ACCIDENT RECONSTRUCTION AND TODAY'S TECHNOLOGY

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S-E-A, Ltd.

What is Accident Reconstruction?

- The who…
- The when…
- The where…
- The what…
- The how…

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Accident Reconstruction

Step 1: Data Collection

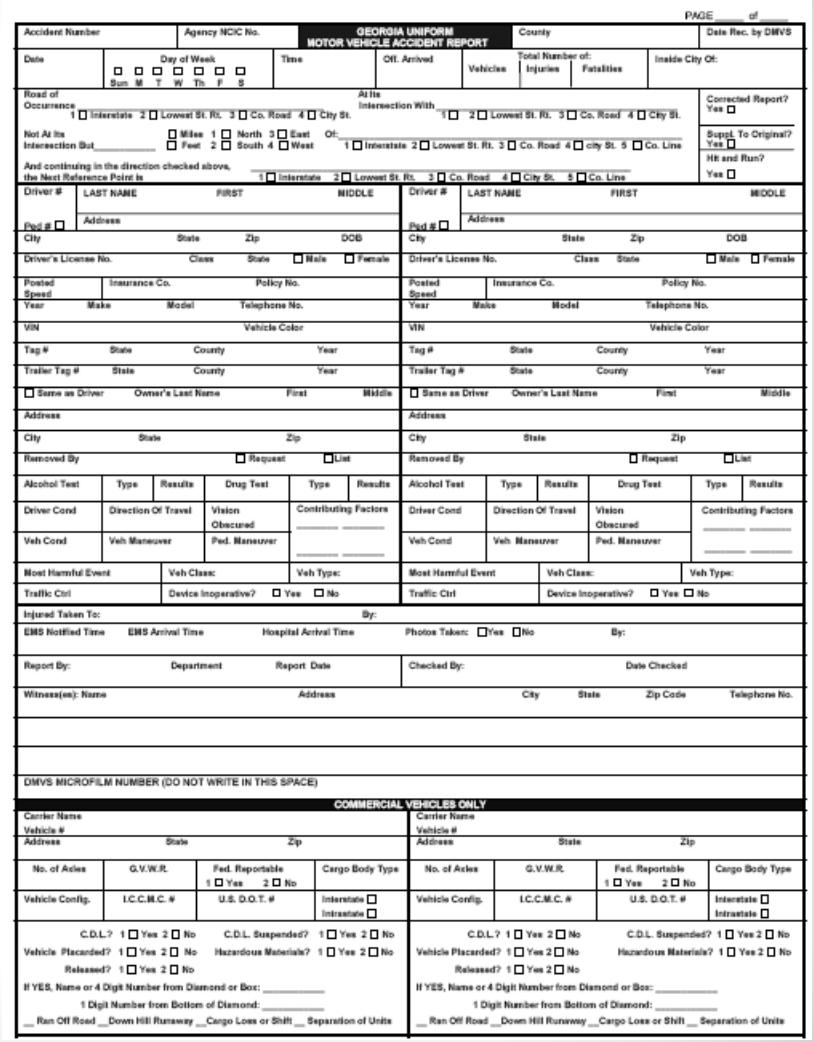
…get the basic background information
you need to get started

Data Collection – Crash Report

Objective Incident Information:

- Names
- Location
- Date & time
- Vehicles
- Witness statements
- Roadway measurements*
- Photographs

* info is (*usually, sometimes, occasionally*) accurate



GEORGIA UNIFORM MOTOR VEHICLE ACCIDENT REPORT

PAGE ____ of ____

Accident Number | Agency NCIC No. | County | Date Rec. by DMVS

Date | Day of Week (Sun M T W Th F S) | Time | Off. Arrived | Vehicles | Total Number of: Injuries | Fatalities | Inside City Of:

Road of Occurrence | At Its Intersection With | Corrected Report? | Suppl. To Original? | Hit and Run?

Not At Its Intersection But | And continuing in the direction checked above, the Next Reference Point is

Driver # | LAST NAME | FIRST | MIDDLE | Ped # | Address | City | State | Zip | DOB | Driver's License No. | Class | State | Male | Female | Posted Speed | Insurance Co. | Policy No. | Year | Make | Model | Telephone No. | VIN | Vehicle Color | Tag # | State | County | Year | Trailer Tag # | Same as Driver | Owner's Last Name | First | Middle | Removed By | Request | List | Alcohol Test | Type | Results | Drug Test | Driver Cond | Direction Of Travel | Vision Obscured | Contributing Factors | Veh Cond | Veh Maneuver | Ped. Maneuver | Most Harmful Event | Veh Class: | Veh Type: | Traffic Ctrl | Device Inoperative? | Injured Taken To: | By: | EMS Notified Time | EMS Arrival Time | Hospital Arrival Time | Photos Taken: | Report By: | Department | Report Date | Checked By: | Date Checked | Witness(es): Name | Address | City | State | Zip Code | Telephone No.

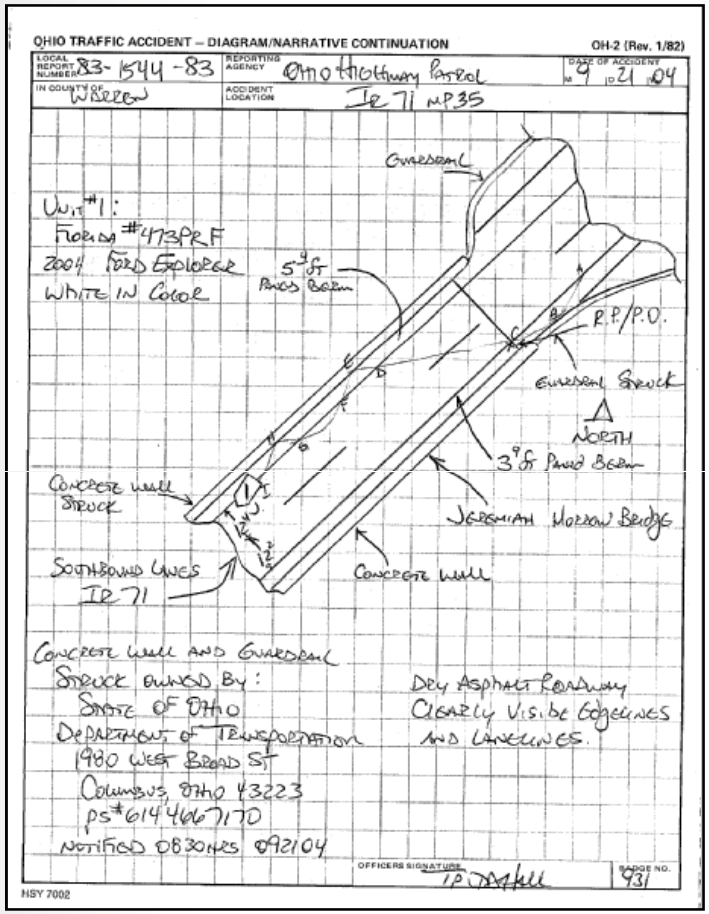
DMVS MICROFILM NUMBER (DO NOT WRITE IN THIS SPACE)

