



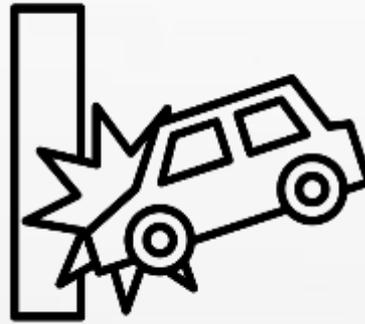
Module on Scientific Crash Investigation

Why Forensic Crash Investigation?

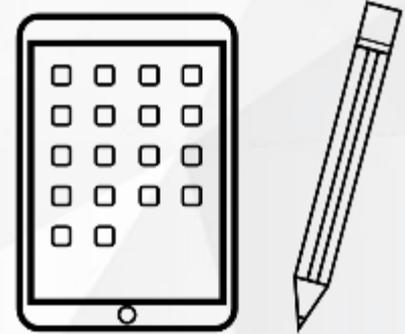
"To scientifically discover the causes and consequences of road crashes".



Gather and analyze evidences to understand the sequence of events that led to the crash



Identify any deficiencies in any vehicle and safety systems



Make recommendations to prevent similar crashes from occurring in the future

Forensic Crash Investigation



Scientific and evidence led method to determine the root causes, contributing factors, and sequence of events to reconstruct the crash and understand its mechanics.

Primary goal is to provide an unbiased and accurate account of the incident

- Site Investigation
- Vehicular Investigation
- Scientific evidence collection and interpretation
- Detailed interview with victims and officials

Crash Investigations & Haddon Matrix

Developed by Dr. William Haddon Patrol Vehicle. in 1970, the Haddon matrix looks at factors related to **Human**, **Vehicle** and **Infrastructure**; before, during and after a crash. By utilizing this framework, one can then think about evaluating the relative importance of different factors and design interventions.



The Haddon Matrix

PHASES		FACTORS		
		HUMAN	VEHICLE	INFRASTRUCTURE
PRE-CRASH	Crash Prevention	<ul style="list-style-type: none">• Information• Attitudes• Impairment• Police enforcement	<ul style="list-style-type: none">• Roadworthiness• Working lights• Good brakes• Handling• Speed control	<ul style="list-style-type: none">• Road design and layout• Speed limits• Pedestrian Facilities
CRASH	Injury prevention	<ul style="list-style-type: none">• Use of safety systems	<ul style="list-style-type: none">• Crashworthiness• Crash protective design• Occupant restraints• Other Safety devices	<ul style="list-style-type: none">• Crash protective roadside objects
POST-CRASH	Life sustenance	<ul style="list-style-type: none">• First-aid skill• Access to medics	<ul style="list-style-type: none">• Ease of access• Fire risk	<ul style="list-style-type: none">• Rescue facilities• Congestion

Contributing Factors for Crash - Human Factors

Driver/Rider Error-Reaction
Failed to look properly
Failed to judge other persons path or speed
Over steer/understeer
Sudden Steering without indication
Junction overshoot
Moving off at junction
Failed to signal or misleading signal
Other
Driver/Rider-Impairment and Distraction
Impaired by alcohol
Impaired by drugs, illicit or medicinal
Driver using mobile phone
Distraction inside vehicle
Distraction outside vehicle
Sleep/Fatigue/Drowsiness
Driver Inattention
Driver-Other

Pedestrian
Pedestrian inattention
Careless,reckless or in a hurry
Failed to judge vehicle's path or speed
Pedestrian dangerous behavior on roadway
Wrong use of pedestrian crossing facility
Pedestrian disobeyed traffic signal
Other
Pedestrian Impairment
Pedestrian - Alcohol
Impaired by drugs, illicit or medicinal
Pedestrian - Other
Speed
Sudden braking
Speeding - Exceeding speed limit
Speeding - Excessive speed for conditions
Speeding - Speed limit unknown
Driving too slow for conditions
Parked - vehicle on road (full or partial)
Parked - vehicle off the road
Stopped due to traffic
Other

