civil
attorneys side step that protection by indicating that
criminal prosecution was not sought. If the case had been
well documented for a criminal prosecution, they would have
been able to use that information in their suit. In People v.
Hitch, the California Highway Patrol was held responsible for
an incomplete investigation which resulted in a monetary award
to the plaintiff, Hitch.(11)

The fear of law suits against municipalities was greatly
increased in 1979 with the decision in the American Motorcycle
Association v. Superior Court, Los Angeles County.(12) This
case began the "joint and several liability doctrine." This
doctrine basically holds that any party held at fault in a
civil matter is severally responsible for the award. Plainly
written, if the County of Los Angeles is found to be 5% at
fault, party number two is found to be 50% at fault, and party
number three 45% at fault, all parties are reponsible to the
plaintiff for the full amount of the award. If party number
two and number three can not fulfill their portion of the
award, the County of Los Angeles would be totally responsible
for the payment of the award. This doctrine has cost
municipalities hundreds of thousands of dollars since 1979.

METHODOLOGY

The population to be served by this curriculum is law
enforcement officers who currently investigate traffic
collisions. A prerequisite for this class is successful
completion of a Basic Accident Investigation Course such as required by Section 40600 of the California Vehicle Code, or its equivalent.

The content of this course of study has been extracted from the existing Advanced Accident Investigation and Reconstruction Course, and the Traffic Accident Investigation Skidmark Analysis Course which are both validated programs that have been offered throughout the State of California at law enforcement training centers. These courses are designed for a special population of traffic investigators who will become experts in the field with the additional training and experience.

This curriculum consists of basic scene documentation principles. It includes all elements of scene documentation presented in the more in-depth courses, and allows this training to be received by many more officers because it does not require any previous mathematical or scientific knowledge, and because the shorter course can be taught by local reconstructionists in a one week period of time which is much less expensive that the existing courses.

In conducting the study which led to the development of this curriculum, accident investigators who are currently conducting field investigations were consulted. These investigators agree overwhelmingly that the majority of the individuals who are in the field conducting accident investigations are not trained properly, including many of themselves.
In accident investigation courses, a primary issue discussed is that there is no organization to advanced training. Equally as fundamental an issue is that there are not enough training programs available even for the agencies which have the funds and manpower to support this training.

Interviews were conducted with many accident investigation instructors and supervisors in the field, to establish what steps would be required to organize training, and simplify the training process so that it would not jeopardize the current course offerings, yet allow more investigators to receive the advances training needed to adequately perform the service they are currently performing.

Scene documentation is the issue agreed upon by all parties involved, as the one area where every investigator must be competent. Computations, organization, presentation, and all other areas may be addressed after the scene documentation has been completed. However, none of these processes can be performed completely if the scene is not documented properly.

The two existing advanced investigation courses which have been approved by the California State Commission on Peace Officer Standards and Training offer complete and comprehensive training. During these courses, research was conducted a thorough breakdown of the course content to identify the areas which addressed scene documentation. This curriculum includes all aspects of scene documentation which are presented in the advanced classes.
EXISTING PROGRAMS

Riverside Community College's course of Traffic Accident Investigation Skidmark analysis is a curriculum centered around physical evidence, specifically skidmarks. The program offers a complete course of instruction in the identification, measurement, and calculating of speed from skidmarks. Many aspects of scene documentation are covered in this program, however a majority of the class time is devoted to mathematical theory which both limits the population of students and limits the parameters of the curriculum.

Riverside County Sheriff's Department's program of Traffic Accident Reconstruction is an advanced program for experienced officers which has been designed to add state of the art technology to the investigations these officers conduct. The quality of instruction, and the content of the program are equally superior. The instructional staff is made up of California's leading accident investigators, and the program was designed by a state committee of accident investigators whose purpose was to train accident reconstructionists.
Riverside Community College Course Outline for Administration of Justice 102

1. Course Description

Prerequisite: None

A course devoted to the basics of skid investigations and analysis. Course content will include: identification of the various types of skids; skid measurements; terms and definitions relating to skid investigations; courtroom preparation and admissibility of evidence; determination of coefficient of friction; and speed from skids using various formulas. (Total of 40 hours lecture)

2. Course Objectives

I. To gain an understanding on the techniques of determining speed from vehicle skid marks.

II. To become aware of the proper and accurate way of measuring skidmarks.

III. To become aware of the proper utilization of a vehicle for skidmark testing.

IV. To understand the application of mathematical formulas in skidmark analysis.

3. Text and References

Course Handbook.

4. Course Content

<table>
<thead>
<tr>
<th>I. Registration and introduction</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Outline of course</td>
<td>2</td>
</tr>
<tr>
<td>B. Case law</td>
<td></td>
</tr>
<tr>
<td>1. People vs. Herman</td>
<td></td>
</tr>
<tr>
<td>2. Legal aspects skidmarks</td>
<td></td>
</tr>
<tr>
<td>II. Definitions and terminology</td>
<td></td>
</tr>
<tr>
<td>A. Definitions</td>
<td></td>
</tr>
<tr>
<td>B. Terminology</td>
<td></td>
</tr>
</tbody>
</table>
III. Identification of skidmarks

A. Impending

B. Locked wheel
   1. Gap-skid
   2. Skip-skid

C. Side

D. Centrifugal
   Critical speed

IV. Measurement and recording skidmarks

A. Accuracy of various measuring methods
   1. Pros and cons
      a. Steel tape
      b. Roll-a-tape
      c. Pace

B. Measuring skidmarks
   1. How to measure
   2. What to measure
   3. When to measure

C. Recording measurements
   Proper documentation—all evidence gathered
   1. Field notes
   2. Final report

D. Post impact measurements
   1. Speed analysis
   2. Direction

V. Use of charts and equipment

A. Use CHP Form 185
   1. Completion of form gathering data
   2. Determining velocity from skids
   3. Determining coefficient of friction

B. Use of Northwestern traffic template
   1. Determining velocity from skids
   2. Determining coefficient of friction
   3. Determining grade
   4. Various scales
      a. 1/10th
      b. 1/20th
   5. General use of template