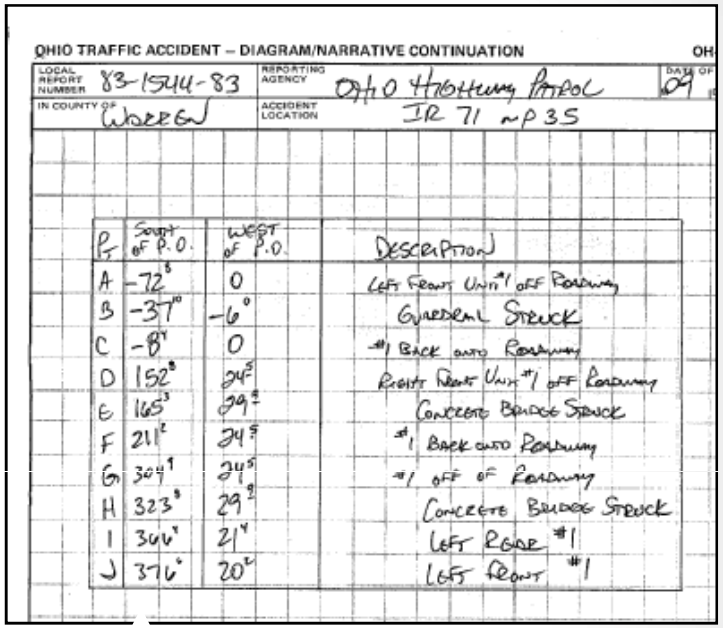
COMMERCIAL VEHICLES ONLY

Carrier Name | Vehicle # | Address | State | Zip | No. of Axles | G.V.W.R. | Fed. Reportable | Cargo Body Type | Vehicle Config. | I.C.C.M.C. # | U.S. D.O.T. # | Interstate | Intrastate | C.D.L.? | C.D.L. Suspended? | Vehicle Placarded? | Hazardous Materials? | Released? | If YES, Name or 4 Digit Number from Diamond or Box: | 1 Digit Number from Bottom of Diamond: | Ran Off Road | Down Hill Runaway | Cargo Loss or Shift | Separation of Units

Data Collection

Crash Report Diagram and Measurements





Y

Baseline - X

Usually baseline-edge-type measurements; however, total station surveys becoming more prevalent with police agencies

Data Collection

Crash Report Diagram and Measurements

Easy – until……

Data Collection

Commercial Vehicle Inspection Report

Objective Truck-Related Information:

- Brake conditions
- Brake adjustments*
- Axle weights
- Crash damage
- Other deficiencies, such as structural issues with frame

*NOTE: this information is not always correct!

Data Collection

Commercial Vehicle Inspection Report

VEHICLE IDENTIFICATION:

Unit	Type	Make	Year	State	License#	Company #	Unit VIN	GVWR	Issued Decal#	Existing Decal#	OOS Stkr.#
1	TT	INTL	1993	AL	7X900089	NONE	2HSFBBJR1PC074700	0			
2	ST	PITM	1993	AL	7TR00951	62829-2	PE9LT40T3PP100068	0			

BRAKE ADJUSTMENTS:

Axle #	1	2	3	4	5
Right	2 1/2	1 3/4	2 1/2	2 3/4	3
Left	2 1/2	2 1/4	2	2 3/4	3 1/4
Chamber	C-20	C-30	C-30	C-30	C-30

VIOLATIONS :

Section Code	St	Unit	OOS	Lvl 6	Citation #	Verify*	Crash	Violation Description
393.9H		1	N	N		N	Y	**Inoperable head lamps, missing from housing
393.60(b)		1	N	N		N	Y	**Windshields required
393.80		1	N	N		N	Y	**No or defective rear-vision mirror
393.81		1	N	N		N	U	Horn inoperative
393.82		1	N	N		N	Y	**Speedometer inoperative / inadequate
393.75(c)		1	Y	N		U	N	Tire-other tread depth less than 2/32 of inch axle 1 right side more than three area on tire
393.9T		1	N	N		N	U	Inoperable tail lamp
393.25(f)		1	N	N		N	U	Stop lamp violations
393.9TS		1	N	N		N	U	Inoperative turn signal
393.95(a)		1	N	N		N	N	No/discharged/unsecured fire extinguisher
393.28		1	N	N		N	U	Improper or no wiring protection as required, electrical line on deck
396.3A1B		1	N	N		N	N	Brakes (general), bolt not bolted into proper housing on brake chamber

