Crash Reconstruction: A Complete Step-by-Step Procedure

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Intersection
Crash Reconstruction
from
Cradle
to
Grave
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Outline

• Description of Crash
• Required Physical Data
• Police Accident Report
• Data Development
• Data Reduction
• Analysis
• Conclusions
• Discussion
Description of Crash

- Not a Real Crash
- “MSU”

GOAL:
- Present a Procedure
- Not to Present a Case Study
Description of Crash

- Small, Rural Town
- 90-degree Intersection
- Relatively Level
- 4 Lanes (2 in each direction)
- 2 Vehicles (Passenger Cars)
- Stop Signs
Questions to Address

• **Cause**
  - Vehicle Speeds?
  - Inattention?
  - Failing to Stop?

• **Avoidability**
  - What If…?
**Required Physical Data**

- **Impact Speed**
  - Position at Impact
  - Position at Rest
  - Path between Impact and Rest
  - Wheel Lockups (Drag Factor)
  - Damage Profile
    - Required for Collinear Collision
    - Optional for Oblique Collision
Required Physical Data

- **Begin Braking Speed**
  - Impact Speed (previous slide)
  - Position at Begin Braking
    - 13 ft of faint tire marks (ABS)
  - Pre-impact Wheel Lockups (drag factor)
Police Accident Report

- **Basic Scene Information**
  - General Location
  - Rest Positions
  - Crash-related Artifacts
    - Skidmarks
    - Gouge marks
    - Glass...

- **Basic Vehicle Information**
  - Make/Model/Year

- **Witness Statements**
  - Limited Emphasis
Vehicle Inspection

• Make/Model/Year/Body Style
• Dimensions/Inertias
• Wheel Damage/Lockups
• Damage Profiles
• Documentation
  ✓ Photographs
  ✓ Other Notes/Observations
Site Inspection

- Location/Direction
- Street Dimensions
- Skid/Scuff/Gouge Locations
- Surface Irregularities
- Survey
- Documentation
  - Origin
  - Photographs
  - Other Notes/Observations
Data Reduction

- Vehicle Models
- Environment Model
- Crash-related Artifacts
Vehicle Model

• **Dimensions**
  - Exterior
  - Wheel Locations wrt CG

• **Weight/Rotational Inertia**

• **Tires**
  - Friction
  - Cornering Stiffness
Environment Model

- To Scale!
- Driving Surfaces
  - with Skids/Scuffs/Gouges
- Sidewalks
- Buildings (vision obstructions)
- Stop Signs
Analysis

• Reconstruction
  ✓ Speed Estimates
• Simulation
  ✓ Confirm Speed Estimates
  ✓ Time-Distance Study
• Perception/Reaction Time
• Cause/Avoidability
Reconstruction

• **Damage Analysis**
  ✔ Crown Victoria Only

**Result:**

• **Speed Estimate**
  ✔ Impact with Brick Building
Reconstruction

- Position at Begin Braking
  - Crown Victoria Only
- Positions at Impact
- Positions at Rest
- Wheel Lockups

Results:
- Speed Estimates
  - Begin Braking
  - Impact
  - Separation
Simulation

• **Initial Positions**
• **Driver Controls**
  ✓ Steering
  ✓ Braking
  ✓ Throttle
• **Wheel Impact Damage**

Results:
• **Confirmation of Initial Speeds**
• **Time-Distance Study**
Perception/Reaction Time

- **Initial Visibility**
  - Position
  - Time
- **Begin Braking**
  - Position
  - Time
- **Difference is Maximum Perception/Reaction Time**

\[
T_{P/R\ (max)} = T_{Begin\ Braking} - T_{Initial\ Visibility}
\]
Result...
Result...

- **Initial Visibility**
  - Time = 1.32 sec
  - Position (to be used later)
    - Crown Vic X = -73.2, Y = 20.0
    - Impala X = 18.0, Y = 97.4

- **Begin Braking**
  - Time = 2.52 sec

- So:
  \[ T_{P/R} \text{ (max)} = 2.52 - 1.32 = 1.20 \text{ sec} \]
Observations

- Typical Perception/Reaction times
  - 0.75 sec for Reaction Time Test
  - 1.25 sec, min (lots of sources)
  - 2.50 sec, max (AASHTO)
Conclusion

- Inattention Not a Factor

Also...

- Time at Begin Steering = 1.52
  - Driver began steering almost instantly (0.20 sec after initial vis)
  - Driver was probably watching for cross traffic
Was Speed a Factor?

- **Crown Victoria Speed = 40 mph**
- **Speed Limit = 25 mph**
- **To Find Answer:**
  - Position vehicles at initial visibility (from earlier result)
    - Crown Vic X = -73.2, Y = 20.0
    - Impala X = 18.0, Y = 97.4
  - Reduce speed from 40 to 25
  - No steering/braking
  - Re-execute
Result ...
Result ...

- At 25 mph, Crown Victoria passes behind Impala
- Misses by 25 ft
  - Speed was a factor
Additional Information

- **Did Impala Stop?**
- **To Find Answer:**
  - Position vehicle at stop line
  - Accelerate at WOT to impact point
  - Compare speed with impact speed
Result ...
Result ...

• Speed = 24 mph (less than impact speed, 35 mph)
  ✓ Impala did not stop at stop sign
Conclusions

1. Crown Victoria was exceeding the speed limit
2. Collision does not occur if Crown Victoria obeys the speed limit
3. Although collision is avoided, it is a near-miss
4. Impala did not have sufficient room to pull out safely
5. Impala did not stop
Discussion/Questions
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Thank You

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