C. Dragsleds
   1. Use
2. Construction
3. Various types

D. Detonators
1. Gravity
2. Electronic

E. Tools for measuring grade
1. Sexton
2. Clipboard with Northwestern template
3. Carpenter's level
4. Line bubble blancer

VI. Conversation factors

A. Purpose of conversation factors
   1. Compatibility with other formulas
   2. Study of closing distances

B. Miles per hour to feet per second

C. Feet per second to miles per hour

D. Perception and reaction time
   1. Simple
   2. Complex
   3. National test studies

VII. Use of symbols

A. Definition/purpose of symbols
   1. Not universal
   2. Language
      a. Mathematics
      b. CHP definitions
      c. Northwestern definitions

B. Symbol
   1. \( V = \text{MPH} \)
   2. \( v = \text{fps} \)
   3. \( s = \text{distance} \)
   4. \( f = \text{friction} \)
   5. \( F = \text{Force} \)
   6. and etc.

VIII. Test skids

A. Purpose of test skids
   1. Determining coefficient of friction
   2. Determining stopping distance

B. How to conduct test skids
   1. Types of vehicles
   2. Weather conditions
3. Roadway surfaces
4. Safety procedures
5. Use of detonator
   a. Gravity
   b. Electronic

IX. Field application
   A. Identification of skidmarks
   B. Measurements of skidmarks
   C. Recording skidmarks
   D. Test skids
   E. Practical exercises

X. Formulas derived
   A. Newton's Laws of Motion
   B. Motion defined
   C. Purpose of derivations
   D. Formula derivations
      1. Coefficient of friction
      2. Impending/ locked wheel skidmarks
      3. Centrifugal skidmarks
      4. Vehicle speed computation
      5. Demonstrations
      6. Combined velocities
      7. Grade
      8. Acceleration
      9. Freefall

XI. Practical application
   A. Discussion of "field applications" exercises
   B. Solving of hypothetical exercises
   C. Use of Pythagorean's theorem

XII. Discussion of field problems
   A. Past/ recent investigations
   B. Possible problem areas discussed
   C. Courtroom testimony
Riverside County Sheriff's Department Course Outline

Traffic Accident Reconstruction

1. Course Description

This 80 hour course is designed to expand the traffic officer's scope of knowledge in the area of Traffic Accident Reconstruction and Investigation. This course is not designed to create expert reconstructionists, but rather to make the student aware of what information is available, how to find and accurately record it so that a reconstruction can ultimately be accomplished. Course subject matter includes: human factors, the roadway environment, the vehicle, the law, collision trauma relationships, and auto/pedestrian accidents.

2. Course Goals

I. The student will realize that the facts he perceives and records at the scene will lead him, or others, to recreate the exact instant of the crash, information about relevant conditions prior to the crash, and after will be vital in later criminal or civil actions.
II. This course will stress the importance of going beyond trying to find out who was at fault in a traffic accident. The student will appreciate the need to determine primary cause, then go on to discover the other contributing causes. The student will understand the importance of searching for and recording positive evidence as well as negative evidence. This course is intended to assist the student to conduct totally objective and factual investigations.

3. Prerequisites

The student must have successfully completed a basic accident investigation course such as required by section 40600 of the California Vehicle Code, and a speed from skidmark or skidmark analysis class.

4. Course Objectives

I. The student will be made aware of human factors while documenting a traffic collision.

II. The student will learn aspects of Penal Code, Vehicle Code, and Case Law as they relate to traffic collisions.

III. The student will understand the effects of the roadway environment upon the cause of accidents and the results of accidents on the roadway.

IV. The students will be exposed to the mathematics principles necessary to work conservation of momentum problems.

V. The student will obtain a background in those elements of physics necessary to understand and apply the principle of conservation of momentum to the calculation of the impact speeds of vehicles involved in collision.

VI. The student will understand the collision process and utilize this understanding to conduct pre and post collision positioning.

VII. The student will be exposed to all the elements of a procedure for reconstruction the pre, at and post crash motion of vehicles involved in collision.

VIII. The student will have the ability to calculate the launch speed of a vehicle involved in a launch and freefall during any portion of the collision.
collision sequence.

IX. The student will have the ability to use the principle of conservation of momentum to calculate the impact speeds of vehicles involved in a collision.

X. The student will be able to identify cases where momentum velocity solution techniques should be used, should not be used, and should be used cautiously.

XI. The student will be able to conduct a time-position study of vehicles involved in collision.

XII. The student will have an overview of the automobile collision process and procedures available to conduct speed analysis of motorcycles involved in collision.

XIII. The student will develop the ability to recognize and explain the significance of different types of damage to a vehicle.

XIV. The student will acquire skill in usage of various damage measurement and recordation techniques.

XV. The student will understand collision types and be able to analyze the forces acting upon the vehicles during collision.

XVI. The student will have a general knowledge of the complexities of speed from damage analysis.

XVII. The student will have an understanding of lamp analysis and its evidentiary value.

5. Course Content

I. Course overview and registration

- A. Goals and objectives
- B. Course history
- C. Class schedule
- D. Requirements for successful completion
II. The law

A. Vehicle code update
current changes in vehicle code

B. Search and seizure
current case decisions as they relate to
vehicles and collection of evidence

C. Miranda warning

D. Impounding vehicles
current case decisions

E. Penal Code as it relates to traffic
collision
1. 187 P.C. - Murder
2. a. 192 P.C. - Manslaughter
   b. 192 c P.C. - Vehicular Manslaughter
3. 245 P.C. - Assault with a deadly weapon

F. DUI - Driving under the influence
1. Vehicle code
2. Case decisions

G. Hit and run
1. Felony-elements per case decision
2. Misdemeanor

H. Staged accidents-insurance fraud

I. Civil aspects
1. Difference between criminal and civil trials
2. Importance of determining all causes of the traffic collision, not just primary fault