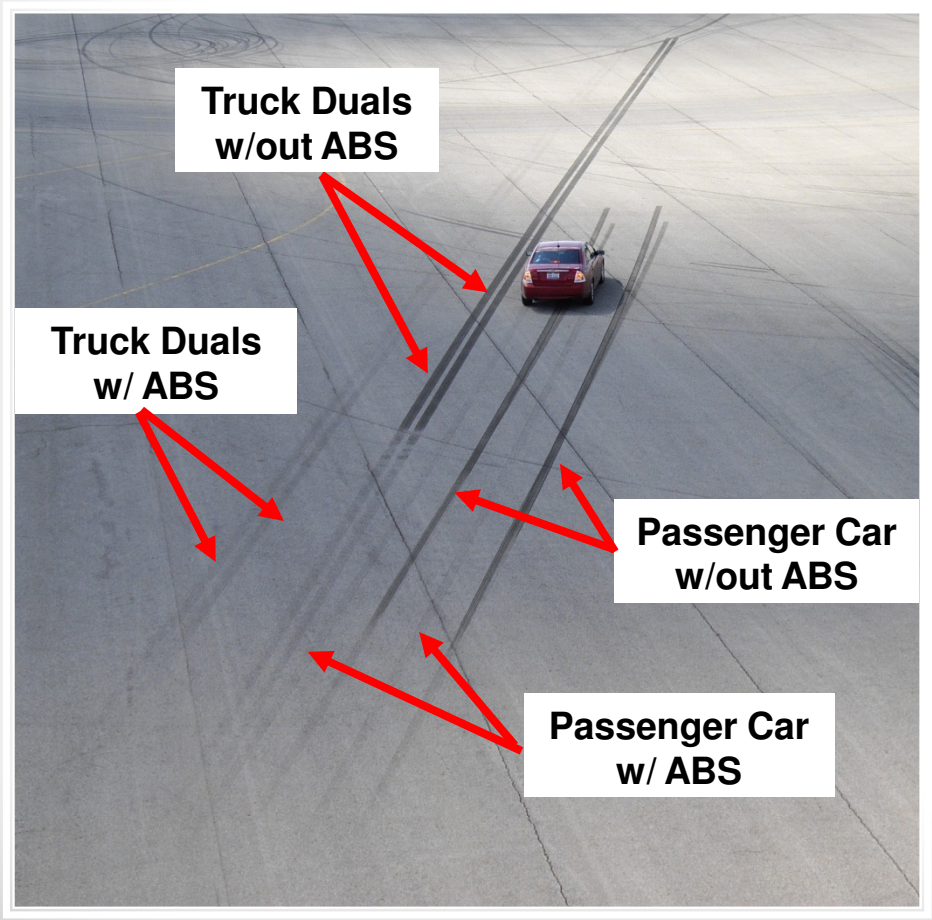
Accident Reconstruction

Step 2: Document Evidence

…measure, photograph, collect, PRESERVE

Document Evidence *ASAP*

Roadway evidence (tire marks, scratches / gouges)

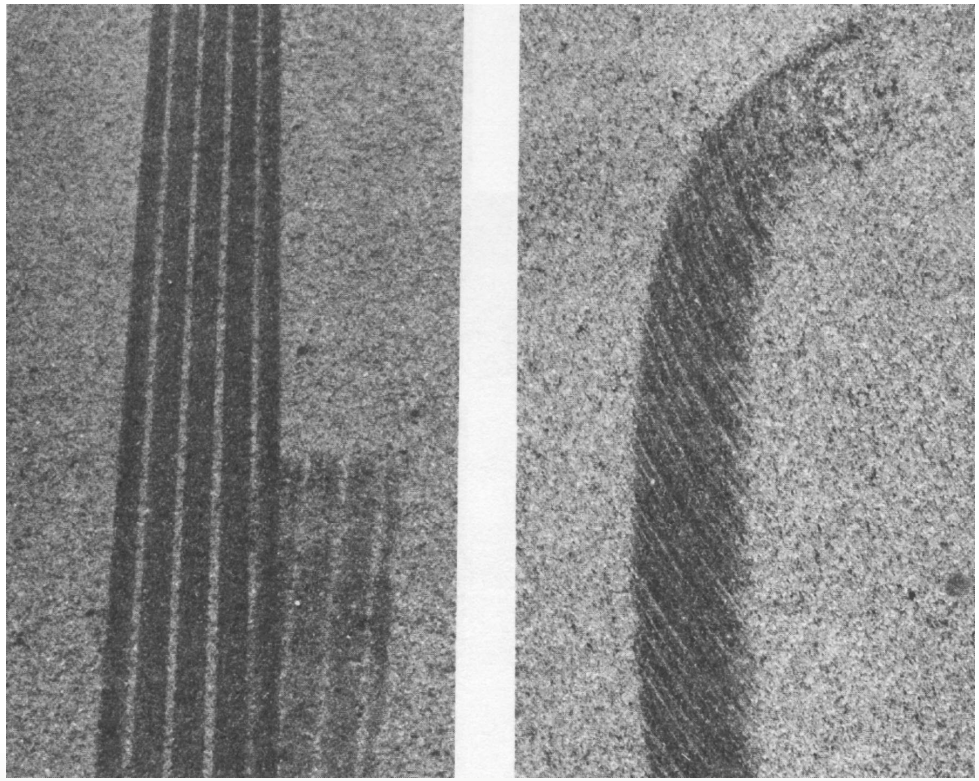


- Photograph
  - Good: standard
  - Better: aerial
- Measure
  - Good: tape measures and/or wheels
  - Better: survey equipment

Document Evidence *ASAP*

Roadway evidence (tire marks, scratches / gouges)

- Not all tire marks are created equal….



Skid/Braking

Yaw

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Accident Scene

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Accident Scene

Document Evidence *ASAP*

Vehicle Inspection: Get in ASAP

- Vehicles get towed ….
- Get crushed, lost, sold, ….
- Parts get lost, altered

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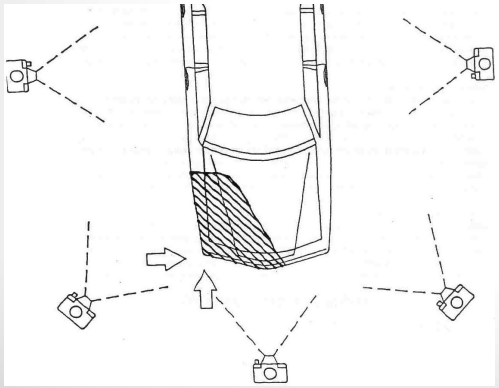
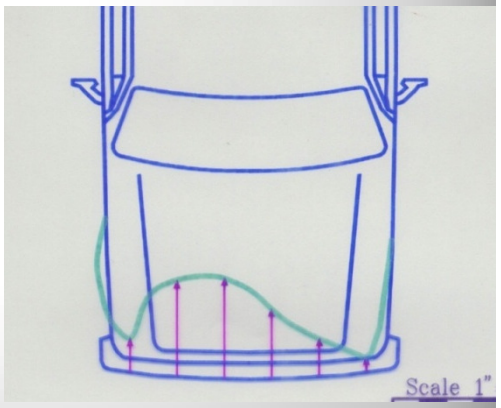
Document Evidence *ASAP*

Vehicle Inspection (Damage):

- Photograph evidence
- Damage or *crush* :
  - Document nature
  - Measure
    - *Tape measure*
    - *Photogrammetry*
    - *Digitize*





Document Evidence *ASAP*

Vehicle Inspection (Damage):
Scene Inspection

3D scanner

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Document Evidence – 3D Scanner