Behaviour or Inexperience
Careless driving or in a hurry
Overtaking in undivided road
Illegal road usage (includes travelling in the wrong direction)
Violation of Right of Way
Following too closely
Overtaking on left side of vehicle
Improper lane change/lane usage
Disobeyed traffic signal
Inexperienced Driver
Vehicle slowed down/stopped suddenly without any traffic influence
Other

Contributing Factors for Crash - Vehicle Factors

Vehicle Defect
Defective - Tires
Defective - Brakes
Defective - Steering
Defective - Suspension
Defective lights or indicators
Defective or missing mirrors
Absence of Reflectors
Absence of wiper
Defective - Other
Vehicle Misuse
Overloading - goods
Cargo not secured properly
Overloading - people
Other
Vision Obstruction
Due to vehicle interiors
Other

Contributing Factors for Crash - Infrastructure Factors

Road surface/ road design
Slippery road surface
Deposits on road surface (oil, mud, fluids, etc.)
Poor/defective road surface
Poor road marking/signage
Poor street lighting
Poor object conspicuity
Inadequate warning about accident/parked vehicle
Defective traffic signals
Sharp Curvature
Bridge
Narrow Shoulder
No Shoulder
Uphill gradient
Very narrow road/lane width
Narrowing road
Others

Pedestrian Infrastructure
Crossing (Zebra crossing, pedestrian signal)
Walking alongside
Public Bus stop
Other
Vision Obstruction
Parked vehicles
Manmade objects
Trees/Plantation
Hill Crest
Road Curvature
Water splash from other vehicle
Other
Road Traffic Flow
Undivided
Gap-in-median
Intersection
Work zone
Animal/object on roadway
Other

Environmental factor
Rain/Fog
Other weather conditions

Contributing Factors for Injury - Human Factors

Crash	Safety System Use
	Seat belt not used
	Helmet not used
	Improper use of helmet
	Others
	Vehicle Misuse
	Occupants in cargo area
	Overloading of occupants
	Other

Post Crash	Life saving skills
	Improper accident/breakdown management
	Lack of first-aid skills
	Improper evacuation of occupants
	Other

Contributing Factors for Injury - Vehicle Factors

Crash	Crash protection
	Seatbelts not available/usable
	Passenger Compartment Intrusion - Underride/Override
	Passenger Compartment Intrusion - Other
	Non - enclosed occupant cabin
	Knock-down (for Pedestrians, M2W & M3W occupants)
	Run over (for pedestrians, M2W riders)
	Fall-down
	Cargo bed extruded
	Illegal alteration or fitment-Fuel kit,gaurds
	Others
	Vehicle cargo misuse
	Protruding/oversized cargo
	Unsecured Cargo
	Other

Post Crash	Vehicle
	Entrapment
	Fire
	Ejection
	Other

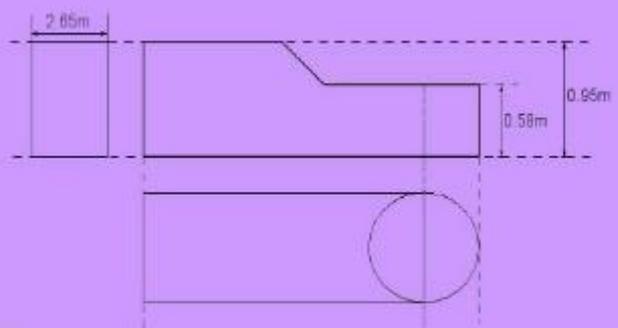
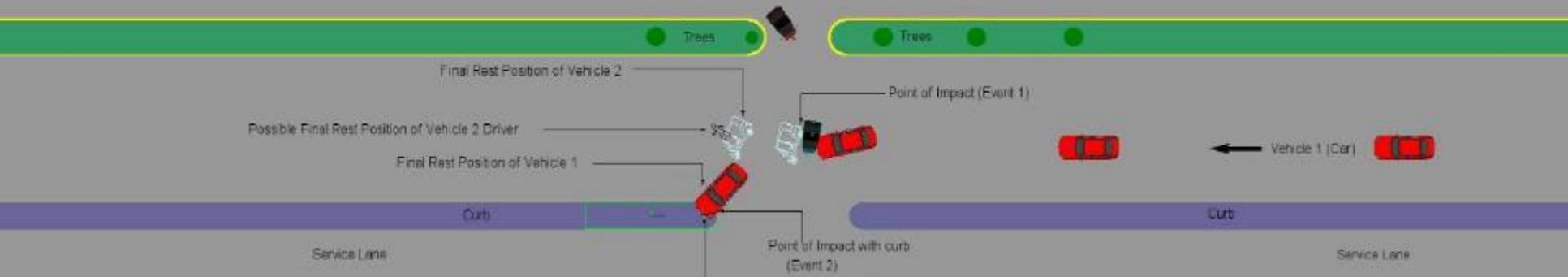
Contributing Factors for Injury - Infrastructure Factors