III. Human factors

A. Introduction to human factors/overview

B. Psychological factors
1. Culture
2. Emotional

C. Physiological factors
1. Nervous system
2. Senses
   a. Touch
   b. Hearing
   c. Visual
3. Reaction time
   a. Detection
   b. Perception
   c. Decision
   d. Reaction
      1. Reflex reaction (.1 - .2 secs.)
      2. Simple reaction (.2 - .6 secs.)
      3. Complex reaction (.7 - 1.5 secs.)
      4. Discriminative (1 second or longer)

D. Altered physiological factors
   1. Physical handicap
   2. Alcohol and drugs
   3. Fatigue
   4. Environment

E. Witnesses
   1. Attention
   2. Field of view
   3. Education and experience
   4. Emotional condition
   5. Prejudice
   6. Bias

F. Mechanisms of injury
   1. Morgue scene follow-up
      a. Description
      b. Photographs
   2. Autopsy evidence
   3. Collision trauma

IV. Roadway environment

A. Introduction to scene measurement and scale diagramming
   1. Purpose of scene measurements
   2. Field notes
   3. Scale diagramming
   4. Tools

B. Mathematics assessment

C. Roadway environment
   1. Environmental factors
      a. Definitions
      b. Alignment
      c. Controls
      d. Surface
      e. Weather
f. Determination of coefficient of friction
2. Physical evidence
   a. Points of rest
   b. Damage to vehicles
   c. Tire marks
   d. Gouge marks
   e. Debris
   f. Fixed objects

D. Measurement methods
   1. Stationing-field notes
   2. Spot coordinates-field notes
   3. Triangulation-field notes

E. Scale diagramming
   1. Equipment
      a. Northwestern template
      b. Engineer scale
      c. Compass
   2. Planning the diagram
   3. Drawing the diagram
   4. Establishing right angles
   5. Intersects
   6. Curves
   7. Irregular curves

F. Field exercise-on scene measurements
   establishing field notes

G. Classroom exercise-diagramming exercise
   reduce field notes to scale diagram

H. Speed from skidmark refresher

V. Momentum and dynamics

A. Basic mathematics
   1. Cartesian coordinate systems
      a. Basic definition and intro
      b. Positive and negative numbers
      c. Locating points
      d. Simple line equations (optional)
   2. Angle and angle measurement
      a. Angles in standard position
      b. Measuring angles in a cartesian coordinate system
   3. Right angle trigonometry
      a. Standard right angles
      b. Trigonometric functions
         1. Sine
         2. Cosine
         3. Tangent
         4. Cotangent, secant, cosecant
c. Sine, cosine, and tangent functions of standard angles—Demonstrate the use of the scientific calculator
d. Inverse trigonometric functions
e. Problem solving using right angle trigonometry
f. Sine, cosine and tangent function of angles in a cartesian coordinate system (0-360 degrees)

4. Conversion factors
   a. Factor dimension method
      1. Miles per hour to feet per second
      2. Feet per second to miles per hour
   b. Standard conversion factors

5. Negative numbers
   a. Addition and subtraction
   b. Multiplication and division

B. Basic physics
   1. Physics definition of velocity
   2. Physics definition of acceleration
   3. Quantities
      a. Scalar quantities
      b. Vector quantities
   4. Mass and weight
      a. W - mg
      b. Concept of center of gravity
   5. Overview of Newton's Laws of Motion—first, second and third laws of motion
   6. Impulse and momentum
      a. Derived
      b. Defined
      c. Examples of application to vehicle collisions
   7. Friction
      a. Basic physics definition
      b. Coefficient of friction, acceleration factors, G's
      c. Resultant drag factors
      d. Example problems
   8. Forces
      a. Types of forces
      b. Point of application
      c. Line of force

C. Vehicle dynamics
   1. Collision types
   2. Impact sequence and times
   3. Second collision
4. Inferred motion

D. Dynamics reconstruction methodology
1. Scene evaluation
2. Vehicle evaluation
3. Scale drawings
   a. Roadway maps
   b. Physical evidence diagrams
4. Scale dynamics
   a. Two dimensional
   b. Three dimensional
5. Physical evidence and vehicle damage analysis
6. Motion analysis
7. Dynamics diagram
8. Quantitative analysis
9. Example dynamics reconstruction

E. Freefall analysis
1. Freefall equation
   a. Explanation of variables
      1. Horizontal distance
      2. Vertical distance
      3. Launch angles
2. Evidence of launch
3. Evidence of vehicle trajectory
4. Evidence of vehicle landing
5. Example problems
6. Calculation check

F. Momentum analysis - general application
1. Momentum defined
2. Conservation of momentum defined
3. General application of conservation of momentum
   a. Symbols and general equation
   b. Coordinate system
      1. X-Axis equation (V1)
      2. Y-Axis equation (V2)
   c. Intersection solutions process
      1. Departure angle determination
      2. Entry angle determination
      3. Post impact speed determination
      4. Application of X and Y axis conservation of momentum equations
   5. Example problems
      a. Left turning collision
      b. Intersecting roadway
      c. Right angle collisions
   d. Colinear collisions with known pre-impact speed of one of the vehicles
      1. Colinear collision defined
2. The solution process
3. Example problems
   a. Head-on collisions
   b. Rear-end collisions

G. Momentum analysis - special conditions
1. Shallow entry angle and colinear collisions - unknown pre-impact speeds
   a. Shallow entry angle defined
   b. Discussion of problems associated with speed analysis
   c. Solution process demonstrated
2. Large vehicle versus small vehicle collisions - discussion of problems associated with speed analysis

H. Time position analysis
1. Equations of motion with constant acceleration explanation of variables
2. Outline and demonstration of solution process
3. Example problems

I. Auto-motorcycle collisions
1. Drag factors
2. Lock wheel braking analysis
   a. Rear wheel braking only
   b. Front and rear wheel braking
3. Velocity reconstruction from rider launch

VI. Vehicle damage analysis

A. Introduction
   1. An overview of what the course will entail
   2. How the course will focus on a primary investigator's level rather than an engineer's level