Vehicle Scan – this is NOT a photograph

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Document Evidence – 3D Scanner

Scene Scan – single scan

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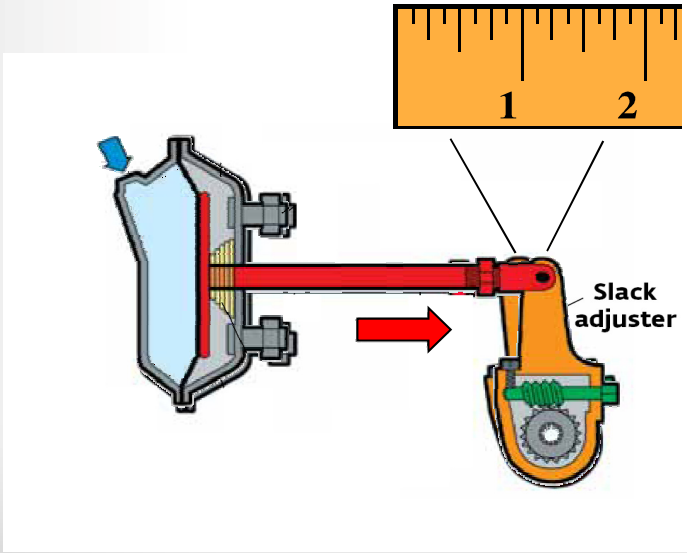
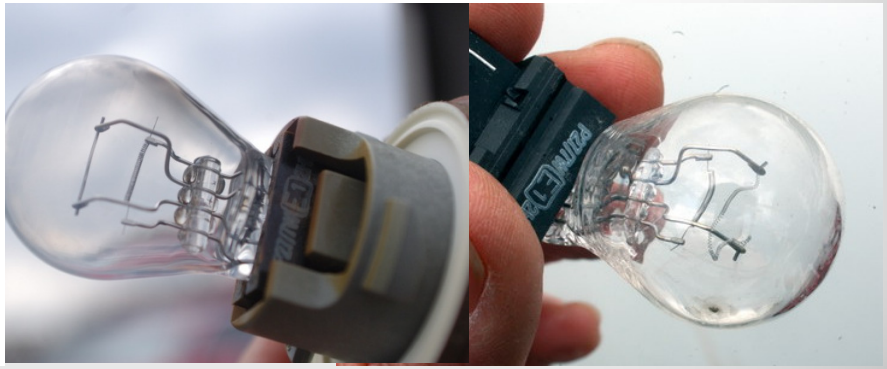
Document Evidence *ASAP*

Vehicle Inspection (special circumstances):

- Brakes
- Conspicuity (lighting, reflectors, clothing)
- Seat belts, guides
- Others (suspension, tire)?





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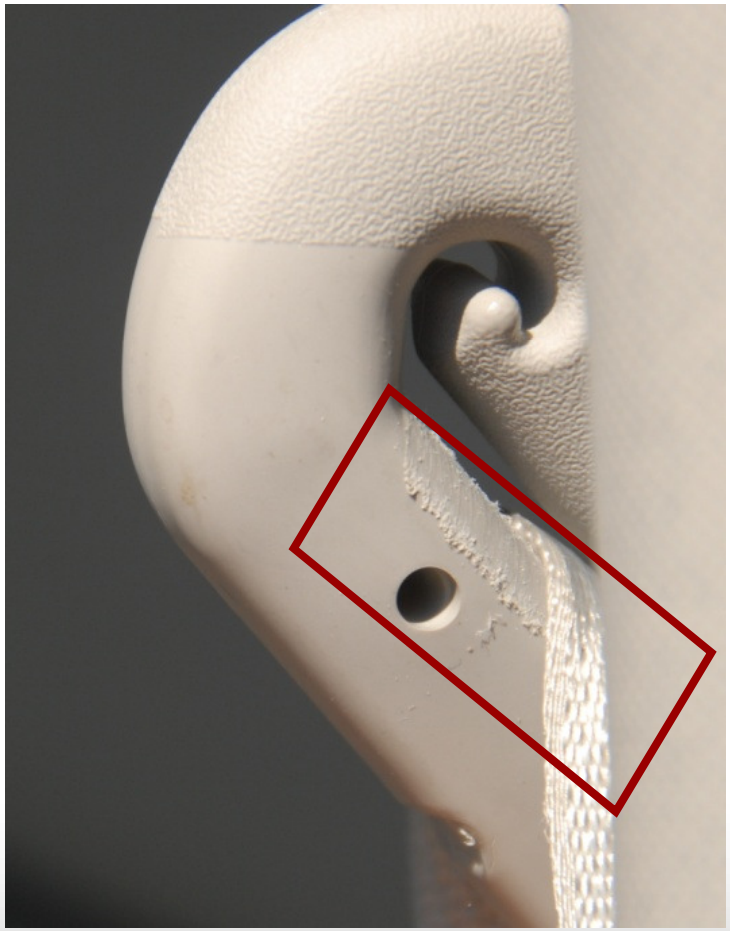
Document Evidence *ASAP*

Vehicle Inspection (special circumstances):

- Seat belts - evidence of use – close-up



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Document Evidence *ASAP*

Engine Control Module Data Extraction:

- It is engine specific, not truck specific
  - *Cummins, Caterpillar, Detroit Diesel…*
- Is the record option activated?
- What data is retrievable?
- What is the best means to extract the *NECESSARY* data?
  - Onboard
  - Direct to module
  - Exemplar engine/truck

Event Data Recorders

For HEAVY TRUCKS

Remember – It <u>is not</u> truck specific, <u>it is engine specific!</u>

<u>The List (ECM's that store time & speed data):</u>

- Caterpillar
- Cummins
- Detroit Diesel
- Mack (send to specific shops)
- Volvo
- International

Also,

1. the option must be turned on
2. the threshold for "hard stop" must be crossed during the event