Crash	Road Furniture
	Object impact - roadside - trees/plantation
	Object impact - roadside - manmade structures
	Object impact - Other
	Roadside - Steep slope/Drop off
	Other

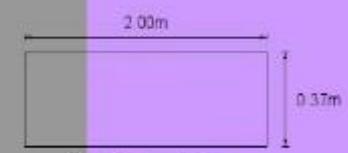
Post Crash	Medical response
	EMS unavailability
	Distance to hospital
	Other

Car Vs Auto Rickshaw Crash

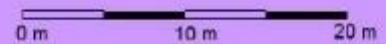
Vehicle 2 (E-Rickshaw) Vehicle 2 taking U-turn



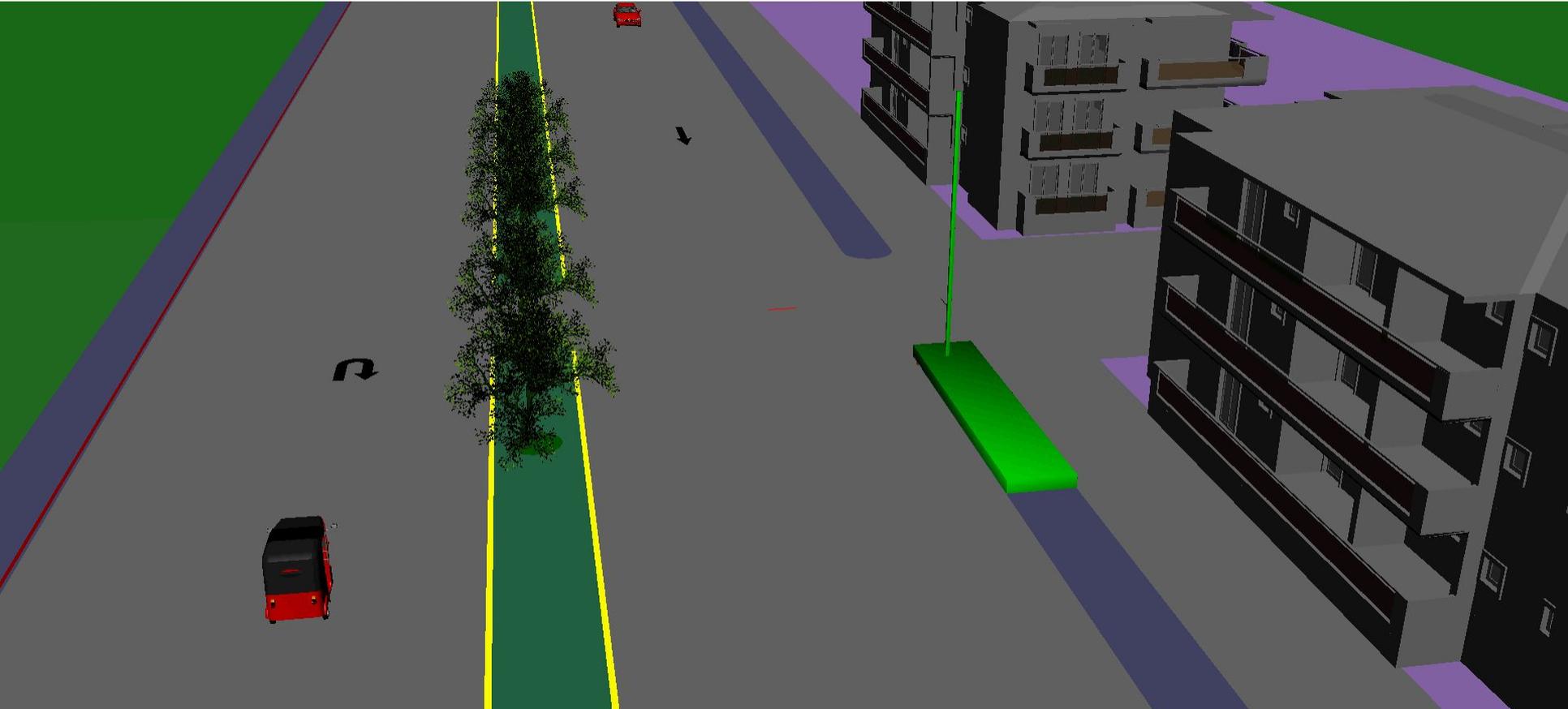
Cross-Section of Median Curb



Cross-Section of Curb



Car Vs Auto Rickshaw Crash



Car Vs Auto Rickshaw Crash



Car Vs Auto Rickshaw Crash

Phase	Human	Vehicle	Infrastructure
Pre-crash (Crash Prevention)	Speeding - Excessive speed for conditions (Vehicle 1)	Not Applicable	Poor Road Marking / Signage (Vehicle 1)
	Violation of Right of Way (Vehicle 1)		Defective Traffic Signal (Vehicle 1)
			Vision obstruction due to trees (Vehicle 1 & Vehicle 2)
			Road traffic flows through gap-in-median (Vehicle 1)
Crash (Injury Prevention During the crash sequence)	Not Applicable	Seatbelts not available (Vehicle 2)	Not Applicable
		Non-enclosed occupant cabin (Vehicle 2)	
Post-crash (Life Sustaining)	Not Applicable	Ejection (Vehicle 2)	Not Applicable