B. Reason for inspection
   1. To record damage
   2. To determine force lines
   3. To inspect for possible mechanical defects
   4. Check vehicle for occupant contact

C. The inspection process
   1. The general walk around
      a. Get over the shock of devastation
      b. Establish what factors are
involved
c. Note unusual evidence

2. Vehicle damage description
a. Contact damage
   1. Definition
   2. Examples
   3. How to record
      a. Vehicle outline sketches
      b. Profiles
      c. Premade vehicle damage
b. Induced damage
   1. Definitions
   2. Examples
   3. How to record

c. Reason to determine between contact and induced damage
   1. Helps determine positions of vehicles to one another
   2. Helps identify multiple impacts

3. What to measure
a. All damage whether it is old or new
b. Emphasis on major component displacement
c. Importance of not overlooking minor component damage
d. Horizontal and vertical dimensions
e. Establishment of pre-crash dimensions
f. Occupant contact damage

4. How to measure
a. Station line method through longitudinal axis of vehicle
b. Body line extension
c. Base line along the side or front of the vehicles
d. Rectangular stationing around the vehicle
e. Stand and cord

5. Diagramming the damage measurements
a. Selection of appropriate scale
   1. Based on the needs of the investigation
   2. Ability to enlarge or reduce to scale
b. Plotting reference lines
c. Vehicle damage profile as diagrammed from recorded measurements
d. Usefulness of reconstructed vehicle damage in establishment of a dynamics diagram

6. Motorcycle damage measurements
a. Measurement of wheelbase displacement
b. Nature of fork damage as a consequence of braking
c. Usefulness in speed analysis

D. Lines of force
1. Determination of force lines helps establish direction and magnitude of forces acting on vehicles
2. Key to determine how vehicles were related
3. General overview of forces
   a. Location of center of mass
      1. In general
      2. During rotation and/or jackknife
   b. Central collisions
      1. Definitions
      2. Translation instead of rotation
   c. Non-central collisions
      1. Eccentric impacts
      2. Rotation is primary
      3. Flips and vaults
   d. Complete collisions
      1. Definitions
      2. Speed match-up
   e. Incomplete collisions
      1. Definition
      2. Sideswipes
4. Force line determination
   a. Study damage thoroughly
   b. Explanation of changes in force magnitudes during impact
   c. Resultant force or direction of principle force
   d. Primary identifier is the "flow of damage"
   e. Occupant kinematics
   f. Force line determination is subjective
   g. Accuracy of determination
   h. Force line estimates as aids in the reconstruction process

E. Speed from damage
1. Introduction
   a. Explanation of speed change vs. initial speed
   b. Get more than one opinion
   c. Record estimates for comparison
   d. Use only as a last resort
2. Factors affecting vehicle crush
3. There are formidable problems in crush speed analysis
   a. Knowledge of a particular vehicle's characteristics is necessary
   b. In a practical sense, speed estimates are limited to a few collisions
4. Methods
   a. Visual estimate
   b. Chart comparisons
   c. Linear regression equations
   d. CRASH program
   e. Available data

VII. Overview of the reconstruction process

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

B. Scale diagramming
   1. Necessity of scaling
   2. Methods
      a. Stationing
      b. Spot coordinates
      c. Triangulation
   3. Selection of appropriate scale
   4. The finished product

C. Damage analysis
   1. Identification of contact vs. induced damage
   2. Detailed measurements
   3. Preparation of scale diagrams of vehicles
   4. Force line estimates
   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 fluid leaks and trails
   3. Gouges and other evidence
   4. Overlapping areas of contact damage
   5. Plot vehicle positions

E. Motion analysis
1. Vehicle movement with respect to the scene and each other
2. Motion relative to the centers of mass
3. Dynamics analysis should identify
   a. Impact
   b. Rest
   c. Other significant events
4. Motion analysis should examine the effects of vehicle motion on occupants
   a. Injury mechanisms
   b. Seating positions
   c. Mode of ejection
   d. Restraint system

F. Velocity reconstruction
1. Post impact velocity analysis
   a. Determine how much vehicle moved from impact to rest
   b. Determine deceleration factors
   c. Calculate post-impact speed
2. Impact velocity analysis
   a. Departure and approach angles derived from dynamics diagram
   b. Weights of vehicles
   c. Unusual loading conditions
   d. Momentum analysis
   e. Establishment of impact speeds
3. Pre-impact velocity analysis
   a. Pre-impact deceleration or acceleration
   b. Combined velocity
4. Speed changes
   a. Vector speed changes
   b. Comparison with other known information for consistency

VIII. Lamp analysis

A. Filament analysis
1. Why do it?
   a. To establish the situation
      1. Erase uncertainties as to "on" and "off" operation of lights in general or individual lights
      2. To calibrate the statements of the parties and witnesses involved.
   b. Opposite-direction collisions
      1. Examples -
         a. A fatal opposite-direction collision
occurred when one of the two cars involved was overtaking and passing a third. Why did the approaching car fail to slow down to let the over-taking car pass? Examination revealed the headlamps of the passing auto were not on thus the approaching driver did not see the darkened auto while facing the headlamps of the overtaking car.

b. Left-turn situations when questions arise as to whether or not the left turn signal was activated

c. Head-ons with slight overlap. Could the driver have misjudged the clearance properly due to the left headlamp being out?

c. Same direction collisions
   1. To clarify and establish presence of tail and brake lamps operation and in passing situations the left turn signals in operation
   2. On freeways, an issue often raised is the the emergency flashers on a stopped/parked vehicle were inoperative.

d. Angle-direction collisions
   1. Right-of-way examples:
      a. Driver entering a highway from a lighted area may have forgotten to turn on the lights prior to entry
b. Driver claims the motorcycle did not have the headlamp activated.

e. Hit and run investigations

1. Examples:

a. A suspect involved in a nighttime hit and run claims the damage to his vehicle occurred in a daytime crash, or in reverse when a daytime traffic collision is claimed to have occurred at night. Proper examination of the lights may well establish the situation.