Event Data Recorders

For PASSENGER VEHICLES

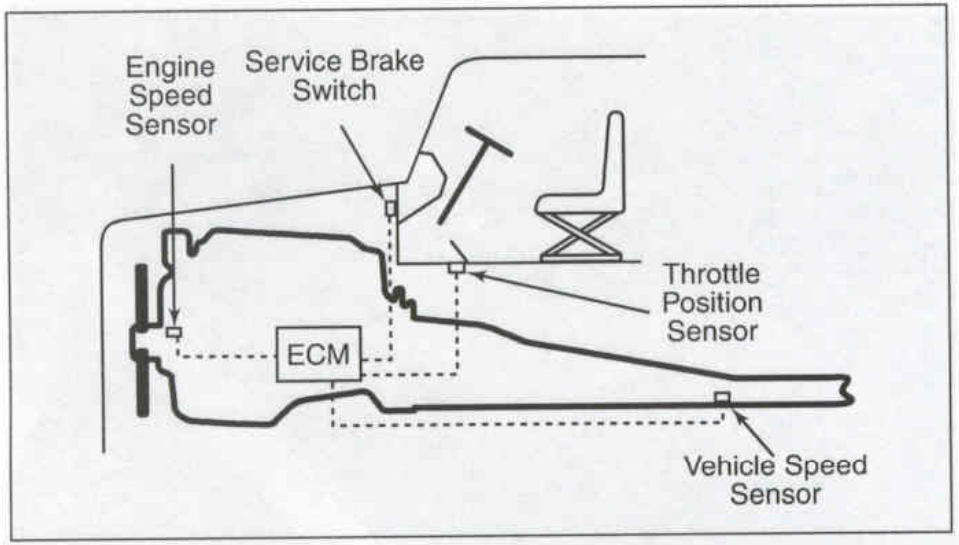
DATA is stored in Airbag Control Modules (ACMs)!

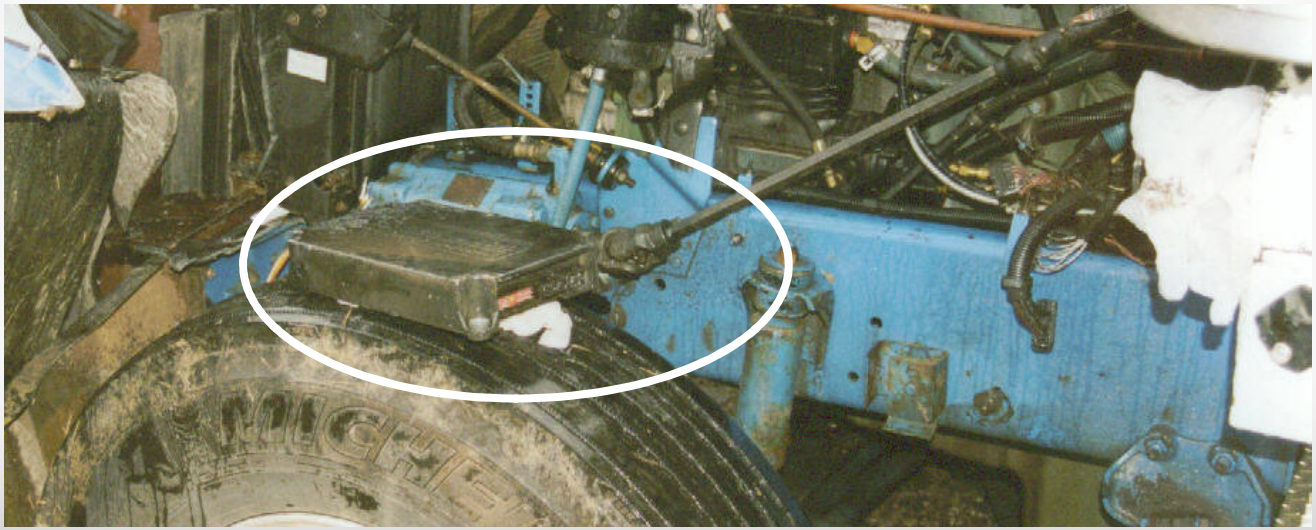
<u>This List is constantly growing:</u>

- Ford
- Chrysler
- Chevrolet
- GMC
- Dodge
- Honda
- Acura
- Toyota
- Etc.

Event Data Recorders

For HEAVY TRUCKS - Location





Event Data Recorders

For HEAVY TRUCKS

What happened here? (hypothetical case)

Time	Vehicle Speed (mph)	Engine Speed (rpm)	Brake	Clutch	Engine Load (%)	Throttle (%)	Cruise	Diagnostic Code
-0:15	58.0	1293	No	No	68.50	0.00	Yes	No
-0:14	58.0	1295	No	No	69.50	0.00	Yes	No
-0:13	58.5	1302	No	No	68.50	0.00	Yes	No
-0:12	58.5	1302	No	No	70.00	0.00	Yes	No
-0:11	58.5	1310	No	No	71.50	0.00	Yes	No
-0:10	58.5	1311	No	No	72.00	0.00	Yes	No
-0:09	58.5	1308	No	No	72.50	0.00	Yes	No
-0:08	59.0	1312	No	No	73.00	0.00	Yes	No
-0:07	59.0	1313	No	No	73.00	0.00	Yes	No
-0:06	59.0	1309	No	No	73.00	0.00	Yes	No
-0:05	59.0	1313	No	No	72.50	0.00	Yes	No
-0:04	59.0	1320	No	No	71.50	0.00	Yes	No
-0:03	59.5	1326	No	No	67.50	0.00	Yes	No
-0:02	53.0	1188	Yes	No	99.50	100.00	Yes	No
-0:01	49.0	1088	No	No	100.00	100.00	No	No
0:00	45.0	982	Yes	No	0.00	0.00	No	No
+0:01	37.0	766	Yes	Yes	0.00	0.00	No	No
+0:02	29.0	499	Yes	Yes	80.50	0.00	No	No
+0:03	20.5	602	Yes	Yes	11.50	0.00	No	No