Car Vs Object and Rollover



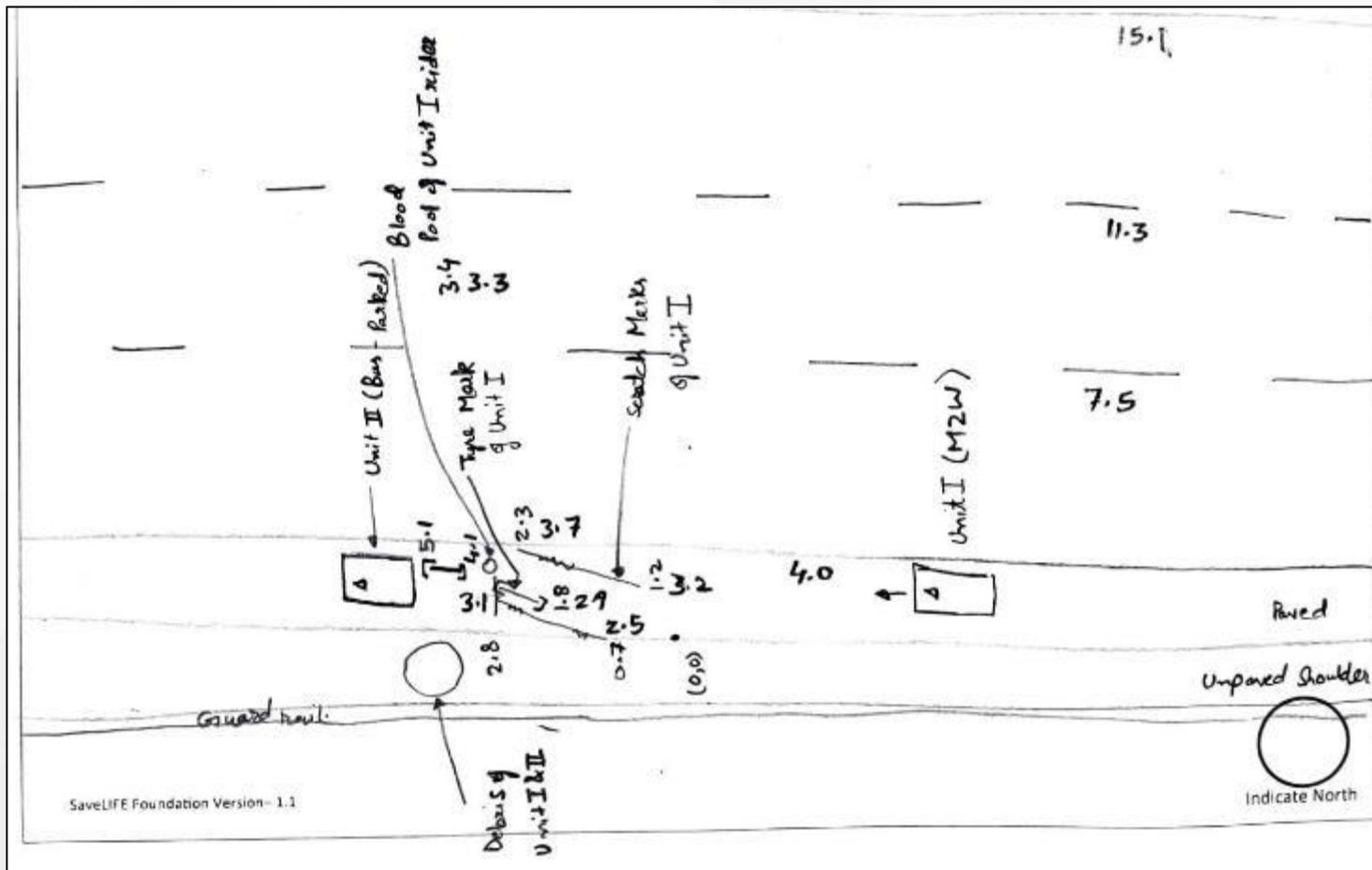
Car Vs Object and Rollover



Car Vs Object and Rollover

Phase	Human	Vehicle	Infrastructure
Pre-crash (Crash Prevention)	Speeding - Excessive speed for conditions	Not Determinable	Not Applicable
Crash (Injury Prevention during the crash sequence)	Not Applicable	Rollover	Object Impact with roadside furniture
Post-crash (Life Sustaining)	Not Applicable	Not Applicable	Not Applicable

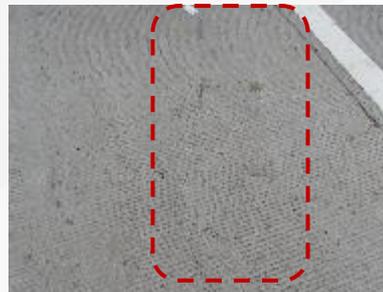
Motorcycle vs Bus Crash



Motorcycle vs Bus Crash



Motorcycle vs Bus Crash



Motorcycle vs Bus Crash

Phase	Human	Vehicle	Infrastructure
Pre-crash (Crash Prevention)	Overtaking on the left side of vehicle (Vehicle 1)	Not Applicable	Inadequate warning about the parked vehicle (Vehicle 2)
	Speeding - Exceeding speed limit (Vehicle 1)		
	Parked - vehicle on the road (Vehicle 2)		
Crash (Injury Prevention During the crash sequence)	Helmet not used (Vehicle 1)	Knockdown of M2W rider (Vehicle 2)	Not Applicable
Post-crash (Life Sustaining)	Not Applicable	Not Applicable	Not Applicable

Crash Scene Examination

Equipments for Crash Investigation



Safety jacket



Measuring tape



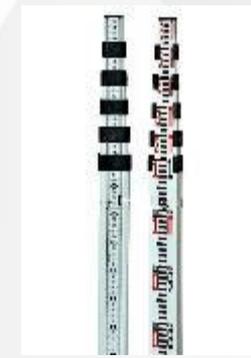
Rodometer



Camera



Pressure gauge



Measuring scale

Equipments for Crash Investigation



Safety cones



Reflective Baton



Spray paint



Inclinometer



Disposable gloves



Disposable mask

Objective Of Crash Scene Examination

The primary objective includes -

- Information of road geometry and surface condition
- Vehicle trajectories of involved vehicles by analyzing scene evidences
- Sequence of events leading to crash by analyzing scene evidences
- Point of impacts and resting positions of involved vehicles
- Gather witness or victim statements

In short, can gather crucial information and evidence necessary for understanding the crash dynamics, identifying contributing factors, and making informed conclusions about the causes of the crash.