2. What is it?

a. The study of the complete system - including

1. Bulbs - visual on-scene as well as a laboratory exam often requiring photography under moderately powered magnification

2. Switch - from a basic on-scene exam of whether it was in the "on" or "off" position to a much closer exam of any signs of short circuit problems, scorching of wires, wire separation.

3. Connecting wiring, fuses, and circuit breakers, generally thorough overview and inspection of as much of the system as you can inspect visually. If the original traffic collision was at night, a second inspection during daylight may be required.

B. Lamp types

1. Introduction

a. Lamps for motor vehicles are
described by four basic classifications
1. Filament configuration
2. Base arrangement
3. Bulb shape and diameter
4. Volts and watts or amperes

b. Lamps with the same "Trade Number" but made by different manufacturers are interchangeable although not necessarily identical.

2. Single filament type
a. Component descriptions
1. Filament
   a. Made from tungsten, used for its ability to maintain its shape at temperatures of incandescence
   b. Filament is smooth, regular, and has a silver luster
   c. Straight lengthwise scratches or "draw" lines
   d. Filaments are clamped to much larger steel wire of supports
   e. Small filaments may be supported by a third support.
   f. New filaments may be arched or looped and could be taken for impact shocked
2. Support clamp
   a. Made of steel, nickel, etc.
   b. Supports the filament
3. Stem - sealed to the base with glass to prevent the gas/vacuum from leaking
4. Inert gas-slight vacuum air removed replaced by noble or non-reactive gas
5. Base -
   a. Usually made of brass
   b. Trade number and manufacturer printed on base.
c. Pin used to lock lamp in place and provide ground
d. Insulator and contact used to provide energy source.

b. Most common usage
1. Clearance lamps
2. Tail lamp only in some systems
3. License plate lamp
4. Some turn signals not used in combination with clearance lamps

3. Dual filament type
a. Component descriptions
   1. Same as single filament except:
      a. Dual filament arrangement
      b. Twin contact points
      c. Twin offset pins to align contact posts for proper filament usage

b. Most common usage
1. Brake/turn systems
2. Tail/turn systems
3. Clearance/turn systems

4. Headlamps
a. Standard headlamp
   1. Description - usually twin filament arrangement in sealed enclosure
      a. One for low beam and one for high beam
      b. Both filaments approximately the same size and approximately equally bright
      c. Infront of the low beam filament is a "hood" (shade or shield) which keeps the upward light from the low beam from reaching the lens. The effect is to reduce "back-dazzle" reference from...
moisture droplets in rain, fog, etc.

b. Halogen headlamps
   1. Descriptions - sometimes called quartz-iodide, halogen, regenerative, cycle lamps, or halide lamps.
   2. Became available for motor vehicles headlamps in U.S. in 1978 after the maximum permissible candela was increased from 75,000 to 150,000 by the Federal Motor Vehicle Safety Standard #108
   3. Advantages over std. sealed beams
      a. Produce significantly more light
      b. Require about 1/2 the power to operate
      c. Longer life
   4. Small halogen bulb is enclosed in a sealed reflector in round or rectangular shape.
   5. Interchangeable with conventional sealed beam headlamps especially the four light systems

C. How lamps work
   1. Standard conventional lamps
      a. Current flow - current flow enters at the base posts and travels up the stems to the supports and across the coil where the filament is heated
      b. Incandescence -
         1. The filament is heated to white heat or incandescence (Approx. 4000 F)
         2. At moderate temperatures tungsten and most other metals do not combine (react) with oxygen in the air, but tungsten and other metals do oxidize rapidly in air at incandescent temperatures. (Oxidation is a metals reaction to air, rust is a form of oxidation.)
c. Slight vacuum - To prevent oxidation of the filament; it is enclosed in a glass bulb and the air is removed and replaced with an inert gas usually nitrogen at a slight vacuum (slightly less than atmospheric pressure)
d. Normal life characteristics
   1. Filament evaporation ("Boil off")
      a. When heated to incandescence the filament gradually evaporates or "boils off" weakening the filament.
      b. This evaporation process produces deposits on the bulb, reducing the available light.
      c. Recrystallization process
   2. Oxidation: due to the replacement of air with nitrogen or other gas at least atmospheric pressure, oxidation does not occur in the normal process.

2. Quartz halogen lamps:
   a. Current flow - halogen lamps prevent almost all glass blackening. Operation is the same as standard lamp except for its relation to the inert gas.
   b. Halogen fill -
      1. A small amount of a halogen gas, usually Iodine, Bromine, or Chlorine is added to the gas in the lamp.
      2. Pressurized to 4-8 times atmospheric pressure.
         CAUTION: use extreme care in handling, especially if cracked or scratched.

D. Characteristics of a normal lamp

E. Lamp abnormalities resulting from accidents:
   1. Principles involved:
      a. Impact shock:
         1. Hot filament:
            a. A hot filament under shock
is ductile (capable of being drawn out, stretched) and will stretch out, uncoil, or even tangle without breaking or before breaking.

b. Resulting deformation of a hot filament is called "hot shock" or "hot impact."

c. Stretching of a filament can also occur when the glass breaks and some foreign object snags the filament or bends the support(s).

d. The filament must be hot but need not be incandescent (as is tinted filaments).

e. Coils may weld together under severe impact.

f. Filaments may burn in two as the temperature at the narrowest point reaches the melting point.

g. Melted wire ends—where the filament separates, the ends of the filament may be tapered or necked. Sometimes little balls or beads of melted tungsten form on the ends of the filament.

h. Oxide (smokes)—when incandescent filaments are exposed to air the rapidly oxidizing filament produces oxides of tungsten in the form of a yellow smoke (looks whitish) which is deposited on nearby surfaces, leaving telltale signs that there was an incandescent filament in the lamp after the glass broke, even if the filament itself is completely gone.

i. Minute particles of glass on an incandescent filament is a telltale sign that it was incandescent when the glass was broken.

j. Discolorations may range from very black to a
combination of tinting. To be oxidized at all a filament must have been hot; to be heavily oxidized (blackened) it must have been incandescent. Tinted filaments are usually found in a two-filament lamp with the other filament heavily oxidized.