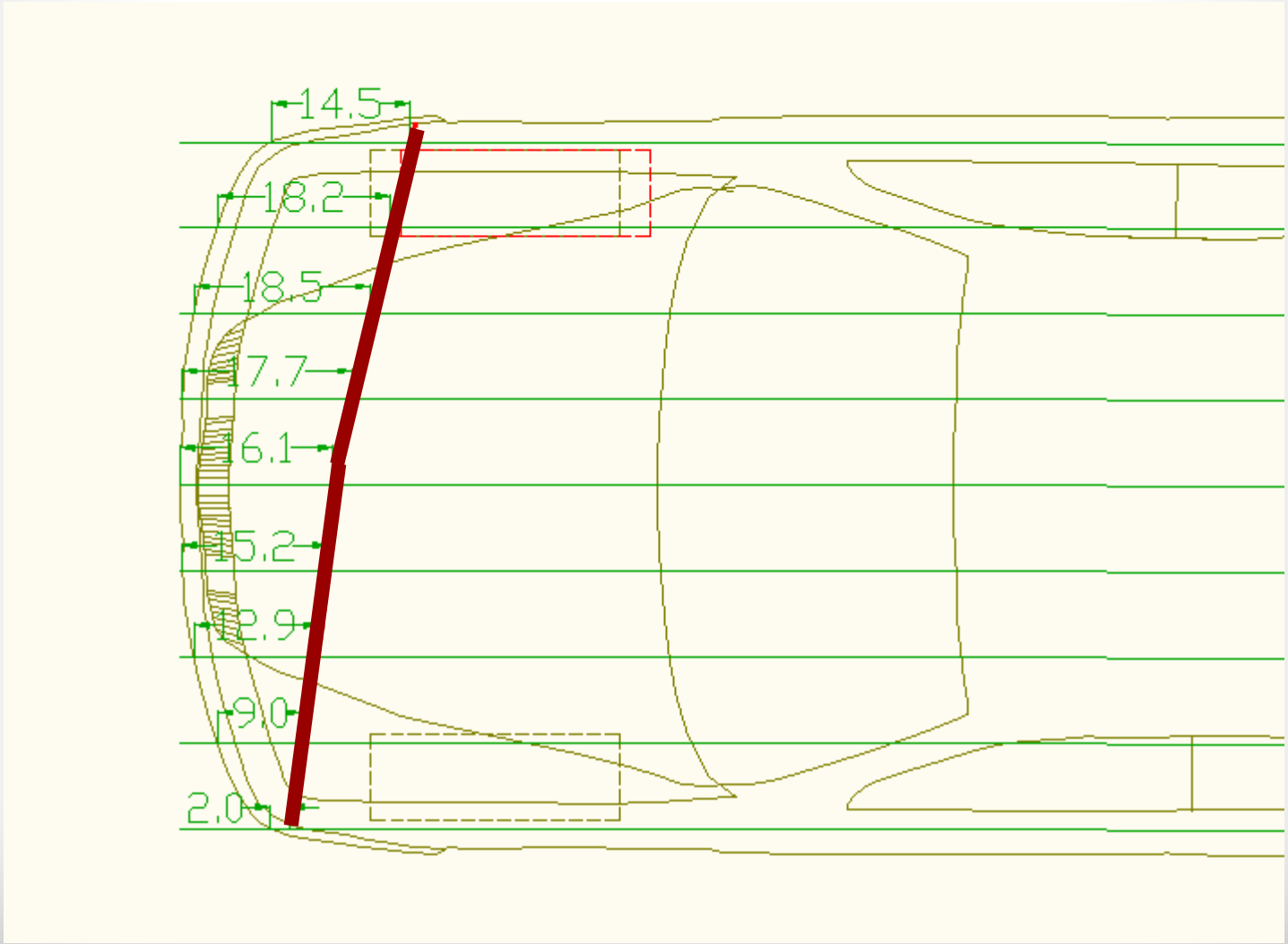
Accident Reconstruction

Step 3: Scene / Vehicle Layouts

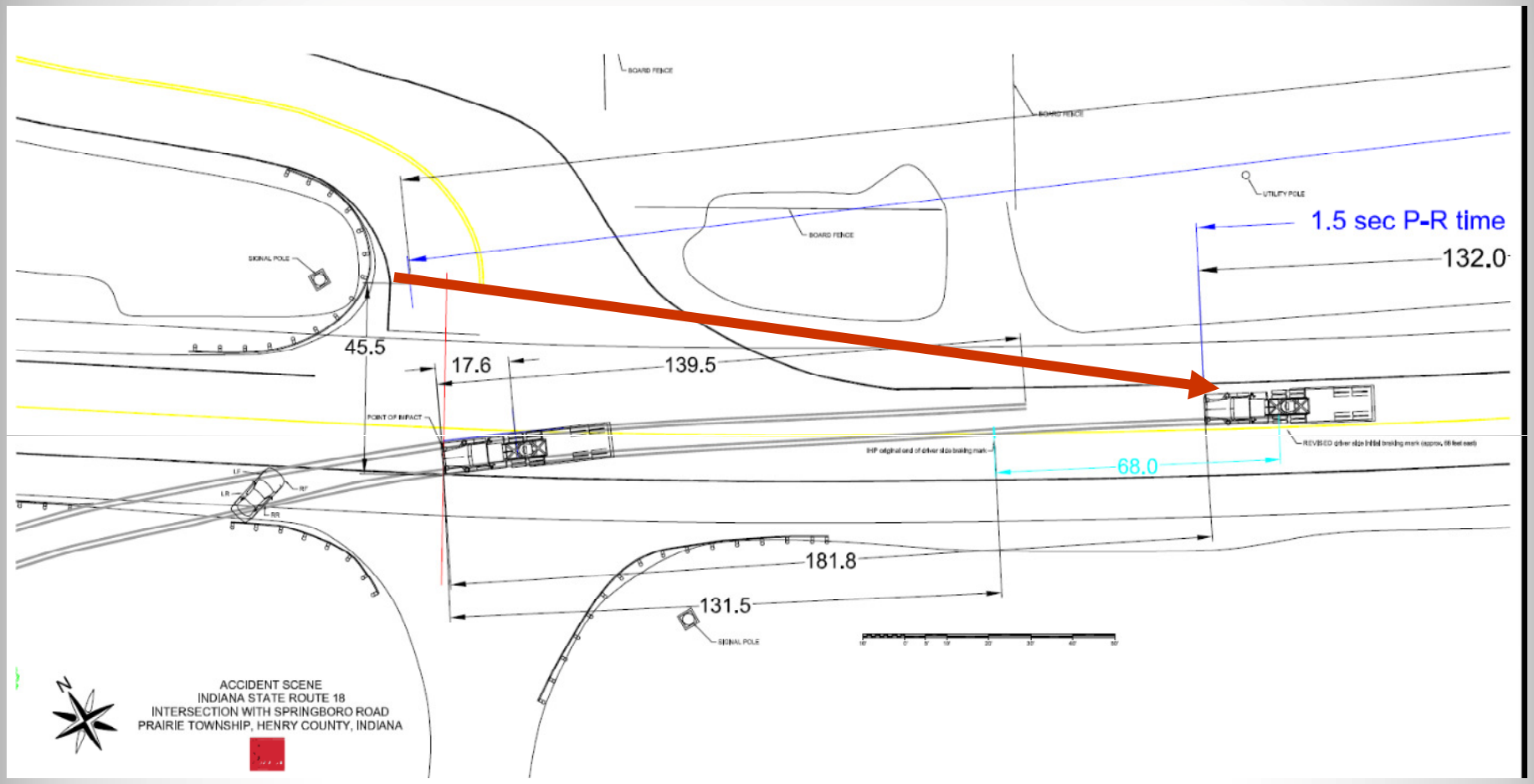
…digitally reproduce (draw) scene, vehicles
(including photogrammetry)