Steps in Scene Examination

1. Secure the Crash scene

2. Identify the Physical Scene evidence

3. Mark the Physical scene evidence

4. Document the Scene - Photography and hand sketch

5. Interview the Witness

Secure Crash Scene & Ensure Personal Safety

1. Ensure personal safety by wearing reflective safety jacket
2. Take appropriate precaution to any potential hazards such as traffic, fire or any dangerous substance.
3. Cordon off traffic using barricades, cones or tape
4. Document scene condition by taking photos or videos before any evidences disturbed or moved.



Physical Scene Evidence

Some common types of scene evidence investigators can find:

1. Tyre or skid marks
2. Gouge marks
3. Scratch marks
4. Oil or Coolant pool
5. Blood pool
6. Debris/Broken vehicle components
7. Damaged objects



Physical Scene Evidence

Tyre or skid marks



Acceleration mark



Brake mark



ABS Brake mark



Yaw mark

Physical Scene Evidence



Acceleration mark

Physical Scene Evidence



Deceleration mark (Without ABS)



Deceleration mark (With ABS)

Physical Scene Evidence



Yaw mark

Physical Scene Evidence



Scratch mark



Gouge mark

Physical Scene Evidence



Physical Scene Evidence



Blood Pool

Marking of Scene Evidence



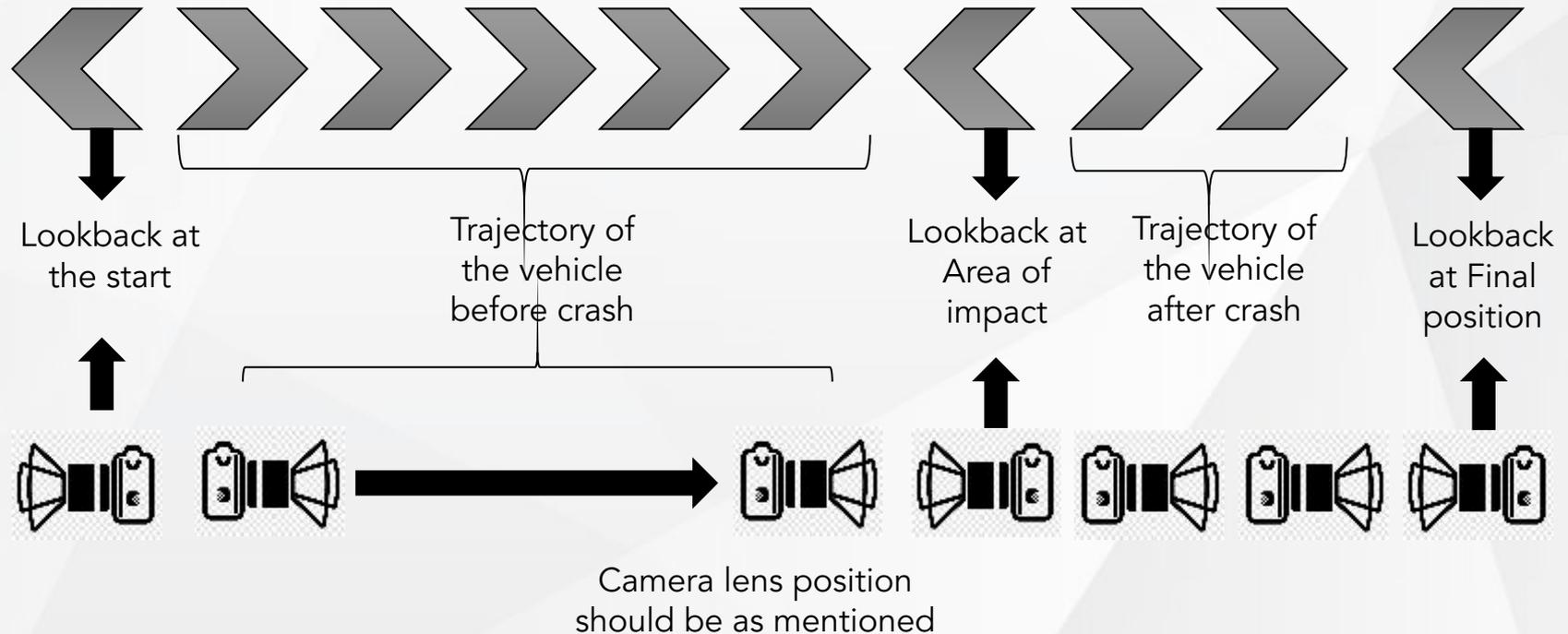
Scene Photography



Scene Photography

Vehicle trajectory photographs

To document the perspective of the driver both before and after the crash.