2. Cold shock:
   a. Cold filaments are not ductile, thus there is a minimum amount of stretching.
   b. Fractures are produced by impact of collision. The wire ends are not melted but have a rough appearance at the ends. (brittle) A fracture definitely indicates that the filament was not incandescent when impact occurred either:
      1. because the filament was previously broken.
      2. because the light was off and impact broke it.
   c. There will be no oxidation found.
   d. There will be no glass deposits fused to filament
   e. The absence of brittle fracture does not mean that the light was on, the impact may have not been great enough to break the filament.
   f. There is no discoloration or oxidation whether the glass is broken or not.

b. Special considerations:
   1. Bulbs turned on after accident:
      a. Oxidation of a filament in a broken lamp is not enough. Look for other positive evidence such as, stretched loops, fused glass particles.
      b. If there is oxidation of a broken lamp but no arched loops you should have a sudden urge to examine
further. Was shock severe
enough? Could they have
been turned on after
impact?

2. Flashing lamps-
   a. Signals flash on and
      off between one and
two times per second.
   b. Depending upon the
      frequency of the flash
the current is flowing
in the filament about
half that time. It
could have as much as
0.6 sec. cool off
between flashing.
   c. Oxidation can occur
      more than half a
second after current
is off, and hot
defformation can occur
several seconds
afterward. Therefore,
while flashing, lamps
can only show the
effect of having been
incandescent or in
operation regardless
of whether the crash
occurred in the light
or dark phase of
operation.

F. At scene examination of lamps:
   1. Determine extent of examination required
      a. Nightime accidents vs. daytime
         accidents -
         1. Determine which lamps are or
            may be involved -
            a. First attention should
               be given to the
               involved lamps closest
to the impact area.
            b. Examine lamps that
               should have been used,
turns, etc.
      2. Anyone at the scene says or
even suggests that a vehicle
lacked required lighting.
         b. Disposition of vehicle(s) involved
         1. Do not switch the lamps on to
            see if they operate. This
            may destroy any evidence of
2. If the vehicle is to be stored at a local tow yard, do not remove the lamps at the scene, save the removing and tagging for a safer storage yard.

2. Procedure
   a. At scene notes -
      1. Make a list of the relevant lamps and the control switch, and indicate the following:
      2. Identify vehicle by using license number and year, model, etc.
      3. Identify which lamps were on-off when observed.
      4. Locate the lamps as to area of contact, ie. direct, induced, or unaffected area when observed.
      5. Record whether the lense was broken or unbroken.
      6. For switch, if observed, in on or off position
      7. For filaments, if visible, apparently broken or unbroken.
      8. Fuse box (intact, missing, damaged, separated filament)
         Look for fuses wrapped with foil which usually is a telltale sign that the fuse is separated.
   b. Storage yard -
      1. If you did not make the field notes at the traffic collision scene, make them now as if you were at the scene before you attempt to remove any lamps. Photos should be taken if desired, before removal.
      2. Removal:
         a. Use caution: Sharp edges and glass
         B. Tools: philips screw driver, and ordinary screwdrivers, short pry bars to get housings free, long nose pliers and channel locks are helpful. Diagonal cutting pliers are indispensable. Avoid hammers-they do more harm than good. A roll
of 3/4 inch masking tape and a dozen styrofoam cups will help in temporary labelling and packaging.

c. Marking for I.D. - remove the entire lamp housing, label, initial.

d. Storage and preservation Method: broken vs. sealed beam.

VIII. Final examination and course critique

A. Final includes
   1. Scale diagram
   2. Equations used in scale diagram
   3. Written test

B. P.O.S.T. course evaluation instruments
THE CURRICULUM

Advanced Accident Investigation for Field Officers:

Scene Documentation
Performance Objectives

By the conclusion of this course, it is expected that students will have met all of the following objectives:

1. The student will be able to determine vehicle speed from skidmarks.

2. The student will become proficient in the proper and accurate ways of measuring skidmarks as demonstrated through a practical exercise.

3. The student will be able to identify various human factors associated with accident investigations.

4. The student will demonstrate a knowledge of the Vehicle Code, Penal Code, and Case Laws in determining cause factors associated with accident investigations.

5. The student will be able to identify and describe roadway factors associated with collisions.

6. The student will be able to identify, describe and use vehicle damage to estimate speed.

7. The student will be exposed to a general overview of the complexities of the conservation of linear momentum.
Course Content

I. Registration and course overview 2

A. Goals and objectives of accident investigation

B. History of P.O.S.T. accident investigation courses

C. Class schedule - expectations

II. The law 2

A. Accident investigation and terminology

B. Search and seizure
   1. Case decisions relative to accident investigation
   2. Exigent circumstances

C. Statutory Laws
   1. Penal code
      a. 187 P.C.
      b. 192 P.C./192(C) P.C.
      c. 245 P.C.
   2. Vehicle code
      a. 23152 V.C./23153 V.C.
      b. 20002 V.C./20001 V.C.