Vehicle Drawing

Characterize Crush



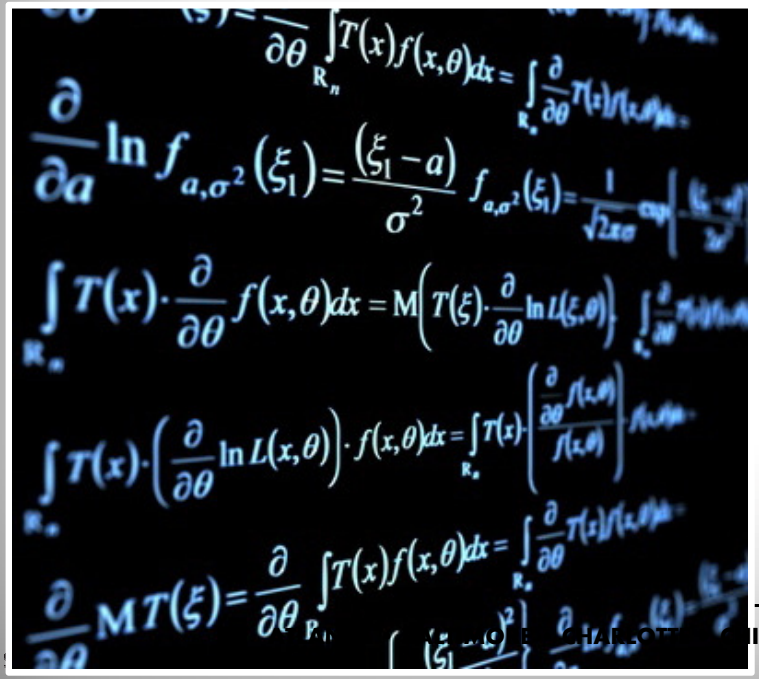
Scene Drawing



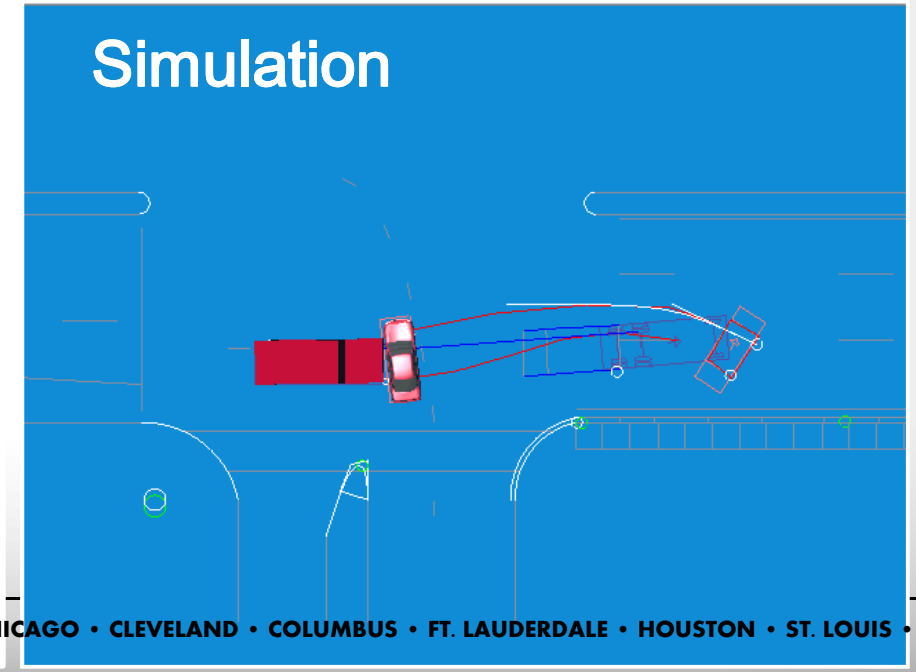
Analysis Options

Testing

Calculations



Simulation



Vehicle Mechanics / Dynamics

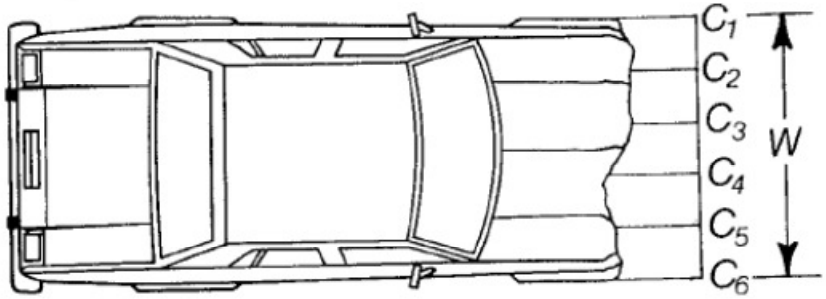
1. **Speed calculations**
   - Crush energy & force
   - Conservation of Momentum
   - Conservation of Energy
   - Force balance

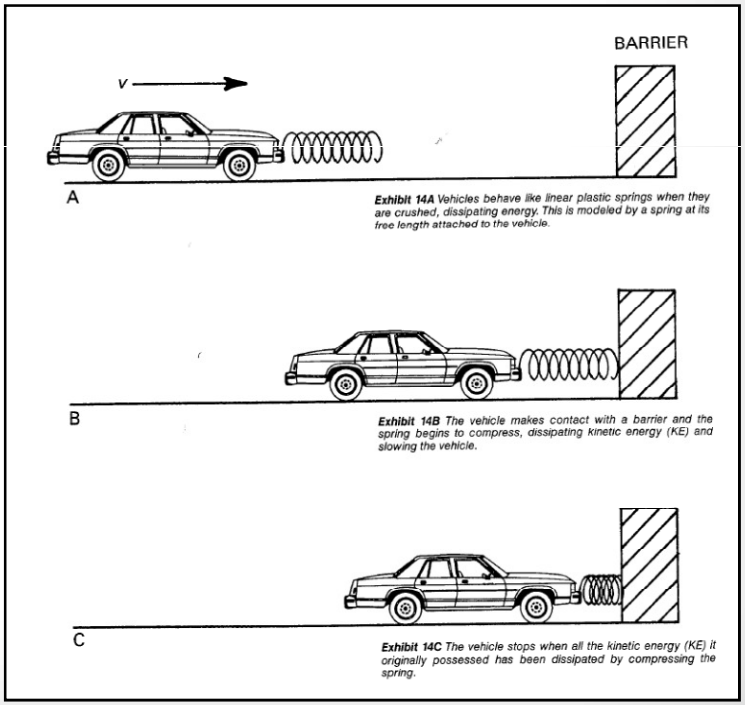
Vehicle Mechanics / Dynamics

Q: What is *crush* energy?