Scene Photography

4 - angle photograph

To document the scene evidences for analysis at later stage during correlation of scene evidences.



Vehicle Examination

Objective of Vehicle Examination

Vehicle examination helps to gather evidence and determine factors that contributed to the crash and Injury.

- Extent and nature of damage which helps in understanding angle of impact, direction of force, severity of collision and estimation of vehicle speed.
- Damage pattern which helps in determining point of impacts with vehicles or objects by identifying deformation on vehicle, paint transfers, or other physical evidence.
- Vehicle to vehicle interaction which helps to determine sequence of impacts when multiple vehicles are involved in collision.
- Mechanical failure of vehicle system such as brake system, steering system etc.
- Use of safety features such as seat belts, airbags, headrests, and other occupant protection systems.
- Identify contact points, areas of intrusion, and any other factors that may have caused or influenced specific injuries sustained by the occupants.
- To understand the post crash movement of occupants inside the vehicle.

Objective of Vehicle Examination

- Documentation of basic information of involved vehicles
- Exterior examination of involved vehicles
 - Deformation analysis
 - Measurements of deformation and vehicle dimensions
 - Tyre inspection
 - Door and Glazing inspection
 - Brake system inspection
- Interior examination of involved vehicles
 - Inspection of interior occupant contacts
 - Intrusion measurements
 - Inspection of seating system, steering system, and safety systems
- Interior and exterior photography of involved vehicles.



Documentation of Basic Vehicle Details

Following are the basic details which need to be collected.

- Vehicle make, model and model year
- Vehicle registration details
- Fuel type of vehicle
- Odometer and speedometer reading
- Availability of ABS and ESP system
- Cargo details
- Availability of front, side and rear underride protection device (For Heavy vehicles)

Steps in Vehicle Examination

Tyre health



Interior Examination of Vehicle

Passenger Contacts

The common types of contacts are hair, blood, body scuff mark, crack and dents on interior component of vehicles.



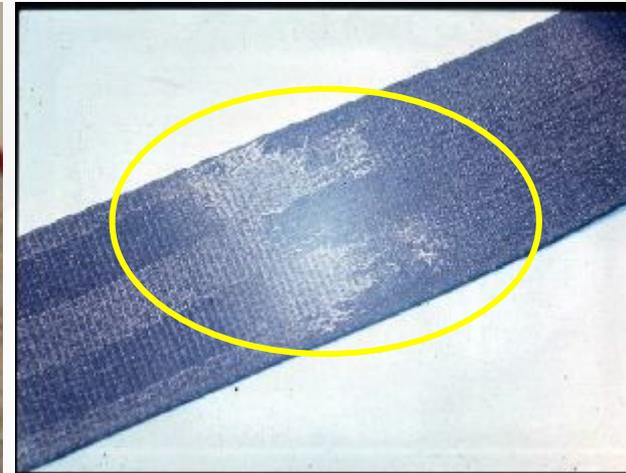
Interior Examination of Vehicle

Inspection of seating and safety system

It is important to understand the seating position and safety system available for occupant protection inside the vehicle for injury causation analysis.



Burn mark on buckle tongue



Scuff on seat belt webbing

Vehicle Photography - Exterior

Eight angle:

Picture at every 45 degree of a vehicle in a clockwise direction starting from the front end of the vehicle.



Vehicle Photography - Exterior

- Detailed photos of the evidences should be captured for scratch marks, paint transfers, damaged tyre of vehicles etc.



Paint
transfer

Damaged
tyre



Vehicle Photography - Interior

- In vehicle interior photography, photos from every door needs to be taken in sequence as shown in below image.



Vehicle Photography - Interior

Interior photography includes photos of :

- Occupant contact
- Intruded components
- Seatbelts
- Airbags
- Steering assembly
- Speedometer
- Seat and seat back