D. Civil aspects
   1. Criminal trials vs. civil trials
   2. Role of officer/investigator

III. Identification of skidmarks 2

A. Impending

B. Lock wheel skids
   1. Gap
   2. Skip
   3. Multiple surfaces

C. Sideskid

D. Centrifugal skid

E. Critical speed

IV. Measurement and recording of skidmarks 2

A. Accuracy of various measuring methods
   1. Pros and cons
      a. Steel tape
      b. Roll-a-tape
c. Pace

B. Measuring skidmarks
   1. How to measure
   2. What to measure
   3. When to measure

C. Recording measurements
   1. Proper documentation - all evidence gathered
      a. Field notes
      b. Final report

D. Post impact measurements
   1. Speed analysis
   2. Direction

V. Use of charts and equipment

A. Use CHP form 185
   1. Completion of form gathering data
   2. Determining velocity from skids
   3. Determining coefficient of friction

B. Use of Northwestern traffic template
   1. Determining velocity from skids
   2. Determining coefficient of friction
   3. Determining grades
   4. Various scales
      a. 1/10th
      b. 1/20th
   5. General use of template

C. Dragsleds
   1. Use
   2. Construction
   3. Various types

D. Detonators
   1. Gravity
   2. Electronic

E. Tools for measuring grade
   1. Sexton
   2. Clipboard with Northwestern template
   3. Carpenter's level
   4. Line bubble balancer

VI. Conversion factors

A. Purpose of conversion factors
   1. Compatibility with other formulas
   2. Study of closing distances

B. Miles per hour to feet per second
C. Feet per second to miles per hour

D. Perception and reaction time
   1. Simple
   2. Complex
   3. National test studies

VII. Use of symbols
   A. Definition/purpose of symbols
      1. Not universal
      2. Language
         a. Mathematics
         b. CHP definitions
         c. Northwestern definitions
   B. Symbol
      1. V=MPH
      2. v=fps
      3. s=Distance
      4. f=Friction
      5. F=Force
      6. and etc.

VIII. Human factors
   A. Introduction to human factors/overview
   B. Psychological factors
      1. Culture
      2. Emotional
   C. Physiological factors
      1. Nervous system
      2. Senses
         a. Touch
         b. Hearing
         c. Visual
      3. Reaction time
         a. Detection
         b. Perception
         c. Decision
         d. Reaction
            1. Reflex reaction (.1 - .2 secs.)
            2. Simple reaction (.2 - .6 Secs.)
            3. Complex reaction (.7 - 1.5 secs.)
            4. Discriminative (1 second or longer)
   D. Altered physiological factors
      1. Physical handicap
      2. Alcohol and drugs
      3. Fatigue
      4. Environment
E. Witnesses
   1. Attention
   2. Field of view
   3. Education and experience
   4. Emotional condition
   5. Prejudice
   6. Bias

F. Mechanisms of injury
   1. Morgue/scene follow up
      a. Description
      b. Photographs
   2. Autopsy evidence
   3. Collision trauma

IX. Roadway environment

A. Diagramming
   1. Purpose of scene measurements
   2. Field notes
   3. Tools
   4. Preparation of diagrams

B. Roadway environment
   1. Environmental factors
      a. Definitions
      b. Alignment
      c. Controls
      d. Surface
      e. Weather
      f. Determination of coefficient of friction
   2. Physical evidence
      a. Points of rest
      b. Damage assessment (vehicles/property)
      c. Tire marks
      d. Gouge marks
      e. Debris
      f. Fixed objects

C. Measurement methods
   1. Stationing
      a. Field notes
      b. Types of equipment/documentation
   2. Spot coordinates
   3. Triangulation

X. Vehicle damage analysis

A. Introduction
   1. An overview of what the course will entail
   2. How the course will focus on a primary investigator's level rather than an engineer's level
B. Reason for inspection
1. To record damage
2. To determine force lines
3. To inspect for possible mechanical defects
4. Check vehicle for occupant contact

C. The inspection process
1. The general walk around
   a. Get over the shock of devastation
   b. Establish what factors are involved
   c. Note unusual evidence
2. Vehicle damage description
   a. Contact damage
      1. Definition
      2. Examples
      3. How to record
         a. Vehicle outline sketches
         b. Profiles
         c. Premade vehicle damage
   b. Induced damage
      1. Definitions
      2. Examples
      3. How to record
   c. Reason to determine between contact and induced damage
      1. Helps determine positions of vehicles to one another
      2. Helps identify multiple impacts
3. What to measure
   a. All damage whether it is old or new
   b. Emphasis on major component displacement
   c. Importance of not overlooking minor component damage
   d. Horizontal and vertical dimensions
   e. Establishment of pre-crash dimensions
   f. Occupant contact damage
4. How to measure
   a. Station line method through longitudinal axis of vehicle
   b. Body line extension
   c. Base line along the side or front of the vehicles
   d. Rectangular stationing around the vehicle
   e. Stand and cord
5. Diagramming the damage measurements
   a. Selection of appropriate scale
      1. Based on the needs of the investigation
      2. Ability to enlarge or reduce to scale
   b. Plotting reference lines
   c. Vehicle damage profile as diagrammed from recorded measurements
d. Usefulness of reconstructed vehicle damage in establishment of a dynamics diagram

6. Motorcycle damage measurements
   a. Measurement of wheelbase displacement
   b. Nature of fork damage as a consequence of braking
   c. Usefulness in speed analysis

D. Lines of force
   1. Determination of force lines helps establish direction and magnitude of forces acting on vehicles
   2. Key to determine how vehicles were related
   3. General overview of forces
      a. Location of center of mass
         1. In general
         2. During rotation and/or jackknife
      b. Central collisions
         1. Definitions
         2. Translation instead of rotation
      c. Non-central collisions
         1. Eccentric impacts
         2. Rotation is primary
         3. Flips and vaults
      d. Complete collisions
         1. Definitions
         2. Speed match-up
      e. Incomplete collisions
         1. Definition
         2. Sideswipes
   4. Force line determination
      a. Study damage thoroughly
      b. Explanation of changes in force magnitudes during impact
      c. Resultant force or direction of principle force
      d. Primary identifier is the "flow of damage"
      e. Occupant kinematics
      f. Force line determination is subjective
      g. Accuracy of determination
      h. Force line estimates as aids in the reconstruction process

E. Speed from damage
   1. Introduction
      a. Explanation of speed change vs. initial speed
      b. Get more than one opinion
      c. Record estimates for comparison
      d. Use only as a last resort
   2. Factors affecting vehicle crush
      a. Available energy
b. Vehicle stiffness  
c. Energy partition  

3. There are formidable problems in crush speed analysis  
a. Knowledge of a particular vehicle's characteristics is necessary  
b. In a practical sense, speed estimates are limited to a few collisions  