A: Kinetic Energy *converted* to Crushing the Vehicle…

$$E = (A^2/2B)W + (A + BC/2)WC \qquad (25)$$





Vehicle Mechanics / Dynamics

2. Time-Speed Distance Calculations

- Set bounds on the possible
- Evaluate perception/reaction times
- Is a scenario physically possible

Accident Reconstruction

Trucks are Different

The Truck is 20 TIMES Heavier than your SUV!

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Heavy Truck Accidents

- **Mass ratio** - can exceed 20:1
- **Stiffness**: Heavy trucks and trailers are primarily designed to haul weight – not absorb collision energy
- **Bumper heights**: Front bumpers, tractor frame, trailer deck and rear ICC bar are higher than passenger car bumpers. Results in engagement of comparatively weaker structures.

Effect of Mass and Stiffness Disparity

- Collision forces between vehicles are <u>equal</u> and <u>opposite</u>

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Effect of Mass and Stiffness Disparity

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When things get complicated:

SIMULATION and TESTING

"it is what it is…"

- Scientific proof
- Good court exhibits

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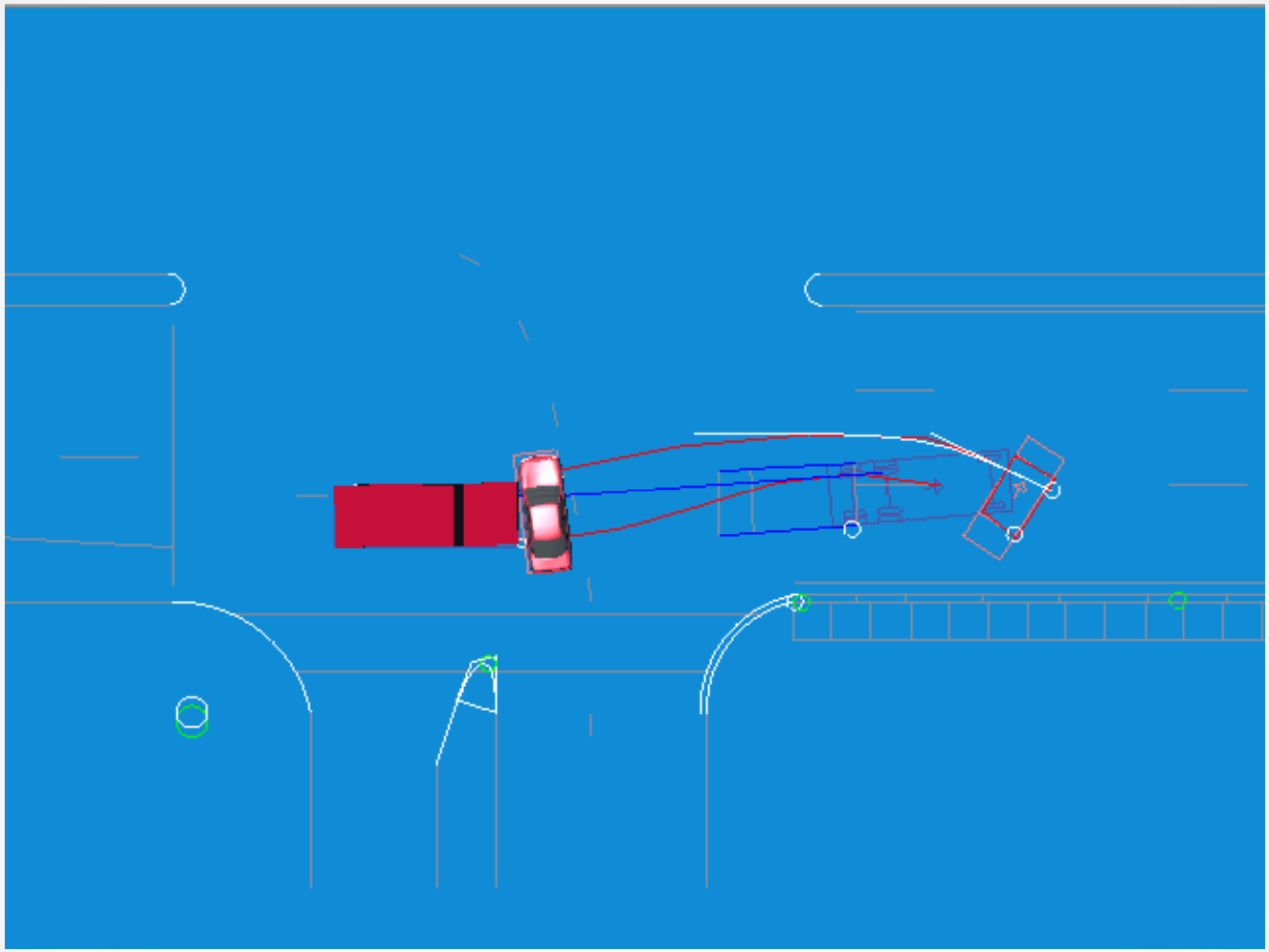
Simulation Analysis



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Testing

Case Example: Accurate Determination of Speeds

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Testing

Case Example: Accurate Determination of Speeds

Testing

Case Example: Accurate Determination of Speeds

Goal: Duplicate Damage on Subject Vehicle

Accident Vehicle

Test - Target Vehicle

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Testing and Simulation

Minor Impact Simulator

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Integrating Technology

3D Scanning, Animation and Video evidence

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Integrating Technology

3D Scanning

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Thank You for your time today!

Douglas R. Morr, P.E.