4. Methods  
a. Visual estimate  
b. Chart comparisons  
c. Linear regression equations  
d. CRASH program  
e. Available data  

XI. Overview of the reconstruction process  

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

B. Scale diagramming  
1. Necessity of scaling  
2. Methods  
   a. Stationing  
   b. Spot coordinates  
   c. Triangulation  
3. Selection of appropriate scale  
4. The finished product  

C. Damage analysis  
1. Identification of contact vs. induced damage  
2. Detailed measurements  
3. Preparation of scale diagrams of vehicles  
4. Force line estimates  
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 fluid leaks and trails  
3. Gouges and other evidence  
4. Overlapping areas of contact damage  
5. Plot vehicle positions  

E. Motion analysis  
1. Vehicle movement with respect to the scene and each other  
2. Motion relative to the centers of mass  
3. Dynamics analysis should identify  
   a. Impact
b. Rest

c. Other significant events

4. Motion analysis should examine the effects of vehicle motion on occupants
   a. Injury mechanisms
   b. Seating positions
   c. Mode of ejection
   d. Restraint system

F. Velocity reconstruction
   1. Post impact velocity analysis
      a. Determine how much vehicle moved from impact to rest
      b. Determine deceleration factors
      c. Calculate post-impact speed
   2. Impact velocity analysis
      a. Departure and approach angles derived from dynamics diagram
      b. Weights of vehicles
      c. Unusual loading conditions
      d. Momentum analysis
      e. Establishment of impact speeds
   3. Pre-impact velocity analysis
      a. Pre-impact deceleration or acceleration
      b. Combined velocity
   4. Speed changes
      a. Vector speed changes
      b. Comparison with other known information for consistency

XII. Final examination and course critique

A. Final includes
   1. Investigation and diagram of scale model
   2. Written test

B. Instructor evaluations

C. P.O.S.T. course evaluations
THE BUDGET FOR CURRICULUM IMPLEMENTATION

The costs indicated for the two existing programs are 1987 estimates based on information gathered relative to the cost of three presentations of the courses in the 1985-86 educational year.

The costs indicated for the presented curriculum are based on current instructional costs, and instructional fees at the Riverside County Sheriff's Department.

### Traffic Accident Investigation Skidmark Analysis

1. **Instructional needs**
   - I. Assistant professor (mathematics) 2 Hours $100.00
   - II. Course coordinator 120 Hours $3000.00
   - III. Deputy district attorney 4 Hours $150.00
   - IV. Law enforcement instructor 68 Hours $1700.00

2. **Instructional costs**
   - I. Misc. instructional supplies (per student) $8.00
   - II. Cost of instruction per student (20 students) $247.50
   - III. Cost of course per student $255.50

### Traffic Accident Reconstruction

1. **Instructional needs**
   - I. City attorney 8 Hours $500.00
   - II. Forensic pathologist 2 Hours $200.00
   - III. Course coordinator 240 Hours $6000.00
   - IV. Civil attorney 6 Hours $300.00
   - V. Professional engineer 16 Hours $1000.00
   - VI. Law enforcement MAIT supervisor 24 Hours $1500.00
<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII. CHP motor carrier specialist</td>
<td>8</td>
<td>$300.00</td>
</tr>
<tr>
<td>VIII. Criminal lab technician</td>
<td>12</td>
<td>$750.00</td>
</tr>
<tr>
<td>IX. Law enforcement instructor</td>
<td>20</td>
<td>$500.00</td>
</tr>
</tbody>
</table>

2. Instructional costs

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Misc. instructional supplies (per student)</td>
<td>$22.50</td>
</tr>
<tr>
<td>II. Cost of instruction per student (20 Students)</td>
<td>$552.50</td>
</tr>
<tr>
<td>III. Cost of course per student</td>
<td>$575.00</td>
</tr>
</tbody>
</table>

Scene Documentation Course

1. Instructional needs

<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Course coordinator</td>
<td>80</td>
<td>$2000.00</td>
</tr>
<tr>
<td>II. Deputy district attorney</td>
<td>2</td>
<td>$100.00</td>
</tr>
<tr>
<td>III. Advanced accident investigator</td>
<td>18</td>
<td>$450.00</td>
</tr>
<tr>
<td>IV. Law enforcement instructor</td>
<td>12</td>
<td>$300.00</td>
</tr>
<tr>
<td>V. Accident reconstructionist</td>
<td>20</td>
<td>$500.00</td>
</tr>
</tbody>
</table>

2. Instructional costs

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Misc. instructional supplies (per student)</td>
<td>$4.00</td>
</tr>
<tr>
<td>II. Cost of instruction per student (20 Students)</td>
<td>$185.00</td>
</tr>
<tr>
<td>III. Cost of course per student</td>
<td>$189.00</td>
</tr>
</tbody>
</table>
SUMMARY AND CONCLUSION

The Riverside County Sheriff's Department has an in-depth and extensive program of instruction in traffic accident investigation. The course offerings have been designed to train investigators to conduct sophisticated scientific investigations. These courses fill a long time need for advanced training in the area of traffic accident investigation.

This curriculum has been designed to augment the current program by offering specific instruction in the one element of accident investigation that is lost when the scene is cleared: scene documentation.

This curriculum will complete the course offerings to establish a comprehensive program for both intermediate and advanced officers by breaking the scene documentation elements of instruction down into a program which will offer training to officers not intended to become accident reconstructionists. This curriculum will introduce more investigators to advanced training than the present program can allow, and do so at a price which is affordable for law enforcement agencies.
FOOTNOTES


5People v. Herman (1940) 20 N.Y.S. (2nd) 149, 174 N.Y.


7Collins. p. 196.


12American Motorcycle Association v. Superior Court, Los Angeles County. (1978) 20 Cal. 3d. 578.
BIBLIOGRAPHY

American Motorcycle Association v. Superior Court, Los Angeles County. (1978) 20 Cal. 3d. 578.


People v. Herman (1940) 20 N.Y.S. (2nd) 149, 174 N.Y.
